

Charlie's Journey (& 4-D Sharing)

(A Full and Fortunate Life)

*My journey from Louisiana, through
Okinawa, to Drexel University, to NASA
Astrophysics, to the University of Colorado
and Teambuilding Worldwide*

*by Charlie Pellerin
with contributions from 4-D Providers*

Foreword

Although my formal name is "Dr. Charles James Pellerin, Jr." I prefer plain "Charlie" as it helps me connect more personally with others, particularly workshop participants, hence the title.

This began as an update to the notes in the workshop slides. I then decided to add a section of hopefully interesting material, previously unknown, about my life, beginning with my one-page bio. Early readers reported that they found this interesting and I continued to write. Also, "*How NASA Builds Teams*" was my China publisher's best seller and they asked me to write another book.

Gerald Huesch generously hosted my 75th birthday December 2019, in Berlin. 4-D providers came from China, Canada, Siberia, the Dominican Republic and, of course Germany and Europe. He set aside a day for all to talk about 4-D experiences that could add to the book I was writing. I have edited and included those.

I am now home in the Covid-18 lockdown and writing to pass the time. I hope that this is fun for you, my readers.

This reflection has created a set of revelations. Many people gave me kindness and respect because it was in their nature to do so, highlighting a goodness in humans, providing a needed uplift in this difficult time. I am grateful for all of you.

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Chapter 1: Charlie's Brief Bio

NASA - Goddard Space Flight Center

With a BS in physics from Drexel University (1967), Charlie patented "A Two-axis Fluxgate Magnetometer," published in *IEEE Transactions* and received Goddard's highest patent-related monetary award.



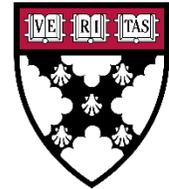
Catholic University of America

He then earned an MS and PhD in *Astrophysics* from Catholic University publishing in *Solar Physics* and the *Astrophysical Journal*. He received Catholic University's *Alumni Award for Outstanding Achievement in Science*.



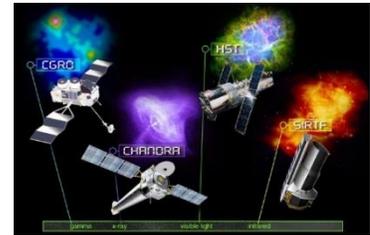
Moving to NASA Headquarters

Charlie worked as a "staff scientist, then Deputy Director, Spacelab Flight Division, and earned an "Executive MBA" at the Harvard Business School's *Program for Management Development*.



The Great Observatories

In 1983, Charlie NASA named him Director, Astrophysics. He led this multi-billion-dollar program for a decade, building and launching 12 satellites. NASA awarded him the *Creative Management Award* for motivating and inspiring, then an *Outstanding Leadership Medal* for excellence. Charlie invented the *Great Observatories Program* garnering over \$20 Billion for space astrophysics. NASA then awarded him the *Distinguished Service Medal*, "when the contribution is so extraordinary that other forms of recognition would be inadequate" for leadership of the *Astrophysics Program*. The *American Astronautical Society* gave Charlie their highest award, the *Space Flight Award* for the *Great Observatories*.



Hubble's Space Repair and Distinguished Service Medal

In 1990, Charlie's team sent *Hubble Space Telescope* into space with a flawed mirror. He then mounted the space repair mission that fixed the telescope. For this NASA awarded him a 2nd *Outstanding Leadership Medal* "for creatively finding the resources and inspiring the team to repair the telescope." Less than 50 people in the history of NASA had this honor of two of these medals. Charlie received a "Presidential Rank" award from Ronald Regan and from Bill Clinton for "sustained superior accomplishment." All of the Medal nominations were made by people who worked for me without my knowledge!



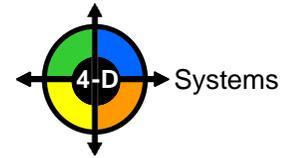
University of Colorado

In 1993, Charlie joined the *University of Colorado's Business School* as a professor of Leadership. He created and delivered a course called "*21st Century Leadership*" to undergraduates, MBAs, and executives. His classes had the highest ratings in the college, *consistently "A+."*



4-D Systems

In 1995, Charlie founded "4-D Systems" with sales of about \$50 Million over a decade. His team won the International Coach Federation's 2007 *Prism Award for "enhanced excellence and business achievement..."*



Wiley Publishes How NASA Builds Teams (2009)

His book continues to sell well in English and eight other languages. His current passion is supporting human-developers worldwide in using his "4-D processes" to manage "Social Context" fields enhancing lives and work.



China Honors Him

Over the past decade, Charlie provided ~60 workshops in China. We believe that 100,000 have participated in 4-D workshops. *China Aerospace* made Charlie an "*Honorary Professor,*" and *Asia America Multi-Tech Association of China* made Charlie a "*Professor,*" the 1st foreigner and 9th person ever to receive this honor.



Movie About Hubble and His Life

Finally, David Frigerio (photo), a LA-based screenwriter wrote a movie about Charlie, engaged a producer and they are marketing to networks.



A Fulfilling Life

Charlie lives a fulfilling life with his wife, Junko, in Colorado.

Chapter 2: Family, Germany, and Okinawa

Family Background

My family on my father's side went from France to Nova Scotia likely in the early 1700's. I know this from visiting there and the fact that my last name has two "ls" which is unique to Nova Scotia and there are lots of "Pellerins" there. Moreover, the staff at "Grand Pre" (photo) were sure that my family was documented in their records. They were expelled back to France by the British in about 1750, then left again for Louisiana as it was a French territory until 1803 when Napoleon sold it to the US for \$18 per square mile.



My Father

My father, same name as mine, as I am "Jr.," was born in Lafayette, LA and his father was one of 22 children from two wives (French Catholicism!). The photo is of a nearby "bayou," great for fishing for "Sac-a-lait," (sack-of-milk) a delicious and plentiful white perch. (My father had one sister, Audrey in Lafayette, and brother, Harvey in St. Paul, MN, both much older than he. I was very fond of both of them. His family spoke French more often than English at home.



My Mother

My mother, Joy, was born in Shreveport, LA and she had one older sister, Mary who she did not seem to like very much. She had a son, Stewart, who committed suicide in his early 30's. Joy's father was from Germany, and her mother from Ireland.



Some Background

My parents met at the University of South Louisiana ("USL") in Lafayette (photo). When the Japanese attacked Pearl Harbor in 1941, all the men in the University immediately volunteered for military service. Apparently, some family member of ours had one of the first airplanes in LA and my father had some flight experience. So, he joined the Air Force as pilot. I recently saw in an old newspaper article that he was called the "international pilot," and was awarded "Air Wings" by China, Mexico, and France. He was in France during much of WWII because he was from Louisiana from a family that spoke French. Despite never finishing college, he became an officer somewhere along the way, I suspect for bravery in action. My mother stayed



at USL, earning a master's degree in a Social Work. She worked as a social worker much of her life.

Early Childhood

I was born December 11, 1944 at Barksdale Air Force Base in Shreveport, Louisiana. As a military officer's dependents, on-base medical care was free (and good). My mother's parents lived in Shreveport, and I spend much of my early childhood with them. I am not sure if my father was present at my birth as he was overseas a lot, and I have seen photos of him holding me as a baby.



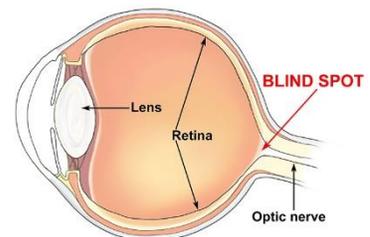
My Disability

It soon became apparent that I was cross-eyed, that my eyes did not track together, a condition called Strabismus giving me double-vision (stock photo, not me). My brain solved this by permanently disconnecting most of the function in my left eye, a condition known as amblyopia. I had corrective surgery when I was about one year old and again when I was about 12. This helped my eyes track together but did not resolve the amblyopia.



Wearing a "Patch" Over my "Good Eye"

The worst part of this condition was I had to wear a "patch" on my good eye during the summer, limiting my vision and unpleasant with sweat. The idea was that this would strengthen the weak eye providing an insurance policy against something affecting my "good eye." I do not think it did any good, and my vision with that eye is still about 20/200, legally blind. It is not a problem of focus. We all have a blind spot at the "optic disk" within the retina.



There are no photoreceptors there and most do not notice this as the brain fills it in. I suspect my "lazy eye" comes from my brain blocking most of my left eye. I have seen photos of myself from that time and I did not look happy!

Life in Germany

When I was 2 years old, we moved to Germany, living in Bamberg, then Heidelberg. My father later flew C-47 airplanes (photo) ferrying supplies during the Berlin Airlift which spanned June 1948 to September 1949. (Little did I suspect that I would fly in a similar plane as a research scientist tracking my experiment across Canada.) My mother joked for many years that only my German maids understood me, as I was with them all day and we



conversed in German. Apparently, I refused to speak English! The German language sounds pleasing to this day. I have seen photos of me playing in the snow, as this was so unusual for my parents living in the southern US.

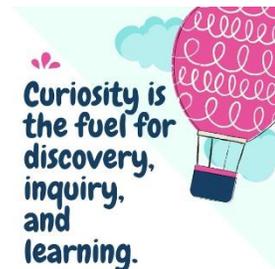
Back to the US & a Polio Epidemic

We returned to the US and lived in Southern Pines, GA then Fayetteville, NC. In 1948, the US had a polio epidemic, and I was about 4 years old. My parents were concerned for me, so they sent me to live with my maternal grandparents in Shreveport, at 920 Elmwood Avenue, which they believed was safer (photo is the house, today). I was fine with this as both grandparents were good to me, as you might expect. My parents (and baby brother, Mark) stayed in Fort Bragg, North Carolina. (There is not much about Mark in this document as he seems to prefer not to be in things about me, e.g., my Movie.)



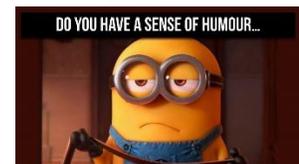
Life with my Maternal Grandfather

My grandfather worked his way up to CEO of an oil-well supplies company. He was now retired and spent a lot of time with me. During this time, and after, he challenged me with science questions, like "How does the body make heat?" When there was a health concern, we looked it up together in the Physician's Desk Reference ("PDR"). He ignited an innate curiosity in me that has served me well to this day. He even taught me how to change an auto tire when I was very young.



His Sense of Humor

My grandfather was certainly eccentric. His first name was Mark (very German) and middle name was Gilmer and he preferred to be called "MG." He had an affable younger brother, "Uncle Benny," who worked at his company. He loved to tell, "People ask, 'What does Ben do at your company?' The answer, 'I never knew.'"



Photography

He loved photography with a suite of Leica range-finder cameras (I still have one in my office) and Bolex 8 mm. He was the photographer for the coroner (ugh!). I inherited his love for taking pictures and had an (B & W) enlarger in our laundry room when I was in my 20's mounting the photos on "ceiling tiles" (cheaper than frames) which I trimmed with my "radial arm saw." Mostly, I took photos of Julie. I had to quit enlarging when the Vietnam war drove the price of silver up.



Guns

He also loved guns and they were laying around the house. A large-caliber chrome-plated revolver was my favorite. One day my grandmother noticed me heading out the door with the gun in my hand. She said, "Charlie, where are you going?" I responded, "I am going to shoot Bubba." Needless to say, that ended quickly.



Police Station

He did not want me to be afraid of police, so we frequented the police station. He showed me photos of severed limbs from people riding with their arms outside the windows (turn signals?). Although I see people riding with their arms hanging outside the car, I never have. Lessons learned early stick! My grandparents also loved travelling to Guatemala. While I surely enjoyed the photos, I never understood the attraction.



Savannah, GA

We moved to Albany, GA then to Possum Island, GA for three years from about my 5 to 8 years old. I remember this house well. It was a large, one story rambler set in old trees with hanging moss. I believe I went barefoot in the summer. One day, I was poking a Coral snake with a stick, freaking my mother out. My father would take me fishing in an aluminum boat with a smoky old Evinrude engine. Outboard engine exhaust still smells good to me. He was in the Strategic Air Command ("SAC") with his flight gear in the trunk of the car. He would receive a phone call and walk out the door unable to tell us where he was going or when he would be back. When he returned, he usually surprised us with a treat. On one occasion he had a pile of fresh, living lobsters that he dumped into a bathtub.



My Father Goes to Okinawa

Then, my father was sent to Okinawa to pilot B-29 bombers during the Korean war. These were dangerous, 24-hour missions and the planes were attacked from the ground. The anti-aircraft guns were on the Chinese side of the river between the two countries and he was not permitted to bomb them. On one occasion, he changed places with another pilot at the last minute and the replacement pilot was shot and died during the flight.



To Lafayette

When he left, my mother, brother (Mark) and I moved to an apartment in Lafayette at 510 Oaklawn Avenue (photo is that address today). My father assumed that his family would take care of us – they did not. I recall being generally miserable, and suffering in the summer heat, as air-conditioning was not common. In fact, it was so hot that we picked asphalt from the street, formed it into balls and threw it at each other. I was sent to Catholic school, became an “altar boy” and was terrified about going to hell. I also imagined dead relatives surveilling me. Catholic school was not a pleasant experience in deeply religious French LA. We then went back to Shreveport to prepare to travel.



To Okinawa, Japan

The Korean war ended in July 1953, and my father arranged for us to come to Okinawa and live with him in September. Okinawa is part of Japan in the “Ryukyu Islands,” about 1,000 miles (1,500 km) from Tokyo. My mother, Mark and I made a month-long car trip from Lafayette to San Francisco. We joined a “convoy” of other air force wives for the long trip. Along the way, my mother had a falling-out with them, and we were on our own. I recall that I was paying the bills for lunch and I was 8 years old! We then boarded a troop-carrier ship and began the 6,000-mile (10,000 km) two-week long trip. This was not a luxury liner like a modern cruise ship. I remember everyone being sea-sick with vomit everywhere. Our ship stopped in Tokyo, my father joined us, and we went on to Okinawa.



Life at Kadena AFB

We lived in a small cinder-block house in 1817 Stearly Heights on Kadena Air Force base built by the military (photo is a similar house). The roof was ceramic tiles, and a typhoon took most of them off more than once. I recall feeling lost and lonesome as my parents went out at night to the Officer’s club to eat steaks and drink scotch, leaving Mark and me home with our live-in Okinawan maid. Life on the military base was, however, in many ways idyllic. There was no crime, and no bullying. Parents were responsible for their children’s behavior and if problematic, the family was sent stateside! I rode my bicycle



around the base going to the swimming pool, movie theatre and Base Exchange ("BX"). I was fortunate to have a December birthday as that was the only time of the year that the BX had toys (for Christmas). There was pampas grass behind our house that was so high that we crawled through making tunnels that could not be seen from outside. There was a hill behind our house with ancient tombs that we explored. We also came across unexploded ordnance from time to time. Roaming around outside was high adventure.



Boy Scouts and Baseball

I became a Boy-scout (No, nobody molested me) and was urged to play little-league baseball. Of course, without depth perception, I was no good. I was assigned to the outfield, and someone would hit balls high in the air. Baseballs would hit me in the face. I was ashamed as my father was now a Major, commanding a flight squadron, and I worried that my inability might reflect on him.



Okuma Officer's Rest Center

The highlight of each year was a vacation at an Officer's rest camp called Okuma on the north end of the island (photo is real). It was 45 miles away and the trip took most of a day. Okinawa was shelled by 4,000 US ships for months before the invasion. The roads were terrible, and the island had an overall speed limit of 25 mph. We rode horses, swam, paddled kayaks in the ocean, and shot arrows. We loved the place.



Kubasaki School

For school, I took a bus to Kubasaki-high. The school was in Quonset huts, semi-circular prefabricated corrugated steel buildings. The schools and teachers, as I recall, were good. (I still recall the "school song/cheer.") I suspect that my sight visibility may have helped me do well in academics as it had no effect on my ability to read and write.



Military "Single-Payer" Medical Care

In those days, the military took good care of dependents overseas (and, in the US as well). Healthcare was "single-payer" with the doctors with officer rank on salaries, which worked well. Basically, doctors received financial aid during med school in return for service later. The extreme political resistance to this form of medicine remains a puzzle to me.



An Unappreciated Life

Life was good, although we did not appreciate it at the time (stock photo from that time). When I was 12 years old (and younger?), I drove our car (with my father in the passenger seat) on deserted military airfields. We had a live-in maid, a day-maid, a houseboy (sometimes) and an elderly gardener who also washed the car. I expressed concern to my parents that we paid them so little. I felt badly for these agrarian people who suffered so much in a war that I suspect they cared little about. Their response was, "They are happy to have it."



Television

We had no TV for the first years. Then, a single USAF station came in black and white. The programs were several years old – it was fun to see ads for our old car as a new car. I particularly liked the "Winky-dink" show. Each week, I put a piece of saran wrap on the screen and copied parts of a coded message on the screen. The idea was to fill in more of the puzzle each week.



Unfortunately, the station did not put the shows in the proper sequence, so this did not work.

I Returned to Okinawa in 1998

Fast-forward about 40 years! On the same trip that I took to Japan to look for Junko, my Harvard friend, Yuji Akita, and I went to Okinawa. I was shocked at how much the place had developed. When I lived there shops lined the road behind messy (sewage) trenches and the roads were terrible with an island-wide speed limit of 25 mph. Now there are superhighways and luxury hotels. All the signage was in *Nihongo* (Japanese) so fortunately Yuji drove our rental car.



We had no difficulty driving into Kadena AFB and finding our old house in 1817 Stearly Heights. The neighborhood looked the same. We went to Okuma in 90 minutes, a trip that used to take all day! The place looked about as I remembered. Another surprise was how isolated Kadena AFB felt from the rest of Okinawa, vastly different from my childhood memory.

Back to the US

We yearned to be stateside during our entire nearly 5-years on Okinawa. There were no trips back except when my father went to his father's funeral in Lafayette. We finally returned to the US the summer before my 8th grade and immediately regretted it. This time we flew in a Lockheed Constellation "Connie" troop carrier with four piston engines. Commercial jet aircraft were not yet common. When we



arrived, it was late night in California, but morning Okinawa time. We went into a restaurant and my father ordered bacon and eggs. We were shocked when the kitchen door flew open and a large man appeared, saying "Who's the son-of-a-bitch that ordered breakfast?" This would never have happened in Okinawa, Japan. Unfortunately, we needed to return to the US to appreciate how wonderful life on Okinawa was.

Driving to Annapolis

Our old Chevy "woody wagon" left Okinawa before us and was waiting for us when we arrived in California (El Segundo?). We were all shocked at the speed and traffic on California freeways. (I still am.) We then took a month to drive across the US to Annapolis, Maryland. There were no interstate highways at that time. (Route 66?) I remember the trip as generally enjoyable as we stopped for sightseeing, e.g., Disneyland, the Arizona meteor crater, the petrified forest, and the painted desert. When we crossed the desert, we had a rented, window-hung evaporative cooler, as automobile air conditioning was not common. And the highlight of each day was a (cheap) motel with a swimming pool.



Chapter 3: Waterfront, Annapolis High & Randolph Macon Academy

Life on the Waterfront

We finally arrived in Annapolis. My father rented a pleasant cape-cod style house on the waterfront with a wonderful view of Church Creek. The view from our house was the frontispiece in a popular cruising book. We had a small dock, and I wanted a boat. My father bought a wooden rowboat with a single cylinder inboard engine. I named it "Sea Jay," in honor of my father since he had bought it for me. The engine had a huge flywheel that I wrapped a rope around and pulled up as hard as I could to start the engine. There was no clutch or transmission so once the engine started, the boat began moving. I had to leap back to the tiller and steer. I suspect that top speed was about 5 mph. I loved that boat as it gave me the freedom to go as I wanted. I had a friend, John Joplin, on the next creek over, Crab Creek, who I liked to visit. His home had a boathouse, which was great for fishing and his older brother had a really cool Fiat Spyder. I recall my grandfather praised me to my father when he saw me go to the boat in the winter, break the ice out of the bottom, and throw it overboard. There were lots of ducks in the creek in the winter and I tried shooting them with a pellet rifle, which of course was nonsense.



Dirt Road

We had a pair of Weimaraner dogs that would steal chickens from a nearby farm and come home with buckshot. Our house was on Bywater Road, a dirt road with a walk of about a mile and a half to catch the school bus at Forest Drive. I had a crush on an older pretty girl who took the same bus, my first experience with romance. Of course, I never let on about this, and she paid no attention to me.



Zeinna

The (wealthy) neighbors next door had an attractive and a bit older daughter, Zeinna Schufelt, with an ornery horse called "Hurry-up." (stock photo) The horse would look for opportunities to kick me with his back legs. I had to keep an eye on him. She and I would ride bareback with me in the back holding on to her! This was great fun.



A Difficult Transition Back to the US

The transition from Okinawa was difficult for all. My mother and father were miserable, getting drunk at night and yelling at each other. I enrolled in Annapolis Junior High (actual photo) a month or so after school started. I apparently did well on exams and was put in an "A" section ("8A6"), for students bound for college. I remember that they distributed, comic books where we colored the ever-expanding "red" threat of communism in the world. We also practiced hiding under our desks in case we were attacked with nuclear weapons. (Can you believe this?)



Life Was Generally Miserable

Public schools were being desegregated by Federal law and there was a lot of tension. As a "new" person (both slow to mature and young for my grade), I was a target for bullies. Once, on the way to the bus, I was stabbed with a (small) knife. (Elon Musk was also bullied and much worse.) So, life was miserable at school and home. I coped by assembling electronic "Heath kits" (amplifiers and tuners). In those days there were no circuit boards or transistors. The "kits" provided an aluminum "chassis" with holes and a bag of potentiometers, resistors, capacitors, etc. A manual provided step-by-step instructions. When I finished, my father would "touch-up" my soldering before the dramatic "power-on." When I finished, I would sell the completed units for more than the kits cost, then buy the next model up. I remember the excitement when a transistor amplifier became available! And of course, escaping in my boat.



My Grandfather Visits

My grandfather visited and saw the craziness in the house. He was quite fond of me (even though my brother, Mark was his namesake) and offered to pay for me to go to a private school. My father recommended Randolph-Macon Academy ("RMA"), a military school which was OK with me (actual photo). The reputation was that there was more emphasis on academics than military matters.



My Boat is Drydocked

I spent most days crabbing, fishing or just riding around in my beloved boat. However, there was no one to take care of it in the winter. So, when I prepared to leave for RMA in the fall, we rented a trailer and put it on sawhorses. The bottom was just planking so when I arrived home for the summer there were



gaps. I got the idea to fiberglass the bottom and had seen some resin and cloth in a mail-order catalogue. (Photo is "chrome" fiberglass cloth like we used.) We ordered it, rented a belt sander, and began preparation. When we got to the shaft and strut, it seemed easier to remove them, so we did. We fiberglassed the bottom and about 2 inches up the side. Of course, this made a heavy boat even heavier.

An "Aquaplane"

We took the one-cylinder engine out and replaced it with an outboard. I think 25 hp. The boat tipped up, ploughing through the water at about 20 mph, creating an enormous wake. This was way too slow for skiing, and I thought fast enough for a large piece of plywood. So, we went to a lumberyard and bought a piece of marine plywood. I cut holes for the ropes and painted the plywood brown. When I wanted to use it, father would drive the boat and I would lay in the water keeping it



pointed upward. (stock photo) As speed picked up, I pulled on the front ropes and put my knees on the back. Then I stood up, going side to side crossing the wake. Finally, something I could enjoy with limited visibility. Great fun!

Life in Military School

I went to RMA in 9th grade and I liked it. Life was simple. They told us what to do, when to do it, and even what to wear, i.e., the "uniform of the day." (stock photo) Everything was managed with different bugle calls which I quickly earned to interpret. The morning started a little after 6 AM with "first call," then, 10 minutes later with a second (different) bugle then "reveille," which meant immediately out of bed.



At a specific time, perhaps 7:15, a bugle call would signal room inspection, which we would stand "at-ease" for. This was a casual inspection, checking whether beds were properly made, i.e., with "hospital corners," etc. Then we assembled on the main floor in our military configuration (squads and companies), cadet officers checked the roll, shouting, "all present or accounted for," and we marched into the "mess hall" to assigned seats and tables. We ate "family style," with faculty members and their families. Proper manners were strictly (but politely) enforced. I remember that the meatloaf looked like a giant elephant "poop." (FYI, no girls when I was there.)

No Free Time

We had about 20 minutes after breakfast before our first class. (stock photo) Yes, "free time" was rare. Bells would ring, and we would go to class, then the next class, and so on until noon. Then we assembled in formation again, roll was taken, and then marched into the area with tables for "mess-2" (lunch). I believe there was one more class after lunch, then we went to (mandatory) sports. With only one working eye, I had no depth perception, so I was awful at most sports. The only things I did well (except academics) were swimming and a competitive drill team that marched in parades in various cities competing against other schools.



A Regimented Life

For Mess-3" (dinner), we organized into formation again, and when the weather was good, marched around the building with the band playing for an "eyes-right" competition for the straightest lines across each company, judged by faculty officers. (stock photo) At the end of dinner, an announcement ranked the three companies for the night, and where each stood in the year so far. Study-hall was from 8 PM to 10 PM. Unless you were on the "honor roll," you had to sit in an assigned seat in a large room and had to "keep a pencil moving." I was on the honor roll my entire time, so I studied in my room, and could read books in the second hour.



Day's End

"Taps" closed the day at 10:30. Again, someone went down the hall with a flashlight checking that we were all in bed. We were not allowed to get up and go to the bathroom for an hour after.



The Routine

We had "town leave" on Monday and Friday nights. The highlight was the "Royal Dairy" for a milk shake. There was also a small movie theater downtown. and had free time on Sundays, although we had to write a letter home each week. To minimize "homesickness," we and our parents were discouraged from having phone-calls for the first several months. In the spring, we would wear dress-whites with "Sam Browns" and polished breast plates providing a parade for spectators, e.g., visiting families, and locals.



Christmas Spectacular

The gymnasium had a large stage and each Christmas the band and chorus put on a spectacular performance. People from the local area and most parents



came as they were taking cadets home the following day. I took on the job of managing the audio-visuals for the event from a small control room in the upper back of the building. I don't remember asking anybody, I just did it. I actually enjoyed doing this.

Demerits

We received "demerits" for shortfalls, e.g., failing inspections, which were constant with a heavy-duty one on Saturday.

(stock photo) Cadet officers could issue demerits, subject to confirmation by a brief meeting with the Commandant, a faculty member. Minor infractions would give 3 demerits, and these would vanish after a week. If one never exceeded 7 nothing happened, and I learned to do this reliably, as the price was marching "tours" instead of town leave. I was never recognized as anyone special. (My brother, nearly 4 years younger, followed me to RMA and became a cadet officer.) I basically "kept a low profile."



My Family Purchased a Lot and Built a House

While I was away at school, my parents bought a waterfront lot and built a house in "Annapolis Roads." ("Roads" is a nautical term for a place where boats anchor waiting to go into port, likely coming from the name of the line attached to an anchor, called a "rode.") I took a room in the basement, isolating myself from much of the family stuff. My father inherited some money from his father's estate and bought a 16 foot "Winner" speedboat, a 25 foot "Owens" (plywood) cruiser (photo) and an MG-A sports car, the latter to my mother's dismay.



The MG

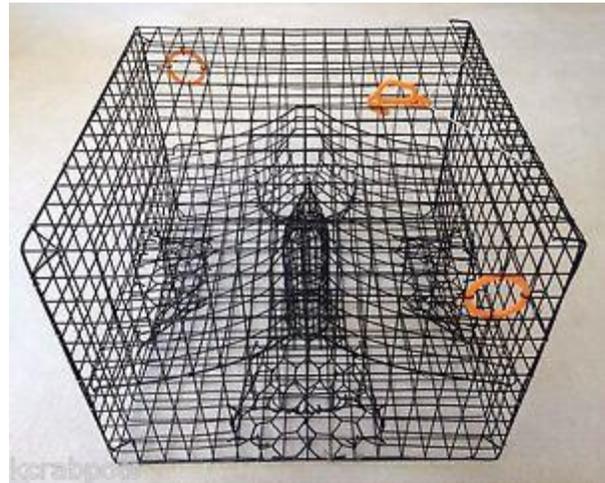
The Morris Garage ("MG") was an unusual and fun car. It had "rack and pinion" steering, a 4-speed manual transmission. It was a convertible with "plastic" side-screens instead of windows. There were no door handles. To open a door, one lifted a small spring-loaded panel near the bottom of the side-screen and pulled on a vinyl covered wire to release the door latch. The electronics were British, and generally not very reliable.



The seats were low to the floor, and one's legs were not far from horizontal. Safety features were near non-existent, and I shudder to think about what would happen in an accident! In summary, the car was really cool and fun!

I Become a Commercial Crabber

I used the Winner speedboat for crabbing. I bought a commercial crabbing license and placed "crab pots" out in the bay near the Lake Ogleton channel. Crabs enter via funnels. Because the bait is difficult to eat behind wire mesh, they try to leave. When they encounter the wall, their natural instinct is to go up and they become trapped in the top of the "pot." I had about 10 pots that I serviced daily. I would open the top and dump the crabs into a bushel basket, measuring small crabs to make sure that they were 5 inches point-to-point. I bought bushel-baskets of "L-Y" (alewife), froze them, then used them for bait as crabs loved the "stinky fish." There were lots of other crabbers and we each marked our "buoys" with different colors. The neighbors liked my crabs fresh out of the water which I sold to them at their docks directly from my boat. I saved some in a "live box" for our family, especially "peelers," which molted into (delicious) soft shell crabs. I learned to look for a very faint pink line on the last paddle on the backfin. Moreover, peelers tended to be kind of "leathery" when steamed or boiled.



Fishing for Rockfish

I learned how to use the Owens to catch delicious "rockfish" (striped bass). I would cross the bay, about 7 miles, and anchor on a large sandbar, like "Brickhouse bar" when the tide was running strong. (Note: There is also a "rockfish" in California waters that is a completely different fish.) I would place "mano clams," soft-shell clams, in a metal bucket then smash them with the end of baseball bat. Then, I would dribble this "chum" out the back of the boat into the current to attract a school of fish which were visible. Then, with an occasional drop to keep the school there, I would place a large piece of clam on a hook and "spin-cast" it into the school with light line (8-pound test). This was fantastic fishing with a feisty fish with nothing but a hook and light line. One could really feel the action. I had a cooler with ice and we often caught 20 or so fish. We would pan-fry some as soon as we arrived home. Delicious. (This is long gone from the Bay.)



I Dismasted Pete's Dad's Thistle

Pete Hommel lived nearby and became my best friend. His father, (retired) Marine General Hommel liked me, although I dismasted his "thistle" sailboat showing off for a girl I liked (which was the end of that relationship) when the "backstay" hung-up on a channel-marker. (stock photo) I had raised the centerboard for the shallow water in the channel and "side-slipped" more than I thought. The mast was complicated as the haulyards ran inside it. General Hommel was kind to me and rebuilt the mast with me only paying for materials.



Pete Is on His Way

We lived on the waterfront on "Lake Ogleton" which had a narrow, shallow channel connecting it to the Chesapeake Bay. The winters were much colder then, and we would ice-skate much of the winter. Of course, this is natural ice and not the finished ice of a skating rink. One evening I called Pete and said that I was going skating. He said that he was coming right over, so I went out on the ice.



I Fall Through the Ice & Pete Saves Me

I made a sharp stop, which one could with figure skates, and went through and under the ice. After a bit of a struggle, I found the hole and poked my head out. I was too cold to call out, and I tried to climb out, but (of course) the ice kept breaking. I knew that this could happen, so I kept an extension ladder on our dock. Pete also knew this and saw me in the water. He walked out with the ladder, pushed it to me, and I climbed out. We went to the house and my wet skates were frozen to my feet. We cut the laces and after I warmed up was OK. Thank you, Pete.



I Go Out the "Dog Door"

One summer, my parents "grounded me," meaning I was not allowed out at night. I do not remember what my offense was and did not much care. My room was in the basement, connected to the garage which had a "dog door." At about 10 PM, I would crawl through this and meet my friends on the road. This was a windy road through mostly forested woods with little traffic. We could hear cars coming and jump into the woods, undetected.



Pete and I Go Joyriding

I am guessing that we did this when Pete was 14 and I was a little older. His father had a stick-shift English Ford and kept the keys in the kitchen. (stock photo) After we met in the road, we would go to his house. Pete would get in the car, give it a push, and roll it silently down the driveway. Then he would start the car, continue backing up and pick me up. We would ride around for about an hour whooping and hollering, including driving past the police station for an extra thrill! Pete would drop me off, build up some speed and coast back into the carport with the engine off. We were never caught, but his father finally noticed the missing gas, and became suspicious, so we stopped.



I'm Tiring of Military School

By the 10th grade RMA was so-so, and by the 11th grade I did not want to return. My father planned for me to go to a military college, e.g., Annapolis or the Air Force Academy. However, the longer I spent in military school, the less I wanted to go to a military college. I told him that I was not going back, and he said, "Yes, you are." (Steve Jobs did the same thing and also prevailed.)



Chapter 4: Severn School – Class of '62

General Hommel Comes to the Rescue

My father pushed back but I was immovable. Pete's father, General Hommel was a teacher at Severn. I got to know him and Pete's mother, Jean, as I was frequently at their house. They liked me, so I asked him if he could get me admitted to Severn for my senior year. He did so, and I was delighted. My father grudgingly relented saying, "The amazing thing about you is that you always know what you want."



Life at Severn School

The main social activity at Severn was during lunch time and we all played bridge. I enjoyed the game because you can "do well" irrespective of the quality of the hand you are dealt. The atmosphere was genteel, as befitted a school named for a nearby river, in turn named for the longest river in England. It's likely that most my classmates had been together for years. So, I was the "new kid." However, I never got the sense that this bothered anybody, and I really liked being there. I think most were focused on college and the future was optimistic for all, or nearly all.



Commander Seeger

The most impactful teacher was retired Navy Commander Jack Seeger, who taught chemistry. He was a diminutive character and would jump on top of his desk to make a point and bark loudly at us. He liked to talk about things like how to flush a toilet in a submarine. I loved it! I learned like never before.



Riding with Qualey

It was near impossible to get to Severn from our home using public transportation and I did not yet have my own car. My mother arranged for the son of one of her friends who was also a Severn student, Mike Qualey, to drive me to and from Severn each day. I recall a three-speed manual transmission with the shifter on the steering column.



Unfortunately, he insisted on leaving for home as soon as classes ended, so I could not participate in extra-curricular activities. General Hommel had a photography club that I would love to have joined. Few knew me except for the midday bridge sessions. Thus, my mention in the Yearbook named me as "anti-gregarious." John Nolan recently apologized to me for this. Actually, I found it understandable and a bit humorous. Moreover, I never cared much about things like this.

A Neighbor Gives Me a Car

One day, a neighbor said, "Charlie, I have a Renault Dauphine which I rolled, caving the roof in. You can have it if you want." I was delighted. We found a young black man, Bud Brashers, with a body shop, who was willing to restore the car. His one-person shop was in a black, rural neighborhood. He was willing to let me help, so Mike Qualey dropped me off after school and my father picked me up on his way home. I learned how to drill holes and pull the dents out, then fill with putty, which we would then power sand to smooth. After we had enough prep, I picked out a metallic silver and Bud "shot" the paint. Bud was an affable person and we enjoyed working together. The car was lousy quality, but more importantly, "I had a car!" Unfortunately, I graduated shortly after.



Pete Gets Brain Cancer

Pete was diagnosed with brain cancer and admitted to Walter Reed Hospital. His mother, Jean, invited me to join her for visits and I happily did. We went in their Chevy "Corvaire," the only American car with a rear mounted, air cooled engine. They "cured" the disease, but Pete was never the same. Pete and I stayed in touch for several years until he moved away. Some years ago, Junko and I traveled to West Virginia to perform a wedding (I am a Minister in the Church of Universal Life). It was the fourth marriage for both Pete and his bride!



General Hommel

My relationship with General Hommel continued many years including keeping my sailboats at his dock. His calm demeanor was a role model for my life. For example, when I told him that I wrecked his Thistle as described above, feeling ashamed and embarrassed, he said, "If that's the worst thing that happened to you, count yourself lucky. Just pay for the wood and I'll rebuild the mast." Unfortunately, he later contracted a horrible, incurable disease, throat cancer. I visited with him until he became very sick and finally died. He was a wonderful person.



Fishing with Joel Kauffman

Kauffman Jewelers was a chain of high-end jeweler owned by Mr. Joel Kauffman. Somehow, he found me, and asked me to go fishing with him (with pay) on Sundays. He had a large waterfront home with lots of garages filled with exotic cars. His "regular car"

was a Rolls Royce. When it needed service, a mechanic would fly from New York to a nearby airport and come to his house to fix it! His boat was a wonderful, dual engine inboard, perhaps 40 feet long with a fiberglass lapstrake deep “V” hull, ideal for the bay. We would go into the bay, then look for “birds working” with binoculars. This meant that a school of “blues” was likely feeding. We ran there at high speed, slowed as we approached, then trolled around the perimeter to avoid driving them down. Fishing was so-so, and I enjoyed his company, the high-speed runs, beers and delicious ham and cheese sandwiches. What a hoot!



Go Get a Summer Job

At the start of my senior year, my father said to me, “Why don’t you see if you can get a summer job at the Navy’s Marine Engineering Lab (“MEL”).” I went there and met a kind Mr. Fox, “Charlie, we don’t hire summer students, but we participate in the CO-OP program with several universities. It takes 5 years, rather than the usual four, as you will work half-time and go to school half-time during the middle three years. If you get admitted to one of these, we’ll hire you. We also pay half of your tuition.” This sounded great to me and I loved the idea working half-time and getting some experience. Drexel seemed like a good choice, a good technical school, and in downtown Philadelphia about 200 miles away. It was close enough to drive there in a half-day, and far enough away that it would be difficult for my parents to hassle me. Also, I looked forward to living in a city with a subway.



Drexel Grants Me Early Admission – Thank You!

So, I made an appointment at Drexel for an admissions interview. I had not yet taken the required “SAT” exams, only the “pre-SATs.” We talked for a while and she examined my transcripts. Then, she smiled and admitted me on the spot! I was happy to avoid the costly and onerous exams. FYI, I recently found the follow-on acceptance letter with, “You need to send a \$50 deposit to hold your place.” (I wonder what that costs today?)



I Become an 18-Year-old Government Employee!

Summer came and I became a government employee, “GS-2.” (GS-1, is the lowest level, and I left NASA as Senior Executive Service (“SES”) – 6, the highest level.) I was delighted as this was great pay for a high-school graduate. Plus, I was earning retirement credit! Every year that I worked more than 6 months counted for a full year of retirement credit.



I Learn How to Use X-ray Diffraction

Mr. Fox assigned me to an (unmarried) middle-aged engineer, Jim Brady, who was studying material properties using X-ray diffraction. (stock photo) He taught me how to prepare the samples, by grinding them, mounting them on a stainless-steel stem, placing them into a vacuum chamber, "pumping down," then turning on the X-ray beam. We worked shoulder to shoulder. The x-rays reflect off the lattice structures revealing details on the structure and composition which we observed on film. I also visited him in his apartment in downtown Annapolis listening to music. I worried a bit about this but nothing untoward ever happened. He was a kind mentor for me during my first summer after graduating from high school!



Driving Out of MEL in the Afternoon

Leaving MEL was a bit strange. In the late afternoon, most left at about the same time in a long stream of cars. The guards would stop random cars and look in people's trunk for stolen items. We used to joke that you could take anything you wanted in a paper bag on the front seat! (In the Fall, I went to Drexel.)



Chapter 5: Drexel University Physics Major – Class of '67

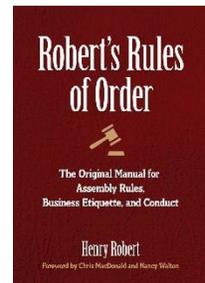
I Join a Social Fraternity

When I went to Drexel to look for a place to stay, I discovered that there was no dormitory for men, just women. (real photo)
The rooming houses were awful, so my father called and vigorously complained. The school then agreed to let me be a “house freshman” at a social fraternity (“Alpha Pi Lambda”) that had been forbidden to have them because they were on social probation. This was another stroke of luck. These fraternities typically “rush” athletes, and so they never would have picked me! I endured the “hazing” and became a “brother” in the spring. Ironically, my pledge class was the most effective, by far. Random selection was better than when the brothers selected pledges!



Politics and Social Chairman

Although I only stayed in the “house” for my freshman year, I learned a lot. We hired a cook, Carrie, who made breakfast and dinner which we ate together. (I believe with jacket and tie?) Meetings aired serious differences of opinion and were managed by a “parliamentarian” enforcing “Robert’s Rules,” so I learned a lot about politics. My second semester, I was social chairman, contracting for bands, food and beer for Friday night “mixers” and Saturday night parties.



Observing Human Behavior

The fraternity was a great laboratory for observing human behavior. The “house” was old and complex requiring a lot of maintenance. Saturdays were the best time for this, and on one occasion I saw a brother was sanding the floor. Another brother came down, sat on the sofa, and turned the TV on. When the first brother saw this and realized there was no way to make the other brother work, he stopped working. I decided that when (and if) I became a supervisor I would not tolerate lazy (or stupid) people as they “infect” all the rest.



Tough Freshman Year

Freshman year was academically difficult. The freshman engineering class, the dominant population, was 1,000. The following year, only 500 were left. We all were told this at freshman orientation. My freshman year was 22.5 credits which equated to about 35 hours in classes because labs, PE and other



things require more class hours than credits. (I envied the liberal arts majors at other universities with 15, or less, credits.) I worked hard and did well.

Joining the Drexel Sailing Club

One day, I noticed that Drexel had a "Sailing Club." I met with the faculty advisor and when he heard that I was from Annapolis, a national sailing center, I was immediately in. The truth is that I had little sailing experience except in my friend, Leo's "Annapolis 30." Drexel had a fleet of 12-foot "Alpha" dinghies on the Schuylkill river. (stock photo) The "club" was a sailboat racing team. Luckily, there were two "world-class" skippers from the Eastern Shore in my freshman class. We "match-raced" other universities with "one-design," (meaning all boats are the same) swapping boats to neutralize even small boat-to-boat differences. This made the competition only about sailing ability.



Going to Regattas

Here's how it worked. On a Friday night, 4 or 5 of us would get in someone's car and go to another university, staying in their dorm. We were competing with the Naval Academy, the Coast Guard Academy, and ivy-league schools. Saturdays were race days, and we would race around a set course, maybe 10 times in a "round robin." (stock photo) The host school always hosted a big party on Saturday night, and we drove back to Philadelphia on Sunday. And Sunday night we are back studying.



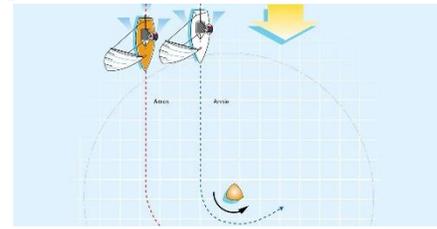
Sailboat Racing Start

Sailboat racing is tricky. It begins with the "start," the single most important event in a sailboat race. A buoy and a "committee boat" mark the starting line which is usually perpendicular to the wind and with the first "mark" upwind. The mark is placed making starboard tack (wind coming from the right when facing the bow) favorable as this is the most favorable "right-of-way." A gun sounds with 5 minutes to go, and again at the start. A late start places one in the "bad air" (turbulence) of the boats ahead. Being too early requires one to turn around, re-cross the starting line, then restart. This is made even more difficult by the rest of the fleet coming across the line with right-of-way as they are all on starboard-tack, close-hauled.



Buoy Room!

And there are other tricky parts. When approaching a “mark” as an “inside boat,” others do not have to make space for you unless you establish an “overlap” 3-boat-lengths out, which you claim by shouting “buoy room.” If you believe that someone fouled you, by breaking a rule, you shout “protest,” and continue to sail raising the issue with the “race committee” after the race.



My Role

I sailed mostly with skipper Denny Domin. (stock photo) My comfort moving around a small boat and physics understanding of hydrodynamics made up for my lack of racing experience. (I saw sailing as operating between two fluids of different density.) I was responsible for trimming the jib, the smaller and critically important sail on the front of the boat. I also related observations about wind, currents,



and other boats, helping Denny with tactics. Moreover, I shifted my weight as necessary to keep the boat tilted slightly to leeward (downwind) as this is the most efficient sailing configuration. It is crucially important to maintain laminar flow across both sides of the two sails as the power comes from the “Bernoulli effect,” the same reasons airplanes can fly. Sails have yarn attached near the “luff” (front of the sail) called “tell-tales.” So, I had to manage the “sheet” (the only “rope” on a boat is the “bell rope”) attached to the jib’s “clew” to keep the tell-tales flowing aft (toward the back of the sail). I also adjusted the jib block for different wind speeds to get laminar flow uniformly up and down the “luff.” Thus, Denny could change course and know that I would automatically trim the jib and leeward tilt. Although the “foresail” is smaller, it is crucially important as the “mainsail” has its laminar flow disrupted by the mast and the jib gets “clean air.”

Drexel’s “Letter” Banquet

Each spring, Drexel awarded “letters” to sports teams at a large banquet. We were always first to the stage as we had the best record in the University. (And we never practiced!) One year we were intercollegiate champions and were rewarded by racing against Navy, crewing one of their 44-foot Luders Yawls. Of course, they trounced us as these were their waters and they sailed these boats all the time. I think we needed a crew of 9 people, so we had to ask some friends for help.



Jim Persuades Me to Change to “Physics Major”

Each fraternity had a “bench” in the “court” in the center of Drexel’s main building where house freshmen, pledges, and brothers would gather and talk (and meet girls). I

met and made friends with (commuting) freshman Jim DeFelice who remains a close friend to this day. One day I said, "Jim, I don't know what to do. I am an Electrical Engineering major and discovered in the summer at MEL that I don't like engineering." Jim said, "Why don't you take physics, it's fun." I answered, "I hate physics because my high-school teacher (at RMA) was an idiot." Jim said, "That's not a good reason, my high school teacher was an idiot, too." Upon reflection, I agreed and switched my major to physics, and the rest is history as I now have three physics degrees, a BS, an MS, and PhD! There were only about 40 physics majors and with half in industry for the three middle years, I studied with the same 20 people, in effect, a small class in a large university.

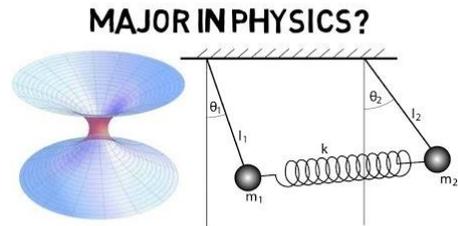
Bad Sophomore Year and Negotiation with My German Teacher

Although freshman year went well, my sophomore year was a mess. I had moved out of the fraternity house and into a roach-filled apartment with a guy who wanted to drink and party all the time. I had a class in scientific German that I thought was a waste of time. When I was at MEL and I needed a document in German translated, I put it into an internal mail envelope and quickly received it back in English. Sensing I was about to fail, I went to the professor and said, "I know I am in trouble and am asking you to pass me. I am a physics major and just don't think this is useful. If you fail me, I'll likely just fail again." He looked at me and said, "I will pass you on one condition, that you never tell anyone that I taught you German," I said, "deal," we shook hands and I left. (No, I will not tell you his name.)

I am Excused from ROTC

Everyone was required to take Reserve Officer Training Corps ("ROTC"), a kind of college-level military training. (stock photo) I told them that I had three years in military school and had no need of this. A surly student officer said, "Grab an M-1 (a standard US military rifle at the time) and I will inspect it." Now, I had carried an M-1 at RMA for years. We had "inspection arms" every Saturday. Upon command, we would all bring our rifles to the correct position and open the bolt. It was tricky (dangerous) to close the bolt. You had to use the heel of your hand to press the bolt back while depressing the spring in front of the bolt imitating a clip, then rotate your hand to quickly extract your thumb before the bolt cut it off.

Games Men (Boys?) Play

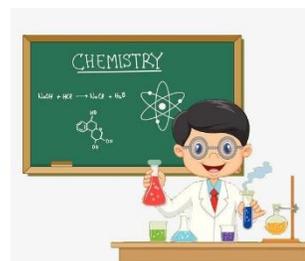


At RMA, cadet officers would walk down the line and inspecting both our uniform and rifles. Occasionally, they would try to distract us by pointing to some imaginary problem on the stock with their left hand. Then, they would grab the front hand guard very quickly, leveraging the rifle butt into your genitals. (Games men play?) So, the correct defense was to watch for any rapid hand movement on their part, immediately release the rifle, and place your hands at your side. Back to the ROTC. The student officer at Drexel, moved his hand toward my rifle, so I immediately released it and placed my hands at my side. The rifle noisily clattered on the concrete floor. One of the regular military officers approached me as I stood at rigid attention, and said, "What's happening here?" I said, "He made a move for my weapon, so I released it." He turned to the student officer and said, "Is that right?" He sheepishly answered, "Yes." He said, "Where did you learn to do that" I answered, "With three years at Randolph Macon Academy." He then addressed me, "You don't need this, you are excused from ROTC." I saluted and left.



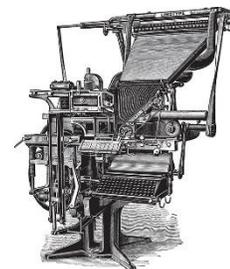
I Skip Chemistry

The other good thing that happened is that chemistry was the course that "weeded" people out of technical majors. As I said, I had an excellent chemistry teacher at Severn, Commander Seger, an ex-submarine captain. He was a small guy and stood on the desk when he wanted to make a point. I really, really knew chemistry. So, I went to the chemistry department and asserted that I did not need the class. They smugly said, "Really, take this test." I sat down, finished the test in a few hours, and turned it in. After a few minutes, they returned, and sheepishly said, "You are right, you do not need this course." Whew! Finally, a bit of free time.



"Pre-junior" (third) Year

A mild-mannered fraternity brother, Charlie Culver and I rented a large apartment from an elderly Jewish man, Leo, on top his "typesetting" business. Charlie was a "Commerce and Engineering" (business) major studying to be an actuary. He was also a numismatist, beginning in high school at a time when "coin books" were popular driving up the price of rarer coins. He made a lot of money buying and selling coins at "shows." Leo's machines would turn molten lead into type. We worried a bit about lead poisoning. We were young, and he seemed to be OK standing in the midst of it all. Moreover, the location and price were super. There was (rare) private parking in the back and my father let me have the MG while he drove the Renault to work and back! When MG's battery died, I used a "hand crank" to start it! My main use was buying groceries once a week at the Philadelphia Navy Yard PX, as I was a



“dependent” until I was 26 and had a military ID. I also did all the cooking. (Vertical integration!)

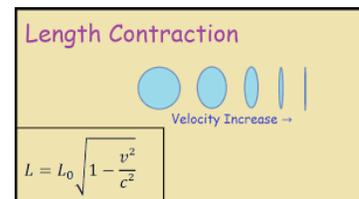
Back on my Feet Academically

My grades went steadily up for the following three years as I was now taking more physics classes and we had left “blocks and planes” for special relativity and quantum mechanics, which fascinated me. These are both non-intuitive and only understood through the mathematics! What fun! More emphasis on conceptualization worked for my “Blue” brain. Here is a little more about these fascinating subjects.



Special Relativity

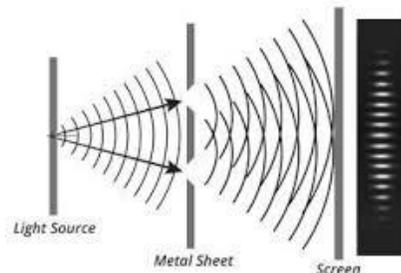
“Reasoning by analogy,” which is both lazy and inappropriate, physicists believed that light, like sound, traveled on a “aether.” Two physicists Michaelson and Morley attempted to measure the speed of the aether through space. They knew that the earth was moving around the sun, the sun was moving around the galaxy and so on. Therefore, they expected a positive result.



The experiment saw nothing, hence it failed. However, it this only made sense if the aether did not exist! This was one of the most important “failures” in science. Physicist Albert Einstein, unable to get a university job, and working in the patent office, “reasoned from first principles” (in contrast to reasoning by analogy) that the speed of light (in a vacuum) was constant with important implications for objects moving relative to each other. He did “gedanken” (thought) experiments imagining objects (e.g., trains) moving relative to each other changing perceptions of time (time dilation) and length (length contraction). The amount is determined by the “Lorentz factor,” which involves the relative velocity squared divided by the speed of light squared. Beautiful! This is real as a person who leaves and travels away from will have aged less than you when they return! GPS requires use of this adjustment to keep time sufficiently accurate.

Quantum Mechanics

Many physicists contributed to the development of quantum mechanics, particularly during the first half of the last century. The idea of quanta came from Einstein’s (also 1905) paper on the photo-electric effect that (much) later garnered a Nobel Prize. For me, the most important experiment is the “two-slit” experiment. In 1801, Thomas Young did the experiment and discovered the wave nature of light. Instead of seeing two bright lines, a

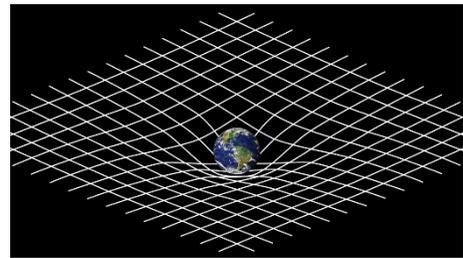


symmetric interference pattern appeared proving light was a “wave.” The experiment has been repeated many times since and here are some findings: Even with the interference properties of a wave, light impacts the screen with discrete “quanta.”

Electron beams have the same interference patterns. Individual electrons each emitted at different times and never simultaneous have the same pattern! The conclusion is that it is impossible to predict the path of any given corpuscle of light, or particle leading to the "Heisenberg uncertainty principle," and the math that reality consists of "probability distribution functions." We calculate these with the *Schrodinger Wave Equation*. While quantum mechanics challenges our intuition and daily experience, it is accurate to more than 15 decimal places! While quantum mechanics is required for a smart phone, or a quantum computer, I do not know of any manifestations in ordinary life. (Do you see why physics is interesting?)

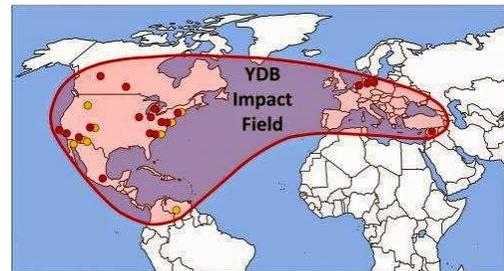
General Relativity ("GR")

Newton provided us with the equations that let us make "classical mechanics" calculations, accurate enough for most "real applications. However, nobody, including Newton understood a physical mechanism for gravity until Einstein published "GR" in 1915. He generalized special relativity, including accelerations, and refined Newton's laws providing a unified description of gravity as a "curvature of space-time." The formalism uses a "tensor," a 4 x 4 matrix of x, y, z, and t which I understand, and 10 Einstein Field Equations, a set of partial differential equations, which I do not. Importantly, it makes many experimental predictions that differ from classical physics, e.g., gravitational lensing, which have been tested and all confirmed the theory. Moreover, GPS requires GR clock corrections of 45 microseconds/day!



Origin of the Anthropocene (Current climate)

We know a lot about the long-term history of Earth's climate. For example, we can chart 500,000+ years with Antarctic ice cores. The earth's stable states are cold, think ice sheets 100 miles thick, and hot, think Jurassic Park at the poles. So, how did our climate happen? I think that this is the likely explanation. There are large objects, e.g., comets in orbit around the sun that can impact the Earth. We were in an ice age about 12,000 years ago when a comet broke into multiple pieces and hit the earth, mostly in the northern hemisphere. This is called the Younger Dryas Boundary named after a flower (*Dryas octopetala*) that grows in cold conditions that became common in Europe. This melted the ice, creating a great flood. Evidence exists in giant channels in the earth, a crater and, of course, all the stories in antiquity about a flood. This created the current epoch, the Anthropocene.



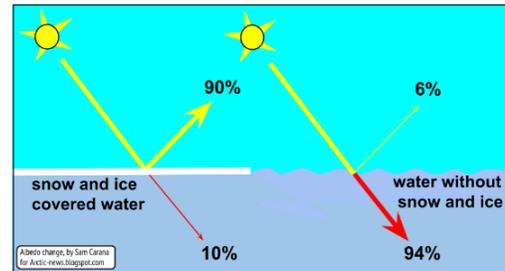
Early Climate Science

While “doing science,” thought I might explain climate, hopefully simply and clearly. A Swedish scientist, Svante Arrhenius (photo) did the math in the late 1880’s and wondered why the earth was not an ice ball? It was straightforward to calculate the “solar insolation,” the energy incident on the surface of the earth. He knew that the atmosphere was largely transparent to visible light and that water vapor absorbed most of the reemitted energy which would be in the infrared. Water vapor is still the dominant “greenhouse gas.”



Current Climate Science

The burning of wood, coal and now oil introduced additional greenhouse gases, carbon dioxide and lesser quantities of a far more potent greenhouse gas, methane. On time scales that matter, these are stable. Many have the misconception that reducing emissions will lessen the insulation. It will not, it will only reduce the rate that the heating increases. Therefore, nothing except massive removal of the existing greenhouse



gases will slow the heating. There is no known way to do this, not even in concept. Moreover, if someone found a way, the heating from the energy required to operate the equipment would itself add to the heating! Moreover, there are many “self-reinforcing” feedback loops that accelerate the process. An easy “tell” to watch is the arctic. It still has ice even in the summer, reflecting about 95% of the sun’s energy back into space. When it goes ice-free (“Blue water event”) about 95% of the incident energy will be absorbed. If we have a strong el-Nino, that could be this year! This is a “tipping Point,” from which there is likely no recovery. To visualize this, think of an egg rolling off a table and breaking on the floor!

Suppose We Magically Ended all Emissions?

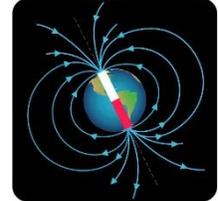
Would that at least buy us some more time? Scientists noticed something unexpected after 9/11. There was a rapid, measurable heating arising from the fact that US flights were suspended for 4 days, even though airplanes are a relatively minor contributor to “global dimming.” Industrial activity is a much larger factor! The calculation shows that if we stopped all these particulates, we would get an immediate 3⁰ Centigrade temperature rise within days or weeks! Evolutionary biologist, Guy McPherson’s (“Nature Bats Last”) calculations indicate that the slowdown in industrial activity from the Coronavirus will cause a one-degree-Centigrade world temperature to rise by the end of this year



ruining crops and virtually guaranteeing human extinction! (We will know if he's right, soon! And we both hope that he's not!)

Joining the MEL Magnetometer Group

By now, I had transferred to a magnetics group at MEL. We were measuring telluric (natural magnetic fields) currents with high sensitivity magnetometers (e.g., Metastable helium by Texas instruments) to improve submarine detection. The problem was that the geomagnetic noise was much larger than the sensitivity of the magnetometers. The idea was that if these were correlated over some defined scale, we could compare magnetometers signals over that distance and eliminate the geomagnetic component dramatically improving our sensitivity to submarines.



Our Experiment at Wallops

The experiment was conducted over most of a summer at Wallops Island, VA. I loved this as I made money on travel. I believe that the PerDiem was \$16 per day. This was 1966, and one could buy a "doormat" (meaning very large) flounder dinner for a dollar in the Pocomoke City Hotel (likely long gone). We took data 24 hours per day with magnetometers in the ocean and on land. Other co-op students were there, and we worked in shifts. We "hot-bunked" the hotel bed to save money. In the evenings when we were not working, we played pool and drank beer. This was a lot of fun!



Backing the Truck Over the Magnetometer

One day, I was backing a "6-by" truck and someone had moved the very expensive TI metastable helium magnetometer to a new location and had not told anyone. I backed the truck over the instrument, and fortunately did not break it. It did imprint a black image of the truck tire on it. (Imagine explaining that to the bosses!) Actually, they said that I should have checked, and not my fault since the person who moved it should have put up traffic cones or something. Whew!



Crabs!

We had an amiable technician, Leroy Mathau, who said that he had a special experience for several of us Co-Op students. He told us to bring a bushel basket, inflated inner tube, short piece of rope and crab net. We met near Annapolis and drove over the bay bridge in his truck. Then he insisted on blindfolding us. When the truck stopped, we got out, put the bushel baskets inside the



inner tubes and tied the baskets to our waists. There were so many crabs that we walked along scooping them up and tossing them in the baskets. When we each had a full bushel, we got back into the truck, and blindfolds returned. I can see why blindfolds were necessary, as if this place were common knowledge, it would be fished out in hours!

Enduring Friendships

FYI: I enjoyed these people and still see Hank Whitesel (an EE, I also played my guitar in a band with him) from time to time as he has a son in Colorado. And I was at a leadership workshop in Washington, and the group leader, Will Anderson, recognized me (from nearly 30 years earlier) and suggested that I read "7-Habits," a profoundly moving book.



Senior Year – My Money Ran Out!

My first year was financially difficult, as my father had retired from the Air Force and was now selling real estate and had his own financial problems. The next three years were OK because, living at home, I could save enough in 6 months to cover my living expenses at school for the next 6 months. Then came my senior year with only 3 months of work and 9 months of school. I ran out of money. Period!



Charlie Culver's Business Idea

I was sharing an apartment with Charlie Culver, a business ("Commerce and Engineering") major. I was distressing about running out of money. Charlie said, "I was walking in the garment district and saw clothing like the kind companies are selling with fraternity insignia, except these were really cheap." Charlie and I went and talked with a shop owner who could silkscreen insignia on clothes. So, we took the various fraternity insignia to the shop and made some samples. Our costs for these sweatshirts and jackets were a fraction of what the mainstream companies were charging. I went to each of the fraternities and found a person who would "sell" our merchandise in return for free items. This made a lot of money in only a few months, solving my problem. I took-away the lesson that making money is much easier than physics.



Schrodinger's Wave Equation on Our Jerseys

My senior year, I decided to organize a "physics-major" touch football



team. I played "center" because vision was not important. I decided that we would wear blue sweatshirts manufactured by my "clothing company" with the "Schrodinger Wave Equation," the fundamental equation of quantum mechanics, on the front of each. We had a lot of fun with this. I recently reminded Jim DeFelice of this and he told me about something I had forgotten. The other engineering "majors" that we played football against wanted sweatshirts with their equations on them, so I manufactured them and sold them, too.

I Become a Teaching Assistant

My senior year, I worked as a Teaching Assistant ("TA") for a chemistry laboratory class. I discovered that one really had to know the material to teach it. We were also required to complete a senior thesis to graduate. I built a primitive spectrometer and attempted to take spectra of bright stars. It actually did not work very well as the Philadelphia sky was too light-polluted.



Graduate School and a Dilemma

A few years earlier, I was surprised to learn that I needed to go to graduate school to get a reasonable job as a physicist. I applied to three graduate schools and was accepted at all. I decided to go to Tulane to reconnect with my South Louisiana roots. (Which would likely have been a mistake.) And, I had an additional problem. I did not want to go back to MEL the coming summer. Contributing to the Navy did not excite me and I felt like I had outgrown the place. Then, all my plans abruptly changed for the better.



Chapter 6: NASA Engineer, Sounding Rocket Division

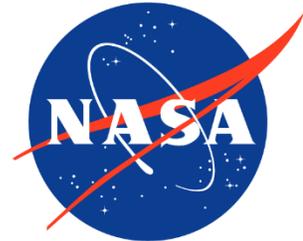
A Person at "NSA" "NASA" Wants to Hire You

One day, my father called me at school and said, "I just sold a house to a man who wants to hire a "fresh-out" (new graduate) who knows magnetometers and I said you would give him a call." (My father was not very technical, but he was interested in what I was doing.) I said, "Where does he work?" He said, "The NSA." (That's the National Security Agency, a spy agency with highly classified "spooks.") I said, "I have no interest in the NSA." (This was during the height of the Vietnam war, something none of us wanted any part of.) He said, "I told him that you would call so you must do it."



NASA Hires Me!

I called, and he was with NASA, not NSA! Wow! I told him (Bud Hudgins) that I was excited to work at NASA and had planned to go to Tulane for graduate school. He said, "There is a program called the "Three-quarter Program" that will pay your tuition and give you two days a week to go to school. I cannot promise that you will be admitted, and I will try if you want." My salary as a GS-7 was about \$7,000 and my Teaching Assistant stipend would have been \$1,500 per year. Moreover, I would continue to accumulate retirement years. NASA sounded good to me, so I cancelled Tulane and moved to Greenbelt after graduation.



We Are Going to the Moon!

I showed up at Goddard, and was "processed in." It turned that Goddard only hired four of us that year, in marked contrast to the hundreds in prior years. I was at first disappointed to learn that I would be working in a rundown building in Beltsville, off the main Goddard campus. However, this turned out to be a good thing, as we had more freedom of action as I will explain later. Many of our rockets carried experiments supporting Apollo. We were preparing to go to the moon, and the mindset was "We are going to the moon, and if you have a problem, go talk to the president. In the meantime, get out of our way."



I Am Tasked to Invent a New Magnetometer

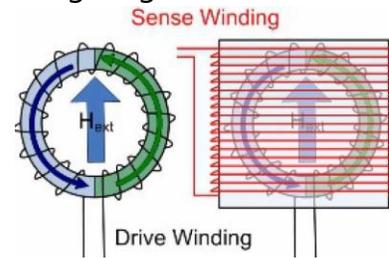
I am now at Goddard for my first day. I did not have an office, but rather a bench with a toolbox and an oscilloscope, and later a spectrum analyzer. Bud explained that the reason he hired me was to develop a new, inexpensive magnetometer. The problem was that they were buying magnetometers for "aspect sensing," the angle between the rocket and



Earth's magnetic field, from Schoenstatt for \$8,000 each. This was too expensive as we were flying 80 sounding rockets each year.

Settling on Fluxgate Technology

I began by surveying all the ways one could measure strong magnetic fields like Earth's. I built sensor prototypes and placed them in a plastic case, calling it the "magnetometer museum." I quickly concluded that a "fluxgate" was the way to go. I then realized that I could use a circular "ring" detector and measure two-axes at the same time, instead of just one like the Schoenstatt. I calculated the desired properties (optimizing the "hysteresis") and contracted with a company to make the rings to my specifications for \$100 each. I soon had a working prototype, and everyone was delighted.



A 30-cent Detector!

Bud asked if I wanted a contractor, Mario Acuna, from Argentina to help me. I was delighted as I knew that foreigners who came here were likely excellent. (photo) So, Mario looked at what I had done, asking about the ring core. He said, "Charlie, you are not an engineer, are you?" I answered, "No I am a physicist." He then said, "Well, I am an engineer, and we call those 'ring cores' and routinely use them for transformers. One can buy them from a catalogue for 30 cents." Sure enough, I found stock, cheap, ring cores that could be used in my magnetometer design.



Mario – Hardware, Me – Software

Mario had an MS in Electrical Engineering and was excellent. He took over the electronics design and began improving my design so quickly that I had difficulty keeping up. Bud introduced me to very unusual programming language developed by Bell Laboratories called "A Programming Language," or "APL." It was an "interpreter" language, in contrast to a more common "compiler" language like FORTRAN. APL used "operators," which are common in physics,

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▽DET[□]▽
▽ Z←DET A;B;P;I
[1] I←□IO
[2] Z←1
[3] L:P+(|A[;I])|Γ/|A[;I]
[4] →(P=I)/LL
[5] A[I,P;]←A[P,I;]
[6] Z←-Z
[7] LL:Z←Z×B+A[I;I]
[8] →(0 1 v.=Z,1ρA)/0
[9] A←1 1 ↓A-(A[;I]÷B)∘.×A[I;]
[10] →L
[11] ▽EVALUATES A DETERMINANT
▽

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e.g., quantum mechanics. For example, a single keystroke could "invert" a matrix. I quickly became adept. So, I focused on building a mathematical model of the magnetometer. I could vary all the parameters, optimizing performance then feeding numbers to Mario for test in the prototype. I could change material properties, drive currents, sense windings and the like. I wrote a paper on the model, published the work in *IEEE Transactions* under both our names, and made a presentation at an IEEE conference. I was published!

Flight "Packaging"

Now, we had to package the magnetometer for the rigors of space (sub-orbital) flight including the 60g loads of Nike-boosted rockets. The Nike (Greek for victory) was proposed by Bell Labs in 1945 as an anti-aircraft weapon to shoot down German jets. Mario and I had an electronic design with everything on one small circuit board with the sensor on one end, the electronics in the middle, and a Canon "DE-9" connector on the other end. (photo) This was also my original layout. I then got the idea to build a stainless-steel mold and "pot" the entire unit in "Eccofoam," a plastic with excellent electrical properties that could be poured into a mold, and then hardened. This was possible as there were no heat-rejection issues. This worked so well that our magnetometers functioned even after hitting the ground with failed reentry parachutes!



We Acquire a US Patent

Mario and I then applied for a patent using a Goddard attorney. (We could have made a ton of money with as our own business, however, we did the work while being paid by the government, so the government rightfully owned the patent. A hallmark of my (happy) life has been to "do the right thing." We submitted about a dozen claims and everything looked good. Then the lawyer called and said, "Have you ever heard of a man named "Geyger." We had not. He then said, "Well he wrote a book that describes most of what you did." In the end we still got a patent because Mario's electronic design was so clever and unique.



We Manufacture Magnetometers by the Hundreds

I began looking for a contractor to manufacture large numbers of magnetometers for our rocket flights. I had the idea to look for a small rural company with access to women who crocheted (from the French word for small hook). The only difficult part of building these magnetometers was laying the sense windings very uniformly. I knew that women who were able to crochet could do this "fine motor work." I found a small company in Virginia and taught them how to solder for space flight, e.g., avoid "wicking." I negotiated a fixed price of \$100 per unit with the CEO and wrote a sole source for 100 units with options for more. The only difficulty was that the company closed for a week or two when hunting season opened.



A Large Financial Reward!

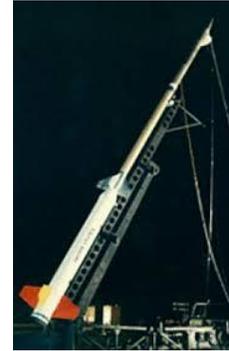
Bud nominated Mario and me for a "patent related monetary reward" because we replaced many hundreds of \$8,000



magnetometers with units costing \$100! The reward we received was the largest ever given at Goddard for an invention, a major fraction of our annual salary. Mario and I formed a close personal relationship that lasted until his death some years ago. Life was good.

"Severance Rings"

My favorite story about the times is that we were having problems with "severance rings." These are explosive charges used three times on every rocket flight. When the first stage (booster) burns out, a severance ring fires, severing the skin of the rocket (hence the name) separating the booster, then the second stage ignites. When the second-stage motor burns out, the next severance ring fires, separating that motor from the payload. Then, during reentry, (about 20 minutes later) the third severance ring fires, triggered by a barometric sensor, removing the cover over the parachute so it can deploy, slowing the descent to minimize damage to the payload.



Expeditious Testing

These are dangerous explosive charges with enough energy to cut through a rocket skin. (stock photo) Most would defer to experts to deal with these. But we were in the social context of "We are going to the moon." So, several of us brought in shovels from home and dug a pit behind the building and packed the dirt in sandbags. Then we built test equipment that would fire the "squibs" that ignite the explosive material in the severance rings. We knew that a freight train came through behind our building about noon. We went outside and waited, testing the severance rings when the train noise would mask the explosions. Management knew that we were doing this and stayed at their desks with their heads down. Those of us who were at NASA during this time are different than those who came later. The urgent "moon" social context shaped us all, forever.



NASA of Today

Today, in contrast, NASA people would form a review committee, document a plan, convene a safety review, perhaps build a test facility and after some years, testing would begin. Those of us who were in NASA during Apollo are different, more dedicated and committed than people who came later. This is the power of team social context (More about this later)!



I Ace the PhD "Comps"

I was working 4 days per week (turned out that one of the two days “off” in the three-quarter program was Saturday) and taking a full-time course load at Catholic University, which I chose because they would allow an off-site thesis, i.e., at Goddard. This was really important as I could keep my government job. After about three years, I finished my course work. Now, I had to pass the comprehensive exam. Typically, half of the students fail, and can take it one more time. If you fail it twice, you receive a master’s degree and are dismissed. I had saved a lot of “annual leave” (vacation time). So, I went on vacation for 2 months and went to the Goddard library every day to study. My thesis advisor suggested that I study Richard Feynman’s “Red Books,” which I did. When the exam finally arrived, it was incredibly difficult conceptually. This was perfect for me, a “Blue” overdone intuitor. If it had been straightforward, I would have likely failed, as I cannot do details easily. As it was, I scored the highest in the class! (Lucky, again)



Chapter 7: Personal Life After Graduation from Drexel

I Buy a Porsche 911

I rented an apartment in Greenbelt, near Goddard, with a classmate, Ira Blatstein. His college girlfriend, Sue, lived in the area so we had little social interaction as he was busy with her. (stock photo) My father was concerned that I would not go to college, perhaps because the attack on Pearl Harbor took him out. So, years ago he promised me a car when I graduated. I became obsessed with Porsche "911" cars. I managed to find a person with connections to a dealer who could get me one for \$6,500 and my father contributed \$2,000. My annual salary was about \$7,000.



140 mph on the Beltway

The car was designed for very high speeds on the German Autobahn. At the time, the Washington beltway had just opened and had a 70 mph (about 115 Kph) speed limit. There was little traffic late at night. So, I would go on the beltway, cruise at about 80, slowly overtaking the car in front of me. When I confirmed it was not a police car, I downshifted, floored it, and quickly shot up to about 140 mph (about 230 kph). In Maryland, the police were not allowed to use radar at night. The car actually felt better at high speed as the wind pushed the car down.



Rallying with Ira

I also "rallied" the car with Ira. (stock photo) The organizers provided complex directions in rural areas. The object was to arrive at "checkpoints," at the exact times with points deducted for arriving too late or too early. When we missed turns and had to make up time there was no better car to "make the time back."



Hanging Out in Lorena's Bar

During my senior year, Fran and my close friends Jim, Carol, Bruce, and Sue would regularly hang out at bar called Lorena's. We would drink beer and play a machine with a sliding puck. Bruce was the "wildest," drinking flaming shots with a beer chaser. I thought that Fran liked doing these things.



My Mother Unexpectedly Dies and Loneliness Sets In

Then, my mother died unexpectedly the year I graduated. She was only 44 years old, and the cause was ostensibly a heart attack. No autopsy was performed, so we

never knew for sure. I soon felt very lonesome as my father was depressed and emotionally unavailable, and my brother was away at school in Louisiana ("USL"). My colleagues at NASA were all older and mostly veteran technicians. They generally saw me as an obnoxious first lieutenant. My closest friends from Drexel had married their college girlfriends, who would just as soon not have me around. They did not want their husbands going to bars and drinking beer. I had never felt so lonesome, transitioning from a rich social life at Drexel to none.



Fran's Mother and Uncle Frank

I was traveling regularly to Philadelphia as Fran's mother and uncle, who lived nearby, made me feel like family. They gave me the family-love that I could get nowhere else. I suppose, they saw my physics degree and British sports car as a "savior" for "drop-out" Fran's otherwise limited life. Fran's father was ostensibly an engineer, and as I later learned actually a technician never having graduated college. He was also an overt racist in the style of "Archie Bunker." I also later learned that he was an alcoholic and abusive to Fran's younger twin and mentally challenged brother. Fran was a "college dropout," working as a legal secretary. When we began discussing marriage, the plan was for her to continue working or go back to school. After we were married it became apparent that she did not want to do either. We also agreed to have children eventually, but not soon as I was working nearly full-time and in full-time graduate school.



Ocean City, NJ & A Pilonidal Cyst

People in Philadelphia loved to go to the "Jersey Shore" during the summer. Fran's "Uncle Frank" had moved to (at that time) oil-rich Venezuela after graduating from college with a degree in petroleum engineering. He hooked up with politically connected people and made a lot of money. He lived with a sister (Margaret) near Fran's parents in Philadelphia. He was generous and would rent a large house in Ocean City, New Jersey. Fran liked to go, and I was ambivalent, and went occasionally. On an early trip, Fran insisted that we ride on a dilapidated roller-coaster. I was sitting on the metal bottom and a flaw in the track jolted me hard. When I returned home, I needed surgery for a "pilonidal cyst," an infection in a



bone that is a remnant of a primordial "tail." Dr. Jerry Sandler, Head of Surgery at Prince Georges County hospital performed the surgery. After the cyst is removed, the area must remain open and repeatedly cauterized taking about a year. Dr. Sandler had an office near Catholic University and did this himself and we developed a strong relationship as he was interested in my physics studies.

Marriage

We married in June 1968 in Philadelphia with my friends and relatives taking an entire floor of an upscale hotel. My Father and his (new) wife, Alice brought a case of champagne (they liked to party) and we put it in a bathtub filled with ice. I remember seeing my friend, Pete, dragging his (unconscious) wife down the hall. The wedding party looked "green," the next morning. I learned years later from Fran that she wanted to "back out" the morning of the wedding. I had no idea! I wish she had told me then, not 20+ years later. I used to joke that I married her for her Mother's cooking. The real truth was not far away!



Unexpected Change?

We went to a Holiday Inn that night and they gave us small bottle of champagne. I went to open that and she said, "You cannot have that." I wondered, "What happened to the partying girl I had been dating. Was it all an act? Apparently so!" We moved into the garden apartment that I had shared with Ira, who had married his college sweetheart, Sue, and moved out. I was surprised that Fran did not know how to cook anything, which was actually not much of a problem as I surely did. My father came to stay with us as we had a spare bedroom, and he had no place to go. He was obnoxious when he drank, and she demanded that I throw him out, which I did.



We "Score" a House

A good friend, Ted Cannon's, wife unexpectedly left him, and he had a house in Bowie which was nearby. It was a very cheaply built "Levittown" house and only cost about \$14,000! (stock photo) Ted had a Veteran's Administration loan that I could "assume." I sold the Porsche for the same \$6,500 I had bought it for and borrowed the money to "buy Ted out." We now had a house, the apparent path to wealth in those days.



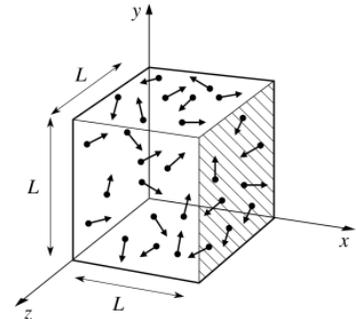
And a Car – a TR-3

The house had a Triumph TR-3 in the garage which Ted was restoring. He included it with the house. I finished the work and Fran had her own car as I had bought a new very basic Volvo (\$1,800) which I drove to Goddard and Catholic University. She briefly worked in Washington for a legal firm, then quit and refused to work, sitting home watching daytime TV.



Early Married Life

I was in a good place as I liked my job, but school was difficult. My Norwegian "advisor" taught statistical mechanics (boring) with his notes instead of a textbook. When I took my first exam in graduate school with three problems, I received a (failing) grade of 66! When he showed the class how to do the problem he marked wrong, I had done it correctly. When I showed him, he said that I had started it incorrectly. I then showed him that I had drawn "X's" over that first attempt, then done it correctly. He said, "You should have done it right the first time!" Needless



to say, I immediately went to the department chair and got a new advisor, Hall Crannell, a great guy, whose wife, Carol Jo, was also a physics professor. (Their house address was an amusing 10^6 .)

Fran is Pregnant!

Fran was apparently unhappy, and I was not aware of this, as there were no outward signs and she never said anything. I heard years later, during our separation, that she went to her mother and discussed divorcing me. Her mother suggested that perhaps she would be happier with a child? Our agreement was that she would use a diaphragm for birth control, and we would discuss children much later, perhaps after I completed my physics coursework. Then, she announced that she was pregnant. (With so many withheld truths, it's a wonder the marriage lasted as long as it did.) Fran and I had only about 6 months as a couple, as women totally change the moment they become pregnant. Instead of partying with friends and skiing, attention turned to the baby's room and furniture.



Labor During Apollo 12

Fran went into labor in November and I drove to the hospital with her smacking the car's headliner and screaming all the way. The Apollo 12 moon landing was on TV in the waiting room while she was in labor, so I watched it. (The mission was struck by lightning twice shortly after launch.) After a long labor, Julie was born



November 19, 1969. She and Jules do not like each other from the moment of birth. When the nurses brought her to Fran, she cried and pushed her away. So, here I am with a near-full-time job, full-time graduate school and a wife and baby who do not like each other!

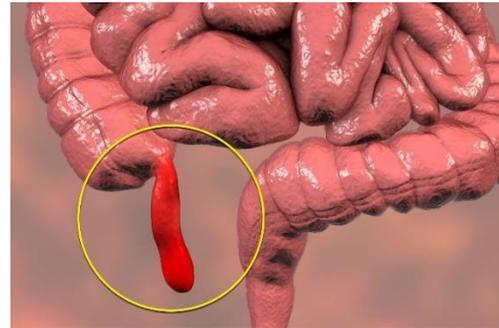
Playing with Julie

Moreover, she had terrible "colic," with no treatment except simethicone. He life with Fran was a series of power struggles over everything including "potty training." (stock photo) Julie would cheerfully run and greet me when I arrived home. I would play with her in the back yard and one precious memory was her putting her finger on a bumblebee and saying, "horsey." I would give her baths at night before "hitting the books."



Terrible Stomach Pains!

One day I came home with terrible stomach pain. Fran said, "There's nothing wrong with you, I need you to hang these curtains." She repeatedly insisted and I was unable. The pain persisted, then became worse. I had some General Practitioner ("GP") friends in Bowie and went to their office. They examined me and said, "This is serious, you need to go to the hospital immediately." When I arrived I said, "I would like to see Dr. Jerry Sandler, as we are friends." He came and said, "I have examined you and looked at your bloodwork. You need an immediate appendectomy. The nurses will prep you and I'll meet you in the OR." The next morning, he came to see me, "You were lucky. You had a "red-hot" appendix, ready to explode!" The pain during recovery was profound! I was able to get a potent pain relief drug, Demerol, every four hours by pressing a nurse-calling button. I went from debilitating pain to "dancing on the bed" in a matter of seconds. (Small wonder that these drugs are addictive!) I counted down the seconds until I could press the button!



An Aqua Cat

After I graduated, I bought a 12' 6" long "Aqua Cat" with a trailer for (I think) about \$500. It had a "lateen rig" with a short mast and no motor. Julie (she changed her name later to Jules) liked to be with me and would come sailing, laying on the trampoline before she could walk.



A Coronado 25

A few years later, I bought a "Coronado 25," a sailboat more notable for a roomy cabin than speed with an outboard motor under a "lazarette" hatch. (stock photo) I believe that this boat cost \$5,000. The motor was a bad design as the exhaust fumes collected and choked it. I finally designed a new "breathing" arrangement that worked better. General Hommel let me keep the boat at his dock for free. (Although, I would give him a case of his favorite scotch whisky, Laphroaig, from time to time.) We would go cruising as a family most weekends and for vacations.



CJ is Born

Charles James Pellerin, III ("CJ" same nickname as my father) is born almost exactly 2 years after Jules on November 21, 1971. He is easy and likeable, does well in school and sports, played Lacrosse, a popular sport in Maryland, and graduated from Clemson with a degree in Civil Engineering. Lacrosse is the oldest organized sport in North America, with its origins in a tribal game played by the indigenous peoples of the Eastern Woodlands and by various other indigenous peoples of North America.



Chapter 8: The Army Almost Captured Me

My Pre-induction Physical

I hate war. I hate stupid wars even more, wars that begin with lies, like our Vietnam war. Our system of forced induction is called the “draft.” My place in the draft queue was decided by a lottery. In my third year at NASA, just after passing the “comps,” my number was low enough that I received a letter to appear in Annapolis at 5 AM for a bus ride to Baltimore for a pre-induction physical. Moreover, if I missed the bus, I was automatically in the Army. You can bet I was there early. When I boarded the bus, the social context surprised me. I knew that my educated, progressive, friends hated the war, and this was just ordinary guys from Annapolis. Everyone was talking about how to fail the physical, e.g., putting soap under one’s arms to raise your blood pressure.



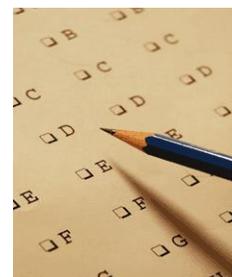
Underpants Only

We arrived at a giant building and were placed with many others in a long straight line. (stock photo) We were then directed to strip to our underpants and put everything else in a cotton bag they provided. The psychological game was underway. We were told bend over and “spread our cheeks.” Someone walked behind us, and we were all pronounced “passed.” Then came the urine test. No, they did not collect urine and analyze it. We just pissed in a urinal. We all passed because we had urine. Then came the hearing test. There was lots of shouting and pushing as people were pretending they could not hear when they could.



The Written Test

Finally, we had a written test with multiple choice answers. We were instructed to blacken a spot in what we thought was the correct answer. There was a machine in the back of the room that quickly scored each test. What to do, I wondered? I suspected, based on the bus ride, that many would attempt to avoid the Army by failing the test. So, I decided to do my best. As I recall, there were 100 questions, and we had an hour. There were many mathematical word problems requiring elementary algebra that I did quickly and easily in my head. There were vocabulary questions that were not difficult. I was at my intellectual peak at the time and finished early. I walked my paper up to the instructor who scolded me to “Sit down.” Apparently, he thought I was trying to fail the test. I just sat there until he collected everyone’s test.



Meeting the Commandant

My eyesight was likely enough to get me out if I could get a sympathetic hearing. I asked to speak with the Commandant, and after some push-back, they relented. His “office” was in a tent in the middle of the huge building. I never imagined that military



school would pay off in this unexpected way, but it did. I entered his office, clad only in my Jockey underpants, and executed the appropriate military protocol, a proper greeting, saluting, then standing at attention until I was given "at ease."

Ophthalmologist's Letter

I explained my disability and produced a letter from an Ophthalmologist stating that my vision in my left eye was 20/200 or worse. I was thinking that he likely met many people trying to avoid the army and I could have faked the vision test. Moreover, my letter was from a doctor at a university hospital, a less than optimal choice given how anti-war academics tended to be, something I realized much too late.



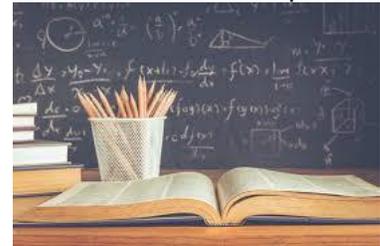
Did I Want to Be in the Army?

He scowled at me and began to read through my file of the results of my day. When he got to my examination results, he stopped, and his expression changed. I suspect that my score was 99 or perhaps even 100. He stared at the paper for a while, then asked me, "Son, do you want to be in this man's Army?" I hesitated a second, wondering on how to answer this crucial question, then said, "No sir."



Why Not?

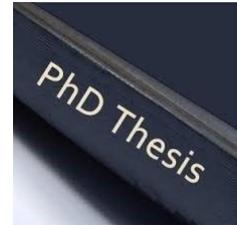
He said, "Why not?" I responded, "I am working at NASA and soon will complete a PhD in Physics. I believe I can serve my country better doing these things than by being in the Army." He seemed stunned, then said, "Son, you have your 4-F (disability) deferment, now go." I don't think I ever felt so relieved in my life. I went back on the bus to Annapolis, then gratefully drove home.



Chapter 9: Solar Physics Principal Investigator – Class of 74

Time to do My Thesis

As I had finished the course work and passed the “comps,” it was time to do a thesis, to complete my PhD. Recall that I picked Catholic University because I could do a thesis off-site. I interviewed in several Goddard science organizations. I chose the *Laboratory for High Energy Astrophysics*. Led by Frank McDonald, I knew it had all the prestige that the University would need, and more. My branch chief and supervisor, Carl Fichtel was an unpleasant individual, but a competent physicist.



The “SPICE” Experiment

Dave Bertsch and Don Reames, wonderful people and excellent physicists suggested that I take over the Solar Particle Intensity and Composition Experiment (“SPICE”). They had launched small payloads into solar flares using Nike-Apache sounding rockets launched from Ft. Churchill, Canada. My role would be to design a much larger payload and automate the “scanning” process to efficiently measure the much larger “pellicles.” This looked like fun and something I could do. My transfer was, however, delayed over an argument over my “billet.” Civil service “billets” were difficult to acquire. Everyone agreed that I should move but the new organization wanted to my billet to come with me, and the old organization wanted to keep it. Time went on and on, and I was increasingly annoyed. I was wasting my time and becoming impatient. Finally, I decided to write a letter to John Clark, the Center Director, a bold (and risky) move. I explained that everyone agreed that the transfer was warranted but we were caught in an “administrative dispute.” I soon found myself (26 years old) in the Center Director’s office with top management from both organizations. I explained my situation, and he decided who got my billet. (I do not recall what he decided.) And I was in my new job in a few days.



Sounding Rockets at the (Magnetic) North Pole

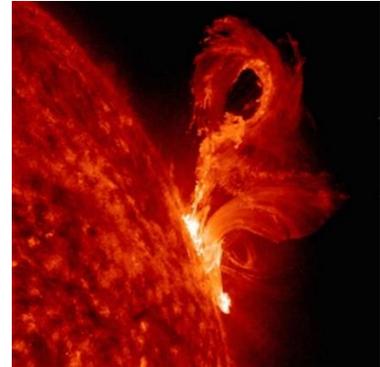
The SPICE experiment interested me because I liked the idea of making a measurement to see if there was anything “special” about our sun. Or is it just the ordinary “G V,” yellow dwarf that it appears to be? I could compare my results with “universal abundances” from chondritic meteorites to see if there was anything unusual. (photo) Moreover, it allowed me to capitalize on my prior experience in the Sounding Rocket Division. They offered me the opportunity take over the experiment as the Principal Investigator. However, I had to improve the measurement significantly, so that I



could publish the results. A “single author” paper in a top-tier refereed journal was a requirement for a PhD at the Catholic University.

Unbiased Samples

The physics was straightforward. All abundant elements have the same charge to mass ratio, 2. Solar flares were so intense that the atoms were “fully stripped,” meaning that all the electrons were removed. The equations of electrodynamics all include this charge/mass ratio. This means that the electromagnetic processes that accelerated the nuclei in a solar flare would act in an “unbiased” manner, ejecting accurate samples of the material in the solar photosphere into space. Also, I had the equation for the ionization rate of the particles in the nuclear “emulsions” as a function of charge and speed.



Designing a Larger Payload

My first task was to design a much larger sounding rocket payload to collect more particles, as the precision of the data were “statistically limited.” I came up with a design and contracted with “Miller Engineering” to build it. After some months we were ready for environmental testing. It was scary to watch my payloads receive 60 g’s (60 times the force of gravity) on the “shaker table,” the loads induced by my Nike-Apache rocket. My payloads survived environmental (and other) testing and I shipped them to the rocket range at Ft. Churchill, Canada.



I Traveled to Ft. Churchill

I then went to the “range” during the winter to explain how to maintain my payloads in flight-ready condition. I had an arctic parka, that zipped to make a long, fur-lined “tunnel” for my breath. Vehicles needed to be plugged into electrical power whenever the engine stopped. We needed to be in confirmed radio contact when we left the main building. During the daytime, we could drive to the dump and (cautiously) observe polar bears. I loved it!



Launch Instructions

I instructed them to launch when I called them, as I was monitoring solar activity back at Goddard. Then there was an intense solar flare and communications to the far north went down, as the same particles that I wanted to measure also ionized the atmosphere. I could not get through and they did not launch. Damn! I needed



another way to initiate launches. They had a riometer, an instrument that measures the opacity of the ionosphere. I then told them that when the riometer showed charged particles in the atmosphere, and they could not reach me, launch my rockets. If the flare was intense enough to interfere with communications, the solar particle flux was enough for my experiment. This worked well and we launched several times into medium-sized flares.

Launching When I Was There!

Once, while I was in Fort Churchill during the summer, servicing my payloads, the riometer alarm went off in the evening. Like most military installations, alcohol was cheap, and we had all been drinking. The range director stood and said, "Let's go launch Charlie's rockets." We piled into vehicles and drove to the range. The launch crew took the Nike booster and Apache second-stage motors out of their underground bunkers and installed the igniters. They stacked the motors on the launcher with my payload on top and installed the ordnance for launch for flight. Everyone then came into the blockhouse and the countdown began. My payload was now turned off, as I did not want power-on during the extreme vibration of the launch phase. A barometric switch would turn it on and open the nosecone above a predetermined altitude. Another would close it for reentry. Flight lasted about 20 minutes.



The Rocket Knocks Me on my Butt

When the countdown reached t-4 minutes, and everything was "go," I asked the range director if I could go outside and watch the launch. He said, "sure." I then asked how close I could go, he said, "Wherever you want." I knew that the Nike motor burned for about 3.2 seconds at which time the rocket is travelling Mach 7. Solid rocket motors are (barely) controlled explosions. I thought to myself, "This surely is going to be spectacular." I walked toward the rocket, illuminated by spotlights, (it was now about 11 PM) and I thought, how cool. My magnetometer was on board as part of the attitude control system and my Solar Cosmic Ray payload was on top. A loudspeaker broadcast the count, 5, 4, 3, 2, 1, 0! I was unprepared for what happened next. The night sky lit up, followed by a thunderous noise that knocked me off my feet and onto my rear end. Although shocked, I picked myself off the ground and reentered the blockhouse as if nothing had happened.



Recovering my Payload

The following morning, we needed to recover the payload lying in the tundra to retrieve the data in the "emulsion stacks." Photographic emulsions are light sensitive silver halide crystals suspended in gelatin. Emulsions are placed on thin layers on plastic sheets to make black and white photographic film. Light photons convert the halides into silver, which are visible when developed. In my case, so called "nuclear" emulsions, because they are used in nuclear physics, there was no plastic, just fairly thick sheets of emulsion, called pellicles, stacked together. Solar particles enter the emulsion, slow, and then stop. The particles, being single atoms are invisible. However, as they travel through the emulsion, they deposit energy leaving (silver) tracks which are easily visible with microscopes after photographic development. The overwhelming number of particles are hydrogen, then helium, with lots of iron as it has the largest "binding energy per nucleon" of any element.



I Go to Get My Payload in a Helicopter

The range director offered that since I, the Principal Investigator ("PI"), was there I could go out in the helicopter to get the payload if I wanted. Of course, I wanted to go. Now, the helicopter of choice is a Bell Jet Ranger. Unfortunately, the only one in the vicinity was appropriated by a politician. Instead, a pilot looking like an octogenarian with an ancient Alouette (French) helicopter arrived. Although concerned, I ran the "Story-line" that an old bush-pilot must be a good one. I got in the right seat and he powered up. As the rotor turned, the helicopter violently rocked side to side, which was worrisome. However, it smoothed as we lifted. We flew out about 30 minutes with me using a map in my lap to guide us.



Fly Lower!

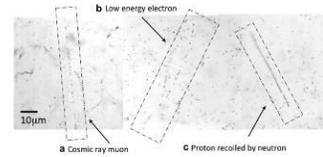
After looking for 30 minutes and no payload, I asked the pilot to fly lower. At first, he resisted, but I insisted as time was of the essence. It was wet everywhere and if the O-rings leaked at the place where nosecone sealed the payload from water, the emulsions would be ruined. Moreover, we were running low on fuel. So, we skimmed the ground, and I spotted the payload. We landed and together loaded the payload into the rack above the helicopter skid. I was surprised to see a cheering crowd



welcome us when we returned. It turned out, that they were tracking us on radar and lost the signal when we went low. They were preparing a message to NASA that we had crashed, and I was presumed dead, when we reappeared on radar.

Processing Back at Goddard

I removed the pellicle stacks, which contained the pellicles with the particle tracks, and took them back to Goddard. My colleague, Dave Bertsch, took them into our darkroom and developed them for me. (I could not have completed the experiment without lots of help from fellow physicists, Dave Bertsch and Don Reames.)



Early Automation

I was trying to make a precise measurement of the relative abundance of light elements including carbon, nitrogen, and oxygen. The idea was to compare these abundances with "universal" abundances from "chondritic meteorites" to see if there is anything unusual about our sun. In the past, people doing this kind of work used human "scanners" to look in microscopes and record observations in logbooks.



This was not practical with my very large pellicles. I set up computerized microscope stages and automatic track measuring. The computer I used was a serial number "5," DEC PDP-8 with a memory of 32 K 8-bit words. Note: Thousand, not mega, or giga of words, and only 8-bit words in contrast to the 64-bit words the computer I am typing this on uses! In the morning, I would turn it on, then "toggle" in about 15 "words" using switches on the front. Then, it was able to load more software with a paper-tape reader and finally communicate with an IBM 1800 to download more software and store the data. The 1800 had a full-time physicist, John Korpi, programming it, providing excellent support.

Mario Saves Me (Again)

I needed an accurate optical detector to measure the tracks and generate digital outputs that I could analyze with a computer. The detector would sit on the top of the microscope. (stock photo) Now, an update on Mario. He was able to become a Civil Servant, then followed me into Catholic University, choosing Applied Physics. He also wanted to move from the Sounding Rocket Division to a Science organization. One day, when I was visiting a science building I saw an ad in a locked box looking for a magnetometer expert. I picked the lock, removed the notice, and took it to Mario. He was so excited that he shook visibly. He went and met with science Director Norm Ness and found out that the job was "wired" for someone. However, Norn saw his potential and created a slot for Mario. I believe that Mario then had a magnetometer on every planetary mission. He even had his own NOVA show. He worked just upstairs from me, so of course I engaged him in my detector problem, and of course, he rapidly solved it.



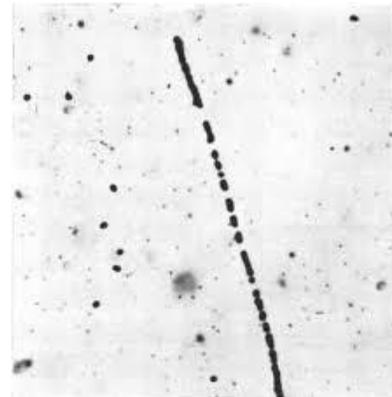
Incredible Luck

Then, I got lucky. On August 7, 1972, one the biggest solar flares, ever, hit the earth. The range at Ft. Churchill successfully flew two of my rockets into the teeth of it! Again, Dave developed the pellicles, and I went to work on the data. I wrote a lengthy program to analyze the tracks in Fortran IV. Every evening, I would take a large steel drawer filled with "punch cards" to the building next door where an IBM 7094 filled the entire basement. Operators would load my cards into a card reader, the computer would read the "Job Control Language," "compile" my program, then execute it overnight. I would pick up the (thick) printout in the morning. It graphically displayed the distribution of tracks as a function of energy.



The Fact That Atoms are Integers is the Key

It was straightforward to calculate energy deposition, " dE/dX " of the various nuclei travelling through the photographic emulsion. However, the "transfer function" of the tracks as measured by the electronic sensor could not be calculated. So, I used the fact that the nuclei had integer atomic numbers to tinker with the parameters and look at plots to see how well the various nuclei were discriminated. I ran my program every night, modifying the parameters, and slowly improving the discrimination. Finally, I claimed the most precise measurement of light elements, and first detection of solar boron.



Publish, then My Grant Is Terminated!

I had made a unique measurement of the composition of the solar photosphere which I presented at a physics conference and published in the peer-reviewed journal, "*Solar Physics*." Then, to my surprise, my grant was abruptly terminated. The reason given was that I had done all that one could so with the methodology. I had successfully flown the largest practical sounding rocket payload into one of the most intense solar flares in history and successfully analyzed the data. Now what?



Chapter 10: e^+ , e^- Large Scale Galactic Magnetic Fields ("Co-PI")

Bob Invites Me to Join Him

So, I joined a colleague, Bob Hartman, in completing a large electronic experiment using spark chambers and a "total-absorption" crystal to measure positrons and negatrons of galactic origin. The experiment built on work Bob had done at the University of Chicago, so it was kind and generous to grant me, publicly, "Co-PI" status. We called the experiment e-plus, e-minus (" e^+, e^- ") as it was measuring electrons (negatrons) and positrons. It was an aluminum "egg," about the size of a Volkswagen chock full of modular "CAMAC" electronics which are commonly used in nuclear physics experiments on the ground. We were working long hours to prepare for shipment and flight as solar minimum approached. Finally, we shipped the experiment to Fort Churchill. We chose this launch site for three reasons: 1. The charged electrons and positrons would funnel down earth's magnetic field like my solar cosmic rays; 2. The experiment could drift across largely unpopulated Canada providing lots of observing time; and 3. The range had the complex infrastructure to fill and launch large (50 million-cubic-foot) balloons which would "float" at an altitude of 15,000 feet!



We Needed "Perfect" Weather

There are two weather requirements to launch such a balloon. First, the upper atmospheric winds had to have reached "turn-around" switching from easterly to westerly. We needed weak westerly winds to get a long float time over land, as we needed to recover the payload to get the data. More problematic, ground surface winds had to be near dead calm. This was because the balloon was extremely long with only a small bubble filled at the top. Once the balloon was inflated, a special giant tractor called "Tiny Tim" had to hold the payload and maneuver exactly under the bubble before releasing it. Any misalignment, and the payload will swing, hitting the ground, damaging it. As the balloon rose, the helium would expand, and the balloon would become spherical.



Bored at Ft. Churchill

Bob and I waited in Churchill for nearly a month for the required early AM calm winds. This was difficult after the big push to finish and ship the payload. We would eat breakfast, go to the hangar, and test the instrument. Unfortunately, it always checked



out fine, so there was nothing else to do. After lunch, we would go to the river and throw rocks for an hour or two. Then we would take a nap and drink after dinner. (Laptop computers did not yet exist.) Then, we would do the same thing day after day. We listened to John Denver cassette tapes while we tested the payload. (I suspect this programmed me to later move to Colorado.)



Following Our Balloon Across Canada

Finally, the weather cooperated, and we had a successful (dawn) launch. Bob and I boarded an old DC-3 that leaked hydraulic oil so badly that one of us had to get out of the plane with the engines running and place pins in the landing gear so it would not collapse. There was a small clear plastic hump in the ceiling, where we could follow the balloon drifting across Canada with binoculars.



We "Cut" the Payload Down

Several days later, we were near Edmonton and decided to cut the payload down as we had a nice long float, and the balloon was sinking lower. It would heat in the daytime, losing some helium, then sink at night. Bob pressed a button on a radio transmitter that released the payload and parachute from the balloon. The payload landed in a forest near a lake.



Taking Off Under a Low Stone Bridge

The next morning, Charlie Ehrman, our electronics expert, and I took chainsaws to meet a float plane that would take us near the payload. Float planes take-off by flying downwind until they are "on the step," like a motorboat "on a plane." Then, the pilot makes a U-turn and takes off into the wind, like regular airplanes. The pilot tried everything but could not get the plane "on the step." So, we went back to the dock, and we removed all the seats except the pilot's. The pilot tried again with no success. Charlie and I tried moving rapidly from the front to the back of the small cabin with the power full-on. It was very noisy, and water flew everywhere. Finally, the pilot succeeded, got us on the step, and turned the plane into the wind. Too our horror, we were approaching a



low stone bridge. The pilot continued, and we flew under the bridge. That night in town, all the talk in the bars was about the idiots who flew under that bridge!

Physicists Become Lumberjacks

Anyway, we landed on a lake near the payload, and tied the plane to a beaver dam. We then made our way to our payload and began to cut trees down. Bob and a few other people soon arrived having hired a Jet Ranger. (Interestingly, this was a second "Ranger" as the first caught fire the day before during a fueling and was destroyed.) Now, we had a half dozen scientists and engineers with no training or safety equipment wildly felling trees to clear an area large enough for the helicopter to descend and take the payload out.



Repairing a Broken "Jet Ranger"

When the clearing looked big enough, we went to the Jet Ranger and it would not start. Charlie Ehrman began opening doors and found something that looked like a solenoid. He said, "I think it's a bad solenoid, just like my car." I was skeptical, as none of us knew anything about jet powered helicopters." Charlie then said, "I can use my pocketknife to bypass the solenoid and start the engine." The pilot said, "You can try this, but you cannot break the circuit once you start, or you will destroy the engine." Several of us had pocket handkerchiefs, which Charlie wrapped around his knife and proceeded to bypass the solenoid." It worked, the engine started, and the pilot took off.



Bob Attached the Payload

The helicopter descended, with an incredibly loud roar, and strong wind. Suddenly, the clearing looked too small. I became scared. Were the blades going to hit a tree and the helicopter come crashing down on us? Now, someone had to go under the roaring, swaying helicopter and attach a dangling shackle to the payload. I had thought I would do this, but I was terrified. Bob went out and made the attachment while I retreated deeper into the woods. The helicopter powered up but could not lift the payload. It strained and strained. Helicopters get more lift moving forward. So, the pilot began to move forward with the blades chopping the tops of trees and our payload careening off the branches. Fortunately, it worked, and pilot set our payload down near the DC-3. The pilot returned and offered to fly some of us out. Charlie



boarded the helicopter, and I chose to go back to the float plane. With only one passenger, we had no problem taking off and returned to the lake and the dock.

Getting the Payload Into the DC-3

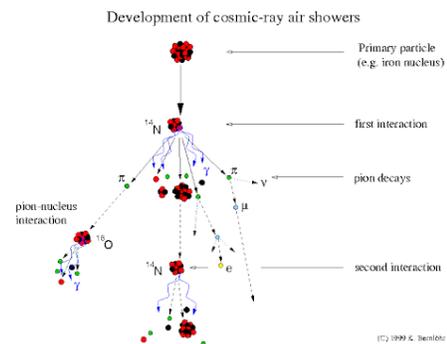
Now we had a new problem, how to lift the massive (600 pound) payload into the door of the DC-3 so we could take it back to Fort Churchill for a second flight. Finally, we all gathered around and under the payload, and with the helicopter applying full power managed to wrestle it in. We then boarded the plane and returned to Ft. Churchill. The balloon flight was entirely successful, and I chose to return to Goddard with the tapes and begin data analysis. Bob and Charlie stayed for a second successful flight. Note:



We never told people at NASA the (dangerous) things we had done, and this is the first time I have written these accounts.

I Hate Making these Calculations

Bob later returned to Goddard, and we began to work together on the data. Cosmic rays from both intergalactic and solar sources collide with molecules in the atmosphere. They then “spall” into secondary particles including positrons and negatrons. We had to calculate these fluxes and subtract them from our measurements as we wanted only positrons and negatrons of galactic origin. The equations to do this involved complex integrals and I hated these kinds of calculations, as getting any tiny detail wrong ruined everything. I was hoping Bob would volunteer for this. Then, he said “This calculation is so important that let’s both do it and compare results.” I was depressed, and worried as I knew this would be a struggle.



These are Not My People

When the day ended I went home, had a few beers, and played with the kids. The next morning, Bob came in smiling and humming. I said, “What’s up?” He said, “I had the best time last night.” “Really, what *did you do*?” “*I went home last night, had a quick dinner, and went into my office until 1 AM finishing the calculation.*” I thought, “These are not my people.” I began contemplating doing something else.



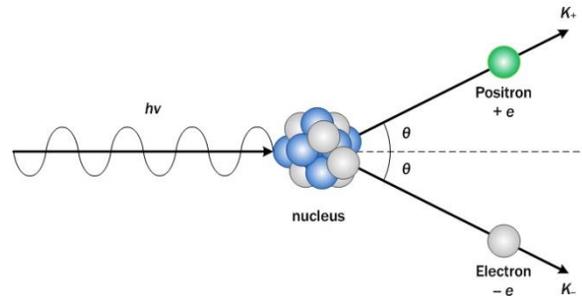
Grant Cancelled (again)

I do not recall how the calculation was resolved, and in any case, we got a good result, and published in the *Astrophysics Journal* letters. Then our grant was cancelled. It was the same as my sounding rocket situation. We had two successful flights drifting slowly over Canada at an altitude of 150,000 feet. No one could do better with the methodology.



Energetic Gamma Ray Experiment Telescope ("EGRET")

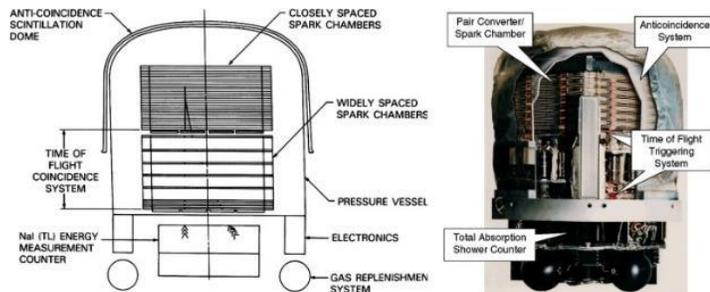
I worked in a group of a half-dozen experienced, talented physicists. We were building a very large, complex gamma ray "telescope" (nothing like an optical telescope) to fly on the Gamma Ray Observatory, a mission much heavier than Hubble and in many ways more complex. We all had to work to build this instrument, called "EGRET."



Here's basically how the instrument worked. Gamma rays would impact a thin tantalum sheet on the top and "convert" into an electron and positron pair, triggering a spark chamber to turn on and measure the tracks. A magnetic field deflected the particles allowing us to "track" the path and measure the energy of the two particles. The final energy measurement came from absorption of the particles in a large crystal with photo-multiplier tubes in the bottom of the instrument.

Back to Electronics Engineering

Our balloon-borne e+,e- experiment was similar with a spark chamber and absorption crystal. People knew I was pretty good with electronics, so I was assigned the task of designing the Charpak time-of-flight system for Egret's spark chamber. I had enjoyed being a "PI" like I was with the rocket and balloon experience as I "ran my own shop." Now, however I was the most junior scientist working under an unpleasant boss (Carl).



Chapter 11: NASA Headquarters Staff-Scientist & Home Life

Good with People?

One-day Bob said to me, "You are really good with people, why don't you try management?" (My first thought was, "Only compared to you guys." Then later, I thought he might have meant, "You are not that terrific as a physicist.") I think that I was an OK physicist and would have been better if I had been a Teaching Assistant in graduate school, like I was at Drexel, rather than working in the Sounding Rocket Division. Also, there was no alignment of my coursework, or faculty expertise with my research. In any case, I was soon contemplating moving to NASA Headquarters where the grants are administered so I could decide about other scientists' grants rather than having mine cut. Then, Tom Cline, a scientist in our group said, "Why don't you talk with Al Opp, the Discipline Chief for Astrophysics, he said he was looking for help?" I talked with Al, liked him and he was excited for me to come.



"Detailed" to Headquarters

I was not sure if I would like Headquarters and knew that Goddard had a program that temporarily "detailed" people to other centers and Headquarters. Thus, I could try Headquarters out before I gave up my (very prestigious) research position in the *Laboratory for High Energy Astrophysics*. So, I applied for the program and waited. Nothing happened for months, and I assumed Al had changed his mind about me. One day, Tom said, "I talked to Al and he is wondering why you have not shown-up?" So, I went to the office that managed "details" to see what happened. I learned that Carl (my boss) had turned my application down, while telling me (and Al) that he was supporting it. He lied to both of us! Shortly after, I was at a social event and saw Goddard's Director of Science, George Peiper. I had never met him, but he seemed like a pleasant person. I told him about my situation including what Carl had done and asked for his help. He said, "I don't understand why anyone would want to go to Headquarters, but if that's what you want, I'll make it happen."



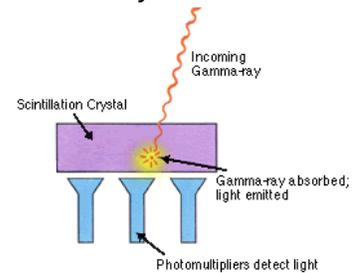
"Staff Scientist"

So, I wrapped up my work and went to NASA Headquarters. Al (photo) was an old-style German gentleman, and always willing to mentor me and wonderful to work for. My job basically had two parts: 1. Working with Al and another physicist, Sabatino Sofia to administer the research grants program; and 2. Overseeing missions as a "Program Scientist."



Jerry's Gamma Ray Burst Detector

The first thing he asked me to do was review a proposal from Jerry Fishman for a gamma ray burst detector. I read it and said it looked reasonable. (Interestingly, when I became Director, Astrophysics, I placed Jerry's instrument on the Gamma Ray Observatory against the recommendations of the science working group.) Al then asked me should we fund it. I said, I cannot make that determination without seeing the competitors. Then, Sabatino discovered that Al was basically giving "block grants" to universities and we were furious. We asked, "How could young people like us write proposals and compete?" It turns out, he was doing the right thing for the early days of the space program. At the beginning there were no space science departments or majors. That essential infrastructure had to be built first. (When I became Division Director, all grants were awarded only after competitive review by a committee of expert scientists.)



Al Teaches Me!

One day, Al heard me tell a proposer, "I am sorry, we do not have sufficient funds to give you a grant." Al said, "Charlie, that is not the truth. The truth is that your proposal is not high enough priority for us to fund." This was a point well taken that, as you can see, I never forgot it.



Spacelab-2 Program Scientist

It is fun to notice the small events that change the directions of one's life usually only seen retrospectively. Al said to me, "How would you like to be Spacelab-2 Program Scientist." (Spacelab was a system of habitable modules and pallets provided by the European Space Agency to fly people and instruments attached to the Shuttle Cargo bay.) The mission was astrophysics instruments that I was familiar with, flying on Spacelab pallets. I really enjoyed this work, overseeing the project to make sure the integrity of the science was maintained. As you will later see, this greatly affected my career path.



Frank and I Become Friends

Al worked for Bland Norris, the Director of the Physics and Astronomy Division, who worked for Associate Administrator, Noel Hinners and his Deputy, Tony Calio. Frank Martin (photo) was the Division's "Advanced Planner," and we liked each other immediately. Frank later played a major role in my life and remains a close friend and confidant to this day., a friendship spanning 45 years!



"Stop by for P, B, and J"

One day, Noel Hinners, Associate Administrator for Space Science, (photo) sent me a note saying, "Charlie, stop by for some P, B and J." I was delighted to have attention from top management and wanted to "get it right." Frank had a personal relationship with Noel, so I asked, "Is this Program, Budget and Justification." Frank laughed, and said, "No it's peanut butter and jelly as Noel brings a sandwich for lunch." Noel and I had a delightful conversation and developed a close relationship that remained until his death a few years ago. He also contributed greatly to 4-D development.



The Suborbital Program

Jack Holtz and Bill Logan managed the Suborbital Program. They embraced me immediately as I had real field experience with both rockets and balloons. I enjoyed working with them as they appreciated my knowledge and insights.



I Need to Find a New Job

After only a few weeks I knew I wanted to stay in HQ. So, I went to Division Director, Bland Norris as my detail was for one year and asked him to hire me. I might have been able to extend my detail and did not want to as the "GS" grades in Headquarters were much higher than at Goddard! He said that there was another person (Jeff Rosendhal) who had come earlier, and I was in line behind him. As I had little respect for Jeff, I told Bland that this was unacceptable, and I would go elsewhere. He said, "Go ahead." (Bland later became "DC rep" for Perkin-Elmer and I teased him relentlessly about "firing me.")



Code "O"

At the time, there was another organization, the Office of Planning and Program Integration (Code "O") charged with managing the agency-wide integration of Spacelab missions into the Shuttle. The Office of Space Science ("OSS"), and particularly Tony Calio, hated this organization and was determined to destroy it. Because I was Spacelab 2 Program Scientist, I was frequently in strategy sessions about how to get rid of this organization. Shortly after my meeting with Bland, I saw an ad for a GS-15 in Code O that looked interesting. I met with the sponsor, Bill Goldsby, who was immediately excited to have me. He knew of the fight with OSS and loved the idea of hiring one of their scientists. Unfortunately, I was only a GS-13 and could not apply for a GS-15 job. Bill said, "No problem, I'll immediately re-advertise as a GS-14.



Code "O" Hires Me!

I applied for the job and Bill immediately offered it to me. While the personnel office processed my transfer from Goddard, I found myself in another of these strategy sessions. I interrupted and said, "There's something I must tell you all." Floyd Roberson said, "We know about that, don't worry," and continued talking. I realized that they did not and interrupted again, "I have accepted a job in Code O working for Bill Goldsby." The room went silent, then Floyd said, "Hand me the icepick."



I Become the "Front Man"

My new job was interesting as I had no such prior experience with this work, called "analytical integration." Astronaut Rusty Schweickart was in that small office also and he was particularly interesting to work with, as he was a wonderfully eccentric person. There were many viewgraph presentations by Code O, with OSS/Tony Calio in the audience. Because Tony was hostile to the organization, others were intimidated so I offered to do these, I was confident in my briefing abilities. Before my presentations, I sat next to Tony and we talked amicably together. He had a personal dislike for the office head, Phil Culbertson, but not me.



I Inherit Some Money

Then, my grandfather died, and I inherited some money. I called a stockbroker who I knew and asked for the safest long-term investment for the kids college. He recommended an REIT which turned out to be a terrible mistake. We moved from our "Cape Cod" in Bowie to a newer nearby colonial in the Yorktown section that backed onto a wooded ravine. This was another mistake as the day after we moved in the newspaper headline was "Yorktown Still Stinks," and our back yard often smelled like a sewer. Moreover, we were surrounded by renters with a motorcycle gang next door, who would beat women in the front yard, another mistake.



C&C 30

The only thing that worked out was deciding to upgrade to a 30-foot Canadian sailboat designed by naval architects Cuthbertson and Cassian ("C&C"). I wanted a used boat with two fairly uncommon features, a "shoal draft" as the channel into Lake Ogleton was shallow and "wheel steering" instead of a tiller. I found a suitable boat for \$20,000 (about



half the new price) in Wilmington, NC and had it surveyed. The boat had "pock marks" from osmosis in the bottom that the surveyor minimized. This turned out to be an enormous hassle at the annual haul out as they had to be punctured drained and refilled.

Bringing the Boat "Home"

I bought the boat in December. Mario drove me and my brother, Mark (who has a U S Coast Guard Captain's license) and dropped us off to bring the boat to the Hommel's dock. (stock photo) The first scare was meeting a large boat with a powerful spotlight in a narrow canal. I moved so far to the side that I feared grounding. Next, we had to cross Albemarle sound in darkness and find a marina. (There was, of course, no GPS in those days.) I narrowly avoided destruction as I heard waves breaking and executed an immediate U-turn. We tied up at the marina just as a two-day storm hit. The wind blew so hard that we had to crawl on the dock to go ashore.



A Long Slog Upwind

Then we had a long "beat to weather" going up the Chesapeake Bay. It was so cold that ice formed on the decks. I had a large kerosene stove that I first worried that ventilation was inadequate to use it at night. Then we became so cold that I did quit caring. We finally entered the Lake Ogleton channel at dusk on Christmas Eve. Then, there was a horrible crashing sound. We were motoring, so I stopped. The lake had frozen over! Worried about damaging the hull, I roped the dinghy on the front and Mark got in. Just like an icebreaker the dinghy would ride up on the ice, then break it. This was of course, very noisy so homes were turning lights on everywhere. We made it to the dock and tied up to a cheerful reception by the (surprised) Hommel family. Whew! Ironically, while I worried a bit that the boat was a bit of an indulgence, it held value better than my "investments."



Racing My C&C 30

It's an interesting thing about sailboats that anytime one is near a similar one, informal racing occurs. I "club raced" my boat in the "South River Sailing Association." I chose the fall "frostbite" series because the people who were out then were serious and understood the rules. Each boat was "handicapped" by data organized by "sisterships" (same manufacturer



and models) gathering from races with similar weather conditions. Each had a number that adjusted the finishing time, called Performance Handicap Racing Fleet ("PHRF"). My number (134) included the "shoal draft" which made my boat a bit slower than the standard draft.

My Crew and Preparation

I raced with a crew of 5 people. (stock photo) I was the tactician, responsible for our strategy. One helmsman ("driving" according to the telltales like my collegiate racing role), one person "grinding" the "jib sheet, one "tailing," another "grinding" the main sheet, another "tailing," with the "tailers" moving to the foredeck to set or douse the spinnaker. I learned that the most important single factor was a clean bottom. So, before each race, I would go to a shallow sandy beach on Crab Creek, jump into the cold water and quickly clean the bottom with a "scotch pad" on a pole. I did very well winning trophies nearly every year. J/24's have a PHRF rating similar to mine, and could beat me in near calm days, I "cleaned their clocks" with some chop. I was pretty aggressive willing to take spinnaker "knockdowns" to maximize speed. I also had mylar (racing) sails.



The Boat

Needless to say, the boat was used much more frequently for cruising with the family. (stock photo) Everybody enjoyed this, and of course I "ran" it with Fran choosing to do as little as possible. It was a typical (beautiful) C&C design with a high bow, and aluminum toe rail sealing the deck and hull together. The haulyard winches were (unusually) mounted vertically on "Dorado" boxes instead of the usual place on the mast. This, one could hoist sails standing on the deck rather than having to climb on top of the cabin. It had a light, thin hull, and an "external" lead keel. A gas-fueled "Atomic-4" provided auxiliary power. It rusted out after about 10 years. I removed it and towed the boat to a yard where they installed a (better) diesel engine.



Cruising on the Chesapeake Bay

Fran and I usually slept in the "V" in the bow as there was an opening hatch overhead. There was a sofa-like bed with a back that flipped up to make an upper-bed. We could all eat together at the dinette which could be turned into two more berths. We had pressure water and a hand shower. The oven was gimballed so we could, e.g., cook a chicken underway. We had some interesting adventures:

- During a storm, I took refuge at night in a small inlet with a Coast Guard station at the end. One of their boats entered without using their spotlight and almost rammed us. I, of course, had an anchor light on that might have been difficult with the lights of the station in the background. They insisted on boarding us and scolding me, and that was the end of it.
- I was aware from the charts that there was a large, restricted area in the southern bay. However, with no buoys or markers and far from shore it was not obvious where the boundary was. Suddenly, artillery shells were whistling overhead and exploding into the water. They must have seen us as it was daytime with sails hoisted!
- Once, sailing in heavy weather, we "lost" the jib halyard. We were out in open water and I needed to get it back. I put CJ in a bosun's chair and hoisted him on the main haulyard. I worried about what might happen if the shackle somehow opened and told him to keep his arms around the mast. All OK as it turned out.
- When we anchored for the night I tried to avoid other boats directly upwind, especially smaller boats that might have less experienced "skippers."
- I worried about the powerboats as the drivers were often inexperienced and drinking. Once, sailing home from Oxford in the very large Choptank River in heavy weather, a very large powerboat circled around me and shouted, "Which way is Annapolis!"



Sailing with Tony Calio

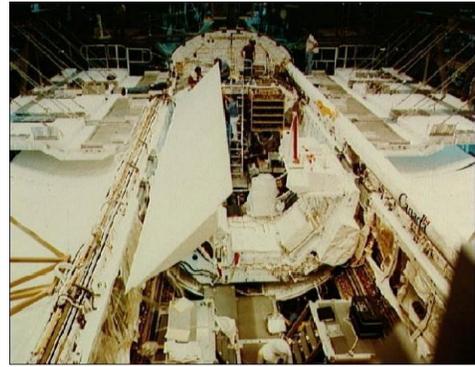
One day, sailing came up. He told me that he had a sailboat when he was in Houston. I told him that I had a C&C 30 in Annapolis. Then, I took a deep breath and invited him to come sailing with me. He said, "I would love to do that, but I come in a pair. My wife, Cheryl must come, too." I said, no problem, and we began sailing together, including my longest trip other than my initial delivery trip. We sailed from Annapolis to Lewes, Delaware, going up and down the treacherous Delaware bay. In the office, Tony was all business at work, but on the boat, was my wonderful and responsive crew.



Tony Wants me to Go with Him

One-day Tony told me that he would soon be moving to a new job, and when that happened, he wanted to bring me with him. Soon thereafter, Tony killed Code O and the head of the office left NASA. At the time, procurement wanted to revise the

process for soliciting science proposals, so I went over to help as I had little else to do. I worked directly with the head of NASA procurement and the chief procurement counsel, Gary Tesch, learning a lot. Gary and I developed a deep friendship. Then, Tony was named Associate Administrator of the Office of Space and Terrestrial Applications. Tony wanted to remove all the top management, so he selected an attorney, Sam Keller as his deputy. Tony is of Italian descent, and I later accused him of bringing his consigliere, like a mafia don. (Fortunately, he laughed.) I waited a while and heard nothing. I met with Tony and reminded him of what he had said about bringing me with him. He said, "Oh yeah, I would like you to take over one of my divisions. I said, "I don't know anything about their work, and would like to try my hand at program management." "I think the first Shuttle payload, OSTA-1 would be a good start, as it is not too complex." He asked, "Are the people there now any good?" I said, "I don't really know, and I told him who they were. He then said, "Well, I am going to direct Floyd to remove them and make you branch head." Wow, I was suddenly managing all their Shuttle attached payloads, including the Spacelab-3 mission and a high-altitude aircraft program. As you might imagine, the removed people were not helpful, and I had to staff with new people. The project people at the centers, however, were very patient with me and excellent mentors in my new role, especially Stan Reinartz at Marshall, who later managed the Shuttle's Solid Rocket Motors during Challenger. I continued to learn.



Jogging Around Washington

NASA headquarters had a "stress lab" with exercise equipment. I would "jog" around Washington during lunchtime and learned that NASA had a "runner's club" that sponsored a race around the "Mall" every November, with other agencies sponsoring other months. There were several people in the club who were thinner and more avid runners than me. Tony Diamond was the club president, and we would run together occasionally, and he was a significantly stronger and faster runner. The annual NASA-sponsored run came, and Tony asked me to join the race.



I Run the 10 K with Tyrone

There was a world-class runner in the club, Tyrone Taylor, a black man. As the race approached, Tyrone mentioned that he had that signed up to run the 10 K. I figured that all the other top runners would choose the 5 K, hoping to win first place. So, I signed up for the 10 K. On race day, I was planning to take a taxi to the start. I was "suing up," when Tony Diamond showed up and said, "Charlie, let's run to the race to warm up." Although reluctant, I ran with him and was tired at the start. Somehow, I "sucked it up," and ran



a good 10 K, coming in second to Tyrone. I was delighted and NASA Administrator, Jim Fletcher, handed me my trophy in the Administrator's suite.

Candidate House on the Magothy River

The Yorktown house was a disaster and we had to move. Although Fran agreed that we needed to move, she refused to look at houses, so I went by myself with a friendly (wise) realtor. I wanted to live on the waterfront with my boat nearby and found what I thought was perfect. The house was on the Magothy River, nice with a fine dock, and near the commuter rail station making my commute downtown convenient. Finally, I persuaded her to let me take her to look at it. When we approached, the house across the street had a pick-up in the driveway and she said, "I am not living in a neighborhood with pick-up trucks." I kept looking and found nothing that suited her.



Ferry Point Road

One day I said, "This is interesting, a 2-acre waterfront house on Ferry Point Road for \$160 K." That was ridiculously cheap for such a property. My multi-millionaire friend, Leo's father lived near there, so we went to look. We drove through two crumbling pillars up a dirt driveway to a dilapidated house and my instinct was to turn around and leave. She said, "I want it," so we took a look. The place was run down, and uninsulated with a flawed floor plan. It was a cabin with a large addition. There was no dock, and the water was shallow. But it was 2 acres near downtown Annapolis. So, I began to warm to the idea and designed a new floorplan.



Intransigence on Layout

It made sense to me to move the kitchen to the large room with a fireplace and water view. Fran was increasingly intransigent refusing to discuss the matter (or much of anything else). I had to relocate the basement staircase to make the far end work, increasing the (rapidly escalating) cost and delaying completion. So, we spent almost all our time in the smallest rooms in the house with no views and very rarely used the largest room, the "parlor."



Renovations Delayed

I hired a contractor and planned a 6 week overlap between leaving Yorktown and moving in to get the bulk of the work done before we moved in. I had grown up in Annapolis and still had friends there. One called me and said, "Charlie, you need to know that the septic system has failed, and they are having it pumped very other day." As this is a \$25,000 problem, this took all my attention. They claimed it was untrue and delayed the settlement as I accumulated evidence. Therefore, all the renovations, including replacing the worn, pine floors had to be done with us in the house. Everyone was miserable and Fran's increasing "under functioning" (and general hostility to me) pervaded everything.

DELAYED

Very Expensive to Heat

It was much colder then and some of the windows were flapping plastic sheets as we waited for replacements to arrive and be installed. Although I replaced the Burner in the ancient hot-water furnace, heating the house was awfully expensive using oil delivered by truck. I am guessing that it cost at least five and perhaps ten times what we pay to heat our current 5,000 square-foot house per month. I mostly heated the house with a wood stove that I fueled with wood that I cut and split from our property. The prevalent wood (I forgot the name) was so hard that sparks flew out of the chain saw! I suspect that this is the cause of my tinnitus! In a rare use of the parlor, we put the Christmas tree and presents there. Jules and CJ began opening their presents wearing coats, then started crying and went to their rooms.



Jules Pays the Price

Fran insisted on placing Jules in the Catholic School to please Frank. Jules has had a learning disability from childhood. (stock photo) So, predictably, the Catholic School was a disaster and they asked her to leave. I hired a team of expert psychologists to evaluate her and make recommendations. They presented a comprehensive report that said that they had found a special boarding school that could likely completely cure her, but she had to go immediately. I had saved the money for her to go, no problem. Fran said, "Absolutely not, she is not leaving." I was astounded and asked, "Why?" She said, "Only parents who don't love their children send them to boarding schools," a very thinly veiled swipe at me. I could not see how to get around this, so Jules has had a tough time, especially with higher education. I am happy to report that, turning 51 this year, she will graduate from college and has two lovely daughters!



CJ

CJ had a paper route delivering early in the morning and for a while worked in a friend's restaurant washing dishes. He graduated from Clemson with a degree in Civil

Engineering. When I divorced Fran, she got the waterfront house, then worth about \$2 million and everything in it. She later remarried and moved in with her new husband. CJ moved into the house and remains through today. He still has the Boston Whaler, a Chaparral 236SX speedboat, a jet-ski and a Hunter 33.5 sailboat that needs lots of work that Fran's new husband gave him.



Lots of Stress

I was driving to work and back as there was no other option and with increased traffic and construction on Rt. 50, my time each way went from 45 minutes to 1 hour and 15 minutes. So, I am driving 2.5 hours a day in heavy traffic, managing a complex program, and dealing with the renovation issues at night.



Boston Whaler

I have long been a fan of "Boston Whalers." The construction is unique. A shell of fiberglass is filled with rigid foam. Their advertisements showed people in two halves of a boat sawed in half. This allowed features that I liked: The floor of an unoccupied boat was significantly higher than the waterline making the boat self-bailing. Next, the freeboard, the distance from the waterline to upper gunnel was small, lowering the wind resistance and making it each to climb in from the water or reach things in the water. Finally, the boats are relatively light making them easy to "plane."



I Found a Used One

Unfortunately, these boats are expensive. I found a simple used 15-foot boat at a good price because the engine was shot, and the trailer was not good. This was not important as the "ramp" was only a few blocks away. The only cushioned seat was the top of a large cooler. The hull was rounded in the center with two slots. I bought a 50 hp motor, which had enough power to pull skiers. We went for a ride on the river nearly every night. What I loved most about the boat was that once it was "on the plane," air through the two channels lifted the hull mostly free of the water, lowering the drag, so I could throttle way back and keep running fast and economically. It was quite ideal for the relatively small waves on "South River."



I Buy a "Laser" Rowing Shell

The annual Annapolis Boat Show was a big deal and I enjoyed going to see what the new boats looked like. One year, I saw a "singles," sliding-seat rowing shell made by "Laser" a popular small sailboat company. However, what really impressed me was that it came with beautiful, hollow, wood "Piantedosi" oars. The price was excellent, so I bought it. I built a floating dock on Styrofoam logs to store it.



Rowing My Shell

Single-seat rowing shells are tricky boats as they are highly unstable. The only way to enter was to install the oars and hold both with one hand, stepping into the center and lowering onto the seat. Then, rowing must be carefully synchronized, or you would dump over. If a blade got caught in the water, called "catching a crab," or catching air a capsized was likely. And it was non-trivial to get back into the boat absent a dock. When friends came, I warned them of the difficulty and most ignored me. I begged them, "Please at least empty your pockets." Sure enough, most capsized at the dock. I enjoyed rowing long distances, even during winter storms. Slipping through the waves at high speed was exhilarating.



Chapter 12: Deputy Director, Spacelab Flight Division & Sailing *Working for Tony*

So, I am now working for Tony as a “Branch Chief” managing Spacelab missions and earth-sensing aircraft, the most interesting being an “Earth Resources-2,” a commercial version of the famous “U-2” spy plane. It could fly at 70,000 feet, with a “stall speed,” just a few knots below its cruise speed. Sam Keller, a night-school attorney, who I did not know previously, named himself as my acting Division Director. I saw a lot of him as there was not much more to the division beyond my branch. He, an “Orange” gave me, a “Blue” far more direction than I wanted.



Spacelab Fixes the Shuttle Problem

NASA had a problem. The Space Shuttle was supposed to fly 50 times per year with a 15 ft by 60 ft cargo bay able to take 60,000 pounds to low-earth-orbit. I am guessing that a typical Shuttle payload cost something like a billion dollars each. There was not enough money to fund so many payloads, so NASA approached ESA about developing habitable modules and pallets called Spacelab, that would remain in the shuttle, returning to earth for reuse.



“Analytical Integration”

My office managed the “analytical integration” of instruments into Spacelab components, a complicated systems engineering process allocating resources, generating timelines and the like. The Science Divisions managed the instruments which was problematic for me as they would frequently not meet agreed schedules. So, when they changed their schedules, I would need to change the mission assignments which I would show at the monthly review.



Tony “Pulls My Leg”

Near the end of a day, Tony’s secretary called and asked me to go to his office. I walked in and he said, “You want to be Associate Administrator, go sit in my chair. Take my desk.” I had no idea what he was talking about and was becoming worried. When he repeated himself, I said, “Tony, what in the world are you talking



about?" He said, "You came from the Office of Space Science and know that the only person who can authorize removal of instruments from missions is the Associate Administrator. Now, I understood, and said, "Tony, your issue is not with me but John Carruthers as he changed the instrument delivery date." He (thankfully) laughed, and patted my back saying, "Charlie, just wanted to have some fun busting your balls." Whew!

International Business Class

There is one funny aspect to this. I had a pleasant, but not-too-swift secretary. I was travelling internationally and asked her if I was eligible for business-class. She later told me that no problem, it had been approved. So, I thought nothing of it and kept doing it. I learned much later that my level required an Associate Administrator to sign off. Although Keller was my Acting Division Director, and approving my travel, she put his title as Deputy Associate Administrator, so he was unknowingly approving this!



Creating a New Division

I had heard that there was a Deputy Division Director, Jesse Moore, in the Office of Space Science ("OSS") who had come from JPL and was also unhappy. We met and talked about how to change our situations. He had a similar branch for Spacelab science payloads in his Division. We got the idea to make the case that combining my branch and the one in his division into a new division would give payloads a stronger voice (and solve both of our dilemmas). The idea of a single interface had a lot of appeal and an organization dedicated to developing this unique expertise made sense. We agreed that he would be director and I would be deputy. I liked Jesse, and this worked for me. But, how to proceed? We decided to make a presentation to the NASA Center Directors and get them onboard first. They were likely be amenable and could help with the Headquarters offices.



The Spacelab Flight Division

Jesse and I went to all the centers and generated strong support. Then we presented to Noel and Tony and received their agreement. Now, which organization would we go to? Happily, we went to OSS under Noel. As a new, emerging organization, Jesse and I had to fight for everything, e.g., office space and travel money, and we slowly built a strong division. Noel was replaced by Tim



Mutch, who soon thereafter died climbing a mountain in India. Deputy Andy Stofan took over and Jesse asked to be director of the Planetary Division which was a good fit given his JPL background. Unfortunately, he “threw me under the bus” with Stofan naming my nemesis, Mike Sanders, Director, placing him over me. They were carpool buddies. I was miserable. How could this happen with a division that I created.

I Confronted Andy

I confronted Andy saying, “This is a terrible mistake as Mike has no comprehension of what the division does. And, what’s done is done. I would like to go to Harvard Business School and would like your support.” He agreed, and I later learned that he had nothing to do with the selection.



Staph Infection

I went to my General Practitioner (“GP”) friends in the neighborhood with an odd rash on my leg near my ankle. They said, “We don’t know what this is and here’s the contact information for the Department of Dermatology at John’s Hopkins Hospital. The Department Head did a procedure, and my foot did not heal well with swelling and pain. I went back several times and he said, “I have never seen anything like this!” Getting worse, I asked him to ask other doctors in the department to examine me and several did. They also said they were perplexed.



Now on crutches, I called my GP friends and they said, “I don’t think that we can help, and come at lunchtime because we would love to see something so unusual as we might see it again and would look like geniuses!” My friends walked toward me munching on a sandwich. 10 feet away, they almost dropped their sandwiches and said, “You have a staph infection, call an ambulance.”

Jerry Sandler to the Rescue, Again

I arrived at the hospital and Dr. Sandler greeted me asking, “Did you eat anything recently?” I said, “Yes, I had a hot dog and beer for lunch.” He said, “No matter, we need immediate surgery.” When he came to see me in recovery, “You almost lost your foot, it was close.” I went to see him later, saying “I would like to sue them, what do you think?” He said, “I understand and here are the difficulties. First, you don’t have much in damages. As strange as it might sound, a lawsuit would make more sense if you lost your foot. Moreover, you need physicians, probably from out of state to testify and they will be expensive! I replied, “I understand, thank you.” I let the matter go.



Sailing with Peter and Carol Black

My brother, Mark, worked as a "Boat Nigger," for many years on a very large sailboat (50+ feet) for a family named the "Blacks." (I am sorry, but that's the term. It's on t-shirts with an image of a crossed winch handle and a mop. Moreover, Annapolis hosted a "Boat Nigger's Ball each year.) He lived on the boat (sleeping in the focsle) much of the time. I had met them on several occasions at



their large home on Maryland's Eastern Shore. They invited us to join them on a multiple week cruise around Andros, a large sparsely inhabited island in the Bahamas, likely as a favor for Mark. My foot was still bandaged and oozing. We signed their logbook which had names of famous and wealthy people preceding us. I do not recall the boat's name and think it was over 50 feet long and something like the image which is a Hylas 54.

Catching a Record Marlin

I like to fish and saw some gear and asked Peter Black if I could trail a lure. He seemed unenthusiastic and said OK. I selected a lure, added a steel leader, and tended to the rod. A few days in, the reel screeched, and I began fighting the fish. A huge Marlin broke, and Peter asked for the rod and I gave it to him as it was his boat. We then slowed the boat. I think it took an hour to get the fish close and he asked me to gaff it which I did. I



knew that it would kill the fish, but the lure was too deep to remove. It took three of us to get it on the deck and it measured over 7 feet, perhaps a record. We had no way to preserve it, so we cut some steaks and threw the carcass overboard.

Bone Fishing

Bonefish are perhaps the feistiest fish anywhere and difficult to catch. The Blacks had been in a place known for them before and hired guides with boats. Carol Black and I were in a boat. Our guide saw a bonefish and Carol cast a hook with a piece of soft-shell crab in front of it. The fish took it, and she began to fight it. I saw another, cast in front of it and now we each had a fish. When it looked like the lines might cross, the guide hollered at me, "Out de boat, man, out de boat." Although my foot was oozing, I jumped



into the water which was about chest high. Then we saw the fin of a large shark heading quickly toward me and the guide shouted, "In the boat, man, in the boat." I dropped the rod and reel into the boat and, with his help, clambered back in just as the shark went by! Whew!

Sea Cucumbers and Nurse Sharks

The boat had a nice Zodiac with an outboard motor, so we took it and went snorkeling. Peter chose to pick sea cucumbers off the bottom remarking, "These will be delicious for dinner." My thought was "Oh my," as they did not look appetizing to me. I was kind of swimming around when I came nose to nose with a large Nurse Shark. I thought, "Just stay calm and it will be OK," as the shark would have eaten me already if it wanted to. We sort-of stared each other down and the shark swam away. There were others nearby, and they took no interest in me. Fortunately, the sea cucumbers spoiled on the hot bottom in the tropical sun of the Zodiac and Peter threw them out! Frankly, I was relieved!



Being on the Boat

While we had a good time on the trip, I quickly recognized that this kind of employment was not for me. While the Blacks were surely nice, we "danced to their drum." We are eating and drinking what and when they choose, and not asked what we might like. It was fine for a brief vacation and I could not live that way.



Chapter 13: Deputy Director, Astrophysics, Harvard B-School – Class of '82

Frank Chooses Me to Succeed Him

I was brooding about Mike Sanders when Frank Martin, then Director, Astrophysics appeared in my doorway. He said, "I am leaving at the first of the year after the (very difficult) Infrared Astronomy Satellite ("IRAS") launches, and you are the only person I trust with the astrophysics program. Will you come be my deputy until then?"

I responded, "Are you kidding, that's a dream come true. One thing though, I am going to Harvard Business School in the fall for a 16-week residential program. Any problem with that?" Frank said, "No problem, and off I happily went."



I Focus on Mission Operations

The one constant in NASA Headquarters is change. Science and Applications merged back into one institution, Tony left to become Administrator for NOAA, NASA got a new Administrator, Jim Beggs who made Burt Edelson AA for Science and Applications. Burt came from Comcast completely unqualified for the job. Apparently, they had been roommates at the Naval Academy. Burt then picked Sam Keller for his deputy.



Frank had not had a deputy for some years, and really didn't need one for an alter-ego. (I am the same.) So, I focused on aspects of the division that I thought were underattended, particularly mission operations. At the time, each mission's operations budget was whatever the development people put in the budget. I accumulated all the budgets into a single one and had a "Senior Review" by scientists recommend allocations by mission. When I became Director, I established a "Mission Operations" Branch.

I Covertly Build "IPAC"

Caltech physicist Roby Vought and I went way back. He showed me a lot in Pasadena which was permitted for a "Butler building," a pre-engineered building that could be built for \$5 Million. He wanted to create an infrared science



center, Infrared Processing and Analysis Center ("IPAC") at Caltech starting with the IRAS data. I loved the idea and gave him the funds from reserves I had at JPL. It was an enormous success attracting super scientists as I knew it would.

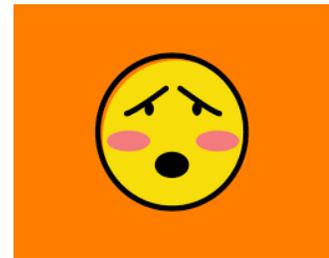
Keller Wakes me Up in Japan

I was in Japan when an angry call from Sam Keller woke me up. "How the F@#K did you bypass the whole system and build a building? You cannot do that!" I do not remember what I said, and there was nothing he could do about it now. It was the right thing to do and would likely have never happened if we "left it up to the system!" Chuckle!



Keller Attacks Frank?

I noticed Sam trying to embarrass Frank with things he knew about Hubble that we did not during the monthly program reviews. Apparently, Sam had a "mole" (mistress?) at Goddard feeding him information. I wondered why, as Frank is a first-rate leader/manager? Perhaps being a lawyer in a technical organization made him insecure and associating himself with Hubble would give him credibility? And rumors of a major Hubble overrun were in the air.



Going to Harvard Business School

It turned out that the competition for the Harvard opportunity was intense. And I got lucky again as the selection committee was chaired by someone I knew, Joe Loftus (photo) from Johnson Space Center, the epicenter of human space flight. So, I talked about my intent to improve the connections between science and human flight citing my PhD, and Spacelab Program Scientist and mission integration initiatives. I was going to Boston in the fall.



Harvard Business School

Then, I went to Harvard. This intense program consumed us all. All the learning was through analysis of "case studies," likely prepared by prior MBA students. We had three 50-page cases to read and analyze every night, except for Wednesday and Saturday when we had two. The case approach supposedly came from the potency of "residency" in educating medical doctors. We lived and worked in 9-person international "can" groups in Mellon Hall. Only 3 of the people in my "can" were from the US. One of our members had a break-down at the end of the first week. We convinced him to voluntarily enter a nearby mental hospital and they kept him for months. I went to visit him occasionally and found the confinement scary. I was always happy to get out of there. I became very close with the Japanese member of our can, Yuji Akita, and the four other Japanese attending. We met every year in Tokyo for a reunion dinner for many years.



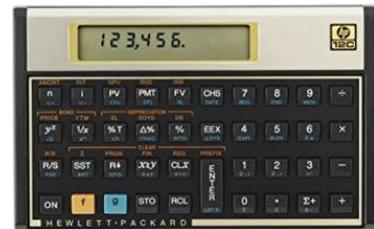
Peer Pressure

The Harvard "Executive MBA" programs were stratified into two parts, one for people in their late 30's and early 40's and one for older. And Harvard relies totally on the companies/sponsors to select the people. Moreover, there are no exams or grades, relying on something much more powerful, "peer pressure," including "cold calling," people in class with questions about the cases! This is a manifestation of our deep need to feel included!



I Am the HP-12C Expert

We all had HP-12C financial calculators, which most found difficult to use because of the "Reverse Polish Notation." As the only scientist in the program, I became the go-to person for how to use this device. Like the programming language APL mentioned earlier, "operators" are common in physics.



A Life-Changing Experience

The Harvard experience changed me forever. At first, I was quite lonesome for my family life and listened to familiar music for comfort. Then, I slowly became amazed at how smart the other participants were. I had never been around really smart people who weren't scientists or engineers. The social context was strange. There were no examinations or grades. Each morning the entire group of 140 people went to three 90-minute classes in an amphitheater setting for a guided discussion of each case. The instructors sometimes "cold called," i.e., called on people without their permission, people with questions about the cases. We were all incredibly competitive people and "peer pressure," i.e., fear of being embarrassed was a stronger motivator to prepare than examinations ever could.



Daily Regime

The cases for the next day were delivered to our rooms early afternoon and we would begin reading. I found the cases difficult as I was not familiar with business terminology. For example, I had to learn accounting with a self-taught course before I attended. I could do this, but not have the day-to-day working knowledge that would have made the cases easier. We would gather together about 9 PM, drink beer (or more) and discuss the cases together until about midnight.



Expense Accounts

Nearly everyone else had an (unlimited) expense account. I had a government per-diem of \$6 per day. Others has their laundry done at hotel prices. I went to the laundromat with the regular MBA students. Our "can" went to dinner together each Saturday night. It was tradition to take turns "treating" the others. These were thousand-dollar events and there was no way I could do this. I worried about this, and finally was "rescued" by a colleague who put my dinner on his account. My inability to "play" at this level limited by ability to participate in off-campus social events. Moreover, I never imagined that I would have a company like "4-D Systems" thinking my future would be in some aspect of aerospace. So, I did little to set the stage for marketing to these powerful executives!



Marketing Vs. Selling

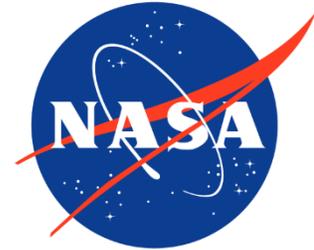
I am fond of joking that, "I spent 16 weeks at Harvard Business School ("HBS") and only learned one thing, the difference between selling and marketing. This would later turn out to be incredibly valuable, as you will see later. And, at Harvard, we used to say, "There's no "BS" like "HBS!"



Chapter 14: Director, Astrophysics

Returning from Harvard to NASA

I returned to NASA in late December 1982. IRAS (finally) launched shortly after and Frank left to become *Director of Space and Earth Sciences at Goddard* with Noel as Center Director, a super job for him. I was now “acting” Director. Keller was supporting me for Director because he thought he could manipulate me. (He later learned that he was wrong. I had changed a lot since our early engagement.) Burt was afraid of me and my very potent science community and was “dragging his feet” on my appointment. We were not afraid to tell the truth to him.



First Order of Business – Hire an Extraordinary Secretary

There are several things that are special about one’s secretary: First, I suggest that its only job in the division that I could not do, as I could not tolerate the endless interruptions of people wanting immediate gratification; Second, this person is your “face” to the world; Third, this person organizes your time efficiently (or not); and Fourth, it is (hopefully) the closest work relationship one has.



Finding “Becky”

I ran ads and the same set of marginally-qualified applicants showed-up. And one could not trust supervisors to honestly rate a difficult person they wanted to get rid of, so I began checking one supervisor back to get an honest appraisal. Then, I got the idea about asking people one level up, Associate Administrators, who had recently hired a secretary about excellent “runner-up” candidates. This is how I found Becky Mulkey, then a secretary working at Goddard. She came in for an interview and was excellent. I hired her on the spot. After about 5 or 6 years, I became aware of a higher paying opening the next level up and urged her to apply. She reluctantly did so, and they selected her. While I was sorry to see her leave, I wished her well. Two weeks later, she was back, even though it meant a downgrade! She missed working with me!



How NASA “Works”

The “action” was at the Division level, which I did for 10 years for astrophysics, as described earlier. Each fall, I would submit budget requests to the Associate Administrator for Space Science usually for the next five years. There were two kinds of activities: “Level of Effort” which stayed mostly the same for research grants, mission

operations, technology development, the Explorer Program, and "New Starts" for flight projects with budgets usually spanning five or so years that rose, peaked, then diminishing. As I generated the budget requests, the funds came back to me and I managed them. I had six "branches:" Three science chiefs organized by wavelengths for: Infrared astronomy; UV/optical astronomy; and x/gamma-ray astronomy. And, I had three mission implementation branches: technology and Phase A studies; Implementation; and Mission Operations. When I left my directly controlled budget was \$750 million per year for contracts administered by the field centers and likely smaller and substantial budgets responding to my requirements for launch vehicles and civil servants which are budgeted elsewhere. I made all the important decisions and only had one hour of review by my boss once per month.

The Science "Branches"

These were headed by "Science Chiefs," and staffed by PhDs in the appropriate fields. They did three things:

1. Manage our "Grants" program: We issued an annual "NASA Research Announcement" inviting proposals. The intent was to develop new instrument technologies for upcoming missions. To select proposals to fund, they would assemble "peer review panels," and manage the process including conflicts of interests. For example, scientists would leave the room when a proposal from their institution, mostly universities, was being considered. I would approve the list of proposals in priority order with a line where the funds ran out.
 2. Protect the mission's science integrity as "Program Scientists: Flight project managers had to make trades between cost and performance (and schedule). The Program Scientists made sure that these decisions protected the integrity of the mission's science goals.
 3. Provide advice to me: I would call on their expertise when I needed to make decisions if I had insufficient technical or political knowledge
-

Requirement Flow-down

The flight projects are the most important activities in the agency as this is where NASA creates value. Also, this is where I spent most of my time and energy. I used a 'requirements flow-down.' "Level zero" was a brief summary of the mission which was my "contract" with the Office of Management and Budget ("OMB") who authorized the mission, and the US Congress who provided the funds. This was more of a formality than a working document. My office had "configuration control" for the "Level 1" requirements. These included the science requirements, usually a few pages, a one page "Gantt" chart master schedule, and funding by quarters. Nothing could be changed without my consent. My program managers worked with project managers at NASA field centers who controlled the "Level II" requirements in 25 page or so document that "fleshed" out the "Level I" requirements. My program managers would attend project meetings, and apprise me on the ongoing status, including technical problems. They

would also provide early warning so I could descope content to reduce costs or provide more money. Increasing funding was very difficult in the current (or near) years, and doable in the "out-years." Their contractors, in turn would maintain "Level III" requirements and their sub-contractors "Level IV." This worked really well as long as everyone respected other's "boundaries," and avoided micro-managing.

Systems Engineering

The systems engineer is the most important person on a NASA project after the project manager. This is because every element of a space mission is constrained and interrelated. I will illustrate this with a true story. When we were designing the Gamma Ray Observatory, the German "COMPTEL," instrument wanted to change their Interface Control Document ("ICD") to reject more heat. ICDs are basically our technical interface agreements. I directed the project to accommodate this and they increased the size of the "radiator." To avoid the resonant frequencies of the launch vehicle, called "pogo," we had to stiffen the structure, so now we had a weight problem. There is no way out of this "death spiral," except some really clever (and expensive) systems engineering.

Project Phases and Reviews

NASA projects uses terms from the military for project phases. Completion of each phase and entry to the next requires a review spanning several days and the project clearing "action items" from the reviewers. Simplified, e.g.:

- Pre-Phase A – Assess feasibility, completing with Requirements Review
 - Phase A – Project plan, cost estimate, technology readiness, completing with Preliminary Design Review
 - Phase B – Prepare for manufacturing, completing with Critical Design Review
 - Phase C/D – Manufacturing and test, completing with Operational Readiness Review
 - Launch readiness? – Completing with Flight Readiness Review
 - Phase E – Mission Operations, completing with end-of-mission Review
-

A Typical Day

I started every day with a 15 minute "micro-staff" meeting with my deputy, branch chiefs and selected new people. I updated them on the status of things, believing that if they would be most effective if they understood the larger context. As you might expect, the remainder of my day was mostly spent in meetings. I required that all meetings be named as "decision" or "information." The requestor had to provide an agenda and take minutes which they would provide to all. At any given time, I might have several missions in every phase. Meetings were in my office or a conference room. My office was a "corner office" with two glass walls, the largest facing Independence Avenue and the National Air and Space Museum. I had a large (historic) desk with a leather chair, a leather sofa, and a table with four chairs. The conference room had a large "U" shaped table with chairs, facing three large projection screens with projectors

behind where the “principals” sat. There about 30 additional chairs for others. I chaired the meetings sitting in the center of the “U.” (A NASA workshop participant said, “Charlie, I spent my career looking at the back of your head.”)

Meetings!

Most of my day was spent making decisions. The important ones usually involved flight projects in Phase C/D because this is the high-cost phase. For example, Hubble’s Wide-Field/Planetary Camera-II had yet another overrun. The “II” means that this was the replacement instrument to be installed during the first servicing mission. My Hubble program manager came my office and alerted me. Our original agreement was that the replacement would be a copy of the original with the addition of the mirrors to correct for the flawed primary mirror. This, of course, was impossible for the “Blue” scientists who were compelled to “make it better.” As I knew this, I put “reserves” in the budget. And, although officially not allowed, I covertly “taxed” my projects to create my own reserve. The camera had overrun before and used up all their reserve. The question was whether I wanted to give them some of my reserve? I held a decision meeting in the conference room with the camera team presenting, and my program manager and program scientist present. When they finished I asked my program scientist about the impact if I “held the line.” He said, “The images will have an odd shape, and exposures will take longer, but in the end they can get all the science.” So, I sent them home with no additional funding. They later named the misshapen images, “The Pellerin images.” Oh, well!

AXAF Procurement – Phase A

NASA spends 90% of its budget on contracts. Therefore procurement, especially for large contracts, is critically important. Of course, NASA is governed by the Code of Federal Regulations, (“CFR”) like the rest of the government. While, we have some flexibility, I learned to stick to basics and be disciplined. Here is how we managed the AXAF procurement. We did a Phase-A study in-house at Marshall to learn enough to issue a draft Request for Proposals (“RFP”) to industry for comment. Although I tried, I could not interest anyone other than Perkin-Elmer (“P-E”) to manufacture the grazing-incidence mirrors. I did not want the competition to be decided by who could team with P-E so, I removed the mirrors from the prime contract.

AXAF Procurement – Phase B

We issued the RFP for Phase B, selected TRW, and Lockheed-Martin (“L-M”) and conducted a third Phase B in-house at Marshall. I told both contractors what I wanted in the proposal. TRW listened to me and L-M did not. The Source Evaluation Board (“SEB”), people who sequester themselves and summarize strengths and weaknesses, evaluate the proposals. Fortunately, the project scientist was a member, saw things like I did and was influential. The SEB reports findings to the “selecting official,” who is not bound by their “findings,” which are not recommendations. When the SEB chairman briefed us, ,

Gary Tesch, NASA's procurement lawyer said, "You can legally pick anyone that you want, but if you fail to pick TRW, you will need to get another lawyer."

Beggs Abruptly Fires Hubble's Project Manager

Hubble's looming overrun was soon all-consuming, with Keller inserting himself, and Administrator Jim Beggs (unfortunately deceased in April 2020, photo on right) and I flying around the country in NASA-1 (a Gulfstream III) to scold the contractors. One day, the Marshall project manager, Fred Spear, and I were summoned to Jim Begg's office. Jim pointed his finger at Fred and said, "You lied to us, you are fired." I had no idea this was coming. We called the Marshall Space Flight Center Director, Bill Lucas, and requested a replacement. Bill called back recommending Jim Odom. I said, "What's he done." "He managed the external tank." (This is a fuel tank for the shuttle.) I said, "Bill, I know that you believe that all cylinders are the same. But, Hubble is much more complex, and I have the meanest scientists anywhere on the Science Working Group." Bill said, "Well, he's the best I have so give it a go."



Jim Odom was Extraordinary!

Jim (photo) turned out to be excellent in every way and we formed a friendship that persists to this day. He also served as MSFC 4-D Client Program Manager for over a decade and was, by far, our most effective.

Keller Brings in Jim Welch

Keller then brought in Jim Welch from the classified world to oversee the Hubble "repricing," a fancy term for overruns. Secretly, he urged Welch (using last names to differentiate him from Jim Odom) to pump the price up as high as possible. When Welch ran out of options, Keller, against my strong objections, Keller asked my Hubble Program Scientist Ed Weiler to get the science working group together and rewrite the "Level I" science requirements from a half page document to a 20-page document. I was incensed, and there was nothing I could do. I did not understand why Keller did this until years later. I learned that he believed that if the overrun was, say \$200 Million the Office of Management and Budget ("OMB") and Congress would make the Office of Science and Applications (OSTA) pay for it. Conversely, if the overrun was, say \$1 Billion, they would have to pay with new money to avoid excess damage to the ongoing program. He was right, and was IMHO, highly unethical.



I Dump Welch

With the new requirements, the overrun was much larger, and Sam asked me to take Welch as my "Deputy for Hubble." This went on for about a month, and I said, "Welch doesn't take direction from me, I cannot be accountable for his actions, therefore I don't want him. Moreover, he disappears for days at a time. When I ask him where he was, he said that is classified. My division has no classified work." Keller said, "Then we will give him his own division." "Go ahead, I said." Welch was doing things that were, in my opinion ill conceived, and he was not going to last long. Both Weiler (despite the requirements rewrite) and Odom remained totally loyal to me. Welch brought in a contractor from the classified world and installed a computer control system and intended to manage the contractors on a daily person-by-person basis.



Welch Soon Left NASA

Sure enough, he did not last long, and the telescope was soon back with me. There was, to the best of my knowledge any farewell event, he just left. His contractor had some good people and I picked up their contract, but to do completely different work.



Traveling with Burt

Burt Edelson was the *Associate Administrator for Science and Applications* and my boss. Burt came from industry and had little sense of the ethics that all civil servants abide by. Burt had a son in school at Stanford and wanted to visit him, so he asked me to arrange a program review at Lockheed, Sunnyvale. He did not know that I knew the real reason that he wanted the trip. (I was still "acting" Director at the time.) So, I called my contact, Bill Wright and he said, "No problem." So, I told Burt and he said, "Great, can you ask Bill to have a car pick us up at the airport?" I said, "Burt, you know that's improper." He said, "I know, just do it." I told Bill, "I am just a messenger," and he said, "OK."



Burt Changes into Sweat Clothes

Burt and I rode to the airport together. Burt went into the men's room and came out wearing sweat clothes. When we arrived, one of the marketing people was there in their personal car. (There were more "Burt requests" involving lunch and dinner, which I will omit.) Burt said, "Charlie, ask Bill if we can get a driver with a limo and hat to go back to the airport."



Our Driver Approaches Me

We were in the hotel lobby, me in a jacket and tie, and Burt in his sweat clothes. A man in a uniform walked up me and said, "Are you the NASA party." I answered in the affirmative and he said, "Which bags are yours?" I pointed to mine, he picked them up, walked quickly out, leaving them at the back of the car as I followed him out. He opened the back door, said "get in," opened his door and sat in the driver's seat. He rolled down the window and shouted to Burt, "Put the bags in the trunk, bub." Burt opened the door, sat, and glared at me. I said, "Burt, don't blame me, I just did what I was told. And you shouldn't dress like that on business trips!"



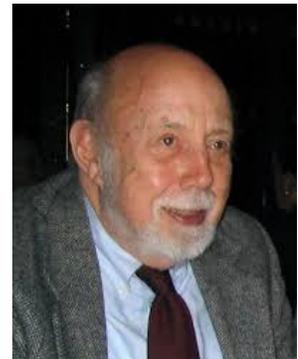
Burt Names me Director

Administrator Beggs was getting a lot of flak about Burt, so he brought Frank McDonald in as Chief Scientist reporting directly to him. While my "acting" status continued (I paid no attention to it) Frank went directly to Beggs and I was immediately made permanent director. (Suspect Burt had no idea how this happened, either.)



Frank McDonald Goes to OSTP

It is interesting how things get done in Washington., Frank McDonald (photo) was Director for the *Laboratory High Energy Astrophysics* where I worked as a research scientist. Before coming to NASA Headquarters, Frank went to the Office of Science and Technology (OSTP) which provides advice to the Office of Management and Budget (OMB). Burt consistently rejected all my requests for budget increases. I think Frank admired and appreciated my acumen in leading the Astrophysics Division and treated me as peer. He would call me and ask me what I wanted augmented in my budget. We thought very similarly so, Frank would go to OMB and put my augmentations in the Space Science budget. Burt would come to my office and ask me how this happened? I would just shrug.



It's Your Division's Social Context, Stupid:

More than half of the new hires I made for the Astrophysics Division did not work out. Civil service hiring opportunities were rare and precious, so this was not OK! One day Doug Broome, a really smart guy, said to me, "People say that you are a son-of-a-bitch to work for, but I love working for you." I responded, "Please don't tell anyone that, I want people who want to work for a son-of-a-bitch to come here." Doug was super, so I asked him about my hiring dilemma.



He said, "You are very demanding, and many do not expect that." Why don't I write what the Social Context (we called it "culture" then) is like here for you. This is a piece of what

he wrote. "At first glance, the following discussion and list of attributes may seem to imply that the excellent science program manager, flight program manager, or program scientist must be superhuman. Although outstanding performance is expected, perfection at all times in all things is not really achievable. Instead, what is expected is that degree of perfection necessary at the time to effectively resolve the issues at hand, as they are encountered, without the need to resort to excuses."

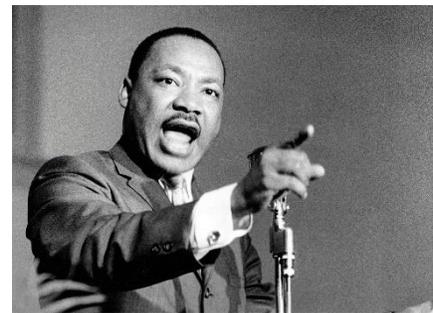
I Had New Applicants Read Doug's Culture Document

I asked every new job applicant to come a half-hour early for their interview and gave them a copy of Doug's description to read. I suggested that if this was not the work environment that they wanted they quietly depart and skip the interview. About half the applicants left and everyone who stayed was a success!



Mad, I Used Anger at Situations to Motivate Action

Martin Luther King (photo) effectively used "anger at injustice" to motivate social change. Project managers from the "Centers" would bring their (money) problems to me looking for relief without working the problem adequately themselves. So, I established a rule, 'Never bring me a problem without at least one viable solution.' I chose to motivate them to work the problems before the easy route of dumping them in my lap. Moreover, it is best to work problems at the lowest possible level because the knowledge is the greatest. So, when managers came into my office with a problem, I stated the rule then asked them for the solutions. If it was the first time, I said, "Come back when you have viable solutions that don't cost me more money."



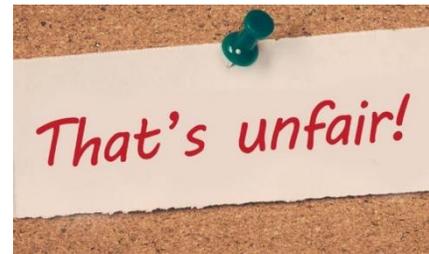
God-dam-it Come Back When You Have Solutions.

If they came back again with no viable solutions, I would recall the saying, "First, get their attention," slam my fist on the table, and say, "God-dam-it, come back when you have solutions." (stock photo) I wouldn't always adopt their solution as sometimes it was better to fund the problem. I also discovered that contractors would ask me to come out when they had problems, mesmerize me with technical presentations, and leave me with a big bill. I imposed the same rule on them with terrific results. I did not have to act angry to get their attention as I had more leverage. In every case, I had options beyond just sending more money to remedy the situation.



Burt's Stacks His Advisory Committee Against Me

Burt and his Chief Scientist, Jeff Rosendhal, did not like that I was growing my program so quickly (at the expense of other programs). So, they "stacked" the "Space Science Advisory Committee, ("SSAC") with scientists from weaker disciplines. There was no point in talking with them about the unfairness of this as they had done intentionally. Congress passed legislation limiting advisory that my friend, lawyer Gary Tesch had developed a "work-around" for called a "Management Operations Working Group." The discipline chiefs had used these for years. I enjoyed working with and sometimes sparring with the community, so I formed one at my level called the "Astrophysics Council."



Five Noble Laureates on My "Council!"

I called Riccardo Giacconi, who would later win a Noble Prize for his work in X-ray astronomy and said that I wanted more prestigious people on my "Council" than Bert's. With his help, I soon had five Noble Laurates: Leon Lederman; Bob Wilson; Craig Wheeler; Steve Weinberg; and Bill Fowler and most of them came to the meetings. So, whenever Burt came to me with some nonsense, I would say, "Burt, it that's what you want to do, I am going to ask Craig Wheeler (or whoever) to give you a call so you can explain your rationale, OK?" He always backed down!



Ron Konkel Buys us Science Computers

Burt hired a head, Ron Konkel, for his Financial Division from the Office of Management and Budget ("OMB") who I did not particularly like. He socialized with a lady from the computer company, DEC, who persuaded him to order scientific computers for managers like me. This was nonsensical as we were actually a business management organization relying on scientific expertise. My computer used large "floppy disks" and a primitive Microsoft operating system. It was too large to take home and I never had the multiple hours to invest in learning how to use it.



I Notice a Mac in an Office

One day I noticed a small Macintosh computer on a desk and asked what can you do with that? Show me, can you write a letter? Yes, it's easy and he did. Can you make PowerPoint slides? Can you make a spreadsheet? It was all so easy!



Ron Says "No"

I went to Ron and said, "Ron, my DEC computer is unusable, can you get us Macs? I have seen how they are so easy to use." He responded, "No, I have decided that we are a scientific organization, and we are going to use DEC scientific computers!" (Can you see why I did not like him?)



I Bring Macintosh's In

My good friend and former division staff, Gael Squibb, was now the Director of IPAC, so I e-mailed him, "Gael, can you please send me a dozen Macintosh computers." He said, "Sure, and the computers arrived air freight the next day." I gave them out and began using mine. We all loved them! I put the DEC in the hall. Well, it did not take long for Ron to appear in my office, angrily shouting, "How did you get these?" I just smiled. Ron was determined to take our useful computers away and did not know how.



Len Fisk is Coming

Burt was finally leaving, and Sam Keller and Jeff Rosendhal were announcing that they were going to be in charge. This was a matter of concern, so I went to see Frank McDonald who was now Chief Scientist. He laughed and said, "Nonsense, Beggs and I have asked Len Fisk to come as Associate Administrator and he will be here in less than a month. This was great news as Len, and I had been colleagues back at Goddard. I e-mailed Len and said that I would like to come to New Hampshire and meet with him before he reported for work. He said that it was not necessary as he was coming to DC the following week. I invited him to have dinner at our home and he agreed.



Len Has Dinner at Our House

I spoke with him about many things then got around to Ron and the Macs. Soon after he arrived, I was briefing charts to him during the monthly review. Len said that he wanted me to make some modifications for use with the Administrator and how soon could he have the new charts. I said, "Len, I can have those for about 15 minutes after we finish today." Ron was presenting charts and Len made the same request. Ron said, "Tomorrow afternoon," as he needed a contractor to make the changes. Len, then asked, "Charlie, how is it that you can do this so quickly?" I answered, "It's because I do these myself with Mac!" Len, then said, "Great! Let's get those for everyone who wants one." Ron never knew what hit him.



Note: I Quit Macs in Private Life

(Fast forward) When I left NASA (1993) I bought a Mac desktop, and it was unstable, crashing frequently when I hit "save," so I watched Apple make an important acquisition decision. When they chose a graphics company over an OS company, I quit and bought a Dell which worked fine. Everything has its time!



My Farewell Event

Without any consultation, Becky (and Martin Harwit?) arranged a farewell event the likes of which I had never seen for anyone! Somehow, she arranged a catered lunch in the Capitol Rotunda, below the capitol dome! There were two hours of (short) speeches by NASA colleagues, scientists, and contractors with hundreds of attendees. Most had presents, e.g., models of missions. I believe that Martin acted as "Master of Ceremonies." The Division gave me a large, framed montage with images from many of our missions that hangs on the wall near my office to this day.



Jules and Sally Ride

Physicist Sally Ride was famous as the first American woman in space. Although we had never met, I asked her if she would speak with my daughter. She agreed and they talked on the phone for 45 minutes. I (recently) asked Jules what they talked about and she said, "women in the workplace." Jules asked her if she had ever been discriminated against and she said, "never." She rose even higher in my esteem when she turned down being NASA Administrator in favor of UC San Diego.

Deteriorating Marriage

Once the divorce was evident, I met with her shrink to understand what happened. She said, two things: 1. We never had enough time before having a child, so no bonding making our marriage "parallel tracks;" and 2. I died a death of a "thousand cuts."



Chapter 15: Space Shuttle Challenger Explodes

That morning, I went to NASA Goddard for a meeting. I think the explosion must have happened while I was driving back to Headquarters. When I pulled into my parking space, members of my staff were waiting for me. "Charlie, Challenger's Exploded"

My Division had a low-cost small satellite called a "Spartan" payload in Challenger's cargo bay. My people had worked closely with Shuttle astronauts as they had to deploy and retrieve our small (2,200 kg) satellite using the Shuttle's "arm," formally known as the "Remote Manipulator System."

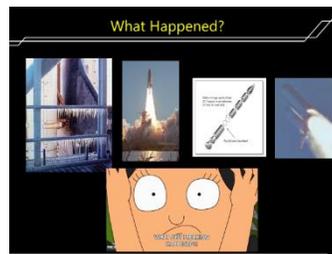
I wondered whether my very-low-cost satellite had broken loose and caused the explosion. I went to my office, asked my secretary to clear my calendar, closed my door and turned on the radio. It played Mozart's Requiem. When I went home that night, my daughter asked me whether I would be fired for this, as she, and children everywhere, had watched the launch at school to see the "teacher in space."

I told her that I did not know.

What Happened? The explosion of *Challenger* on January 24, 1986 surely team launched an ice-covered shuttle in weather. A Solid Rocket Motor's "field hot gases onto the liquid hydrogen tank" causing it to explode, killing the "teacher in space."

Video clip: National Geographic – *Hubble's Cosmic Journey* - This film clip is from a documentary on Hubble's 25th anniversary that extensively featured me. I do not use it with NASA teams, as it might be too painful. It is here for people who do not know anything about this, or for 4-D providers to use if they want to use this example. It gives them "bona fides" to talk about this.

Neil deGrasse Tyson narrated the entire documentary: "Then, in January 1986, NASA's Space Shuttles, the vehicle in whose payload bay the Hubble was designed to fit, are suddenly grounded." NASA Flight Director: "Challenger, go at throttle up" (Explosion) Tyson: "73 seconds after launch, Space Shuttle Challenger explodes killing the crew of 7 astronauts." NASA Mission Control: "Make copies of all your displays, make sure you protect any..." Tyson: "The Nation is plunged into grief."



of *Space Shuttle* rocked the world. The in below freezing joint" failed, spewing and oxygen "external entire crew, including

The Disaster's Root Cause? How happened? Were the people who boosters sufficiently technically have adequate management expertise knew many of the Shuttle propulsion worked with them on "Spacelab." They engineers and managers.) Would any (conventional) training have helped? Or, was the cause the "Social Context?"

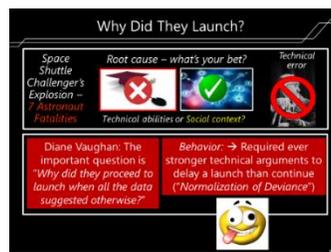


could this have managed the competent? Did they and experience? (I managers, as I had were first-rate additional

I was interested in learning what happened, so I watched the Failure Review Board's (the Roger's Commission) proceedings on television. When Board member and renowned physicist, Richard Feynman (one of my personal heroes) showed how the booster's "O-ring" material stiffened in ice water, I erroneously concluded that the mistake was technical, and lost interest. This is a common error that we technical people make – we assume that all problems that are apparently technical have technical rather than social root causes.

I later read sociologist Diane Vaughan's book, *The Challenger Launch Decision* (1996). She was "adopted" by the Board. She shifted the inquiry to the proper one, asking "Why did they proceed to launch when all the data suggested otherwise?"

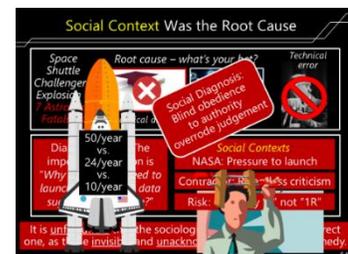
Why Did They Launch? She behavior, "drifting into requiring ever arguments to delay a launch than this "Normalization of Deviance." What competent, experienced managers to inappropriate behavior?



reported their odd stronger technical continue." She called could cause adopt such an

Social Context was the Root the only force strong enough to override their good judgement would have to be the Social Context emplaced by demanding hierarchal leaders. I have changed my opinion about "why" recently. The Shuttle was "sold" as providing much cheaper access to space than the rockets it replaced, known as "Expendable Launch Vehicles." The savings were to come from reusing the "Orbiter," and the Solid Rocket Motors recovered from the ocean. This turned out to be wrong as the Shuttle was far more complex than the rockets it replaced, and everything had to be "man-rated" imposing additional requirements on everything. By National policy, all payloads, military, spy, and commercial, would fly on the Shuttle. Thus, all other launch vehicles were phased out.

Cause: I suggest that



The initial claim was 50 flights per year, then 24, and at the time of Challenger down to 10. With the budget essentially fixed years in advance, fewer flights jeopardized the rationale for the program (and the manager's jobs), and in many people's minds, the Agency. And, the Shuttle is a "serial system," in that delays of one launch rippled

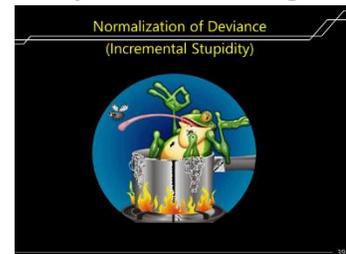
through all subsequent flights. Moreover, the Shuttle's complex payloads require retention of critical engineers, called "sustaining engineering" until the system is checked-out on-orbit. Thus, the political pressure to launch, launch, launch was enormous. Launch delays rippled throughout the system delaying the numerous downstream launches and increasing the costs per launch.

The *Social Context* altered the team's perception, a malleable human function which we will explore more deeply later.

Communications also broke down between Marshall Space Flight Center and Thiokol, the booster contractor. They called the government managers the "Bad News Boys" because all they heard was criticism. The O-rings were categorized as "Criticality 1 – R" meaning failure would lead to total loss of mission including loss of life and redundant because there are two of them. The NASA guys figured out that unless the first O-ring failed with the initial pulse, there would not be enough flow to seat the second. They never communicated this to Thiokol.

She also wrote (small re-editing), "It is unfortunate that the *sociological explanation* is the correct one, as these *invisible* and *unacknowledged* forces elude remedy." For me, this is one of the most important sentences, anywhere! In today's 4-D language: A flawed *Team Social Context* put "Good People in a Bad Place."

Normalization of Deviance: You are likely familiar with the story about the frog who was placed in water slowly heated and cooked to death. My colleague, Frank Martin, calls Normalization of Deviance "incremental stupidity."



Chapter 16: Hubble's Launch and Flawed Mirror

April 23, 1990

In April 1990, my eighth year leading the Hubble development team, we were ready to launch. Usually, because the payload is off, I view my launches in the VIP stand, lobbying for future budgets.

But Hubble was different. If we had an anomaly during the ascent phase and failed to take Hubble sufficiently high, there were two unpleasant options: 1) Leave Hubble in the cargo bay and land the Shuttle at the backup runway in Dakar, Africa which would surely contaminate it requiring complete disassembly and cleaning, which would take years; or 2) Deploy Hubble in a low orbit and hope to get a Shuttle up for a reboost before it reentered the atmosphere and burned up.

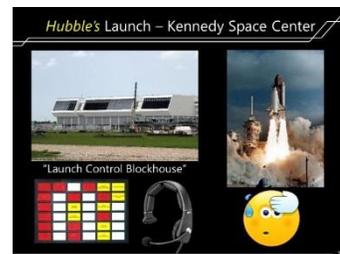
The agency decided that I would make this decision. This meant that I had to train in simulations ("sims") that included all kinds of failures. This was depressing. Fortunately, the ascent was "nominal," and I did not have to make the difficult decision.

Hubble's Deployment – Johnson Space Center: I then boarded a "Shuttle Training Aircraft," a modified Gulfstream-3, and went to Mission Operations in Houston. I was not trained to be "on the floor," so I observed the operations from a VIP room. My NASA Hubble people would visit and keep me posted about progress and issues.

Then, when we tried to deploy the solar arrays, they "stuck." This was a major problem. If we could not get them fully out, the astronauts would have to remove them, and we must put the telescope back in the cargo bay and return it to earth.

The operations team overrode the limits, and the arrays came out. We powered the core systems, all was good, so Hubble was deployed, and the Shuttle returned to earth.

First Light – Goddard Space Flight Center: We waited for about 6 weeks to open the aperture door and take an image. I went to our Hubble mission operations center at Goddard Space Flight Center to observe the event. I had my chief systems engineer, Jean Oliver next to me. The images appeared on the screen and everybody cheered. I was concerned that the stars looked blurry and asked Jean what he thought. He told me that they had not been sure about how the carbon-epoxy truss would change as it outgassed. Therefore, they biased the secondary mirror a bit out, so they would know which direction to move it. He said, "Not to worry."

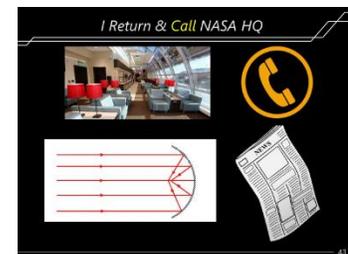


I Go to Japan for Meetings and Recovery: I have always enjoyed Japan and opened cooperation in Astrophysics when I returned to NASA from Harvard. My Japanese counterparts knew that I liked going to traditional Japanese inns, called "Ryokans." So, I met with my boss, Len Fisk and told him I planned to go to Japan and would likely be out of contact for a week. In those days, we had pagers, as cellphones were rare and expensive.



Len was a great guy and asked me if there was anything he could do for me while I was gone. I said, "Len, there will be medals in the rose garden at the White House for Hubble. I want to have President George Bush put my medal on me, not (vice president) Dan Quayle." We laughed a bit and I left for Japan.

I Return & Call NASA HQ: A week later I returned to the US. I landed in Saint Louis and went to an "executive lounge" to wait for my flight on to DC. Although I was tired (on "sake-time") I called my office in Washington. My secretary answered and said, "Have you spoken to Dr. Fisk lately?" I said, "No," and she said, "I'll put you right through."



I wondered what could be so important that Len would be immediately available, and thought "Maybe this is about the medals in the rose garden?" A surprising few seconds later, I heard Len Fisk saying, "Charlie, where are you?" After I told him he asked when I would be back in DC?" I said that I would be back in DC that evening, he said, "I'm glad to hear that."

He continued, "Charlie, what do you know about spherical aberration?" As I wondered why he might be asking, I replied, "I know that it is a common mistake by amateurs. They sometimes make mirrors with a "down-edge." A telescope with a spherically aberrated mirror is useless."

Len then said, "What would you say if I told we launched Hubble with a spherically aberrated mirror?" I answered, "I would say that you are annoyed that I had a good time in Japan, while you had to tend to the Washington bureaucracy. This is a really bad joke."

He persisted, but I remained unconvinced. He finally said, "OK, put the phone down, but don't hang up. Just find the front page of any major newspaper and bring it back." I returned with the "St Louis Times-Dispatch" in hand. He then asked me to read the headline to him over the phone. It said, "NATIONAL DISASTER, HUBBLE LAUNCHED WITH FLAWED MIRROR." "Now what do you say," Len asked? I replied, "You guys are really something. How did you plant a fake newspaper in here?" Later, I named this moment "denial is not a river in Egypt." Len closed the call saying, "Charlie, be in my conference room tomorrow morning at 7 AM."

I Return to NASA Headquarters: I walked into Len's conference room and was confronted by most of NASA top management. They angrily asked, "How did you let this happen?" Of course, I have no idea.



Len then brought me into his office and said, "We need a failure review board chairman and if we let the Congress pick one, we will get a lawyer." How about we form our own board and pick Lew Allen for chairman? General Lew Allen, the Director of NASA's Jet Propulsion Laboratory was an excellent choice. Len called him, and he readily agreed. Len named me as the NASA liaison to the Board because I was at that optimal intersection of political visibility and technical understanding of the telescope's systems. Besides, I joined the Division in 1982 and the contractor manufactured the mirror in 1977, so I had nothing to do with the flaw. Or did I?

We soon met in the contractor's plant in Danbury, Connecticut with ~8 optics experts for three days. People provided various ideas, and none of them seemed likely causes. The board dispersed, and I returned to DC.

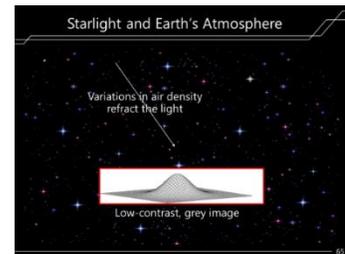


An Angry Congresswoman: Congressperson Barbara Mikulski, the chair of the Appropriations Committee that decided NASA's budget summoned me to her office. Administrator Dick Truly went with me. She was angry!

An Angry Congresswoman: About a year earlier she asked me if Hubble was going to work. What would you have said? "Maybe?" "I don't know?" Of course, the only possible answer was, "Of course, it will work" even though I did not actually know because there were requirements, e.g. the exquisite pointing stability that could not be tested on the ground. Because the *Space Telescope Science Institute* and *Goddard Space Flight Center* are both in Maryland, and central to Hubble, she publicly embraced the project.



Starlight and Earth's Atmosphere: If you went out in a dark place with a clear sky, and looked at the stars, you would see them twinkling. The stars are not changing. Turbulent inhomogeneities in the atmosphere are causing the light to move around, going on and off your retina. The effect on a detector on a ground-based telescope is to "smear" the light over a large area, reducing the contrast. If you had a detector on the ground the light from a star would appear as a low-contrast gray blob. (Modern ground-based telescopes use lasers and adaptive optics to address this.)



Hubble's Incredible Stability Requirement: *Hubble* has a relatively small primary mirror, 2.4 meters in diameter, in comparison to professional ground-based telescopes. So, how does it take such unbelievable pictures? It has more sensitivity and angular resolution because it is above the earth's atmosphere and the energy is much more concentrated.

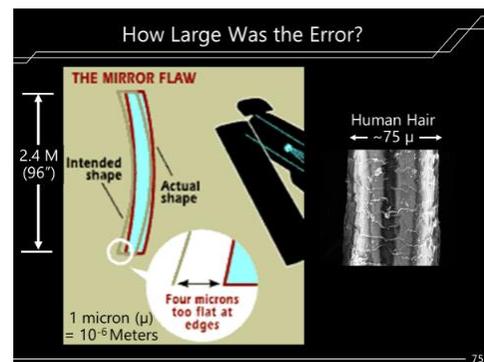


To realize this benefit, however, the telescope must be pointed very stably, in fact, nearly unbelievably stably – just as you must hold a camera steady to get sharp images. The specification is daunting. The telescope must point with a stability of 0.007 arc-seconds, for 24 hours at a time. Now, I suspect that you, the reader, have little notion of what this means.

Imagine that you could place a laser on top of the Washington Monument in DC and hit a 25-cent piece, a "quarter" with a diameter of 25 mm, on Empire State Building in New York City 350 kilometers away. If you were to point that laser as stably as *Hubble* points, the laser beam would stay within a circle half the diameter of that quarter for 24 hours at a time. To my knowledge, no one has ever attempted to build a system with this capability before or since *Hubble*. Moreover, if *Hubble* missed this specification by a factor of 10, it would likely still be the most precisely pointed system ever built, but the telescope would be worthless as its optical performance would be no better than its ground-based competitors.

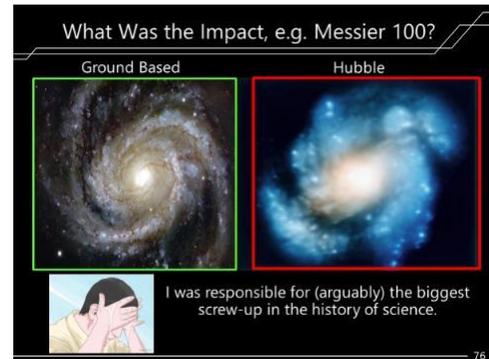
Background of the Flawed Mirror

You can, of course, read about the events surrounding Hubble's manufacturing flaw in *How NASA Builds Teams*. Here's a backstory that few people know. The maximum resolution of an optical system is the "diffraction Limit," or 1.22 times the wavelength of the light divided by the diameter. We wanted the best performance possible, which would be at Hubble's shortest wavelength, the ultraviolet. Eastman-Kodak had manufactured two mirrors which were within a factor of two of performing at the diffraction limit. Perkin-Elmer had a novel, computer-controlled process that could meet that goal. The key measuring device was a reflective (i.e., mirrors instead of the usual lenses) "null-corrector." We tested it on a 60-inch mirror, and it was perfect. The simple task of re-spacing it for the 96-inch flight mirror was off by 1.3 mm. This caused a gradual error in the flight mirror with a maximum of 4 microns at the edge! (A human hair has a diameter of about 75 microns.)



What Was the Impact on Optical Performance?

What were the consequences of such a small error? The difficulty is that in order for a telescope to focus, the light must reflect onto a common point on the "optical axis," a line centered on and perpendicular to the mirror. With this kind of error, the light focuses on a different location on the optical axis as a function of the distance away from the center of the mirror. Thus, it is impossible to focus such a telescope. The French astronomer Messier published a catalogue of 110 astronomical objects in the late 1700's. Messier "100" is a large spiral galaxy in the Virgo Cluster about 55 million light years from Earth. The image on the left is from a ground-based telescope and the image on the right is the best Hubble could do. I was (arguably) responsible for the biggest screw-up in the history of science! Even though the Chairman of the failure named the root cause as a 'leadership failure,' NASA colleagues did not blame me as everyone treated Perkin-Elmer with the same criticism.



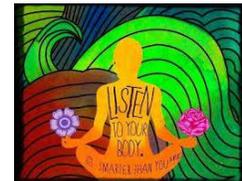
My Psychological Preparation

Some years prior, I had initiated a messy divorce. This turned out to be a very traumatic experience as she did everything possible to punish me for wanting to leave her. I tried psychotherapy, but the people I encountered were crazier and needier than I was. Desperate, I enrolled in a workshop at a place called Esalen Institute in Big Sur California. This turned into a life-changing experience including drumming, smelling the earth and a nude (non-sexual) massage by a beautiful lady.



Somatic Psychology

I enrolled in many psychological workshops after that including a "certification" in somatic (body) psychology by Kate and Gay Hendricks. I learned to attend to the state of my body by "feeling my feelings," breathing into them, then using techniques from cognitive psychology to manage my thoughts, and, in turn my emotions.



I Choose Response-able Over Drama

So, when I returned to my office after meeting Mikulski, I noticed that I was feeling 'lousy.' I knew that this was indicative of a "drama-state." So, I checked my thoughts, which I now call "Story-lines." I was running "I cannot attempt to fix the telescope, because I have been forbidden to do so by Chairman Mikulski and Administrator Truly." I realized that I was in the drama-state of "Victim." Then, I thought, what is the worst that they can do to me, fire me? Well, if I cannot fix the telescope, my career is likely ruined anyway. So, I replaced my "Red" Story-line with



“Green” ones, “I can fix the telescope” and “I will fix the telescope.” This, in turn shifted my emotions to energizing “glad group” emotions.

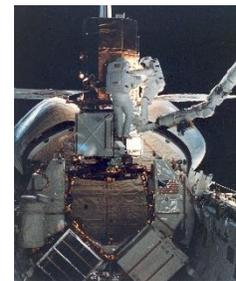
Greg and I “Find the Money”

I called my budget analyst, Gregg Davidson, into my office and said, “Greg, I want to move \$60 Million into a secret account to fix Hubble and we cannot tell anyone because I have been forbidden to do this by both Mikulski and Truly. He was willing to do this, and we had the money an hour later. At the time, we had no viable concept for how to do this technically!



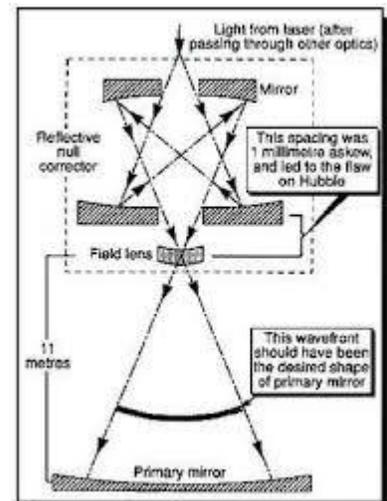
Goddard Servicing and the “Institute” Look for a Fix

I then called the only people with relevant expertise, the servicing organization at Goddard Space Flight center, who had worked with me to repair the Solar Maximum Mission in space several years earlier. I briefed them, and they enthusiastically joined with me. Scientists from the Space Telescope Science Institute met with me and we discussed various technical possibilities. They asked me for \$50 thousand dollars for technical analysis, and I granted it immediately. Note: This was prohibited by the procurement rules that governed our behaviors.



Flawed Assembly of the Null Corrector

I traveled to Perkin-Elmer’s plant in Danbury Connecticut to participate in the third meeting of the Failure Review Board. The “wizards” were stumped. Then, an optics expert from the university of Arizona, Roger Angel’s group, said “I did a calculation last night and if the mirrors in the “null corrector” were misspaced by a millimeter, we would see the aberration that we observe.” This seemed like an impossibly large error in a sub- micron optics shop. Perkin-Elmer stated that they had the original null corrector in “bonded storage.” During lunch, they brought it to our meeting room and the technicians measured the mirror spacing and found about a millimeter of error. (You can read more details about this in *How NASA Builds Teams.*)

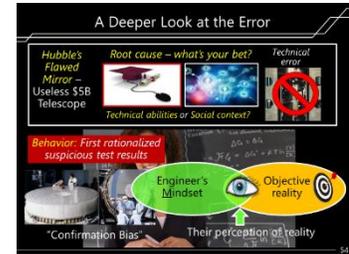


I Thought, “I Dodged a Bullet”

I returned to my NASA office in an upbeat mood. I (incorrectly) believed that I would not be blamed for the flawed mirror as the error was made in 1978 and I joined the Division in 1992. More importantly, it slowly dawned on me that since the flaw was systematic a technical fix might be possible.



A Deeper Look at the Error. So, what do you think caused the flaw, in such a large and carefully reviewed program? Do you think that the scientists, engineers, and managers who worked on *Hubble* were inadequately trained or experienced? (Forgive me; this is a “rhetorical question,” a question asked to make a point, with no answer expected.)



Lew and the optics experts met in Perkin-Elmer’s plant on two more occasions. Nobody could figure out what went wrong.

Mirrors like Hubble’s are fabricated with an “indeterminate” process – the surface is measured, then polished to remove the “bumps,” then re-measured for many (~20) cycles. A device called a “null corrector” creates an optical wave front that shows differences from the desired surface. An image of Hubble’s null corrector is on the upper left. As I recall, the device was several feet high and a foot or so across.

Hubble’s null corrector device was thoroughly tested with a 60-inch test mirror. Hubble’s 96-inch flight mirror required a simple re-spacing. The Board discovered that a technician, working alone, violated a procedure and mis-spaced the “null corrector” by 1.3 mm.

FYI – The technician placed a precision bar provided by the National Bureau of Standards in the center of the null corrector to re-space it. The instructions said to spray a metal cap on the bar with a non-reflective coating. He could not locate the spray, so he covered the cap with non-reflective tape. He then took his “Xacto” knife and cut a hole in the cap. He did not notice that he chipped off a small piece of the tape. Then, as bad luck would have it, when he tried to center the metering bar, the laser beam hit this spot. Believing that this was the center of the metering bar, he mis-spaced the device by the height of the cap, or 1.3 mm, an enormous error in an optics house with routine sub-micron accuracy.

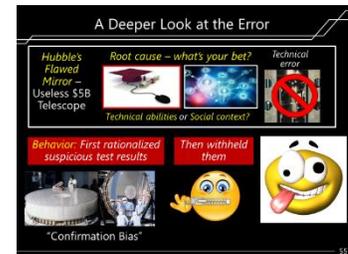
When the Review Board discovered that this is what happened, my relief was profound. A person working alone made a dumb mistake. It appeared that, for once, bad NASA management did not cause the failure, and with the problem solved, I could go back to my regular job, directing the Astrophysics Division. I felt relieved.

Things then took a turn for the worse. General Lew Allen, the Review Board’s Chairman soon found that many, many measurements of the mirror with other devices (i.e. *refractive* null correctors) were rationalized away. I thought of this bad luck – the spacing error was large enough to ruin the telescope and small enough to be rationalized away by people who wanted to do so.

For example, P-E engineers saw a half-wave of error when they placed the mirror in the flight-mount and turned it sideways to continue assembling the telescope. Not wanting to believe the mirror was flawed, they did a calculation to see how much the mirror would bend under gravity. The engaged a common human phenomenon called

"Confirmation Bias." They likely tweaked the parameters until they got the desired result. Lew understood how this could happen.

A Deeper Look at the Error: He then wondered why NASA's scientists had not insisted on additional mirror testing in view of the suspicious test data. Several of them had worked on ground-based telescopes and understood the perils of this kind of mirror manufacturing error, called "spherical aberration." He then discovered that the contractor, Perkin-Elmer, *had never revealed* the numerous test discrepancies to NASA. (We sued them and settled for \$50 Million, far less than the cost of the flaw.)



Lew Allen Reports to the Congress: When the investigation completed, Lew as Board Chairman, told the Congress that, after 15 years and \$2 Billion, a "leadership failure" was the root cause. If the terminology had been available in the lexicon of the day, he surely would have named the cause a "*flawed social context*" caused by relentless criticism of the contractor by NASA officials.



Of course, I was leader of the *Hubble* team, and had been so for the previous 8 years. It was my good fortune that nobody at NASA paid much attention to the Board's finding. Everyone focused on the technical mistake, just as I had with *Challenger*. Moreover, I was so busy managing the aftermath that I had no time to think much about my culpability.

So, what happened? Hubble was difficult technically, and we had an ineffective management arrangement, "associate contractors." The project overran multiple times taking the final cost to \$5 Billion (in today's dollars). Our NASA perspective was that the contractors were to blame for the cost increases, so we collectively rained criticism on them. This *Social Context* field of relentless criticism led them to only reveal technical problems that they believed were real, and there were plenty of these. In their highly stressed condition, they never contemplated that the mirror could have been manufactured incorrectly. (The mirror cost was about 0.5% of the overall program cost.) Moreover, the context motivated the contractor to "rationalize problems away with (sloppy) root cause analysis," and then not report them to NASA. *The remedy to this condition would have been incredibly simple.* Habituating the first 4-D behavior, "Expressing Authentic Appreciation," could have, in my opinion, prevented Hubble's launch with a flawed mirror. *I wish I knew then what I know today!*

Ball Aerospace and the Hubble Science Institute

I was meeting weekly in Washington with the VP of Civil Space at Ball Aerospace, Ed VanderNoord, who was concerned with my mental state, given the stress. We would have a relaxing lunch and he would update me on progress. He had a team working with the Institute scientists looking for a fix. After some weeks, Ed reported that an optics expert, Merk Bottama, had shown that if a small mirror, exactly the inverse of the error in the primary was placed at the proper place (a "pupil" I believe), reflecting the light up to a "flat" then down into the telescope the flaw could be corrected.



An Extraordinary Fix!

There were a number of technical issues, first a set of precise mirrors was required for each of the four "axial" instruments and the three "Fine Guidance Sensors." The Wide Field/Planetary camera already had four relay mirror sets so it could self-correct with a replacement. The small inverse mirrors must be proportionally misshapen just like the 96-inch primary mirror. Incredibly, a company (Tinsley) could manufacture these, removing glass one molecule at a time.



A Hotel Shower Inspires

Then, how to place them in precisely the right places. Jim Crocker, from the Science Institute, figured out how to do this, inspired by a telescoping shower in a Hilton hotel. Finally, how for astronauts, working with balky gloves to install them? An idea emerged to remove one of the "axial" instruments, build a replacement instrument, and install it as a unit. Bob Bless's High Speed Photometer was an obvious candidate and he agreed. Hubble was designed for instrument replacement and the astronauts trained extensively for this.



Nobody Cared

Now that we had a possible technical solution, I went public with my transfer of funds. People were so happy that a fix was possible that nobody was motivated to punish me for moving the money around. Now, I could formalize this as a NASA flight project.



A Retrospective

Several of us who were in the program during those days were talking about this recently and now see what Mikulski as giving me (and NASA) a great gift. If she had said to me, "Charlie, include funds for fixing the telescope in the next budget request," it is likely that I would have done that. Then, we would have not tried the fix until 5 or 6 (or more) years later. Hubble was losing gyroscopes, and it would likely not



have been stable enough to capture with the Shuttle's "arm." The mission would be a total loss.

I was filmed in several science shows for Hubble's 25 anniversary in 2015. An LA screenwriter saw me in one of the shows, National Geographic's I suspect, and asked if I would give him "life rights" to a movie about my life and Hubble. I agreed, signed a contract and some months later, he finished the screenplay.

It took some time for us to engage an excellent company, "All 3 Media" to produce the "movie" later filming me in a "Sizzle Reel" to market to the networks.

Video clip: "Sizzle Reel" - THE 80s WERE AN AMAZING TIME TO BE ALIVE

(screen) And nothing was hotter than space

Just a few seconds away from blasting off here at the Kennedy Space Center at Cape Canaveral Florida

Bye Christa,, Bye Crew

What's happened?

What happened?

And then, everything changed

(Reagan) We mourn their loss as a nation together

(Charlie) Challenger was the 51st Shuttle flight and NASA marketed the thing as routine space access, and believed it, erroneously

What do we do now? And, we didn't know

I'm Dr. Charles Pellerin and I led the Hubble Space Telescope development program for eight years

I think launch may have been 6 months out when Challenger happened, and we got now delayed

(screen) AFTER A 3 YEAR DELAY

(screen) ALL EYES WERE ON HUBBLE

(Charlie) I don't think you could find an astronomer or scientist who wasn't excited about Hubble – This was clearly going to be a big deal

I wanted to have a low-key launch. I wanted to kind of quietly launch Hubble and make sure that it worked, and this was a joke. Three months before the launch, people were already lining up at Cape Canaveral getting ready for this. The Hubble family was there selling their electrical connectors.

(Nightline) Dr. Pellerin, you have been involved with this project for eight long years, what are your thoughts on the night before we all hope this telescope goes up into space?

(Charlie) Well, Chris, I think I feel like people must have felt when they saw Columbus sailing off to discover New Worlds.

It goes back to Jules Verne. You know, the idea of a telescope in space just has a lot of appeal for ordinary people.

(announcer) Start, 2, 1, ignition, liftoff of space shuttle discovery

(Charlie) Hubble finally launched in April 1990

(Barbara Mikulski) Hubble telescope, the greatest telescope since Galileo invented the first one

(Charlie) All NASA top management is in this conference room and I walk in and they are all made saying, "How did you let this happen?" Well, I had no idea what happened. Zero.

(Len Fisk on the phone) Well you launched Hubble telescope with a flawed mirror. (me) did not, (Len) did so, did not, did so, did not, did so

(Charlie) "OK, Stop" I could not believe it. I was literally in denial. So, the first three days and nobody knew what happened. Nobody could figure it out.

The Congress has these "hearings" – no one is hearing anything. They should better be named as browbeating or bashes.

So, I get summoned to Barbara Mikulski's office. And, she's mad. Barbara Mikulski was a congress person at the time, and she was the chair of the Appropriations committee that dealt with NASA's money. That's a more powerful job than being the Administrator. She decides what money we get. So, I walk in there and she throws newspapers at us, then she starts screaming at me so much that spittle is forming on my glasses. She takes her finger and shoves it in my chest and says, "There will never be an appropriated dollar to fix this telescope, this is a nightmare that has to go away."

My first thought was "I can fix the telescope" and the second thought was "I will fix the telescope."

FROM all3 media AND WOODMAN PARK PRODUCTIONS

COMES THE INCREDIBLE TRUE STORY OF THE HUBBLE TELESCOPE

We were all on fire. You couldn't keep us out of the office. Nobody had time for the nonsense of review boards.

You are not allowed to do this. You can't just give someone 50 thousand dollars. I have go with a competition, peer review process. I ignored all that stuff, "50 grand, you got it."

A SCIENTIFIC ACHIEVEMENT THAT CHANGES THE WAY WE SEE THE WORLD.

The images just blew people away. In our imagination, I think we saw images, or in a textbook or movie and thought, "That's kind of interesting looking." But the Hubble images were mind-blowing. Hubble was great science, but it did more than that, it took the whole world on a journey with it.

Fearful? Ask Two Questions: People often say to me, "Charlie, what a great act of courage." I learned many years ago that fear can be a good and useful thing, and one

would be mentally unwell to never experience it. I have learned how to take action in the face of fear. When I was about eight years old, I became a fan of an American frontiersman, Davy Crockett, including a coonskin hat. The saying that I learned was, "Be sure you are right, then go ahead." Now, I have become a bit more sophisticated with two questions: First, is it the right thing to do? And that was easy. Second, am I competent to do it and that was easy also. I automatically moved into the focused state of "100% Committed" which we will explore later, and action was easy and natural. I think of it like Bill Halsey: "There are *no great men*, just great challenges that *ordinary men*, out of necessity, are *forced by circumstances* to meet."



Video clip: *National Geo. – Hubble’s Cosmic Journey - Neil deGrasse Tyson: Perkin-Elmer’s decision to complete the mirror without final testing is not communicated to Pellerin.*

Charlie: Perkin-Elmer stopped telling up about things that they thought would have upset us that they could rationalize away. I was 38 years old when I got that job and I had never managed a multi-hundred-million-dollar project before. And, so I assumed that the people before me knew how to do it, and they didn’t.

Tyson: Amidst a breakdown in communications, a serious flaw had crept into the mirror, and no one had realized it.

Blue Note Lounge - Naked Gun 2 1/2: The aftermath of the discovery of the mirror flaw was awful. Newspapers all over the world blasted NASA and my team. I avoided late-night television. The Hubble mirror failure even made its way into comedy movies. In the movie *Naked Gun 21/2*, the camera pans across an image of the Titanic sinking, the dirigible Hindenburg on fire, and ends with an image of the Hubble like the artist’s concept painting that hung in my office at NASA! There was no escape.



Social Context Management → Success: After about six weeks, we had found a possible technical solution. And I was beginning to connect John Mather’s comment on social influence and Lew’s Allen’s comment on “leadership failure.” As the servicing mission was, in many ways, more difficult than the original development, I was becoming concerned. A failed servicing mission would be a fatal blow. I understood the power of appreciation, as I will describe later. I already understood the necessity of 100% Commitment to sustain hope.



I assembled my leadership team and said, “I insist that you habituate two behaviors that I have mastered: 1) We will all appreciate more than we criticize, and 2)

You must demonstrate 100% Commitment to mission success to sustain hope and team energy. If I see any of you failing to do this, I will remove you.

Early on, I became concerned that the project manager at Goddard was insufficiently committed to the task. He was casual and lazy, and I decided to remove him in a way that “made a statement.” Just then, a person I did not know, John Kleinberg was appointed Director of Goddard and making noises that he was going to take over management of my (and other Space Science) projects. John was on vacation for several weeks on his sailboat on the Great lakes. With Len’s concurrence, I ordered the Coast guard to find him and order him to report to us, immediately. He soon arrived mad as hell and refused to look at me. He turned to my boss and said, “What the hell is going on here.” My boss pointed at me and said, He’s my man.” I said to John, “I am 100% Committed to fixing Hubble, and your project manager is not up to the task. I am not willing to wait for two weeks for you to report to work. Go to Goddard, fire him and provide a suitable replacement and you can go back to your boat.” He did this that afternoon, appointing Joe Rothenberg – a perfect candidate.

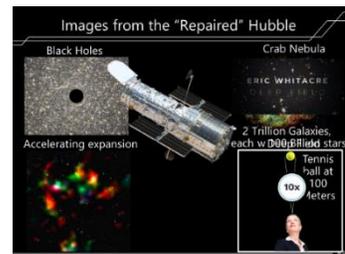
Social Context Management → Success: About 18 months later, the NASA Administrator promoted me to the “front office,” reporting directly to him. I was unhappy, as the job was mostly about politics. I arranged a sabbatical and became a “Professor of Leadership” in the Business School at the University of Colorado (“CU”). I watched the servicing mission succeed from CU.



Images from the “Repaired” Hubble: You are likely familiar with many of the fantastic Hubble images. Hubble confirmed the presence of super-massive black holes at the centers of galaxies.

Hubble also confirmed the presence of “dark energy,” observing that the Universe is expanding at an accelerating rate, a remarkable finding.

My favorite image is the “deep field” which has been reimaged three times. This was a black patch of sky that was completely unremarkable. We gave the Director of the Space Telescope Science Institute discretionary time. The second Director, Bob Williams, saved until he had 100 hours of time, and used it to stare into this patch, despite lots of detractors. The result was amazing, as the field was full of galaxies. Because this was a “deep” look, we are looking back in time to the early universe. Thus, we can estimate the total number of galaxies, currently estimated at 200 trillion, each with 100 billion stars!



This image motivated composer Eric Whitacre to compose a symphony called “Deep Field” which plays with the slide.

We understand the physics of “big bang.” It made mostly hydrogen with no heavy elements, e.g., carbon, nitrogen, oxygen common on earth, including our bodies.

These are made in large exploding stars called supernovas. The Chinese recorded a supernova in 1054, called the "crab nebula." Hubble took a beautiful image of this "remnant."

Chapter 17: The "Penta" Club

Dating Ladies

I did not interact with Tony much in the office and heard that he had divorced Cheryl. I was in the process of divorce and living by myself in an apartment near my office. At the time, the best way to meet women was to run ads in Washingtonian Magazine. I thought about obstacles to meeting the quality of women that I wanted. They must have worried about meeting a man they don't know, even in a public setting. So, I gathered Tony and three other guys I knew were single to form the "Penta Club." Two were colleagues from NASA, Steve Fogelman, and Ron Felice. We met in my apartment and drafted an ad talking about the 5 of us, and that we were inviting 5 ladies to join us at a restaurant near a Metro stop for cocktails and hors d'oeuvres. We received more than 100 letters with photos.



The First Event

We five gathered at my apartment with pizza, opened the letters and selected invitees. Then I requested and obtained agreement on some ground rules: Every woman, no matter how different they were from the photo they sent us would be treated with respect; and irrespective of how attracted you found someone, no more than 15 minutes with anyone, as we had their contact info and you could contact them later. The first event did not generate any lasting relationships, but something unexpected happened. Several said they had a great time and would refer girlfriends to us. After a few of these events, we were all in relationships, with Steve eventually marrying Cindy, who he met at the second event. What a hoot!



More About Tony

Between working together, sailing and the Penta Club, Tony and I developed a deep friendship. Junko and I stayed with him and Jeanne at their home in McClean and they stayed with us in Boulder. My son, CJ took a year off after graduating from Clemson as a Civil Engineer. He could not get job without experience and could not get experience without a job. CJ was living with me when Tony came to visit, now CEO of Raytheon. At dinner (with lots of wine) I asked if he could give CJ a job. Tony said, "I don't need any civil engineers, but get a master's in IT and I'll hire you." CJ did and soon had a job in the classified world in Raytheon Denver!



Tony's House Inspires Us

Tony got quite sick and never fully recovered, although had a more or less normal life. He and Jeanne bought a house on Whidbey Island, north of Seattle and only accessible by ferry. Junko and I visited them and loved the panoramic view of Puget Sound. I said to Junko, "I love this big view, let's buy a house that has one." So, I developed three criteria and we began looking: 1) Big view; 2) Efficient air travel; and low taxes. We looked for a year and bought our current house in Boulder. Thanks Tony and Jeanne for inspiring us!



Tony Dies

Tony died some years and Jeanne had a ceremony in Washington and asked me to come and tell about the Penta Club. Unfortunately, I was scheduled to do workshops in China at the time. Tony, I sure miss you!



Chapter 18: More About Hubble

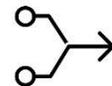
Hubble's Flawed Organization

Hubble was a difficult project for everyone involved. Marshall had the NASA lead and management of the two contractors while Goddard was responsible for the instruments. (What a mess!) This arrangement was negotiated early in the project and somewhat driven by the demands of the "spy-satellite" community. The "associate contractor" approach, with two co-equal contractors, Lockheed-Martin and Perkin-Elmer, meant that Marshall had to do the systems engineering that a "prime" would normally perform. Unfortunately, they did not have the capability or insight to do this across these extraordinarily complex systems. The ("Blue") Science Working Group was from the ground-based astronomy community and did not like the way ("Orange") NASA did business. And there was the intermittent (and unusual) self-insertion of the NASA administrator, Jim Beggs and (lawyer) Sam Keller.



Why Didn't I Consolidate the Centers?

You might ask why I did not consolidate everything at one Center earlier as I did later for the servicing. By the time I took over, this would have been near impossible given the expertise and contracts in place. Moreover, there would have been a political firestorm that I could likely not manage.



Why Didn't I Consolidate the Contracts Earlier?

And it would be fair to ask why I didn't consolidate the contracts under Lockheed earlier? Perkin-Elmer had the bulk of really difficult technical problems and we had, I believe, their best people on the job, technically and managerially. In contrast, we were a ridiculously small and low-profit element of the work at Lockheed/Sunnyvale. I recall hearing that our work was only 3% of that "division." I believe that we did not have the "B-team," but rather the "C-team." Now, one could have argued that if we made them "prime" earlier that we would have gotten better people. I did not give this much thought and if I had, I think it would appear as a dangerous experiment! I finally made this change out of necessity.



Marshall's (Monster) Quarterly Reviews

We reviewed the project in multi-day Quarterly events in Marshall's biggest conference room with upper management, including Marshall's Center Director, Bill Lucas present. Although I never had any difficulty with Bill, he was known to "kill the messenger," humiliating people who brought him bad news. Thus, it was a common belief that the best way to find out what was going on was informal conversations with people outside the formal



review. At that time NASA budgeted Civil Servant's salaries separately from project funds. Thus, a Center Director can place employees as they chose. And Bill Lucas loaded people on Hubble. There was theatre style seating in the back of the conference room which filled with engineers who changed with each topic! I never saw so many people on a project! And too many government employees can make the contractor inefficient with too many questions and change orders.

Streamlined Reviews

In those days (before Dan Goldin) external review committees were not in general use. I liked what we did with Hubble. We invited 4 or 5 experienced project managers to sit in the audience. Then at the end of each day, I, the project manager, and other senior management would meet with them listen to what they had to say. We would assign the project actions as we saw fit. They would also attend design reviews, but did not write actions, e.g., "Review Item Discrepancies." This was, IMHO, highly effective with competent people providing sound advice. And I liked the way it made the proper people accountable.



Monthly Reviews in Nashville

I needed better and more up-to-date information. The question was how to do this without undue burden on everyone doing the work? I got the idea to rent a room in the Nashville airport and meet without people like Lucas and Keller present. The Marshall folks went in a van and those in the DC area went via my Gulfstream (G-3) or commercial air. I liked that this only required one-day for all. We had an agenda that was pretty much what the team members wanted to talk about. The mood was friendly, and information was freely exchanged. And, of course, I made frequent site visits to the contractors. (The airport at Danbury was challenging. On one occasion the G-3 pilots insisted on taking off empty and meeting us at a nearby, larger airport.)



Hubble Failed its T-V Test

We tested the completed Hubble in Lockheed's "Thermal Vacuum" ("T-V") chamber at Sunnyvale. This simulates being in space with a vacuum and an artificial sun. Jim Odom came to my office and said, "Charlie, Hubble failed the T-V test. We have a problem with the MLI (Multi-layer Insulation). I have the team working on this and will have a recommendation soon."



A Difficult Choice

This was a difficult situation. If I decided to launch without a re-test and we had a problem on-orbit, I would be in real trouble. On the other hand, a re-test would mean a 3-month delay and \$25 M more dollars. Moreover, the test facility was near the San Andreas fault and used oil diffusion pumps. An earthquake could allow oil on the telescope which would be a disaster because only one molecule thickness of oil on the optics would prevent observing Ultra-Violet radiation, an important capability. The engineers explained the problem and how they thought they could fix it. I trusted their honesty and analysis and decided not to re-test.

HQ S&MA Challenges Me

The Headquarters Safety and Mission organization wanted a re-test. I told them I was not going to do it and they backed down. I suppose the fact that they were on-record was enough as they would win either way. If I was wrong they could blame me and if I was right, nobody would care. And I was right. Whew!



Reversing the Center Directors

At the close of one of these Quarterly sessions, Bill Lucas and Goddard Director told me that they had agreed to keep the servicing responsibility at Marshall until after the launch. This was in one of our more-or-less private meetings at the end of the day. I blew up, and said, "You are not! Servicing will transition immediately as we agreed previously. What if we have an issue right after launch?" Although they theoretically outranked me, they both sheepishly agreed. I suspect they were trying to work manpower issues. Marshall, with not enough work, concerned about layoffs and Goddard with too much work, concerned about performance.



A Terrible Presentation

Some months before launch, we convened at Marshall for the "pre-ship" review. We were evaluating the readiness to fly the telescope from Sunnyvale (using Moffett field) to the Shuttle landing runway at Kennedy Space Center. Ron Felice (Penta Club) made Goddard's operations readiness presentation, and it was awful. When I said so, directly to him, the room went silent. I guessed that this would take months to fix.



My Shocking, "We Won't Sign"

When the day ended, Marshall's Center Director, Bill Lucas said, "OK, let's sign the pre-ship certificate." I quickly spoke, saying "We are not signing." I was there with my boss, Len Fisk, who looked at me, surprised. Lucas ignored me and now addressed Len, saying "We always sign this." Before Len could speak, I said "Goddard operations are far from ready. We are not signing a pre-ship certificate until the ground system is ready to



operate the spacecraft." Len looked at Lucas and said, "We are not signing." Then to me, "Charlie, let's go to the airport. We will come back when Goddard is ready." What I was trying to do is "build a fire" under Goddard to bring urgent attention to this system. Noel Hinners, Goddard's Center Director, was present and I wanted to embarrass him for this disgraceful presentation. This would also cause a slip in the launch which would be big news. Moreover, the telescope was safer in a clean room at Sunnyvale than Kennedy.

Engaging Sad to Move Through Hubble Losses

The aftermath of discovery of the Hubble mirror flaw provided me an important sadness experience. During the tragic fallout of Hubble Space Telescope's flawed mirror, Ed Weiler, my Hubble Program scientist said to me, "Charlie, you have to do something. The astronomy community is tearing themselves apart. They are spewing hate and venom in their e-mails."



Upcoming AAS Meeting

The American Astronomical Society was meeting in Philadelphia in about two weeks. I called the conference chairperson who said, "All the available time is booked already. I am not willing to displace a researcher to give you time. However, I will put you on at 6:30 PM Thursday, and use posters to let people know that you will be speaking. Nothing else is scheduled at that time. I do not know how many people will come, so, I will place your talk in an expandable room. That way if only a few people choose to attend, you won't be embarrassed." This was fine with me.



Reflecting on the Train

My first opportunity to think about what I would say was riding on the train from Washington to Philadelphia. Then, it struck me. This was a loss, and the proper response to a loss is mourning. The work that these technical people required was on the emotional side!



Standing Room Only!

I arrived in the small room about 30 minutes early. As 6:30 neared, the room filled and filled. As promised, the hotel removed the partitions making the room larger and larger. It looked to me as if everyone at the meeting was coming to hear NASA's Astrophysics Director speak about Hubble. I walked up to the podium and said, "We all need to be clear about what's happened. We have all suffered losses. I have lost my reputation for competence, and embarrassed NASA and my country in the eyes of the world. Many of you bet your careers on this telescope. Your graduate students bet their degrees on Hubble. We have all suffered losses. The proper response to a loss is to mourn it. So, let's take a few minutes to feel our sadness so we can properly mourn our shared losses."



Feel Your Sadness and I Will Fix it!

I bowed my head and felt my own sadness. I heard sobbing throughout the room. I waited for what seemed like a very long time but was probably a minute or two. Then I blinked my eyes to clear them and said, "Complete this process in whatever way you need to. I will now tell you my plan to fix the telescope with a space repair mission. I finished my speech and took a late evening train back to DC. The next Monday afternoon, Ed walked into my office and said, "I don't know what you did but they are settled down." I said, "Ed, it's simple, we just took the time to mourn our losses."



Moving Feedback

I am really moved when I hear from workshop participants that they are using learnings from my workshops. A lady from a JPL e-mailed me saying, "Charlie, I was really moved by your story about mourning the Hubble losses. I gathered my children last Saturday, and my children and I finally mourned their father deserting us. For the first time, we have moved past this loss, thank you."



David Writes a Movie About my Life and Hubble

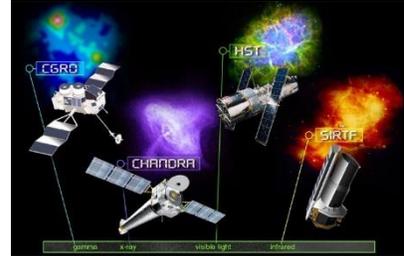
(Fast Forward about 25 years) I was filmed by several science shows for Hubble's 25 anniversary. An LA screenwriter, David Frigerio, saw me and e-mailed me asking whether I would give him "life rights" to write a movie about me and Hubble. I asked book agent and she asked her lawyer. She reported that he said, "Absolutely not." Frank and I met David in Pasadena (we were there doing a workshop) and were Impressed! I happily signed his proposed contract and 6-months later, he finished. We have a producer and are now looking for a suitable network!



Chapter 19: The "Great Observatories," My Greatest Accomplishment (after 4-D)

My Second Greatest Accomplishment (after 4-D)

I get a lot of public attention for my decade-long leadership of the Hubble development team, and especially for mounting the servicing mission that fixed the telescope. However, the telescope would surely have been flown if I was never there. I made some important decisions that I will describe later, and some mistakes which I will also describe. However, it's not likely that Hubble would have been serviced had I not been Director as I will also explain later.



We Need Two More Missions

Frank had started Hubble and the Gamma Ray Observatory, and we had a common strategy to follow these missions with two more missions measuring the last two bands of radiation that could travel through space, infrared, and x-ray radiation. (Radio waves also travel through space, but because they travel through earth's atmosphere, ground-based telescopes can measure them.) We had defined two missions to do this, the Advanced X-ray Astrophysics Facility, "AXAF," and the Space InfraRed Telescope Facility, "SIRTF."



IR and X-ray Debate

My first year as Director went by quickly with lots of attention to Hubble, and the rest of this large program. I had an open-door policy, and although my schedule was packed I spoke with everyone I could fit in. X-ray and infrared astronomers came often to lobby me to do their mission next. I suspect that they were afraid that the next mission might be the last for a long time given the Hubble overruns. Of course, we did not know or even suspect a flawed mirror at this time.



I Do Not Engage

I might have fallen into the trap of debating this had I not attended Harvard. With a fresh mind, I refused to engage in this discussion as neither supplanted the need for the other. In fact, it seemed to me that the opposite was true. Either mission would stimulate more need/desire because they looked at very different aspects of the same objects. Moreover, if I could invent a credible strategy to get all four, the entire community would support the program politically. But how?



How to Persuade the Funders?

The biggest problem that I had was the near total absence of scientists in the DC decision apparatus. I had to persuade these people of the merit of these additional missions to get additional telescopes funded. Their question was always, "Why do you need so many telescopes?" I tried everything I could think of to answer this question. I tried to explain this myself, and peoples' eyes glassed over. Most were lawyers with limited science interest. I tried evening social events on the "Hill," funded by my contractors, with food and beer/wine and prominent scientists speaking. We had excellent attendance, more for the food and drinks, I suspect. And, we had minimal influence on our mostly "staffers" attendees.



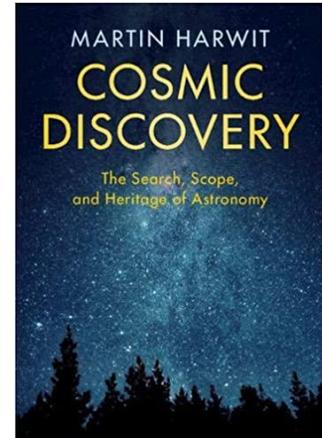
My Resources

I had, I thought, two resources to call upon. First, my mental "reset" in the Social Context of Harvard Business School mentioned earlier. This was my first experience of incredibly smart businesspeople. I worked, lived, and drank with these folks for 16 weeks. Second, I am a physicist, not an astronomer. In fact, I do not find astronomy particularly interesting, at least not in contrast to astrophysics.



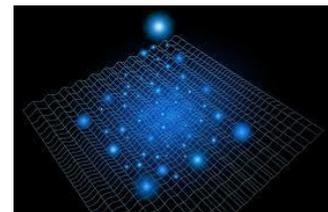
"Cosmic Discovery"

Dave Gilman pointed me to a book by Cornell physicist Martin Harwit called "Cosmic Discovery." (Frank Martin says that he discussed the book with me when I was his deputy, but I do not recall this. And I take him at his word.) The book had two ideas that greatly impressed me. First, there was list of about a dozen interesting, unsolved astrophysical phenomena. For example, how does an event, e.g., gamma ray burst, emit as much energy in a few seconds as our sun in its entire 10-billion-year lifetime? (Dear reader, does this interest you?) Next, persuasive data showed a high correlation of advances in measurement technology with discoveries of new phenomena. And each of the four missions that I wanted in flight were enormous advances in measurement ability. I assessed these capabilities with 5 numbers: Spatial, Temporal, and Spectral resolution; Dynamic range/Bandwidth and Signal-to-Noise/Contrast.



Experiments "Rule"

I also knew that physics evolves with new data. The process is straightforward with an interplay between theory and experiment, with experiment in the "driver's seat." As physicist Richard Feynman said, "If it disagrees with experiment, no matter how elegant, it's wrong." The "double-slit" experiment led to the replacement of classical physics with quantum mechanics. A measurement of



the speed of light led to the replacement of Newtonian mechanics with Special Relativity. How do we move from astronomy to physics? Astronomers can, for example, observe a spectrum in an object and publish a paper. This would please other specialists in the field, and enhance understanding of, for example, a dynamic in a star's atmosphere. But, no new fundamentals, no new physics because our current physics is good enough.

Need to Turn to the Universe

So, I argued that we are running out of experiments that test physics on earth and need to turn to the universe. Time has proven this as the most expensive science experiment, the 10-billion-dollar *Large Hadron Collider* has, as best I know, produced no unexpected discoveries. It did confirm the existence of the Higgs Boson, and this surprised, I suspect, no one. Do you know the difference between scientists and engineers? Scientists love surprises, and engineers hate them!



Use Misdirection!

I am a fan of the magicians Penn and Teller. Penn explains 'misdirection,' which most lay people get wrong. They think it is getting people to look in one direction and doing something sneaky in another place. This doesn't fool anyone! The true skill of a magician is influencing spectator's minds. And I love this understanding of misdirection because it explains a lot. It's "Curating our Attention" by giving us a story that prevents us from knowing we were distracted.



The Vanishing Chicken

Pen and Teller demonstrate this in a YouTube video about the "vanishing chicken." He shows a chicken in a cage then covers the cage with a heavy cloth. A person in a monkey suit comes out clashing cymbals and Teller walks behind the cage and goes backstage with his coat extended apparently hiding the chicken. Penn asks, "How many saw the monkey with the cymbals?" Of, course everybody raises their hand. Then, "How many saw Teller cop the chicken." Again, nearly everyone raises their hand.



The Misdirection

Penn, then says, "How many of you saw us sneak a gorilla into the cage?" He removes the cloth revealing a gorilla, who when she climbs out is revealed to be a famous Vegas showgirl in a gorilla suit. The misdirection was that the trick never had anything to do with the chicken. The showgirl was hidden in the

**THINK YOU
YOU CAN'T
BE FOOLED?**

You just were!
Read it again.

back of the cage and climbed into the front, shaking the cage. Penn kept his arm on the cage and with peoples' minds focused on the chicken, did not notice the shaking.

Tell a "Physics" Story

So, I needed to misdirect the people controlling the purse strings away from telescopes and astronomy and onto something else. I decided to use a "physics" story rather than an astronomy or astrophysics story to market the last two missions together, completing the set of four. I believe most people understand the importance of world leadership in physics. Indeed, US physics leadership was central to the allied victory in World War II, with radar, code cracking and of course atomic and nuclear bombs.



The "Standard Model"

Physics advances when a measurement of a phenomenon is so precise and broad that current theory cannot explain it. We have an excellent physical theory that explains everything on earth, and almost certainly will for thousands of years. Of course, physicists need an elegant name for such a complete theory, and the name they picked is the "Standard Model."

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i\bar{\psi}\not{D}\psi + h.c. + \chi_i y_{ij} \chi_j \phi + h.c. + |D_\mu \phi|^2 - V(\phi)$$

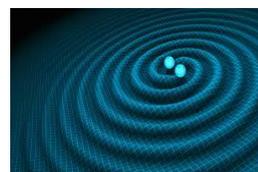
No Idea About 95% of the Universe!

The situation is completely different when we investigate the universe. We have no explanation for whatever constitutes more than 95% of what's out there, as it cannot be explained by the Standard Model. We call these puzzling entities "Dark Matter" and "Dark Energy." There is no way to know what these are except to make measurements and look for a theory that works.



These are basic facts that are easy to understand:

1. Matter radiates photons at different wavelengths depending on temperature, i.e., matter:
 - Room temperature → Infrared;
 - 6,000 Kelvin (temperature of solar photosphere → Visible light;
 - Million-degree plasma → X rays; and
 - Thermonuclear reactions → Gamma rays.
2. Objects of interest, e.g., Gamma Ray Bursts radiate at all these wavelengths.
3. If we include radio waves, which one can observe from the ground, these are all the wavelengths we can observe as interstellar hydrogen is an absorber
(Of course, gravitational waves have been measured since then, opening yet another channel.)



So, let me summarize: If we launch four observatories in space, using the massive carrying capability of the Space Shuttle, we can observe physical phenomena impossible to create on earth, with the potential for a revolution in physics. Sound good?

So, how do I explain this to lawyers, while maintaining the rigor required by the science community? I thought, what medium is least scary? How about comic books? I had two distinct populations that I had to get on board.

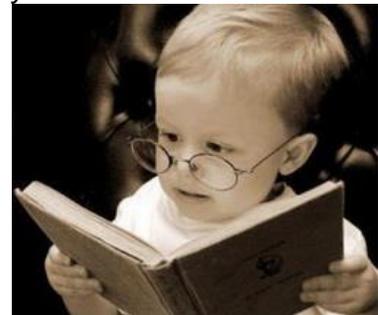
Getting "Buy-in"

First, the science community had to "buy-in" to this idea. I needed them to believe that I could get all four missions into orbit. This was the only way over the most difficult hurdle, getting "new starts" for AXAF and SIRTf. Moreover, I had to get the two communities to stop criticizing other side's mission to advance their own. Second, I had to persuade the non-scientific population in NASA, the executive branch (e.g., the Office of Management and Budget), and the Congress (members and staffers).



Top Theorists Make a Comic Book

So, I asked my deputy, George Newton, to work with my science "branch chiefs" and identify the 8 smartest astrophysical theorists on the East Coast. (There were enough there without asking people to fly across the country.) Then, call them and ask to meet me at Goddard in George Peiper's conference room (even though it was actually Frank's, the names stick) on January 30. He said, "What if they ask me why?" I said, "Tell them that we are going to make cartoons." "What if they don't want to come." I said, "Tell them to call me." Everyone came! (I suspect most were curious about what I was up to.)



Asking Martin to Manage the Meeting

I began to think about the meeting and became concerned. These are giants in science, I wonder if I can control this meeting? I know that I am better at thinking about management than they are. I reasoned that if I had time to think, I could manage them and the meeting. Suppose I had another person manage the meeting process? But who? I needed someone who understood and "bought-in" to what I was trying to do and could go toe-to-toe with them as a scientist. No one on my staff was up to this. Then, I thought of Martin Harwit. Although I had never met him or spoken with him, I was implementing messages in his book, and as tenured faculty at Cornell he could likely handle them. I called Martin, explained what I was doing, and asked if he would manage the mechanics of the meeting. He immediately agreed. Then, I invited him to my home



for dinner the night before the meeting. We had a wonderful time at dinner, the meeting went well, and we became close life-long friends.

The "Comic Book" Meeting

I opened the meeting the next day explaining that I wanted them to use the crayons and markers that I brought and make cartoons showing each of the observatories observing something and some science narrative. Nobody left. Next, I showed slides that I made naming interesting and unsolved astrophysical phenomena from Martin's book and we had some discussion. We took a morning break and George Peiper, Goddard's Director of Science looked in. He said to me, "My god, you have a "who's who" in astrophysics in my conference room."



Making Cartoons

Can you image these famous theorists on the floor making cartoons? That's exactly what happened. At the end of the day, we gathered the materials and Martin said, "I brought my support contractor, Valerie Neal with me, and we can make this into a booklet if you want." I, of course, was delighted and said, "I will add funds to your grant to pay for this, how much do you need?" Martin said, "How about \$25 thousand?" I said, "Done" Martin and Valerie came to see me every few weeks, to show me what they had accomplished and get my guidance.



George Field Appreciates What I had Done

When the National Academy of Science had was completing its "decadal" survey, recommending priorities for the 80s, George Field, who led the effort stopped in to see me. When I told him what I had done, he said, "Charlie, that's incredible. We had dozens of scientists working for two years and did not come up with anything as good as this." I said, "Thank you, George and this program is so great, but I have not been able to think of a name for it." George then said, "Why don't you call it the Great Observatories?" I said, "Wow, what a wonderful idea, thank you."



Printing 50,000 Copies

In a few months, Martin and Valerie had a booklet ready to print. I asked my secretary to find out how many copies someone at my level could authorize the Government Printing Office to print. She said that nobody knew. So, I said, "Let's print 50,000."



Martin Markets the Program

As a Civil Servant I was not authorized to "lobby." Martin, said that he was willing to do this and as an employee of Cornell, he had no such restrictions. He began visiting OMB and the Congress. To the dismay of my competitors, a year later, the Great Observatories was a household word. Soon after, my friend, Noel Hinners left his job as Director of the National Air and Space Museum ("NASM"). The search committee chose Martin as his replacement as so many people had met and liked him during his advocacy visits for the Great Observatories. Valerie became an esteemed NASM Curator and recently retired.



AXAF Goes First!

I decided to start AXAF first for many reasons. It was the most mature, as I had invested heavily in studies both at Marshall Space Flight Center and two competing contractors. Also, it was top priority in the Academy's decadal study. Finally, SIRTf had a much larger advocacy community from both Hubble and NSF-funded ground-based astronomers and would be much easier to "sell." I liked having the easiest mission last.



Headwinds!

And there were powerful headwinds:

- AXAF was an expensive project with a life-cycle cost estimate of \$5 Billion;
- My opponents used Hubble overruns against me; and
- I worked for Burt who did not like me or, more importantly, my program. Fortunately, Len Fisk replaced him.



Being 100% Committed

I believed that with of 100% Commitment that I could prevail.

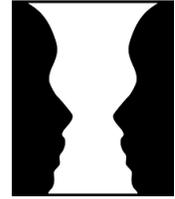
Which Outcomes Should One Commit To? Elon Musk inspired this chart when he was musing about his decisions to enter the auto business with Tesla (to electrify cars and trucks to mitigate climate change) and space rocketry with Space-X (to colonize mars). Here are some questions:



- Should I 100% Commit myself to a Program built on discoveries? *(yes)*
- Benefits significant enough to proceed even if the likelihood of success is low? *(yes)*
- Is it the "right thing" to do? *(absolutely)*
- Am I competent to undertake this? *(certainly)*
- People I depend on want me to succeed? *(yes, my scientists)*
- Like good physics, start with fundamentals and reason up from there, in contrast to reasoning by analogy. *(yes, the measurement improvements were unprecedented)*
- Accept and deal with the fear that I might fail? *(no worries)*
- My biggest risk is "opportunity cost." *(Other important programs would not receive additional funding if I made AXAF first every budget cycle, which I had to do)*

Managing My Perception

Placing things in priority order never worked for me, there were too many things and not enough time. I practiced maintaining clear, respected personal boundaries as this is essential. This helped my professional boundaries as I will describe later. (As an aside, I dated a clinical psychologist for some years. She believed that good relationships required only two things: Clear, respected personal boundaries and reliable process to resolve problems.)



Warren Buffet

I have a lot of respect for Warren Buffet. Not just because he was a brilliant investor, but his philanthropy. Buffett is a notable philanthropist, having pledged to give away 99 percent of his fortune to philanthropic causes, primarily via the Bill and Melinda Gates Foundation. From Warren, "The difference is that really successful people say 'no' to almost everything. We have to know what to focus on, simplifying our lives."



It's Erwin

One day, Len Fisk approached me and said, "Charlie, you are really good with people." I responded, Len, that's a bunch of bullshit and we both know it. What's your problem? Len said, "It's Erwin." I said, "Len, I can work with Erwin. Send him to me."



At that time, all the Office of Space Science's Division Directors were busy meeting and scheming on how to get money from the Space Station for their experiments. I, however, was 100% Committed to the Great Observatories and could not afford the distraction. So, I said to Erwin, "How much time until you retire? He said, "18 months." I said, "You have been bounced out of three Divisions, how would you like to leave with your head high? He said, "More than anything."

We Make a Deal

I continued. "I have a deal for you. Your biggest problem is that you annoy people by talking too much. If you can find a way to stop that, I will make Assistant Director for the Space Station. Can you change your behavior? He said that he could, and I continued. You will attend Director-level meetings and sign correspondence for me. And, if I hear complaints about you, the deal is off." He was very grateful and said he could do this. He kept his word and I kept mine, for a big win-win. And I could continue to be 100% Committed and fully focus on getting the next Great Observatory, AXAF under way!



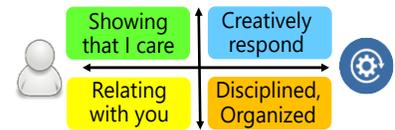
100% Commitment is Situational

Workshop participants sometimes say, "How can one be 100% Committed to more than one thing? I tell workshop participants that I am 100% Committed to them

during the workshop. I do not read e-mail or permit any other distractions when we are in session. I am totally attentive to them and their needs.

This supports me in being 4-Dimensional, a requirement for a maximally-effective workshop, i.e.,:

- They must see that I care about them and their workshop experience;
- Experience that I am in friendly relationships with them;
- That I creatively adapt to changes and unexpected events; and
- Discipline and organization to meet goals



My wife usually travels with me. When I return to the hotel, I am fully attentive to her until we reconnect which may only take 5 or 10 minutes. Then, I might not be Committed to anything for the rest of the evening, drinking some wine, answering e-mail, or reading a book.

A central idea is that you can be 100% committed to more than one thing, as it is situational.

Many Thousands of Daily Safe Landings

I find the many thousands of daily commercial plane landings with rarely any difficulty amazing. It begins with the descent. At a prescribed altitude, usually 18,000 or 12,000 feet, the flight deck "double-chimes" the cabin telling the attendants that they are not to be disturbed except for an emergency. They can tell from which of four colors light up where the chime came from. And, if there are flight crew resting, they come to the flight deck. My flights to Beijing have four "Captain certified" pilots in the cockpit during the landing looking out the windows and monitoring the avionics.



United Air Lines

United usually provides air traffic control on audio channel "9," if I request it, and I listen to the controllers providing detailed instructions throughout the descent. Then, I hear "Cleared to land, runway #." After that, absent an emergency, there is dead silence until the landing completes, supporting the crew in becoming 100% Committed. I frequently visit the United Airlines cockpit prior to takeoff and am always welcomed, sometimes with a copy of the flight plan. I sometimes ask, "How do you totally focus for landings?" They said, "It's a matter of life or death." That, it seems to me, is an effective Story-line."



Chapter 20: My First "Great Observatories" Test – the "Belmont" Retreat

Prioritizing the "New Starts"

Emerson said, "What you do speaks so loudly I can't hear what you say." Was I really 100% Committed to the Great Observatories? The most difficult hurdle was within NASA. There were many more candidates for "new starts" than the budget allows. Flight projects span 5 or more years for development then multiple years for operations, taking data. Of course, it makes no sense to start a project unless there are funds to complete it and operate it. Thus, a "new start" means committing to multiple years of funding in NASA's budget, which the Congress at that time abhorred. One of the responsibilities of an Associate Administrator (my supervisor) is the prioritization of new start candidates from the Divisions. Thus, I had to deal with Burt to get a new start for AXAF. Burt did not like me or my program, because neither I nor my community would kowtow to him as smaller Divisions did.

PRIORITiES

- 1.
- 2.
- 3.



Burt's Inability to Make Tough Decisions

Burt had real difficulty in making decisions like new start priorities as "being liked" was important to him and any decision would disappoint someone. He was surely "Yellow" and likeable as a person if you could overlook his deficiencies as a leader. He got the idea that the way to resolve the dilemma with a retreat, a very "Yellow" idea. So, we all gathered at a house in the Maryland suburbs called Belmont. In the 70s the Planetary Division dominated the Office of Space Science. However, under Frank's leadership, and then mine the Astrophysics Division grew. Our astrophysics "discovery" story had more appeal than their geology story, and the Space Shuttle had more relevance with its large cargo bay and weight capability to low earth orbit. In fact, I believe that the primary reason Hubble started was not science, but the fact that it used the Shuttle for servicing.



AXAF vs. CRAF/Cassini

Anyway, back to Belmont. The real fight was whether the new start would be a planetary mission, Jet Propulsion Laboratory's "CRAF/Cassini" or astrophysics, my and Marshall Space Flight Center's "AXAF." At the time, AXAF was an X-ray version of Hubble in low earth orbit with Shuttle servicing. I knew that the deck was stacked against me because



Burt subtly telegraphed his preference for JPL. The reason likely was because a JPL employee shamelessly “wined and dined” Burt. Burt came from industry and never accepted the rules Civil Servants must obey. (Trust me, I have lots of first-hand knowledge of this.) So, I was shocked to see 5 people from JPL at the retreat including the Center Director, Lew Allen. Lew gained my deep admiration by saying, “If you want best science, pick AXAF. If you want to save JPL, pick CRAF/Cassini. Moreover, there were several “junior staff” who had no idea about the trade-offs in this complex choice.

A Bizarre Event

The whole event was bizarre. Dudley McConnell, a member of the front office set the agenda the first evening. He led a discussion about how we were going to take the Space Station away from manned space flight. For me, this was total nonsense. The idea that Burt and these very weak people was going to overwhelm the people who took us to the moon was just crazy. However, I was there to make AXAF happen and could not alienate these people, so I did not say anything. We spent Saturday on other nonsensical matters.



I Urge the Facilitator to Take Action

We were planning to leave at noon on Sunday. When Sunday morning arrived, I noticed that we had avoided the topic that the retreat had intended to address. Burt had a professional facilitator for the event. I pulled him aside and said, “Look we need to address the new start priorities, or we have wasted our time.” He said, “I agree, and I will not let Burt put this off any longer.” Then the facilitator said, “Let’s take a straw poll and see where folks are.” A chart then appeared on the screen with 9 new start candidates with AXAF last in the list. (The sequence of items in a list matters.) Another program of mine that I was not seeking a new start for, GP-B, was higher in the list. I was shocked and asked where the chart came from. The facilitator believed Burt must have generated such an important document and asked him. No, it was not his. Turned out that the guy behind the screens who flipped viewgraphs made it.



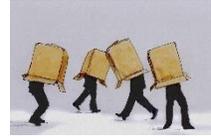
Lew Speaks

The facilitator said, “Let’s take a straw vote to see where people stand. There are 9 items, so let’s give each person 18 votes. We talked for a few minutes. Then Lew said something that endeared me to him.” He said, “If you most value science, you will vote for AXAF, but if you want JPL to endure as an institution, you will vote for CRAF/Cassini.”



The Ignorance!

We took a bathroom break before voting and someone asked me, "Charlie, what's GP-P?" I said, "It's GP-B, testing a subtle prediction of General Relativity. I am a supporter of the mission, but not as a new start. The traditional community would surely kill it if we tried that." I was shocked! People would be voting on programs they knew nothing about!



I Knew What Burt Would Do

I knew that Burt found this kind of decision so distasteful that this vote would be the end of the retreat. I asked the facilitator whether there were any rules about how we cast our votes and he said, "No you can vote any way you want." Sam Keller was sitting next to me and raised his hand to vote first. He voted very "politically" giving each candidate a few votes. I remained silent and the vote continued around the circle of people in the room. Things tend to continue the way they start, and others voted similarly.



I Disrupt the Voting

As the voting proceeded, CRAF/Cassini gradually rose while AXAF sunk with the numerous JPL votes. I kept quiet and was the last to vote. I said, "I give 18 votes to AXAF," bringing it even. Burt jumped up and shouted, "You can't do that." I turned to the facilitator and said, "You said we could vote any way we wanted." He looked sheepish and confirmed what I said. Burt then gathered the sheets and declared that the retreat was over.



Burt Punishes me!

That year was the only year that I did not receive a bonus. I did not care as I was 100% Committed to the Great Observatories. And Burt was soon replaced by Len Fisk, my colleague from Goddard and the most capable leader I ever worked for. And AXAF was in the queue ready to go "head-to-head" with CRAF/Cassini.



Chapter 21: My Second "Great Observatories" Test – OMB Kills AXAF

Jim Fletcher, Administrator, Leaves NASA

Jim Fletcher was NASA Administrator during the 70s. I met him in an awards ceremony when I won a trophy in a 10 km foot race. He then left and worked for NSF on some advisory committees that I also worked with. Most people dissed him. I chose to treat him with the same respect and deference as when he was Administrator.



Fletcher Comes Back

In 1986, Challenger exploded (more about this later) throwing my program (and others) into chaos. Moreover, many senior managers were removed, including the "acting" administrator. Then, ironically, Fletcher was in Washington on other business and the Washington Post photographed him, speculating he was seeking to be NASA Administrator again. He was not. Reagan saw the article, called him, and asked him to return as Administrator. As he related to me later, "President Reagan saw the article and called me and asked me to return as Administrator." Jim continued, "I did not want the job, but it is really hard to say no to the President." He liked me and invited me to meet with him monthly to "find out what is really going on with the NASA workforce."



AXAF is in the Budget!

And, as I mentioned, Len Fisk replaced Burt Edelson. Len understood the Great Observatories and the need to get AXAF going. The final budget goes to the OMB in September, following a negotiation that began in the spring. Unless economic conditions deteriorate, changes after this submission are usually small. Finally, with Len's support, AXAF was in the NASA budget submission to the Office of Management and Budget ("OMB").



OMB Kills AXAF

NASA receives a "mark-up," (which is really a misnomer, things are only "marked down") from OMB usually the day after Thanksgiving, so I went into work, "just in case." As it turned out, Jim (Fletcher) called Len (Fisk) and I to his office. He said, "Charlie, I have bad news. OMB has removed AXAF from the budget." I was in shock. I said, "Please let me reclaim this." Jim said, "Charlie, I would love to help you, but they have deleted more important things like Civil Service salaries and test stands for the Shuttle's main engines." I said, "Jim the entire Great Observatories program which I have worked so hard for and is so important for US leadership in physics. Please?" Then, he said, "OK, Charlie, just for you."



A Challenge

Whew. And, I still had a hill to climb. Here's the "reclama" process. The agency decides what's most important and pushes back against the OMB Director. If turned down, an agency head like Jim could request a meeting with the President, in this case, Regan. People in jobs at this level likely have some relationship with the President, in order to get the job. The OMB Director does not want to be "rolled," so they assess how they think the President would rule.



Marketing vs. Selling

I went back to my office and asked my secretary, Becky, to clear my calendar. I asked one of my favorite people, support contractor, Trish Pengra to sit next to me at my desk facing my computer. As I mentioned earlier, I am fond of joking that I only learned one thing at Harvard, and that was the difference between selling and marketing. Selling is trying to motivate someone to buy what you want to sell them. Marketing is figuring out what someone wants and providing it.



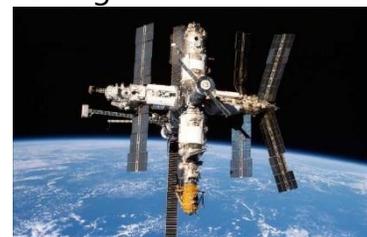
How About the Science?

So, we began to brainstorm, repeating "marketing vs. selling." What does President Regan care about? Let's start with science. I knew that he had lunch with scientists once a month, as my colleague Riccardo Giacconi had attended one. Riccardo was an X-ray astronomer in his early years, and now, of course, a strong advocate for AXAF. (Riccardo later received a Noble prize in physics for this work.) He told me about trying to engage Regan in a conversation about X-ray astronomy. Regan said he knew about X-rays. Riccardo asked "Really?" "He said, "When I was in England during the war and I squinted and looked at the sun I could see the X-rays from the sun." Well, a science argument will not work.



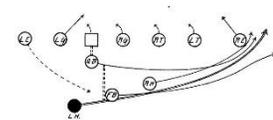
It's the Evil Empire"

How about how much science we get for the cost, a "value" argument? AXAF was negligible in the context of the Federal Budget, therefore no leverage here. So, I am back sitting there repeating "marketing vs. selling, what does President Regan deeply care about that AXAF can address?" I continued for several hours. Then, the "aha moment" came. It's the "Evil Empire."



I End-run the Agency

I had co-chaired the first joint space working group with the Soviet Union with my counterpart Rashid Sunyaev. Rashid had given me a photograph of the Mir Space Station with his (small) Kvant x-ray telescope in the view. So, I made 4



viewgraphs: 1. Image of AXAF, what we are speaking about; 2. Science summary, what it could do; 3. Cost summary, always required; and 4. The “coupe de grace,” a slide with a translucent American flag on one side and AXAF behind, and a translucent Soviet flag with Rashid’s photo behind with the top caption “To Whom Will the Future in Space Belong.”

I Send the Package to OMB

I learned that presidents do not look at projected viewgraphs, rather 2-foot by 4-foot foamboards. Trish found someone to quickly make these. I called Len Fisk’s admin and said, “I have some charts for OMB, anybody want to see them?” She said, “No.” Then I did the same thing with the Administrator’s office with the same result. However, if I got caught this would not have helped much. 100% Committed, we addressed a label to the Director, OMB, and wrote “AXAF Reclama Materials” on the wrapper. We sent the foam boards without a cover letter. Trish called a courier to deliver the package directly to the OMB Director’s office. I am still amazed that we managed to send this briefing directly to OMB with no review by anybody, but we did. We were now two days away from the scheduled meeting with the President.



AXAF is Back in the Budget!

I received a call from Len Fisk the next day. He said, “Charlie, I don’t know what happened, but Administrator Fletcher just called and AXAF is back in the budget, do you know anything about it?” I offered no explanation other than, “No sir, and that’s really good news,” and hung up as quickly as I could.



A Workshop Participant Explains

Some years later I had a participant in a 4-D workshop who worked in OMB during that time. He told me that the chart became famous for its audacity. When the OMB Director saw it, he immediately restored AXAF’s funding.



A Big Risk!

Perhaps the most interesting aspect of this adventure was that I never thought much about the enormous risk I was taking. If “management” learned of what I had done, the punishment would have been severe. When one is 100 % Committed, their mind does not go to fear.



Chapter 22: My Third "Great Observatories" Test – Congress Threatens AXAF

A Major Setback

Normally Congress passes almost everything that gets to them, as they hate to look like "bad guys." The control of our budget had now moved from House Appropriations to Senate Appropriations, chaired by Eddie Boland. During hearings on AXAF, he remarked that "We just do not have sufficient funds for another telescope." I circulated information freely to my direct reports with a daily "micro-staff" meeting including this problem. Art Fuchs, my AXAF program manager, likely told Harvey Tanenbaum, an X-ray astronomer at Harvard-Smithsonian Astrophysical Laboratory ("SAO") about this. Harvey had much to gain from AXAF as we would likely place science operations with his people.



Harvey Visits Me

About a week later, Harvey appeared in my office saying, "I have done something I need to tell you about. I did not tell you before I did it as you would have to tell me not to do it." OK, what did you do?" Harvey continued, "I organized a letter-writing campaign to Boland and an expecting 100+ thoughtful letters to begin arriving any day." He was right, if he told me I would have to tell him not to do this, and I was glad he had done it.



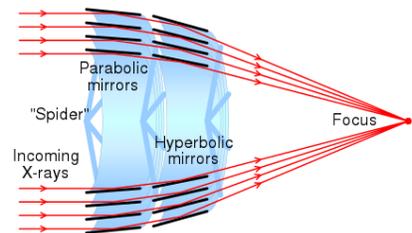
Boland, "Stop the Letters"

As the hearings continued, Boland said to his chief staffer, Dick Malow "While we cannot afford this telescope, see what you can do to stop these damned letters." Dick was so effective that we referred to him as the "other Administrator." I was friendly with Dick, but he had an especially close relationship with Len.



It's Impossible to Make the Mirrors

AXAF's "Wolter-1" grazing incidence mirrors were very difficult to manufacture. Normal-incidence mirrors like Hubble's absorb X-rays. Instead, these mirrors work by reflecting X-rays with a very shallow angle. Dick had a consultant who told him that we could not manufacture these, particularly with the budget we allocated.



Malow Proposes a "Deal"

Dick proposed the following. Congress would approve the budget to fabricate the mirrors on the two-year schedule we proposed and with the budget we proposed. If we succeeded, Congress would approve the entire AXAF project with no additional actions on our part. If, however we



failed, Len and I would call a press conference and announce that we cancelled AXAF, with no mention of Eddie Boland or the Congress. I brought my team together and we agreed to take the deal. I told Len that we were in.

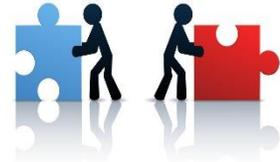
Separating AXAF's Mirrors from the Prime Contract

Although, I tried to get other optics companies interested in manufacturing these mirrors, I was unsuccessful. Only Perkin-Elmer ("PE") was willing to do this because we had funded them to build similar mirrors for an X-ray mission (HEAO-2) some years earlier. We had a competition for AXAF's prime contractor between TRW and Lockheed-Martin. I did not want the competition to be decided by who could team with PE, so I removed the mirrors from the competition and contracted their manufacture directly with us.



I Put TRW in Charge of AXAF's Mirrors

By now, TRW had won the competition and I decided to moved (the legal term is "novated") the P-E contract to TRW. TRW was highly motivated to meet the schedule because they had a large contract for AXAF mission. Moreover, we removed an interface, a lesson learned the hard way with Hubble. I also personally engaged Dan Goldin, TRW top management, because he had resources to move quickly and decisively when problems arose. I also demanded a change in management at PE, to a person I knew and trusted, and who travelled to DC once a week to brief me on progress.



We Finished, and Chanced One Final Cycle

We fudged a little with the budget and finished the mirrors with one week to spare. (Whew!) These mirrors are built (like Hubble's) with a repetitive process of measurement, polishing, measurement, repeating the process until the mirror is finished. The term for this is "indeterminate." PE told me that we could do even better with one more polishing cycle, however we could lose everything if the polishing tool broke. I thought, this is a serious choice, I want to see what Len thinks. We briefed him, and he said, "Let's go for it." We did, and all was OK. True to their word, Congress approved the full program. AXAF was going to happen, opening the door to the entire Great Observatories.



Chapter 23: My Fourth "Great Observatories" Test – AXAF Descoping

Budget Graph Gets my Attention

One day, Len asked me to come to his office and showed me a graph of the Office of Space Science ("OSS") budget, with 7% growth which was the projected growth in NASA budget (with 20% allocated to OSS). The graph showed that Cassini (the remnant after a descoped) and AXAF peaked at about the same time, with the required funds significantly exceeded even this optimistic budget.



Neither of us said a word, as none were needed. I went back to my office and looked at my options:

- Slow down and stretch AXAF out. That would address Len's problem, but that would significantly increase the run-out cost and almost surely lead to cancellation. A non-starter.
- Set up a confrontation in the Congress and force a floor vote on one mission or the other. I would almost surely lose as planetary had a much more focused and well-funded political lobby in place as JPL is a contractor managed by Caltech. Another non-starter.

So, I had to find a way to significantly reduce the cost while retaining the science.

Low Earth Orbit is Lousy

This was my thought process. AXAF was built following the Hubble paradigm flying in low earth orbit ("LEO") at a typical altitude of 170 nautical miles so it could be serviced. This is so close to earth that half of the sky is eliminated. Hubble's maximum slew rate was about the speed of a minute hand so pointing was very inefficient, on target only about 20% of the time.



Re-conceptualizing the Mission

If instead, we put an upper stage under AXAF and boosted it into high elliptical orbit, observing efficiency could go to perhaps 90%. That gave me a factor of about 4 (90/20) to use to lower the cost. At that time, there were six nested mirrors, so I removed two of the most difficult mirrors. For me, AXAF was about high angular resolution, so I took another look at the instruments and found that one of my favorites, a calorimeter, did not use AXAF's high angular resolution so it's off. I later made an agreement to fly it on a Japanese mission.



Unexpected Push-back (Adjustment Resistance)

We lost the servicing ability, and I was not concerned. Unlike Hubble, we did not have a replacement instrument program so all we would lose is the ability to repair failures. A mission of this expense would have a top-quality design with excellent parts, so failures, especially in the more thermally benign high orbit would be unlikely. Moreover, we could eliminate all the expensive “man-rating” and extra testing for that astronaut servicing required. I was so excited that I met with my program manager, Art Fuchs, and told him what I wanted to do, expecting his full support. Instead, he said I “Was crazy, and this was the wrong thing to do.” I called a meeting with Marshall, TRW, and SAO. Everyone opposed me except Gordy Williams, a senior TRW executive and Hank Steenstra, TRW’s lobbyist. This was my first known exposure to “confirmation bias,” a kind of flaw in the human mind that affects perception. I needed a technical study to verify my back-of-the-envelope analysis.



MSFC Center Director

My MSFC project manager refused so I flew to Marshall to meet with J. R. Thompson and demanded his removal. J. R. was polite and said that he would talk with Fred. Nothing changed and I was losing valuable time.



The Science Working Group

Next, I called a meeting of the AXAF Science Working Group, about a dozen X-ray astronomers. No one except Riccardo Giacconi supported me. I was astounded! Of course, Len Fisk loved my plan. So, I went to the only friend who could help me, Gordon Williams and he agreed to do the study. A few months later, we had a redesign that got all the science while reducing the “life-cycle” cost from ~\$5.5 Billion to ~\$2.5 Billion! AXAF launched on July 23, 1999 and continues to operate to this day (20 years!).



Harvey Is Unable to Admit He was Wrong! (30 years later)

Over time, (nearly) everyone realized that I was correct, and my actions saved the mission. Art Fuchs has since apologized and there are surely no hard feelings. Harvey Tannenbaum has not, which says a lot about him. Moreover, he attempted to insult me and my contributions by inviting me to a 20th anniversary of successful operations celebration with he and others speaking while excluding me! I suspect he feared that I would tell the truth about the rescope and his hard opposition!



Chapter 24: Hubble Social Engineering and More

A Successful Servicing Mission?

I understood the importance of appreciation as you will see in the appreciation module. So, I gathered the servicing mission leadership team and said, "This mission is really difficult as we have all the complexities of the telescope plus astronaut operations. We simply cannot fail as this will be bigger than the flawed mirror. I do not know how a leadership failure caused this, although I understand how our expressions of anger at the P-E management inhibited communications about difficult communications. I am going to insist on two habitual behaviors from all of us. Everyone else will be influenced by how we behave. First, we are going to appreciate more than we criticize. Second, we are all going to demonstrate 100% Commitment to the success of this mission. Moreover, I will promptly remove anyone who fails this standard. Are we in agreement?" They all responded in the affirmative.



I Remove the Goddard Project Manager

About a year into the servicing mission, we had a critical systems test at Goddard. I drove out to observe it and noticed that the project manager, whose office was across the street was not present. When the test ended I went to his office, I "braced" him about not being present. He was nonchalant, saying he did not think it was important. I asked my program manager, Doug Broome to look into his behavior. Doug soon reported, "He has to go, now. He is scarcely engaged, takes 3 days for a 2-hour meeting at JPL and nobody respects him. He has to go, now!" He was not the first person to erroneously think that working for me was like early retirement. In contrast, Frank Cepollina, my overall servicing manager at Goddard is my kind of guy. For example, I paged him on a Saturday morning, and he called me from a local contractor plant!



First, Get Their Attention!

I like the expression, "First get their attention." We often talked about this when I was at Harvard. If people are not coming on time to your staff meetings, call a meeting at 4 AM. If people are not communicating with each other, have all office doors and barriers removed over the weekend. I wanted to make a statement that would resonate NASA-wide about Commitment to the Hubble Servicing mission. When I thought about the Hubble servicing mission schedule, I looked at my watch, not my calendar.



New Center Director Recalled from Vacation

John Kleinberg, the center director of Glenn, an aeronautics center that existed before NASA was formed in 1958 was coming to Goddard in two weeks to take over as director there. He had rumored to be boasting that when he arrived, that he would manage my programs, not me. So, I went to my boss, Len Fisk and said, "I want to make a statement about Commitment to the servicing mission and give Kleinberg a lesson about who's in charge of science programs. He is on vacation sailing on the Great Lakes for the next two weeks. I am going to contact the Coast Guard to find him and direct to come here ASAP." Len smiled, and said, "Go ahead."



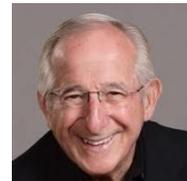
"He's My Man"

A few days later, I went to Len's office and encountered a furious Kleinberg in sailing garb. He refused to look at me and said to Len, "What is this bullshit about?" Len pointed to me and said, "He's my man." I then said, "John, you need to understand that I am 100% Committed to the success of the Hubble servicing mission. Your project manager is not sufficiently committed to this, and I am not willing to wait 2 weeks for you to come to Goddard. So, go to Goddard, find me a committed, expert project manager, and I will have the Coast Guard return you to your sailboat."



Joe Rothenberg

He stormed out and called a few hours later, "How about Joe Rothenberg?" I said, "Excellent choice, back to your boat." Joe, a "yellow" personality, naturally embodied 4-D behaviors and was an excellent leader.



JSC Needs to Name the Servicing Mission Crew

Doug Broome shared my sense of urgency about fixing the telescope, and my very aggressive schedule. One day he came to me and said, "Johnson Space Center ("JSC") is refusing to name Mission Specialists in time to train and meet my schedule. It was again time to "make a statement."



Dick Truly is a Private Person

At the time, Dick Truly was the NASA Administrator and I knew that he was a very private person and did not travel much. At that time, NASA had a "Gulfstream III" recovered from a drug dealer. I knew that NASA had to show high utilization of the airplane to justify keeping it. So, I called the airplane manager and said, "I suspect that you are having difficulty showing effective use of the plane as Dick does not travel much and when he does, he does not take many people with him." She said, "Charlie, you are correct." I said, "I'd like to make a deal with you. I have



a big program and can fill the plane with Senior Executive Service (“SES”) level managers if you will let me use the plane as I choose. And this will be our little secret. OK?” She said, “Sure, Charlie.”

I Make NASA-1 My Personal Airplane

Here’s what this was like. When I wanted to go somewhere, I would invite 11 other managers from Headquarters and Goddard to go with me. I would go to the “Fixed Base Operator,” at National Airport and walk unimpeded to the plane, with no security checks. The others would file in behind me and I would sit where I chose, including claiming the bed in the back for overnight flights. Unlike Air Force 1, the plane used the call sign, “NASA-1” even if the Administrator was not on board. We received priority ATC clearance and cruised at 44,000 feet looking down at the commercial flights below. I visited the cockpit and talked with the pilots as I chose.



Meeting with Aaron Cohen

So, I asked my secretary to call the JSC center director Aron Cohen’s office and arrange a meeting regarding naming the Mission Specialists for Hubble Servicing in his conference room, then schedule NASA-1. Then, I asked Doug to round up 11 SES Servicing Mission managers and meet the airplane to go to JSC. I then asked Becky to call and request cars at Ellington for 12 people and we will radio the ETA from NASA-1 after takeoff. I wanted him to think that Dick Truly was coming. Aaron greeted us with his people cordially, and we had a good meeting. I am not sure we got everything we wanted because I left the Division soon thereafter.



Mikulski Gave us all a Gift

Several of us who were in the program during those days were talking about this recently and now see what Mikulski as giving me (and NASA) a great gift. If she had said to me, “Charlie, include funds for fixing the telescope in the next budget request,” it is likely that I would have done that. Then, we would have not tried the fix until 5 or 6 (or more) years later. Hubble was losing gyros, and it might not have been stable enough to capture.

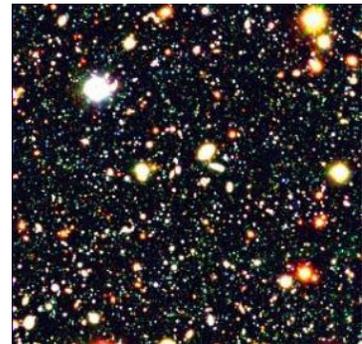


Images from the “Repaired” Hubble

Are you wondering how well the fix worked? Actually, the first servicing mission exceeded expectations. The astronauts replaced Bob Bless’s High Speed Photometer with the Corrective Optics Space Telescope Axial Replacement (“COSTAR”) providing a better than specification optical wavefront for the three (telephone-booth-sized) axial instruments, installed the replacement Wide Field Planetary Camera, replaced the

troublesome (vibrating) solar arrays with rigid ones, repaired gyros, and more. There are many awesome images, and these are my favorites:

- Hubble found supermassive black holes at the centers of galaxies, and imaged their "event horizons;"
- Imagery proving that the Universe is expanding at an increasing rate. When I was a graduate student, we thought that after the initial impulse, the "big bang," the Universe would slow and collapse on itself. This is like throwing a ball into the air, and watching it return to earth. (Unless you propelled it to "escape velocity.") This is like throwing a ball in the air and watching it accelerate away faster and faster. I do not think anyone understands this. The only explanation that I am aware of is the "vacuum energy" of quantum mechanics. The calculation is off by 10 to the 50th power, an unacceptable amount even for astrophysics!
- My, and many others, favorite is the "deep field." In astronomy "deep" means a "long exposure," because the longer you look the farther you see in space, and in time as light has a finite speed. There was a small patch of sky, about the angle a tennis ball makes at 100 meters that was completely black. The Director of the Space Telescope Science Institute had "discretionary time," that he saved, for several years. Then, against the advice of the science community, he pointed Hubble at the spot for two weeks. The image was crowded with galaxies. Knowing this "solid angle," allowed one to estimate the number of galaxies in the Universe as 2 Trillion, each with 100 Billion stars, a factor of 10 larger than previously thought! Composer Eric Whitacre has written a symphony about the image. The "replacement instruments" have taken deep exposures several times since.
- Finally, have you ever wondered about where the elements that comprise us and everything around us came from? The birth of the Universe, the Big Bang only made hydrogen, and a bit of lithium. We, and everything around us is produced in supernova explosions. These occur when a massive star runs out of fuel, collapses, and implodes. Imagine something a million times the mass of our sun collapsing in 15 seconds! The end leaves a dense core with an expanding cloud of hot gas called a nebula. In 1054, a supernova lit up the sky and was recorded by the Chinese! It is called the Crab nebula. We are quite literally stardust!



Chapter 25: Compton Gamma Ray Observatory ("CGRO")

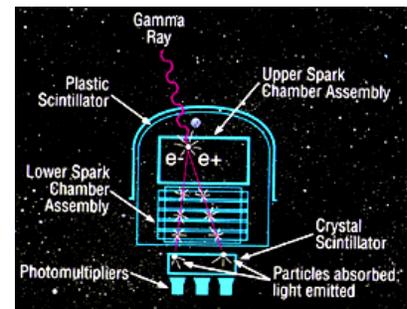
Important Instruments

The most important instruments on the mission were "EGRET" (Energetic Gamma Ray Experiment Telescope) and "BATSE" (Burst And Transient Source Experiment). As described earlier, I was very familiar with EGRET as I worked in the Gamma Ray Astronomy Branch in Goddard's Laboratory for High Energy Astrophysics and my colleagues designed and built this enormous instrument.



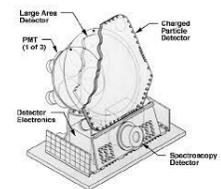
How EGRET Worked

Here's a schematic overview. A plastic "anti" scintillator dome (lights up when charged particles go through) viewed by photo-multiplier tubes surrounded the instrument. A tantalum "pair-production" plate was next. A gamma ray would leave no signal in the anti, convert into an electron-positron pair, travel through the spark chamber, light the scintillator in the bottom, which turned on the high-voltage in the spark chamber showing the path of the particles in the presence of a magnetic field. Finally, there was a sodium-iodide "total absorption crystal" in the bottom (provided by Stanford) to measure the total energy. It was a very complex instrument. We could trace the path backward to find where the gamma ray came from and use the curvature in the magnetic field and energy deposited in the crystal to calculate the incoming energy. This was astronomy, one photon at a time.



Gamma Ray Burst Detector

As I described earlier, I left Goddard and went to NASA Headquarters in 1975 as a "Staff Scientist." One of my first tasks was to evaluate the "BATSE" proposal from Jerry Fishman from Marshall Space Flight Center. I was actually quite impressed. It was very simple, just a set of (at least four, and I have forgotten the exact number) of scintillators with photomultiplier tubes addressing one of the most interesting problems (for me) in Astrophysics.



The Vela Satellites

Here's some background on this. In the early 60's, TRW built the "Vela" satellites to monitor compliance with the Partial Test Ban Treaty with the Soviet Union. These were early versions of Jerry's experiment, using photomultiplier tubes and scintillators, to detect and locate gamma ray burst locations with triangulation.



Nuclear explosions produce gamma rays both in nuclear bombs and high-energy astrophysical phenomena. The story goes that they saw a burst and the triangulation showed it in Chicago! They phoned a colleague in Chicago and timidly inquired, "Is everything OK there?" When the answer was in the affirmative, they realized that the inverse solution was correct, and these were of astronomical origin.

How Far Away Are They?

Now, the important question was whether these were far away, what we call cosmological, or nearby. If they were far away, the energy release was incredible. These short bursts ranging from a few milliseconds to several minutes are a million trillion times as bright as the sun. If they are close, say within the solar system, they might be a danger to us. Jerry's experiment was sensitive enough to likely this question after about a year. If they were close we would expect the spatial distribution to align with the "ecliptic," the plane of the solar system, the galactic plane if farther way and "isotropic," i.e., randomly distributed if cosmological.



Frank and I Both "Reverse the Scientists"

The science community rated it low priority and then Director, Frank Martin overrode them and placed it on the mission. I was well suited to management in this complex environment and advanced unusually quickly becoming Director, Astrophysics in January 1983, replacing Frank who became Director of Science at Goddard. When I was Director and we had a cost problem, the CGRO scientists voted to remove it. Unaware that Frank had done the same, I overrode the scientists and kept it on. (He and I are pretty much "doppelgangers.")



Possible Cancellation

For obvious reasons, I was personally invested in the mission's success. As the Project office at Goddard was small and I had lots of relevant experience, I was deeply involved in the management. At a time when the Administration was looking to cancel something, the Program Manager at TRW, Jerry Glicksman, called me and said, "We are suddenly and surprisingly in real trouble. We began a redesign to accommodate a new heat rejection requirement and this is spiraling out of control causing us to miss milestones." I instructed him, "Tell no one, and I will immediately send you the entirety of my reserves and instruct the project to send you all of theirs. If this gets out, the project will surely be cancelled. Immediately develop a recovery plan and when you have one, I will come out and review it." (I learned not to



visit contractor plants until they had at least one viable solution I could review. Otherwise, they would mesmerize me with technical content.)

An Excellent Plan

I was very impressed with their plan. They knew that they needed a maximal effort from their very costly senior systems engineers. They asked them, for the sake of saving the mission, to work extra uncompensated hours including weekends. And they realized that the real losers would be the families. They broke the time to the next major milestone into three-week intervals and said, "If we are on track at the end of each three-week interval, the company will treat you and your family to dinner (including alcohol) on Saturday night at any restaurant of your choice and you can take Sunday off. They succeeded and saved the project. No one ever knew how much trouble we were in.



Lobbying the Center Directors

I soon worried that EGRET and BATSE were falling behind schedule because of technical problems. (Other instruments were from the Naval Research Laboratory (OSSE) and Germany (COMPTEL) and of less concern.) At the time, Civil Service salaries were budgeted elsewhere so I constantly "lobbied" the relevant Center Directors for priority support. They responded well as the Principal Investigators were in-house.



A "Bolt Problem"

Then, quite unexpectedly, the mission went south. It was the heaviest spacecraft ever built weighing 44,000 pounds (about 20,000 kg). The structure had beams secured with 4000+ exotic titanium (because weight was a concern) bolts. Moreover, EGRET, the biggest and heaviest instrument was secured with a "bolt circle" of very large bolts. This was an unusual design enabled by the Shuttle's capability to take 60,000 pounds to low-earth-orbit. Jerry Glicksman called me saying, "Charlie, we don't know what's happening, but the bolts are shearing off." With no experience with such bolts, we did not know what to do, so our final assembly turned into a three-month "science project." We learned that the titanium, when subjected to pressure, had reduced friction, which caused the torquing to go farther, creating heat that cracked the bolts! We adjusted the torque, remedying the difficulty. Our scheduled launch was coming (maybe 18 months away), and it was becoming apparent the EGRET was going to be late. I was now reduced to hoping for a shuttle delay which was likely but not certain.



Challenger Provides "Breathing Room"

Then, *Challenger* exploded. The delay turned out to be much longer than we expected, and we were able to “reprice” (raise the cost) the project and add some much-needed schedule margin. Most importantly, I could truthfully claim that we finished the project within the budget!



GRO Launches

In April 1991, I went to Kennedy Space Center for the launch. Senior TRW executive, Dan Goldin also came for the launch. (He would later become NASA Administrator.) He and I had become quite close (we are both “Blue”) following selection of TRW as the prime contractor for AXAF. (He kindly invited my friend Jim DeFelice with his wife and daughter to TRW’s prelaunch dinner.) The launch was “nominal.” He and I sat together to watch the deployment. Then, the arm holding the high-gain antenna stuck. The astronauts made an unscheduled EVA and freed it, saving the mission! Whew!



Jerry is on the Cover of Time Magazine!

What about the science? Jerry Fishman frequently shared his sky-maps with me as it became clear that the gamma ray bursts were cosmological! Interestingly, the source of the extraordinary energy is from a weak (but infinite) force, gravity, from events like the merging of two white dwarfs into a black hole or a black hole absorbing another black hole. Jerry got a lot of recognition for this including being on the cover of Time magazine!



Conclusions

EGRET, I believe, operated as designed and I am sure produced lots of valuable papers. OSSE, OK but less so and I think COMPTTEL came in last, a very difficult experiment.



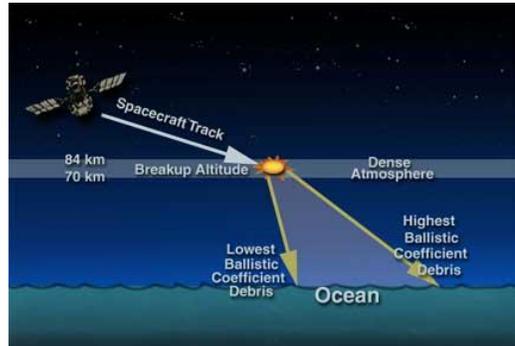
Frank McDonald Wisely Urges me to Keep Madden

The Project Manager at Goddard was Jerry Madden, and I did not initially like his style. At the time, Frank McDonald, who had been my Lab Director was NASA Chief Scientist. I told him about my misgivings about Jerry. His briefings to the Administrator, Jim Beggs, did not meet my standards for crispness and punch. I ended up doing these myself which was unusual. Beggs was a very formal dresser wearing expensive suits. Jerry would show up in casual Puerto Rican shirts called guayabera absent a tie. I was embarrassed. Frank said, “Charlie, he is a good manager. Keep him.” I had enormous respect for Frank, so I did exactly what he said and was later very happy for that advice.



They Send it into the Ocean!

In June 2000, after 9 years and 2 months, Al Diaz decided to use the built-in de-orbit capability to send the spacecraft into the Indian Ocean. EGRET had used all its gas (for the spark chamber) but I believe that the other three instruments were working. I thought this was premature (actually, I think "chickenshit" was the word I used), and unfortunately, I was no longer at NASA. (Note: Hubble needs to deorbit similarly and has no built-in system to do this. A robotic servicing mission will have to install one.)



CGRO Symposium

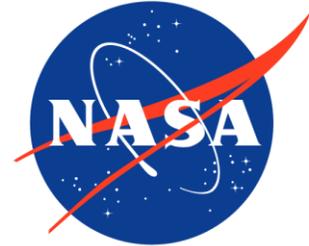
The teams (Project and EGRET) were dismayed by the deorbit and decided to have an all-day symposium to lift people's spirits. They divided the day into 20-minute speaking slots and, of course, asked me to come and speak. It was amazing as every speaker, government, contractor, scientist described the CGRO experience as the best in their entire professional lives! The TRW ops manager, Terry Watson, showed a chart that described the social context as he experienced it. I analyzed the items with the 4-D System, and you guessed it – all four Dimensions filled with more entries on the personal side.



Chapter 26: Completion – Space Infrared Telescope

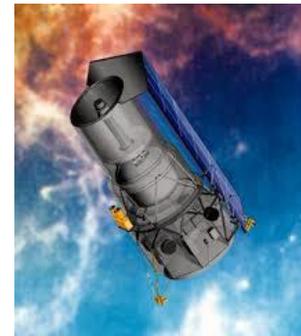
The Three NASA Cultures

All ~~but~~ NASA is divided into three parts: The (original) National Advisory Committee For Aeronautics Centers preceding NASA (Ames Research Center, Glenn Research Center and Langley Research Center, all very “Blue” as they focused on research); the (new) Human Flight Centers (Johnson Space Center, Marshall Space Flight Center and Kennedy Space Center, all very “Orange” as they focused on a single integrated system to send a human to the moon and return them; and the science/robotic Centers the (original) Jet Propulsion Laboratory and the (new) Goddard Space Flight Center, both “Orange” with a healthy “Blue” component.



Making SIRTf a Free Flyer

Now, I had to complete the Great Observatories program with the Space Infrared Telescope Facility (SIRTf), the infrared telescope. This began as an attached Spacelab payload studied at the very “Blue” Ames Research Center. Frankly, this never made much sense, and when we discovered that the Shuttle has an infrared cloud around it, observations became impossible. When I made it the fourth Great Observatory, I got nothing but grief from some people, who should have known better. My old nemesis, “confirmation bias” (adjustment reluctance?) persisted. Some people have great difficulty “adjusting” to new information.



Moving the Mission from Ames to JPL

Ames wanted to manage the new “free flyer” mission. I explained to them that they lacked the essential managerial and technical infrastructure that one requires to manage and support the contractor. If they could show me an enduring line of business” with these kinds of missions, I would consider making the investments to develop this capability. For a single mission this made no sense as JPL had the infrastructure and wanted the mission. They insisted on a competition with JPL. I said that there was no point and they continued to insist. (I did not know to frame it as “orange” vs “blue” at that time.) I thought that a small competitive study might be useful and agreed. We had the competition with little new insight, and I selected JPL. I made a JPL agree to hire anybody from Ames who wanted to relocate to JPL as a condition and forbade subcontracting work to Ames, as I had learned the hard lesson of unnecessary



interfaces from Hubble. Mike Wehner, the Ames project scientist moved to JPL and became project scientist there.

Getting the Cost Down

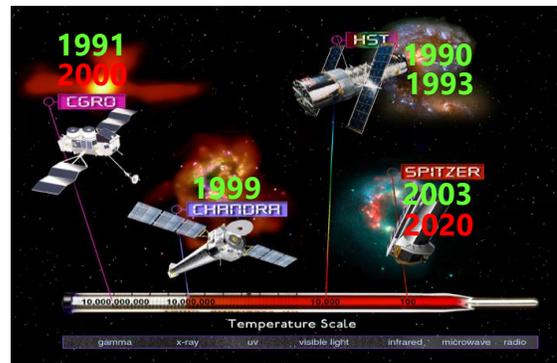
Early cost estimates were \$3 Billion, which was absurd. I knew that IR detector technology had improved by orders of magnitude since the selection of instruments for Spacelab and that we had a Level I science requirements document that everybody was OK with. I asked my Program Manager, Pete Ulrich to work with JPL and the science working group to reduce the technical scope to the minimum to meet the original Level I requirements and get the cost below \$1B. He did this in short order and the fourth Great Observatory launched in 2003! It went into an interesting "Earth-trailing, heliocentric" orbit so it always had the same side facing the sun.



Great Observatories Summary

So, let's look at what happened:

- These would have likely happened independently of my intervention: Hubble's launch in 1990 and GRO's launch in 1991;
- I suggest that these are unlikely without my intervention: Hubble servicing in 1993, AXAF's launch in 1999, and SIRTf's launch in 2003. (What do you think?)
- CGRO (GRO's post-launch name) was deorbited in 2000, and Spitzer (SIRTf's post-launch name) ceased operations in 2020.
- Hubble, after four servicing missions and Chandra (AXAF's post-launch name) continues operations its 21st year!



Roger Launius and the "Space Flight Award"

In 2007, the American Astronautical Society ("AAS") gave me their highest recognition, the "Space Flight Award," for the Great Observatories program. Roger Launius, the senior curator at the National Air and Space Museum, nominated me. I am very grateful for this recognition. I consider the completion of this program as one of the greatest accomplishments of my life, perhaps second only to invention of "4-D Systems."



Chapter 27: The Guru Greet Me! *Siddha Yoga*

I became interested in a Hindu meditation practice, Siddha Yoga. Some years ago, Swami Baba Muktananda brought this practice to the US. His sayings included, Love is our only reason for living and the only purpose of life and through intense deep meditation you reach a state that is beyond thought, beyond change, beyond imagination, beyond differences and duality. He died and gave the leadership to a young woman, Gurumayi Chidvilasananda. Some friends introduced me to this at a weekly meeting in a home in Washington, DC. I liked the people and the practice, which was a "chanting meditation."



A Chanting Meditation

There were a dozen or so repetitive "chants," of varying tempos. The deepest and most powerful being "Om Namah Shivaya." There are various translations of this mantra into something like, "universal consciousness is one." When we met in people's homes, someone would play the harmonium and we would chant together, sitting in a classical Yoga pose like Sukhasana - Comfortable Pose (cross-legged). At home, I meditated daily for about an hour chanting with CDs made by Baba or Gurumayi. I found it much easier than silent meditation as my brain does not go still easily for long periods.



Ashram in Upstate New York

I knew that there was a huge ashram in upstate New York and within a day's or less driving distance. After I had done the practice for some years, I wanted to visit the ashram and most especially see Gurumayi in person. So, a lady-friend and I registered for a multi-day retreat and drove there. As you might expect the accommodations were shared with others, and spartan.



Discomfort and Exhaustion

In contrast, the meditation hall was huge and elegant, deep in the woods with all glass walls. I believe it held 1,000 participants. The marble floor was separated into one-meter by one-meter squares each with a number. The marble floor was heated, I found my spot, and sat on my meditation cushion. While I had never sat for more than an hour, I thought all day would not be very different. I could not have been more wrong. After a few hours, I



became very uncomfortable and I was exhausted by the end of the day. I ate dinner quickly and went to bed early.

Seva – “Selfless Service”

“Seva,” the Hindi word for “selfless service” is a big part of the practice and I was just too tired at the end of each day to do anything. The last day came and I said to myself, “You must do seva, and as the program is nearly over, go volunteer to serve dinner in the food line.” So, I went into the kitchen, announced that I was volunteering to help. They gave me an apron, a serving spoon, and instructions on how much food to serve.



Gurumayi Enters the Hall

Then, I heard a ruckus in the meditation hall. I asked what was going on and a person said, “Gurumayi” has entered the hall and after some remarks will lead a chant. My first thought was, “This is what I came here for, so off with this apron and to my spot.” Then I thought, “If I quit my seva, I will have wasted this entire experience. I will stay at my serving station and be ready when the first people arrive.” My colleague then said, “Come over here and we can watch on TV.”



Gurumayi Approaches and Greets me

I watched Gurumayi exit on TV followed by an entourage of orange monks. She walked into the kitchen some 20 or 30 feet from me intending to continue on through. Then, she stopped, turned, and walked directly to me. She looked me in the eye and said, “Charlie, we are glad that you came.” She, then turned, and walked out. Everybody ran up to me as I was the only person that she spoke to. After she left, I looked at my name badge and it was under my apron! Could it be that she somehow “tuned-into” my struggle? I only had this contact with her and was in the ashram in a sea of a thousand others. I told this story to others in our Yoga community, and no one had ever had a similar experience.



Chapter 28: Deputy Associate Administrator & Associate Deputy Administrator

The NASA Titling System

This may seem quite peculiar, so let me if this helps. The "Administrator" is the head of NASA. Two kinds of "line organizations," meaning that they directly control lots of people and large budgets, report to the Administrator. The "Associate Administrators" in charge of "Program Offices" who are at NASA headquarters, and the "Center Directors" managing the "Field Centers." A program office like the Office of Space Science managed several billion dollars with a relatively small staff of perhaps 200 people. The centers managed programs as directed by headquarters assigning staff, managing contracts, and providing a "second set" of oversight. The Administrator also has "staff" including a "Deputy," a "Chief of Staff," an "Associate Deputy Administrator," for special tasks, a secretary, and an administrative assistant. And of course, there are staff-offices, reporting to the Administrator, e.g., Legal, Procurement, Comptroller.

Deputy AA, S& MA

I maintained a good relationship with NASA Administrator Dan Goldin, and he repeatedly asked me to be Deputy Associate Administrator for Safety and Mission Assurance. Although I was somewhat perplexed by this, after 5 times, I said "Yes." Becky arranged a send-off unlike any I had ever seen. We had a "sit-down" lunch in the Capitol Rotunda and people came from all over to make speeches and wish me well.



He Never Asked Fred?

I called the incoming Associate Administrator Fred Gregory to say hello. I was astounded that he had never heard of me! Dan had picked his deputy without ever talking to him. I took over the office for several months as Fred was still in JSC. I began transitioning from an "inspector" culture into a "build quality" culture as I learned from my time at Harvard Business School. The new, younger people loved me, and the "old timers" hated me.



Fred Pushes Back

Fred finally arrived and after a few weeks he said, "Charlie, we are going roll-back these changes." We argued a bit and it was no use. Then I said, "You know, Fred I have been in Headquarters a long time and know how to run this organization, and you clearly don't." Fred then said, "You can't talk to me like that as I have 5,000 hours in a single seat aircraft." I said, "My point, exactly" and returned to my office. The phone rang, and I answered. Dan said, "What did you do to Fred, he's sitting in my office crying." Dan, I think the best



thing is for me to work somewhere else. Dan said, "I want you to come to the front office and develop NASA's post-cold-war strategy. This was a perfect match to my "Blue" (Although I could not name it at that time.

Associate Deputy Administrator

So, I became Associate Deputy Administrator (Strategy) and promoted to SES-6, the highest non-political level possible. There were four of us in the front office: Dan (of course), Jack Daily (Deputy Administrator, unofficially because he wanted to avoid confirmation hearings), Darleen Druyun (Chief of staff and currently in a federal prison for procurement violations) and me. I looked around and there was a very large, marvelous office with glass walls looking toward Virginia, so I moved in. I went to Dan and said that I wanted about a dozen people. Dan wanted to "make his mark" with downsizing and efficiency, so he said, do it with "detailees" from the Centers. At first I was pretty aggravated, and it turned out that this was a good thing. The Centers were concerned enough about what I might do that they sent me wonderful people.



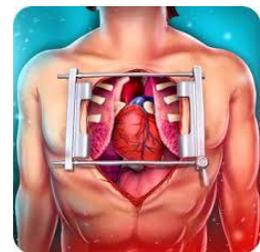
A Planned Intervention

As you might expect, Dan, a 1-D "Blue" (and very smart) had difficulties with his diagonal "Yellow," relationships. We talked how we had both been to Covey's school at Sundance, Utah. We were both acquainted with the lead trainer, Blaine Lee (photo), and I suggested that we engage Blaine to help with his working relationships. Dan agreed, so I went to Ed Hoffman to work with me including the contractual arrangements. Blaine came and conducted interviews with Dan and several of his direct reports. We had planned to meet with Dan and discuss Blaine's findings, and Blaine said to me, "Charlie, I have never seen anything like this. I do not want to engage you in this for your own protection. I need to speak to Dan alone." I agreed and suggested that we have a retreat over a weekend at Wallops with Blaine facilitating.



Dan is Not Going

We decided to do two groups and Darleen said, "Dan does not like these people, put them in the second group. He will meet with the first group and find a reason to cancel the second." So, I began managing this, and of course, people figured out what I was doing. While it was surely embarrassing, I did what I was asked to do. As we approached the first event, with 20 of NASA's top managers preparing to travel, Darleen came into my office and said, "Dan's not going!" I was astounded! Me and Blaine with 20 people who believed that they were going to build a better relationship with Dan, with Dan a "no-show." How



embarrassing! It turned out that my father was having a heart valve replacement that weekend. So, I used that excuse and avoided the Wallops event. (I never even asked what happened.) Blaine told me later that when Dan came to Sundance, he did not participate, choosing instead to mope around in the woods.

Gordy Gives Me Advice

I asked Gordy Williams from TRW how to best serve Dan and NASA and he said, "Dan will come up with crazy ideas, and someone has to stop him from flying into a wall." I did this often in private and occasionally in senior staff meetings. Respect for me from other managers soared.



The "Famous Forty" The "Famous Forty"

One day, Dan called Jack and me into his office, "I want all the AA's (Associate Administrators) and Center Directors to meet with me here in the building once a month, go arrange it." So, we did and just what I expected happened. Dan sat through the entire first meeting, then less at each subsequent meeting. There was a building in Red Square, Moscow that has very different architecture on each side. The story is that they brought Stalin a blueprint intending to ask him which style he preferred. They unrolled the blueprint and before they could say anything, he waved his hand and said, "Just build it." Rather than risk his ire, they built the building. Jack and I were unwilling to risk Dan's ire, so we gave me a half-day each month for my strategic planning presentations.



Topics I Addressed

I claimed that the Space Shuttle was a technical but a policy failure. The program promised low-cost access to space and was, in fact, the most expensive. Several people jumped up and yelled at me. However, I had Greg Davidson going through the books, surfacing all the concealed budgets proving my point. Aaron Cohen, the director for Johnson Space Center was especially annoyed with me. To his credit, he publicly apologized to me at the following meeting.

NASA people could not understand why they were having difficulty getting funding for a moon program. So, I created a hypothetical woman, Chris who was 40 years old, a single mother with a small child making \$40,000 per year. We brainstormed the criteria that would motivate Chris to raise her taxes to go back to the moon. It soon became clear that the only thing that would motivate her is something that would improve life for her child.

NASA was studying developing a new expendable launch vehicle when there were plenty of commercial options. It was intended for NASA's own use. I brought my background from business school and argued that we should focus instead that create value for our customer, the taxpayers. The group agreed and the AA cancelled the organization on the spot.

Applying for Deputy Director, UCAR

I watched Dan (gleefully) remove NASA's most capable managers. I deduced that the common issue was an independent power base, and I was developing one with NASA top management, absent Dan. The group was rallying around me and I was becoming ever more influential, maybe more than Dan. I began to worry that if he learned of this, he would feel threatened and remove me. I began to make plans to leave NASA, applying for the deputy director position for the University Center for Atmospheric Research, in Boulder, Colorado.



Prominent scientists (e.g., Charles Elachi and Berrien Moore) wrote me incredible letters of recommendation. One day I received a call that they had 100 applicants and were down to 2 and I was one of them. I told them I was coming out to learn more. They discouraged me, and I went anyway. I told Darlene about this and I would likely take the job. There was no guard, so I walked in and recognized names of search committee members on office doors. I asked them what the job was about, and they said that the Director had alienated everyone, especially the funding agencies. They needed someone to repair these relationships. I said, "I cannot do this, go select the other person, thank you."

Darlene Offers an IPA (Sabbatical)

When I returned to Headquarters, before I could say anything, Darleen said, "Charlie, Dan and I want you to stay with the agency. We are offering you a one-year sabbatical under the Intergovernmental Personnel Act ("IPA"). I said, "Darlene, thank you and I want 2 years." She said, "Dan will only allow one-year."



I Persuade Dan to Make it Two Years

I went to see Dan and said, "Dan, who is going to win the election?" He said, "Bush." I responded, "That's White House bullshit, Clinton is going to win." He was in silent agreement. I continued, "You are a Republican appointee. How long will you be here once the Democrats take over." Silence again. Then I said something that was untrue that he likely believed, because he knew that he was deeply unpopular, "So, what will they do to me when you are gone?" While I had been loyal to him, I had blunted many of his attacks on NASA people and was well thought of and liked. Even John Kleinberg (brought in from his sailing vacation) said with a smile, "Charlie, who could have thought you became our great humanist?" I then said, "Dan, I think I need 2 years so people forget about our relationship and I can return and continue our plan." He then agreed to 2 years.



Chapter 29: Boulder, CU, Family, and a Beneteau Sailboat

I Choose "CU"

I knew that I wanted to go west, and selected Stanford, Berkeley, and CU as I had good friends at each. Stanford turned me off when they said something like, "You can come, but we don't expect to learn anything from you as we already know everything." I likely would have gone to Berkeley except that my daughter, Jules came out for the weekend and I discovered that the city was a (nasty) suburb of Oakland and most lived 40 minutes away. This was how we lived in the DC area and I did not like it.



Dick McCray Fixes the Mess

I went to Boulder and my good friend, Dick McCray had me to his house for dinner. The next day, I talked with John Tracy, the business school Assistant Dean, who turned me down! Some weeks later Dick contacted me and asked when was I coming? When I told him what had happened, he was astounded and contacted Bruce Ekstrand the Provost, who immediately called the Dean, Bud Sorensen. Shortly after, Bud called me and who it was a terrible mistake, and could I join him for breakfast? I asked Bud how long he expected to be Dean as I was kind of "hitching my star to him?" He was something like the fifth Dean in two years. He assured me that he was in for at least 5 years.



Parking Cinch's It

Parking on campus was a big problem at Stanford and perhaps Berkley, too. When we rolled into the B-school parking lot it was less than half full at 10 in the morning. I asked Bud how much parking cost and he said, "\$15 per month." That clinched it!



Sorenson Is Gone!

My son CJ and I drove to Boulder from Maryland. Half-way there I received an e-mail, "Bud Sorenson is gone, replaced by economist Larry Singell!" This turned out to be a good thing as we got along great! Moreover, his youngest son married my wife, Junko's cousin. We are now family!



Summertime "Minister" In Unity Church

I recounted my interaction with Gurumayi earlier. It was important to me to have Siddha Yoga people in Boulder and there were. However, the group was small and I did not like them much. I had heard that the Unity church was good, so I went. The minister, Jack Groverland, and his wife,



Norma, had done off-Broadway plays, so the services were very animated. This was a Christian church and not in the Roman tradition. There were no crosses as Jesus was about the resurrection, not the crucifixion which was institutionalized by Emperor Constantine. The Bible is interpreted in the sense of "What is the writer trying to tell us," rather than literally. "A Course in Miracles," is given equal status. They offered a year-long class which I took. It's important to note that it is not "The" course, but "A" course. I liked the church as it enabled me to "make sense of Christianity and heal from Catholicism.

Frequent Battery Changes?

I noticed that Jack and Norma had lavalier mics and were changing the batteries every 30 minutes or so. This made no sense, so I wondered if there was a problem with the receiving antennas? I went into the A/V room and saw that the antennas were on the back wall and the front wall was thick masonry. I saw a staff member and said, "If you move these antennas to have a line-of-sight to the stage, you won't have to change the batteries so often!"



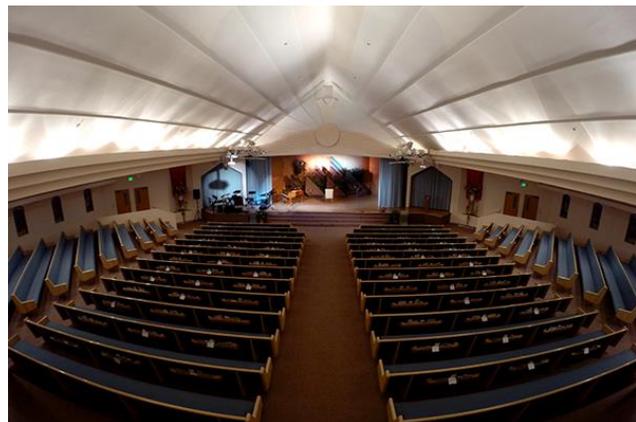
"Aren't You the Hubble Guy?"

Jack saw this and approached, asking, "What's going on?" When I explained, he interrupted with, "Wait a minute, aren't you the Hubble guy?" The local newspaper, the Daily Camera, had run a story about me moving to Boulder. When I answered in the affirmative, he continued, "I am going on vacation soon and will be out for much of the Summer. I would like for you to lead the services in my absence."



I Do Sunday Services

While I was surprised, I agreed. This is a large church with perhaps 800 people at the service. I prepared for this by attending the Wednesday evening meditation service usually led by Norma. I closed each Sunday service with a meditation citing my favorite verses from Jesus in the bible, "Be still and know that I am God"..."For I am in you and you are in me," which I interpret as, Meditate on the fact that spirituality is Universal. I did this for three summers then "outgrew" the church's message. I spent some time in week-long silent retreats. And Jack and Norma married Junko and me on December 11, 1991 (my birthday) in the church with a lovely ceremony. I have not been back since and remain grateful for them and the church.



Biking In Boulder

With the collapse of my marriage, I moved into a small apartment within walking distance to my office in Washington. I soon rediscovered “biking” which had advanced technologically since my childhood. And biking in Boulder was wonderful. Sweat was minimal in the dry air, and hills were everywhere. I bicycled to my office at the University on back paths. On Sundays, I rode an hour-long very demanding route called the Morgul-Bismark loop. The name came from the names of two dogs. Moreover, I often rode 100 km rides (Metric Century’s) non-stop except to get water.



The White Rim Trail

However, the ultimate biking experience was the White Rim. This was a week-long, 100-mile mountain-bike event that Ron Billingsley would invite me to join. The ride is in Canyonlands, high on a plateau between the Green and Colorado rivers. We would go as a group with large pick-up trucks carrying supplies, food, and water.



The first night, we sat around a fire and got to know each other. When my turn came, I told a shorter version of my story about Mikulski and Hubble (related above). I week later, some new people joined the group. As we sat around the fire, someone said, “Charlie, please tell that Hubble story again.” That was the first time I had ever shared this and was surprised that people found it interesting. I have told it many, many times since!

My Class Writes a Letter to the University President

When I first moved to Boulder, I was surprised to see the local newspaper pummeling the university president, Judith Albino, day-after-day. After watching this for a few weeks, I saw her dilemma as a leadership problem. I photocopied the top newspaper stories and passed them out to my undergraduate students. We talked for a few classes about what advice we would give the president. Then my students came to my house on a Saturday afternoon. We used a “post-it” process to write a 1.5-page letter that consolidated 20+ people’s opinions.



My Student Invites Her to Speak to Our Class

A few weeks later, one of my students spoke to Dr. Albino at a social function. He identified himself as a member of the leadership class that sent the letter. He then invited her to come to class and speak. My students knew they were empowered to make those kinds of commitments. At the time, I was holding two misconceptions: 1) that a permanent position might be in the cards for me at the B-school; and 2) that the president of the university might have some say about this. I wanted the president to have a good experience, so the student who made the invitation and I met with Dr. Albino. I explained that our class was about leadership, and we were totally committed to confidentiality. I asked that she speak candidly about her current difficulties and experiences. She thanked us and said she would.



She has no Authenticity or Connection with Us

She arrived at our classroom a few days later. I introduced her and then sat with my students in our amphitheater-style classroom. Have you ever seen a person speaking as if they inserted a tape into their head and played it? That is exactly what she looked like. I stood up, walked over to Dr. Albino and said, "Judith, you know, there are some great leaders in this room. People will blast them at some future time. Can you tell the students what this is like for you to open your front door and pick up the paper and see ugly stories about you? It's safe here." I returned to my seat. She continued as before.



I began to worry. I had taught the class the "BS" signal. You place your hands beside your head and wiggle two fingers. It springs from the notion of ants pushing a piece of BS up a hill. Sometimes a piece of BS would escape and began rolling down the hill. They signaled the ants below by wiggling their antennae "look out, here comes the BS." What would I do if my students gave the president the BS signal? Would this be the end of my teaching career? I was becoming anxious.

I Urge Her to "Tell the Truth"

After a few minutes, I noticed students squirming in their seats. Fearing a mass eruption of the BS sign, I walked back over to her. I turned her toward me and said, "Judith, please tell the students what it's like to open your door every morning and look down at the Camera." I also took the risk of touching her shoulders as I spoke. She looked me in the eyes, and I said, "I promise you that it's safe here" and sat down again. When she began speaking this time, we could actually see her mask drop. She now spoke to the class fully authentically. I had never heard such a persuasive and moving discourse. We were all spellbound.



As the class ending time drew near, I reluctantly interrupted her. The mask popped back up and the "tape" resumed. I thanked her, and she left.

Class Ends and Nobody Moves

This large undergraduate class ended just before lunch. A large table occupied the front center of the room. I learned early on to center myself behind the table before dismissing the class. If I were in front of either of the side doors, the students would sweep me into the hall. I positioned myself and said, "Class dismissed. See you on Wednesday." Nobody moved. Not knowing what to do, I sat back down. Still, nobody spoke or moved. I went to the front of the room and said, "What do you want to do?" They answered, "We want to talk about what we just saw." We talked for another hour and stopped only because another class wanted the room. In the end, Dr. Albino transferred to Denver relinquishing her presidency. It is tragic that a fear-driven persona so limited this person.



Jules Moves in With Me

A year or so after I moved to Boulder, Jules shows up unexpectedly, broke, leaving a relationship with Bruce, drug manufacturer. I took her in and paid for her to get a massage Certification. One day agents from the Drug Enforcement Administration and FBI showed up. I told them my background and that she was not using drugs. I hired a lawyer for her, and they were OK after they interviewed her and sensed that she was being truthful. They were only after Bruce. She later moved into a City of Boulder subsidized housing on her own.



CJ Moves in, Too

CJ also shows up, broke and unemployed and moves in. He chose to take a year off after he graduated to drive around the US with some friends, which I supported. When he applied for Civil Engineering jobs, nobody would hire him because he had no experience! My good friend, Tony Calio said he would hire CJ if he would get an MS in Computer Science and that's what he did.



Happy Together

We lived together for several years, and generally got along well. I enjoyed getting to my adult children better!



A Visitor From Huntsville

A friend of mine, Rick Chappell, was in the area and stopped in to see me. He knew about my background in sailing and wanted me to buy into a large boat he owned that was leaving the "Moorings Charter Service." It soon became apparent that he had mismanaged his finances and it was a really bad deal. (I wondered; did he think I was that stupid?)



Moreover, I had no desire to own such a large boat, as I believe that it was over 50 feet! A boat that large was intended for groups of people to gather, unappealing to me!

Curiosity About the Moorings

Whereas I had no more interest in sailing in the polluted Chesapeake Bay, I loved snorkeling and tropical fish. So, the idea of boat in the islands had some appeal. The conversation made me curious about the Moorings and they paid for me to come to the British Virgin Islands (“BVI”) to try out a 33-foot Beneteau, a high-end French brand. I quickly realized two things. First, that was too small a boat for the large waves as I could not keep a sufficiently accurate track to optimize the sails. Second, I had no desire to be in the BVIs with hundreds of boats anchored near each other, all dumping toilets overboard! I would buy the boat and be the owner with them helping with financing and insurance. They would maintain and charter the boat with a revenue stream back to me to help pay the cost of the boat for, I think, 5 years. There was a replacement schedule for things that wear out, e.g., sails. I could reserve it anytime for myself, of course, free of charge. I could also use the same boat owned by other people in other locations at no cost.



The 38.2-Foot Boat Looked Super!

I boarded a 38.2-foot Beneteau and was highly impressed. The “lights” (the nautical term for windows) were huge. The companionway stairs on front of the engine lifted on hydraulic cylinders making access easy. There was an electric, foot operated, chain windlass for the anchor. The stern had a wonderful “fold-down” arrangement making it easy to enter the water and get back in the boat. As cruising sailboats get longer they tend to get larger in the other dimensions. Thus a 40-foot sailboat is about twice size/displacement of a 30-foot sailboat. The maximum speed, or hull speed, for a displacement hull is 1.34 times the square root of the waterline length. However, the price of \$200,000 was too much for me.



We Have a Used 38.2-Footer!

I was about week away from leaving for my “wife hunting trip” in Japan when I received a phone call. They had a one-year-old 38.2-foot boat in Grenada that the owner wanted to sell. Grenada is a nation in the West Indies on the south end of the Grenadines, comprising a main island and several smaller Islands. There were non-



stop flights from Houston and hurricanes that far south are rare. It is remote with few tourists or yachts. I did not have time to look at the boat, so I asked the base manager to evaluate it and send me some photos. It seemed to be in pretty good shape. They asked me to make an offer. I made a spreadsheet and tried to calculate the price that would cover my payments and leave enough residual value that I could sell it and break even after, say 5 years.

They Took My Offer!

I offered \$144,000 and they took it. While, I was excited, it troubled me that maybe I paid too much. I had a friend and neighbor, Bill Cairns, who parleyed a small used car shop into an enormous dealership. He taught me that you must always “uptick,” or people will think that they paid too much. What that means is that anytime someone makes an offer, even if it’s a really good one, come back with one (slightly) higher. (I was surprised that Moorings did not know this, and I think that most of their sales are new boats at fixed prices?)



Engaged to Junko!

Soon after I returned home, I became “engaged” to Junko who, like most Japanese never learned how to swim and is not much on being outdoors, preferring her light skin tone. She went with me about once a year and snorkeled with me. I went several other times each year with my children or friends. Of course, owners literally got the red-carpet treatment! There was a large, isolated bay near the Moorings station that I could enter using prior “tracks” with my handheld GPS. I would carefully inspect everything for functionality. Then, I would radio the station and people would come in a motor launch and fix everything. This was the best part of the arrangement, as I spent as much time maintaining my C&C 30 as sailing it. We would stay two or three weeks sailing between the islands going as far north as French Martinique. People in the stops/restaurants knew me and welcomed me. The only annoying thing is most of the islands were countries and I had to spot at customs each way.



Finally, I “Sold” the Boat

The flights became less convenient after 911, and I became concerned about a hurricane, which the insurance



did not cover. The first problem was that I would likely have to hire a crew to move the boat to the BVIs. Then while waiting for it to sell BVIs a hurricane was possible. I had become friendly with an Aussie Moorings employee in the BVIs and I sent him an e-mail soliciting his advice. He placed me in contact with a sailing academy for young people who would give me some cash plus a large tax write-off. This was as good as a sale, they would take the boat in Grenada, and it was immediate. Was it a "good deal," in that I could have just chartered? I do not know, and there is something special about being on your own boat. And, Junko, my children, my friends, my colleagues, and I had some unforgettable life experiences!

Chapter 30: Vision Quest and Meditation A'HA

Back to NASA or Stay in Boulder

Deciding whether to return to NASA as planned or staying in Boulder with an early retirement was vexing for me. I had no job in Boulder and if I went back I could retire with a HUGE pension. These were based on one's "high-five" salary and I was a Senior Executive Service ("SES") – Level 6, the highest non-political salary. I would likely return to the Administrator's suite with all the accompanying stress. I might not survive 5 years of that.



My Vision Quest

There are many remnants of Native American culture in Boulder. I looked into the "Sun Dance," and this was far too painful for me. I tried a "Sweat Lodge" and did not like the smoke. I settled on a "Vision Quest" to help me decide. I saw an ad in a Boulder newspaper that a person was organizing these and engaged him. He took several of us into the Sangre de Cristo (blood of Christ) mountains, a remote range in southern Colorado. He conducted a traditional ceremony, then took us each to remote, separate locations. We each had a water bottle and tarp. Nothing else was permitted, e.g., tent or sleeping bag. There was a "drop-off" point where we would leave our empty water bottle and pick up a full one. The organizer would know that we were OK by the empty bottle. The biggest danger was bears. Tagged (troublesome) bears were placed there because the place was so remote.



At One With the Animals

I became quite hungry the first day and felt weak. I mostly thought about food. I took a short hike and became disoriented and almost became lost. The second day was similar although I did not leave except to change my water bottle. By the third day, the hunger was largely gone, as my body had started consuming itself. The weather was mild, so I took off my clothes. Animals (e.g., birds and squirrels) lost their fear of me and gathered near. It struck me how much time we spend on food: Buying it, preparing it, eating it, and eliminating it! The fourth day was easy as I was not in a routine.



My Hallucination

The morning of the fifth day, I awoke and looked into the sky. I watched the stars moving together and said to myself, "Wow, the Earth is spinning." Then a hallucination. A person who was a co-founder of Ball Aerospace who I barely knew appeared. I was lying on the tarp and looking upward. He said, "Charlie, you have too much to offer, you must keep contributing." Later that day, I met the organizer at the water bottle exchange place. I learned that a rogue bear had stolen a backpack from some campers, then broke into a building and was shot! We had a closing ceremony and returned to Boulder. So, part of my question was settled. I would keep working.



The Voice is Not Mine

Now, how about staying in Boulder with my smaller pension? Could I live on it? Would I have to take a roommate to afford my house? I tried many spreadsheet scenarios to see how I could rationalize up the difference. Nothing worked. I still did not what to do. I went to a silent meditation class and heard a voice, "The most important thing is your pension." Then, I noticed that the voice was not mine but my father's! I was in the grip of something he valued. That settled it! I was not going back to NASA.



"Early-out"

The first challenge was to get authorization for an "early-out." I was only 50 years old and this was only possible because I had been a Civil Servant for more than 30 years since I started as a Civil Servant just after graduating college. This was not a big deal, and I needed someone in top management ask personnel to do this. The Deputy Administrator, Jack Daily, and I had an excellent relationship working together to deal with Dan. Jack had, IMHO, had an issue with pettifogging, an undue obsession with details, particularly with the travel budget. So, I called him and said, "Jack, do you remember how hard the hit on the travel budget was when you moved me to Boulder?" He said, "Yes, it was huge." I said, "Well I have really bad news. When I moved here I did not have many things. Living in a house here, I have a lot of furniture, dishes, clothes, and several bicycles. It is going to cost a small fortune to move me back. How about get me an early out and I save you all that by staying here?" He said, "Deal," and we were done!



Chapter 31: The Start of 4-D Systems

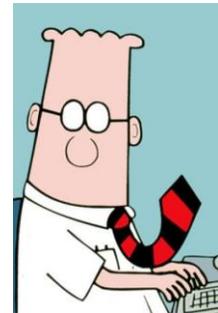
John Mather Stimulates My Thinking

Did you ever know a person who you so totally respected that focused on every work they spoke? John Mather is such a person for me. Not only is he a brilliant physicist with, e.g., perfect college board scores, he is a generous, thoughtful person. He came into my office in the mid-80's as we were building a very difficult satellite, the Cosmic Background Explorer ("COBE") to conduct his experiment. He said, "Charlie, I'm convinced that half of the cost of a project is socially determined." The fact that the cost of COBE was relentlessly increasing further increased my interest. I gave this a lot of thought but did not know what to do. (John's experiment accurately measured the remnant radiation from the "Big Bang" winning him a Nobel Prize in Physics.)



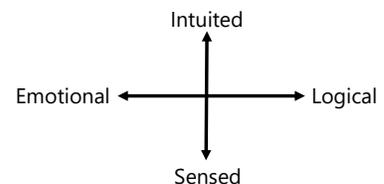
The "Invention" of the 4-D (Organizing) System:

I arrived at University of Colorado ("CU") Business School in the spring of 1993. I designed my course, "21st Century Leadership," on the best content of the many trainings that NASA sent me to. I organized the material with an acronym, "CREATING" with each letter representing an important behavior. I taught this course in the fall of 1993 and spring of 1994 to undergraduates, MBAs, and a group of (non-credit) business executives. As a physicist, I strongly prefer analytical tools, e.g., coordinate systems and equations over acronyms or lists. During the summer of 1994, as I was not teaching, I tried to find such a tool. I turned to popular "business books" as I had read a lot of them. They are all similar with anecdotes about famous people and lists of the "n things one is supposed to do" that are in all "business books." I wrote these actions on large pieces of paper and taped them on the wall in my office. I tried ever more complicated coordinate systems looking for a pattern. Nothing worked. The morning after I abandoned the effort, likely in July 1994, I was inspired by a Dilbert cartoon which said, "Every consultant makes their living with a 2 by 2 matrix." I thought, "I made this too hard, it is an "X-Y" (Cartesian) system!"



Jungian "Personality Types"

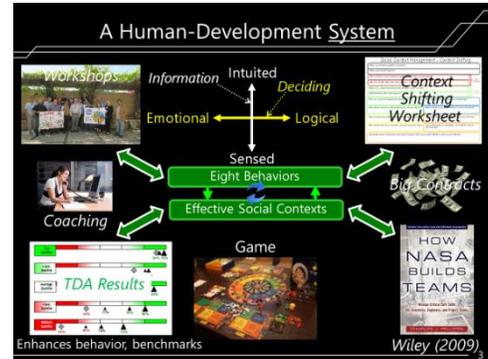
But which X-Y system? At the time I was reading Carl Jung's work on "personality types." He wrote something that captured my attention, that we all build our personalities on our innate (present at birth) preferences for information and deciding! I loved the simplicity: input and output. These were the axes for my coordinate system. And I knew the labels. I knew that there were two kinds of information, "intuitive," an



unconscious integration of past experience, and “sensed,” from our five senses. Moreover, there are two ways of deciding, using “emotions” or “logic.”

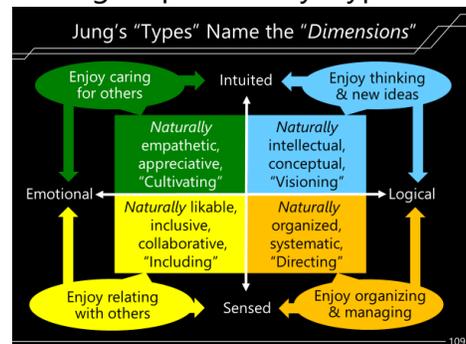
Why is 4-D Systems So Named?

People sometimes ask me to compare 4-D to other methods, like DISC. This is like comparing a narrative about the nature of gravity to Newton’s equation, Force equals mass times acceleration. With this equation, physicists can derive the entirety of “Classical Mechanics,” so named to differentiate it from Special and General Relativity. Similarly, 4-D is an analytical (simplifying) tool providing many insights. A Human-Development System This is the system I developed in contrast to the Covey approach! All parts work together, reinforcing each other to habituate necessary behaviors! The first was a workshop that evolved from my classes at CU. Then, we added coaching when we discovered how quickly people forget without repetition. Next, on-line tools for stimulating, benchmarking, and tracking behaviors of both individuals and teams. Then, the context-shifting worksheet that goes through the entire workshop in about an hour and integrated into the workshop processing participant’s troubling “Situation,” making the workshop “about them.” Soon, I had lots of work with a huge NASA contract! Then, Wiley published “How NASA Builds Teams” Finally, my friends in Novosibirsk, Siberia invented a “boardgame” that teaches 4-D. Here are some examples of the coordinate system applied to various social contexts.



The “Personalities” get “Colors”

I decided to “test drive” the new tool on its origins, Jungian personality “types.” The image on the right easily emerged. Early on, I coined the term “Dimensions” to name the four areas, because that “quadrants” seemed so boring. Of course, I know that this is not a four-dimensional space as I am well familiar the four-dimensional tensor (x,y,z,t) used in general relativity. Then I gave them colors as follows:

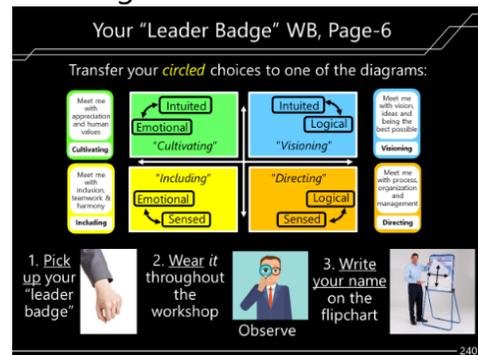


- “Cultivating,” green – because caring grows people;
- “Including,” yellow – because I had better uses for the other primary colors, with the mnemonic yellow flowers attract bees;
- “Visioning,” blue – for blue-sky thinking; and
- “Directing,” orange, like how our sun organizes the solar system. Participants in China asked me, “Why not red?” I responded, “Because although red is a good color in the east, it is not in the west where people think of stop and fire. My wife and I,

however, acknowledge and use the power of red. She packs, and I wear red underpants for every workshop." During a workshop in Shanghai with 250+ participants, my translator said on the second morning, "Charlie, they want to see your underpants." I thought, OK, turned sideways, lifted my shirt, and lowered my trousers. I forgot that there were also 250 video cameras in the room. Videos of my red underpants went viral on "WeChat." In China, I will likely be better known as the foreigner with red underpants than the person who saved Hubble. People love these colors and use them!

Optimizing Team Performance

Workshop participants make their first attempt at finding the "dimension" of their innate personality by completing a 14-question inquiry into their preferences for information (intuited or sensed) and deciding (emotional or logical) and use "key" in the slide to find their personality "foundation." They then pick up a laminated "leader badge," the same size as most work badges that my wife, Junko, manufactures. I also provide color-matching lanyards. They wear these throughout the workshop and write their name in the appropriate dimension on a flip chart. We then discuss the personality distribution and its implications for tasks it would do best in "public" workshops and implications for performance for teams.



Experimenting with the "Organizing System"

I began to experiment with the tool, as though it was an equation I analyzed NASA flight projects and found consistent patterns. Successful projects had all four "dimensions" occupied with more on the "emotional" side. Failed projects had vacant dimensions and less on the emotional side. Had I found the "F=ma," the essence of classical mechanics, for social contexts, i.e., predictive capabilities? It seemed so! Business owners called me asking if they would win bids or not. I only asked them if they bid "vision" or "certainty" and who was evaluating? Turned out that I could accurately predict outcomes! The 4-D System became the foundation of my future courses.



Sarah and the Foundation

CU, like all universities had a "foundation" to raise money from alumni and others. Although the B-school had perhaps 100 faculty, the foundation frequently asked me, a temporary faculty member, to be a speaker at their



events. An employee, Sarah Borst, heard me speak and sent my remarks to her brother, Skip, who was a manager at General Electric ("GE"). He then said to her, "This is a person who talks about important things in a knowledgeable way."

Skip Has an A'HA Moment

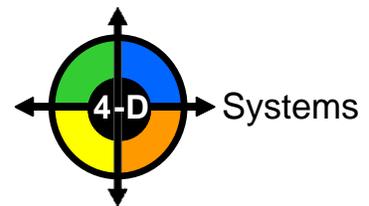
Soon thereafter, Skip invited me to be the keynote speaker at GE's annual conference of "top employees." I spoke to the "CREATING" model with a standing ovation as I finished. Skip then attended a workshop for a NASA team as an observer. At a break, he ran up to me, saying "I got it! I got it! All my life I have been chronically uncomfortable with my parents and at work. So, I took the Meyers-Briggs and was an "NT." (This is "Blue" in the 4-D System and I



will use these colors from now on.)" Skip continues, "It didn't feel right. So, I took the extended Meyers-Briggs with 120 questions, came up "Blue" again. It didn't feel right. Now, I see that I am innately "Green," and was raised by two hyper- "Orange" German parents, attended the Naval Academy, then managed the construction of nuclear plants in foreign countries. I adapted to "Blue" to survive." Then, I asked him, "If money were no object, what would you do for work?" He said, "I would be a coach," confirming his "Green" foundation.

Skip Joins 4-D

Not long after, Skip quit his job at GE, with a large mortgage and two children in college to join my company at a time when we made little or no money. His wife was incredulous, and asked, "Why?" He answered, "All my life I have done what suited others. I am 62 years old and am going to do what suits me before I die." As you will later see, we won a big NASA contract that ran for 10 years, and Skip actually did quite well.



I Loved my Classes and my Students

I loved teaching classes at the University and wanted to stay. Dean Larry Singell wanted me to stay and the faculty, who had the real power did not. Here are some of their reasons: I had the only A+ rated course in the college; When they said, "We would not have let you come if we knew that you would not use your math expertise to help us in our research." I responded, "I came here to teach, if I wanted to do research I would have gone to the physics department." And "The problem with you is that you write papers about things that you have never done to be read by people who are never going to do it." (I have always been outspoken!)



The Problem is That You Tell Them the Truth

Dean Singell said to me, "The problem when you say things like that is that there are two kinds of people, those that just ignore you, and those that know what you are saying is the truth and don't want to hear it. The last person who told the truth was 2,000 years ago and look what they did to him." We liked each other and I took it with good humor.



Convening the "Dean's Advisory Committee"

Larry decided to convene his "Dean's Advisory Committee" ("DAC") to review my course and overturn the faculty. The DAC was formed from prominent business executives (whose companies gave money to the college). They and the faculty did not like each other either as the faculty had not worked in business and focused on writing papers as CU was a "Research University." Unlike the physics department which had lots of "grants" the B-school got very few, using state money to pay their salaries.



Weatherup Asks my Students

Craig Weatherup, the CEO of Pepsi, called the meeting to order and asked me if they could skip my presentation and hear directly from the students. I was very fortunate as the as a graduating management-major MBA spoke first describing my class very emotionally. The others followed suit. Then, Craig said, "Let me see if I heard you correctly. Are you saying that no students should be allowed to graduate this college without taking Dr. Pellerin's course?" They answered with chorus of "Yes's!"



My Academic Career Ends

Then he asked the question that ended my academic career (he should have known better), "Are you saying that no one should be allowed to teach in this college unless they have taken Dr. Pellerin's course?" Again, a chorus of "Yes's!" The Dean told me much later that Craig left him a check for \$50,000 that he could only cash if he kept me in the college. During the break, three members approached me and asked me to bring "4-D" into their businesses!

So, let's "review the bidding," as these were my options:

1. Return to NASA, likely in the “front office” with Administrator Dan Goldin, raise my “high 5” basis of retirement and retire with an enormous pension; or
2. Request an “early out retirement,” which I would likely get, with a 9% reduction for being under 55, stay in Boulder with one workshop and no job.



My basic dilemma was my job back at NASA. Working with Dan was stressful, and I might not live 5 more years. I watched Dan cheerfully demote/remove people who challenged him, so perhaps he would tire of me or turn on me. On the other side, I thought that I might have to take a boarder in to help with house payments.

Choosing to Stay in Boulder

I chose to stay in Boulder and work with Jo Marie Dancik an attractive, tall blonde Area Managing Partner for the accounting firm, Ernst and Young. I did not know a lot about the local business scene, so I asked my friend, Ron Billingsley to suggest a mentor. Ron suggested Tom Hallin who had been a senior executive at a similar firm. Tom was glad to help, and we began meeting in Denver for lunch. Jo Marie had asked me to teach like my class, meeting twice a week for an hour and 15 minutes. Tom explained that this would be a disaster since people on “billable hours” would only intermittently come. So. I went back to Jo Marie and convinced her to do a single three-day event.



Ernst and Young Workshop

I finally did the workshop in December. In those days, I built a ‘lesson plan” and wrote the content on flip charts. Since I could not do this without assistance, I asked a Boulder “therapist,” Susan Carabello (Recommended by the Hendricks) to be “second chair.” Jo Marie immediately disliked her and asked me to “send her home.” Our agreement was that we had each selected “pages” that we preferred to brief and would do those. She was deep “Green” and could not keep the agreement which was stressful for me.



Five, Older, Male Partners

Jo Marie had five older, male partners who worked for her and did not like her, and by inference did not like me. When we ate lunch at the same table at the start of the workshop, they refused to look at me or speak to me. Jo Marie was pleased which was all I cared about. People sometimes ask me about whether our work applies outside NASA since we have done so much work there. Our early work was



in the accounting industry and then later commercial aerospace. The NASA work has only dominated the later years.

Culture Follow-on Stimulus

After we provided a three-day workshop, Jo Marie asked me to improve the culture in the Denver office. I conducted a half-day "brainstorming" activity. The process begins by carefully defining the question you want to address. The group chose, "WHAT DO WE MOST NEED IN OUR OFFICE'S CULTURE?" After an hour or so, the process returned the result ("Green") appreciation. (I knew this. Their overdone "Orange" culture was surely lacking diagonal "Green" appreciation.)



"Green" Methods Not Well Suited to "Orange" Cultures

How would you implement this in accounting firm? Most consultants that teach appreciation are "Green." They typically advise, "You must look them in the eye, express the appreciation emotionally, then hug each other." Would that work in an "Orange" organization? I think not. The "antibodies" would crush it. So, what to do? (Are you seeing why a systemic approach is essential?) We now show how we use the 4-D system as master organizing tool. What kind of appreciation initiative could the "Orange" culture embrace? The answer is that they need an "Orange" one.



Working with the HR Director

The HR Director became friends during the workshop. We decided to make small three-part "NCR" (i.e., carbon) forms with post-it adhesive on the top of each part. The appreciating person filled out the form with: 1) Who they were appreciating; 2) Which action/behavior they were appreciating; and 3) Their name and signature. The top copy went to the person receiving the appreciation and the other two copies went into the two personnel files. After a month, the HR Director called me, "Charlie, the appreciation system is working. There are lots of papers in the personnel files, and more importantly the change in the building is palpable. People are energized as never before and are upbeat."



Turbocharging

I called Jo Marie and said, "Do you want to turbocharge the appreciation system?" She said, "Sure, how?" I said, "Tie say, 5% of each worker's bonus to their participation as both giver and recipient. You have the data in the personnel folders." She did it and business results soared. The office moved from being one of the lowest financial performers to one of the highest in the vast company. Jo Marie was promoted and moved to the company's headquarters.



Chair, Midwest Federal Reserve!

Then, she was appointed Chairperson of the Midwest Federal Reserve Bank. This is one of the biggest jobs in the US! We met for lunch in Boulder when Wiley Published my book and she smiled and said, "Greenspan had to request my permission to speak in my meetings." Habitual appreciation is not just about living happier, healthier, and longer; it's about business results.



Shifting From "Leadership" to "Teambuilding"

With my start-up company, I approached NASA project managers about Leadership because that was the Hubble flaw's cause. Their response was "I don't care about leadership, that's the institution's problem. Moreover, HR has their own leadership program, and they are unlikely to quite theirs in favor of yours." I shifted the emphasis and saw that collective behavioral change working with teams was far more in developing leaders than working with unassociated individuals.



You Have to Show This to Dan

While I was at CU, I would visit NASA occasionally. I enjoyed the Deputy Administrator, Jack Dailey (photo from when he was a Marine General) and would stop and chat with him. On one occasion, I showed him the 4-D model and asked him Administrator Dan Goldin's "color?" (Anyone could easily do this.) He said, "Dan is a Visioning leader." (I was using the colors yet.) I said, "Now, what limits Dan?" He said, "Clearly, it is his diagonal, his relationships." I agreed and said, "Exactly and imagine how much more effective he would be if she could improve that." Jack said, "Yes, Charlie you have to explain this to him." I said, "I don't think so." He said, "Come on, Charlie, you owe me a few, so how about it?" I said, "OK." I went to Kelly, Dan's secretary, who I knew and was fond of, and said, "Kelly, I would like to see Dan. What can you do?" She said, "Charlie, give me a few minutes to move some things around and you can go in." I thanked her and went in a few minutes later.



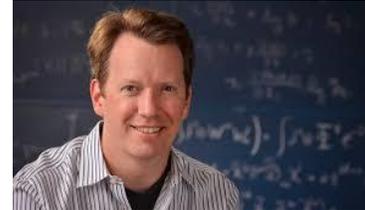
The Model is Wrong!

Dan welcomed me cordially and we chatted for a few minutes. Then I said, "Dan, I have developed a leadership model that I think that you will find interesting. I sketched the "4-D System," and said, "Dan, which leader are you?" He smiled and said, "Charlie, I am a visioning leader." I responded, "Yes, that's correct, I live there too, which is perhaps why we see things so similarly. The model suggests that your limiting weakness is your relationships. What would it be like to improve those?" Dan said, "The model is wrong." I asked, "What's wrong with it?" He said, "Go fix it and come back when you have fixed it and I will show you." I muttered, "The model is not wrong and prepared to depart." Dan

followed me out of his office, through the suite, until my elevator came, shouting, "The model is wrong, the model is wrong..." I hope that you find the story humorous. Dan was in many ways, brilliant...and, he did not like his limitations pointed out. (I suspect nobody does.)

Social Context Fields

We know that other people's behaviors affect how we behave. But what is the mechanism? When Newton published his equations, scientists could calculate "classical mechanics," which is useful today. However, the mechanism for gravitational "action at a distance" was mysterious. The answer was the mathematical idea of a "field." Einstein finally resolved the mechanism question in 1915 with "General Relativity," naming "curvature of space-time" as gravity's mechanism. Caltech's senior theoretical physicist, Sean Carroll says, "A field is something that fills space, taking on a value everywhere."



Social Field Mechanisms

I suggest that the idea of Social Context Fields is likewise useful for understanding what drives behaviors. The primary mechanism is tribalism, a remnant from our evolutionary past, and central to our survival as a species. Moreover, the underlying forces are our needs to feel appreciated and included by our "tribes," at work, our "teams." Finally, the two most important "field shaping" influencers are the hierarchical/team/organizational leaders and team member's behavioral norms.



First Principles

Physicists are trained to reason from "first principles," the most basic ideas, rather than "by analogy," Physicist Elon Musk illustrated this when he announced that he would electrify transportation. Critics said, "It's impossible, batteries cost \$600 per KWH." He countered with, "You are reasoning by analogy. I prefer first principles. I can purchase all the ingredients for \$80, so it is just a packaging problem." So, these are some of the "first principles" in "4-D Systems:"

- Behaviors are everything, we must measure them (on-line tools) and manage them (with the full suite of 4-D processes);
- Humans are innately tribal, powered by needs for feeling appreciated and included and our evolutionary past;

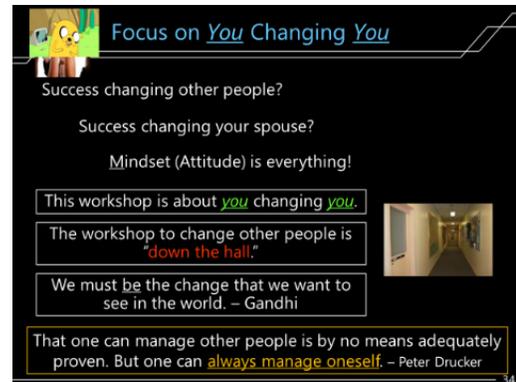


- Team's behavioral norms create "Social Context fields" that influence team member's behaviors like physical fields; and
- The wonderful process, A, M, B, R, Attention → Mindset → Behavior → Result!

The fact that everything comes from "first principles," means that these processes work with all cultures and generations.

Focus on You Changing You

This addresses a really important idea. Even though I show this slide in workshops, several people will ask about changing other people. I ask workshop participants to "raise their hands if they had success changing other people." Usually, no, or few hands go up. Then, I ask participants to "raise their hands if they had success changing their spouses." Again, few or no hands go up. Then, I tell them about a workshop where a lady raised her hand. I asked her, "How?" She replied,



"Divorce!" And, whimsically, "The workshop to change other people is "down the hall." I explain that they should heed Gandhi's wisdom, and "Be the change that they want to see in the world." Finally, from Peter Drucker, "That one can manage other people is by no means adequately proven. But one can *always manage oneself*."

NASA Workshops

Dr. Ed Hoffman at NASA Headquarters directed a program called the Academy for Program and Project Leadership, ("APPL"). He and I became friends and after I left NASA he would hire me to do a few workshops per year for unassociated people at Wallops Flight Facility in Virginia. There were a lot of "repeats." (I suspect that these were people supervisors were just as happy to have out of the office?)



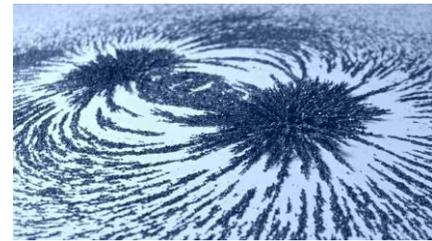
People Forgot the Material?

I was surprised that people who had been in my workshops 6 months earlier did not know the core material! I said to my (Green") colleague, Skip, "We need some reinforcement after workshops, what do you think?" He responded, "I always wanted to be an Executive Coach, let me investigate this." He went to International Coach Federation ("ICF") events and managed to get on an (early) ICF Board. Somehow, the members all gave each other Master Certified Coach ("MCC"). He began offering coaching after each workshop for participants who wanted this reinforcement. So, now, we had two aligned "4-D Tools."



Behaviors Reflect Everything!

I was shifting ever-more to the power of "Social Context," as a potent means to manage human behavior and this tool provided a means to measure it. Just as iron filings are "tracer-particles" for magnetic fields, team behavioral norms are "tracer particles" for social context fields. Just as iron filings respond to everything that affects the magnetic field, this tool responds to everything that effects the social field, even lack of technical competence. Wow!



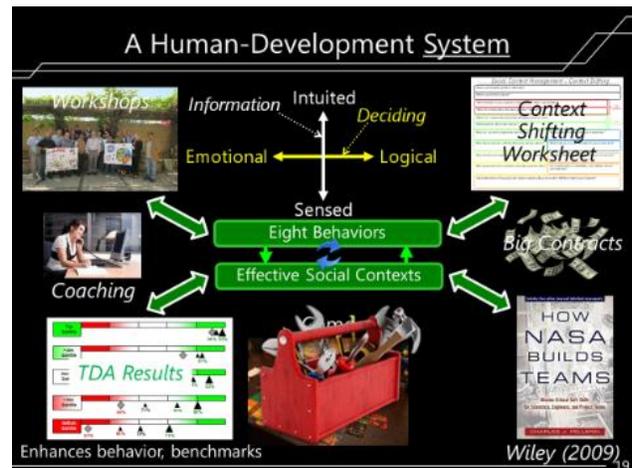
Birth Of the On-line "TDA"

I was shifting ever-more to the power of "Social Context," as a potent means to manage human behavior and this tool provided a means to measure it. Just as iron filings are "tracer-particles" for magnetic fields, team behavioral norms are "tracer particles" for social context fields. Wow! So, we built second (similar) on-line tool to do this which later evolved into today's Team Development Accelerator ("TDA") measuring "team behavioral norms."



Covey's Disappointing Workshop

I really liked Covey's book, "7-Habits," so I requested that NASA send me until they relented, and I went. I was very disappointed nothing after the first hour had anything to do with the book. It was just a hodgepodge of activities. I decided that if I ever did anything like that, all elements would be mutually reinforcing, as repetition is essential for behavioral change. (Would have thought that someone who wrote a book with "habits" in the title would know this?) A Human-Development System: This is the system I developed in contrast to the Covey



approach! All parts work together, reinforcing each other to habituate necessary behaviors! The first part was my CU class (4 credits) reorganized into a three-day workshop. Then, I did a NASA workshop with several repeat participants. I was surprised that they did not recall the material or the exercises! This was my first experience of how forgetful we are. So, my business colleague became an ICF certified coach and provided post-workshop reinforcement for workshop participants. Next, in order to address an issue, I encountered as a consultant, I built on-line tools to measure individual's and team behaviors. My initial motivation was to track the efficacy of our human-development processes. We later discovered, to our surprise that these were powerful behavior-enhancing tools! The Context Shifting Worksheet ("CSW") also came from my

consulting practice. My clients were really smart, and would often pose unsolvable problems, better named "predicaments." So, I began to use the CSW to solve otherwise unsolvable problems. I now had a "critical-mass of capability and money flowed in. The day that we found the enormous behavioral improvements of recurrent TDAs, I decided that this was too important to hold for ourselves, and rather, belonged to the world! That day I made all our IP free and began to write my book which Wiley published in 2009! Finally, my colleagues in Novosibirsk, Siberia invented a "game" to learn "4-D."

Covey's Disappointing "360"

Covey's staff persuaded me to do their "360." In those days, one gave forms with mailing envelopes to assessors which they filled out and sent to Covey's people. They encouraged me to include people who I knew did not like me, and I did so. When the report came, the top finding was "you can be difficult to work with." I pondered this and wondered what to do.



Covey People Are Clueless, Too

I decided to show the report to my boss, Len Fisk. He said, "It's true, and you are by far my best manager. I have no idea about what to do, why don't you call Covey's people." I did and they had no idea. What a waste. Like the example above, I committed that if I were build a similar tool, the actions would be presented. This is the case with "action-learning" built into the Team and Individual Development Assessments/Accelerators.



"Plus-Delta" Workshop Feedback

One of my coaches suggested getting plus-delta feedback from workshop participants. I chose to solicit this at the end of each day, and since most workshops were three days, I could (sometimes) make adjustments. "Plus," what worked for you today and "delta," what would improve your experience tomorrow? I told participants that I would look at them once back to the hotel and read them verbatim in the morning. I provided 3x5 cards and showed the instructions in a slide on the screen.



We Want the Workshop to be About Us

We don't want a "generic" workshop, we want it to address our specific issues. Einstein's (allegedly) said, "You cannot solve a problem with the level of thinking that created it." So, I thought "You cannot solve a problem in the context that created it," and created the Context Shifting Worksheet ("CSW") to address "unsolvable" problems my clients presented to me. One of my MCC coaches said, "Charlie, this is best thing you have ever done. I use it in most of my coaching sessions."



The CSW Guides Workshops

So, my work in the US is only “intact teams.” I guide them in selecting a “Situation” to process throughout the workshop generating action items that take them to desired “Outcomes.” I demo each step with work I did many years ago, motivating the customer to pick my client’s proposal for a multi-billion-dollar contract despite a lower technical score and higher probable cost! This is intentional invocation of “confirmation bias!”

Here are some “Situations” they chose:

- *“We cannot tell our truth without fear of retribution.”*
- *“We don’t trust each other.”*
- *“We cannot communicate...*
 - o with each other.
 - o with (angry) customers.
 - o to increase resources.
 - o with (my) children.

This latter Situation, “I cannot motivate or communicate with (my) children,” works very well in my “public” workshops in China. The CSW process addresses emotions, Story-lines, Mindset-shifting, the eight behaviors and action items. And it works!

Social Context Management - Context Shifting	
What's your current situation?	
What emotions do you experience when you think about your children?	
What are the feelings that you have been "learning"?	Yes
What are the important things that will impact your first case?	
What emotions do you now experience?	
What do you need to appreciate and for what?	What agreement makes most your advantage?
What about "reality" with the other party will you address?	What outcome are you committed to, and/or what best?
What about you include to help you obtain your Decision?	Who holds the Reputation, or Honor you most need?
What agreements have you broken, and why?	What are your Rights, Responsibility, and Authority over it?
What actions will you take and/or repeat will you be able to? Will these actions your Decision?	

Chapter 32: Consulting For TRW

Why TRW?

I typically enjoyed good relationships with my contractors. The aerospace company TRW (the initials of the founders) located in Space Park, Redondo Beach, CA was an especially close relationship. They were GRO's prime contractor and did a great job, especially when we had a crisis early-on. GRO worked great and was deorbited for reasons having nothing to do with them. They were also AXAF's prime contractor and saved the project twice: The first time was when they did the study of my rescoped mission when NASA refused to do so proving the ability to meet the science requirements at a much lower cost. The third time was when Dan Goldin and his team took personal responsibility for completing the "Wolter Type II" mirrors in time to win our "bet" with Dick Malow. The completed AXAF within the NASA budget and it has operated for more than 20 years, continuing to this day!



Fred Brown (TRW) Provides an A'HA Moment

So, here I was in Boulder busy preparing for Jo Marie's upcoming 3-day workshop. I received a phone call from Fred Brown, a friend from TRW. He told me that his VP was very angry. They had submitted proposals to a NASA opportunity with advice from their science working group. The scientists had said that these proposals would likely rank 1st, 2nd, and 4th. They ranked more like 24th, 33rd and 44th. The VP wanted a new science group, and would I chair it? Now, although I suspect that my "union card" as a research scientist expired long ago, I had nothing better to do so I agreed to come out. Fred and I enjoyed dinner and alcohol on the company credit card the night before. I woke up in a sweat at 3 AM wondering how to deal with this angry VP. Then I said to myself, "Just 4-D the situation, it never fails."



I Dazzle the TRW VP

The next morning, I walked into VP Paul Sasaki's office, picked up a marker and explained the 4-D System. Then, I said, "Tell me about your proposal." Each was extreme "Blue" pushing the limits of cost and technology, so I charted each in the "Visioning Dimension," near the outer boundary with "x's". (When I was Director, I would multiply cost estimates at this stage by " π .") Then, I said, "Now, tell me what the government picked." Each was very low cost with proven technology, so I charted them in the "Directing Dimension," near the outer boundary with "O's." Then I said, "Do you see your trouble?" They were awestruck. I went on explain, "You selected very "Blue"



research physicists to advise you and missed the insight that the mood in NASA Headquarters is "Orange," preferring "certainty of result" over "big leaps."

Lots of Consulting

This led to 7 years of consulting for TRW Business Development, proposal, and project teams. Note the panel on the back from the Proposal Operations saying, "I helped them win \$9 Billion in competitive proposals, while helping people to live richer and more compassionate lives." All I did was work with them to find the dominant "color" of the evaluators' leaders (and culture), which is always "Blue" or "Orange" then match that color with their proposal team. You can read about this in the "Culture" chapter in *How NASA Builds Teams* ("HNBT").



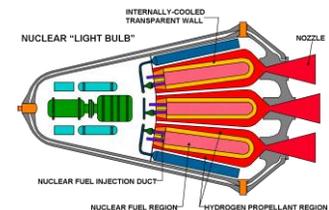
Testing Workshop Materials with Clients

One of the side benefits of this work was that I could usually persuade my clients to do a workshop with me. Then, I could observe them and see what they used back at work. I loved overhearing a telecon with, "If we ran that Story-line, what outcome would we expect!"



Winning the "Nuclear Propulsion" Program!

This looked like a really important program. Donald Rumsfeld, as Secretary of Defense had chaired a committee that declared nuclear propulsion a national security imperative. I came to Space Park to meet with the proposal team. The mood was gloomy. They were not relating or communicating well with the JPL team. I did the personality inquiry, and the team was heavily "Blue," (visioning). This was no surprise to me as Howard Eller, the proposal team leader (and friend) was very "Blue," as evidenced by the fact that his office wall is covered with Patents.



We Need Our "John Casani" and an Orange Team

I then asked, "Who is leading the JPL team?" They said, "John Casani." I knew John as (perhaps) JPL's best project manager. Moreover, he is really good with implementation phase, smart as a whip, with a great sense of humor. They must be someone John can respect as a "peer" project (program) manager and "Orange." We brainstormed these characteristics: Directing ("Orange"), experienced, more Long Beach State than Harvard (not a PhD), earthy, sparring partner, shared experiences, doer not idealist, peer, sees thru fluff, gets angry, dominant, spokesperson, in-charge, center of attention, and stand up to John, humor, fun, wise cracks. I had worked with such a manager, Craig Staresinich now in the classified part of TRW and I suggested him. The



team agreed and he took over the team and they won. After the meeting, I was concerned that I had removed Harold from his job, so I went to his office. I said, "Harold, I hope there are no hard feelings?" He said, "Charlie, are you kidding? You saved me from a disastrous failure! Thank you!"

James Web Space Telescope ("JWST")

People often refer to this as a successor to Hubble, and it isn't really. It is not an optical telescope, but a submillimeter telescope, optimized for wavelengths between radio and infrared. Earth's atmosphere is opaque to this radiation. These wavelengths are important because the "red-shift," places the really interesting radiation from the early universe in this band. It does have near-infrared cameras that should produce startling images like Hubble's. Like Hubble, there is an instrument with an "occluding disk," to block stars in other solar systems to allow spectroscopy of planets measuring constituents in their atmospheres. (Unfortunately, the occulter in ESAs Faint Object Camera could not function with Hubble's flawed mirror.) Moreover, this mission is far more complex than Hubble:



Feature	Hubble	JWST
Primary mirror	2.4 m glass monolith	6.5 m w articulated 18 beryllium segments
Thermal Design	Biased cold near room temp, w simple thermostatic heaters	Mirror 30 ⁰ K, S/C 300 ⁰ K with 7-layer sunshield
Orbit	Low earth orbit (3500 miles)	"L2" (a million miles away)
Instruments	Straightforward, replaceable	Complex, not replaceable

Dan Goldin, the NASA Administrator at the time directed that the mirror be articulated, and that the development cost was < \$500 M. Hubble in current dollars would cost \$5 B! What color of personality would join the project? "Blues," of course!

The "Phase A" Competition

As is common practice, NASA ran "parallel" "studies with two contractors for two years in preparation for the "final competition." There were three competitors: TRW (not known for telescopes in space), Lockheed-Martin (Hubble and the spy telescopes) and Ball Aerospace (Instruments and small satellites). I was doing a 4-D Workshop for the JPL-led Space Infrared Telescope ("SIRTF"). My colleague, Frank Martin, now at Lockheed-Martin, suddenly jumped up and left the room. Incredibly, NASA had picked TRW and Ball for the contract. Apparently, L-M decided that they were a "shoe-in" and wrote a lousy proposal. Frank convinced the president to fund their work with internal (overhead) funds. Not being selected may have been an



advantage as they demonstrated commitment to the project and were unencumbered by the government's rules.

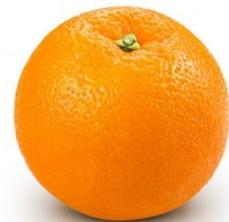
4-D Workshop

I did a 4-D Workshop for a combined government, TRW, and Lockheed-Martin group before the contractor selection. When we did the personality diagnostic, the team leader, Bernie Seery, and most of the participants were "Blue." I explained how projects must necessarily evolve from "Blue," when options and trades are the focus, to "Orange" as discipline and procedures are the focus. We did a Culture diagnosis, and they were heavily "Blue." I paused and asked them what they learned from these diagnostics? They said, "None of us will be there for the launch will we?" I just smiled. Later, I pulled Bernie aside and said, "Bernie, they will remove you as soon as the funding becomes serious. Please try not to take it too personally, they will not know why, and I can assure you that it is structural." Some years later, management replaced Bernie with Phil Sabelhaus, known for "closing" late-phase flight projects. I did not know Phil, so I stopped by his office to introduce myself. When I asked, "How's it going?" He said, "Well, Charlie, it's a strange thing. I don't know why, but I had to get rid of most of Bernie's people."



TRW Chooses An Orange Lead for a Blue Proposal

Ralph Schilling managed AXAF for TRW and except for a "glitch" leading to a major schedule slip in the Integration and Test ("I&T"), did a great job. So, it seemed natural to have him lead the JWST proposal team. It became obvious (to me) that his deep Orange personality was problematic. I knew Ralph well and believed that I could work with him. So, I made a detailed PowerPoint briefing describing the need to tender a Blue proposal, and how to make that happen. We had to lead each point in the proposal with a "Blue" idea, a risky, high promise solution, with the "Orange," tried and true, but expensive solution as backup. Ralph then supported me in briefing the entire TRW team and Ball Aerospace, their teammate. Everyone nodded in agreement.



I Red-team Their Proposal

I was away much of the summer with a home-exchange in the Netherlands when they wrote the proposal. When I returned, they asked me to "Red-team" their proposal, which means review it from the customer's perspective. When I read it, I was shocked! They had done the opposite of what I advocated. They had the conventional solution and the "Blue" backup, if any second. I said, "Why didn't you do what I recommended?" They said, "We did." (The "colors" are strong.) I had to take a yellow highlighter and show them line-by-line before they could fix it!

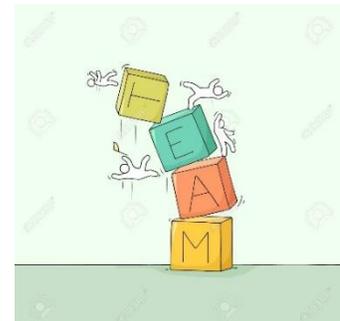


- Drama States: They said, "None." I said, "You have already admitted to being in Victim, and I notice you blaming the customer when you are unhappy. Can you stop all that until you submit the proposal? They said that they could;
- Roles, Accountability and Authority: They took an action to define meaningful roles for the government's engineers.

Engaging "Confirmation bias," the customer **selected them** for the \$1B contract despite a higher probable cost and lower "mission suitability" (technical) score! (I use this as an example in workshops as they participants do the same process. I think if is long enough ago, more than 20 years, that it is not a breach of confidentiality. Participants do the same work themselves, making workshops "about them.")

Addressing Broken Team Leadership

TRW management learned to trust me, and changed people, including team leaders when I recommended to do so. Then, I encountered a proposal team that I found difficult to help. I would not have continued to work with them, except that an important TRW client kept asking me to do so. After several encounters, it became clear that the TRW proposal lead was the problem, although he was able to hide this from his management. The colloquial expression for this is "Shines up, shits down." Moreover, he constantly blamed the team lead of the other company they teamed with.



Monthly Meeting with TRW's COO

During my monthly visits to the Space Park plant, I would end each visit with Joanne Maguire, the number 2 person in TRW/Space Park. She met with me because when she was a VP, she was my client and we liked and valued each other. I told her about the need to replace this individual, and she balked. I believe that she did not discern the difficulties of this person, and it is surely difficult to make personnel decisions solely on the recommendation of an external consultant.



I Needed Data to Persuade Her

So, I asked myself, "What would it take to convince her?" These companies and NASA are "Orange" at the core, although they prefer to display "Blue." Therefore, I need data to convince Joanne. I decided to make a paper "behavior" measurement tool. I made a "radar diagram" with each of the 12 behaviors, organized by dimensions in a circular format. Their customer frequently graded their proposal activities with a color code: Red = Failing; Yellow = Poor; Green = OK; and Blue = Excellent. Then I had each person write the name of the team they belonged to, but not their name, on three sheets of paper I



supplied. I had use the color codes to assess the behaviors of themselves (I had no baseline), the TRW leader, and the other team leader.

Data Analysis

I grouped the data by team membership, and then converted the colors into numbers. I displayed the results with average scores on three vertical lines: Peoples' assessments of themselves, the TRW team leader, and the other team leader. The data were unambiguous. Members of both the TRW team and other team scored the TRW leader lower than the other scores. I took the data to Joanne, and she smiled and said, "Charlie, you are correct, he has to go."



Birth Of the On-line "IDA"

I was fascinated by this, so when I returned to Boulder I had a programmer build me an on-line tool to do this. We began with an IDA measuring individual's behaviors. We intended it to be used with coaching and my colleague, Skip had become an International Coach Federation ("ICF") certified coach (see above).



A Coach Asks to Use the Tool

A coach heard about this and asked if they could use the tool, saying, "The president of a trucking company asked me to coach Mary. He said he wanted to promote her but just couldn't and did not know why. I have been working with her for two months and I cannot find the trouble." At the time, we were measuring 12 behaviors with Victim (complaining) as a separate measurement. He contacted us several weeks later saying, "It worked. She was a habituated Victim, and we are remedying it. The owner is delighted."



Black-Hat the Space Based Laser ("SBL")

To "Black-hat" means pretending that you are the competition and attack the client's proposal to find weaknesses. I realized that the customers, the Air Force, and influential congressman Trent Lott wanted a quick, cheap demonstration which we referred to as "flaming wreckage." Think, "Orange." TRW's approach was high-tech, complex, and expensive. Moreover, the more TRW refined the details, the more implausible the mission appeared!



I Make a Presentation

The room was full as lots of people were engaged with this proposal. Everyone else made technical presentations. I walked to the front of the room and made my presentation basically arguing that their approach could not win. When I finished, you could hear a pin drop. The proposal team leader approached me and said, "Charlie,



now what?" I said, "Go to Lockheed-Martin and make a deal. They build the spacecraft cheaply and quickly and you get funding to advance your chemical laser technology. Then, go together to the customer, and propose to end the competition in favor of a 'national team.'" I think that's what they did.

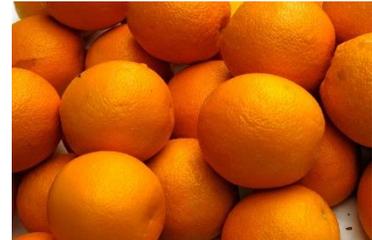
Northrup Grumman's Moon Proposal

Some years, Northrup Grumman, a much larger company, bought TRW. I received a call from two HR folks about N-G's proposal to go back to the moon. They said, "The people in Space Park said good things about you." I explained how I worked with proposal teams to create competitive advantage. They thanked and said that they would get back to me.



I Travel to Redondo Beach

They called me with only months to go and asked me to come out. I met with the team and did my usual diagnostics and was horrified. The team leader was very "Green" and had assembled a "Green" team. I said to the HR folks, "I know the culture of the NASA Centers and the human flight centers (Johnson, Marshall, and Kennedy) are all very "Orange." This is advisedly so, as they were working to build a single integrated system to go to the moon, Apollo." There is no way they will pick a "Green" proposal. We have to "Orange-up" this team and generate an "Orange" proposal. I asked to meet with the cognizant top-management, and they refused. I had no contacts in this part of the company as this was never TRW. So, I did what I always do, get on a plane, go home, and forget about this.



The Financial Times

Some months later, I was travelling in Europe, Switzerland, I think. There was a copy of the *Financial Times* at breakfast every day. For four straight days, there was a blurb saying something like, "NASA will soon make the Moon selection and it is sure to be Northrup-Grumman." And, I said, "No it won't." Then, "A big surprise, Boeing has been selected for the Back to the Moon Program." No surprise to me, completely predictable!



FINANCIAL TIMES

Chapter 33: "That Rainy Day at Wallops"

ED, "Goldin Will Fire Me!"

This was the day that changed everything! Ed often came to Wallops when I provided workshops as we enjoyed talking with each other and he liked updates on my progress. He said, Dan Goldin called me to his office and said, "Ed, we have had back-to-back Mars failures and if you cannot improve teamwork I am going to fire you." I immediately thought of you!"

No Worries

I responded, "Ed, I can do this, no worries. I now have a highly-optimized suite of tools that include a workshop, on-line tools to track progress, and coaching processes." I continued, "How about funding a pilot with flight projects at Goddard and JPL, so I can show you solid results." Ed said, "Great, I'll send funds for this ASAP."

I Meet with Center Top Management

Of course, I knew these people. I said to them, "I have funds to run pilot teambuilding activities with flight projects from Ed Hoffman's "APPL." I continued, "I want to make sure that you are OK with this, and my two ground rules. First, I will not work with a team unless the leader wants this work because otherwise would waste both out time. Second, I will be measuring individual's behaviors and team behavioral norms. Those data, unless they explicitly choose otherwise, will be confidential to them and I will never provide the reports to anyone but them. If you are curious contact them, as I will not give their reports to you. It is crucial that they see these measurements as developmental and not evaluative for them to work. They agreed!

Tom Gavin

When I had the conversation with JPL Center Director (and longtime friend), Charles Elachi, he said, "No problem, go talk with my Director for Projects, Tom Gavin." I did not know Tom, and we quickly developed a friendship. He said, "I am fine with you doing this, but you must attend my project management school. It's at the Ritz-Carlton on the beach. This was his sense of humor as it was it was at a mid-level hotel a few hours from JPL. Trying to be more efficient, JPL had "burned the books" on project management. Tom, cleverly instituted Flight Project Practices ("FPPs"). He identified 44 FPPs, each with a named "owner," with appropriate expertise to document and optimize



each FPP. His week-long class was taught by these owners. He invited me to make the opening speech on “4-D” after dinner for every class going forward.

Welcomed and Word Went Viral

Over the years, I watched a lot of NASA people succumb to narcissism by imagining that their role in e.g., in launching the Space Shuttle was larger than in reality. I told myself that the deference people showed me was because I was Director, Astrophysics and that someday I would just be Charlie Pellerin. So, when I approached the flight projects after being gone for 10 years, I was amazed at how welcomed I was by these people. Here’s what happened. The pilot projects were not just successful, they were viral as they told their colleagues, “This actually works!” Ed and his colleague, Tony Maturo, issued a (many) millions of dollars Request For Proposals (“RFP”), and (of course) we won.



Skip, You are Going to Find this Hard to Understand

I called Skip, my close colleague, and said, “Since you never worked for the government, you may find this hard to understand, but we have to spend the money, or they will get angry. They have “obligated” the money by issuing the RFP, and now we must “cost” it, or it will be taken away and their budget reduced. You and I are both on hourly rates and there aren’t enough hours for us to spend it, we need more people!” Moreover, I thought that this was so much money that we would never need funding again.



Center Program Managers (“CPMs”)

I realized that we needed people to work with the project manager and optimize the mix of workshops, workshop modules (e.g., a single behavior), IDAs, TDAs and provide consulting services (e.g., bottom-quintile teams). Most of my colleagues had joined NASA a bit earlier and were comfortably retire after 55 years of age. I thought, “Who were the best managers at each NASA Center who likely retired recently?” After I had a few people, I engaged them in identifying candidates from Centers that I was less familiar with. I called these people, explained what I was doing, and asked whether they wanted to join with me? Every person answered with an enthusiastic “yes.” This was likely the most talented NASA team ever assembled!



Our Strategy Meeting

We have a very large home in Boulder and the basement was large enough for a workshop. I bought chairs and tables and set it up like a conference room. I suggested, January 31, 2003, and that worked for everyone. We started with a morning meeting



with everyone including Ed and Tony to get their thoughts and guidance. Junko cooked up a ton of food for a celebration and, of course, we have a well-stocked wine cellar.

Columbia Disintegrated!

Our team came back the following morning and Ed and Tony went back to DC. We watched in horror as *Space Shuttle Columbia* disintegrated. We had experienced failures with Hubble and the Mars missions, so this was very real for us. I let it play for a while then realized there was no new information. So, I turned the TV off saying, "You know what we need to do, making sure that nothing like this ever happens again." We returned to the basement and started work.



Success Beyond Anything We Imagined

Well, demand soared and soon we were billing \$400 to \$500 thousand per month! We spent all the money then won another procurement five times the amount of the previous award! We started with flight project teams then included management teams. APPL reorganized into the Office of the Chief Engineer, so we placed new emphasis on teams in "functional" organizations. Budget forecasting was not an APPL strength, so our monthly budgets varied a lot. This was only bearable because we loved the work and for most it was supplemental income. This band of scientists and engineers delivered the most effective HR intervention in the history of NASA working with more than 1,500 teams!



Our Coaching Cadre

We also built a "world-class" coach cadre of eight coaches. Seven had ICF's highest rating, Master Certified Coach, ("MCC") and two were past "Global" ICF Presidents. Although it took some fancy math because the data had so much scatter, I developed an algorithm that could calculate each coach's performance. To do this, I used their average improvements in IDA scores as a benchmark and removed a substandard coach. I think her problem was that she did not coach very often.



An Epiphany, Our On-line Tools Measure Everything!

My Client Program Managers ("CPMs") were very distinguished people, challenging me very usefully. Noel Hinners, former director of Goddard Space Flight Center and the Smithsonian's National Air and Space Museum, challenged me about the TDA scores. He asked, "Charlie, what if the team is not



adequate technically." At first, I did not know how to answer this. Then, upon further reflection, I realized that just as a magnetic or gravitational sensor measures everything that influences those fields, the TDAs measure everything that influences social context fields.

Chapter 34: Some Travel Adventures!

I Travel to Germany for Spacelab Meetings

When I was about 37 years old I travelled to Germany on business. I believe that I landed in Frankfurt and had been unable to book a room there for the night before I returned. I suspect that one of the famous "trade fairs" was the problem, and I did not know of these then. There was a kiosk in the airport that arranged rooms, so I went to them. They said, "We have a room for you in a home, and there is a clerk always on duty." I rented a VW Golf and headed to Bonn. I had difficulty keeping up with the traffic on the Autobahn, even with the accelerator held to the floor!



Thoroughly Lost

At the end of a day, a colleague asked me to go to Aachen with him to show me around and have dinner. He said that the route was easy, and we went. After dinner I asked for directions back and he gave some instructions then said, just follow signs to Bonn. I did not know the difference between yellow signs (back roads) and blue signs (highway). I saw a yellow sign for Bonn and turned. I figured out what had happened and could not find my way back to the highway. I ended up driving most of the night before finally finding my hotel! There were few people out at night and the ones who were did not speak English. I was able to ask for directions in German and discovered that this was a mistake as I could not understand their response!



You Need a Drink!

Near the end of my trip, I drove to the address of the room I had rented in Frankfurt. There were no parking places, so I double parked and knocked on the door, but no one answered! Then, I saw a tram coming! OMG, I ran to the car as the tram raced by missing by what looked like microns. I continued to look for a place to park, then knock on the door. I finally found a parking place and noticed that the shops were closing. I needed to bring something home and found a bakery open and bought some stollen to take home. Finally, an old lady opened the door. By now, I was pretty thoroughly frustrated and managed to convey that I had wasted most of a day. She did not speak English and I figured out that she had fallen asleep. I took my suitcase up to my room and remembered that I had bought a bottle of scotch to take home. I went back down



to get a glass and some ice. I could not communicate this although I knew how to ask except the word for "ice." Finally, she spoke in clear English, "You need a drink!"

I Had Ordered Pigs Foot!

After a few drinks, I thought I had better get something to eat and saw a restaurant across the street. I went, ordered a beer, and requested a menu. When it came, I did not recognize anything. (I had studied scientific German, not colloquial.) So, I asked, "What is good?" (*Auf Deutsch*) He pointed to something, and I said, "OK!" After he left, I found my menu translation and saw to my horror that I had ordered "pigs foot!" I was imagining something with a hoof on it. What to do? If I just left, I might get in trouble for not paying for the beer. So, I decided to stay. When it came it was truly delicious! What a treat! (The airline lost my luggage for a week, so the cakes were ruined!)



"Crashing" in a 172

My friend, Bill Whitten, had a one-fifth share of a Cessna 172. I needed to go to Ocean City, NJ to meet family and they had a car to drive back. So, I asked Bill to fly me there. Pennsylvania sold alcohol in State-stores, which was very expensive, so I routinely brought cases of "rye" from Maryland. As the 172 was a "4-place" airplane, I put the alcohol in the back. Bill took off, trimmed the plane, and turned control over to me. I leveled at 5,000 feet and flew visually to Ocean City. When we arrived, the windssock showed a crosswind of more than 20 knots at 90 degrees! We saw another airplane on short final.. Bill radioed him asking about the landing and he said, "No problem." So, Bill took over, turned base, then lined up to land setting the flaps and trim. Just as we were about to touch down, the plane turned sharply left and we careened between parked airplanes, finally stopping in a large mud puddle. Wow, a really close call. Soon the police came, and I worried how to explain the whisky, and, thankfully, they had no interest! Bill flew the plane back without incident and said that he had too much flaps for such a landing. Then a month later, the plane fell from the sky and crashed!



Summer In Munich

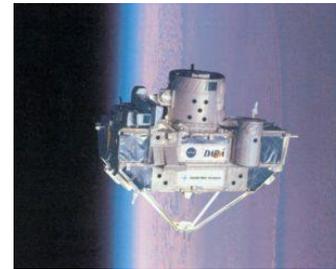
The Max Planck Institutes are the most prestigious science institutes in Germany. My friend, Joachim Trumper, was the director of the Max Planck Institute ("MPI") for Astrophysics (photo) which is in Garching, a suburb of Munich. Muammar Gaddafi, after the bombing of Pan Am 103, was making noises about threatening American tourists abroad. With my understanding of the disconnect between people's perception of risk and the reality, I saw an opportunity to travel to Europe without hordes of American tourists. Joachim had offered me a furnished apartment in his institute which



was inexpensive. So, I took the family. After we settled in, I found a radio and began searching for an English-speaking station. The voice said, "It's a massacre as the gunman has killed 21 people and wounded 19 more." I thought, did I make a mistake with this trip? Then the voice continued, "And that concludes our report from San Ysidro, California." Whew!

To Friedrichshafen with Lynn Cline

I was good friends with the DC rep, Hans, for the German aerospace company Messerschmitt-Bölkow-Blohm ("MBB"). Their Friedrichshafen plant near Lake Constance had an important role in the GRO COMPTTEL instrument and had built a small structure called "SPAS" (photo) that looked like a good fit for my small reusable satellite called Shuttle Pointed Anonymous Research for Astronomy, "SPARTAN." The German government was supportive, so the German Desk Officer in International Relations, Lynn Cline and I went to take a look. After we arrived in Frankfurt, Hans invited us to a bar to enjoy delicious Germans "Pils" beers. We partied late into the night and I struggled to get up and meet Lynn in the hotel lobby the next morning. I had made a big mistake packing with two small suitcases and a briefcase which were very difficult to carry. (Wheelies were not yet popular.) Lynn and I arrived at a very long train and boarded the nearest car which was second class even though we had first class tickets. Neither of us had breakfast, so I ran to a vendor, returning with hot dogs.



The Train Separates!

The conductor came, looked at our tickets, and tried to get us to move to the front of the train. This was a very long train with many heavy doors and a narrow corridor as one side had compartments. The conductor returned again urging us to move. We explained, "Wir grosse gepeck haben." (We have lots of luggage.) We assumed that the problem was that he wanted us to move to First Class. He returned and we repeated our problem. Then, he grabbed a piece of Lynn's luggage and took off. We had no choice except to follow him. He put us in a compartment with a prim German lady who looked at us like he had thrown garbage in with her. I was hot and sweating in my business suit, so I went out into the hall and opened a window. The track was curved, and the train started moving. I looked back at what I thought would be near the front of a very long train. To my surprise, we were in the last car! The conductor was trying to tell us that the train separated into two parts. Who knows where we would have gone had the conductor been less caring! Lynn and I had a useful visit including a lakeside lunch with the local trout, "Forelle!" And the "SPAS," renamed "ASTRO-SPAS" became the primary carrier for "SPARTAN" missions!



Space Astrophysics with the Soviet Union

In the late 80's the US State Department asked NASA to expand space cooperation with the Soviet Union. I, in turn, was asked to co-chair the first meeting with my counterpart, Rashid Sunyaev. We met in a hotel in Washington, with about a dozen people on each side of a long table. NASA and people from State observed us for the first morning, then left. The following morning, I approached Rashid saying, "I observe that you have two kinds of people in your delegation. World-class astrophysicists who surely are fluent in English and your KGB handlers. How about I come over and sit next to you, we mix up the participants. Then seat the KGB together with the translator and continue the meeting in English?" He smiled broadly and said, "Great." I was presenting the NASA Astrophysics program when I showed Hubble's stability requirement of 0.007 arc seconds and the Soviet's began murmuring. I asked Rashid, "What's happening?" Rashid, "Said, it is just a misunderstanding about terminology. We think that you mean 0.007 degrees." I said, "No the slide is correct, the requirement is 7 milli-arc-seconds." Rashid and his colleagues said, "That's impossible!" I said, "No, it's what we are going to do!" This changed the tone of the meeting going forward as this engendered deep respect for our technical abilities.



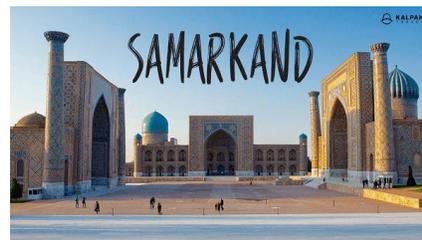
My First Trip to the Soviet Union

Before I left, CIA agents interviewed me and said that they wanted a report after I returned as I would likely be in facilities that few westerners, much less US government officials, had ever been permitted to enter. Our colleagues met us at the airport and took us to the Rossiya hotel (photo), with more than 2,000 rooms, exclusively for foreigners. In fact, our Soviet colleagues were stopped at the door and not allowed to enter. We assumed that our rooms were "bugged," so we were circumspect in what we said. It was "common knowledge" that the KGB occupied the top floor. We were forewarned that it would likely be difficult to get food, so we all brought tons of snack bars and the like. Indeed, when we went to restaurants the menus were multi page and everything we requested was "sold out." After a lot of haranguing by our translator, we finally all got goulash, and of course the ubiquitous cucumbers. None of the automobiles had windshield wipers. Apparently they were scarce, and people stole them. The meetings were in their science institute, "IKI." There were large spaces between the floors with no elevator stops. There were rumors that "secret" activities were conducted there, so I asked Rashid. He laughed and said, "That is empty space between the floors for cables and air ducts." These people were great with honed senses of humor and excellent scientists.



Travel to Tashkent

I believe that we met in alternating countries every 6 months and enjoyed each other's company. Rashid and I became very close and he gave me (and my girlfriend at the time, Linda) a very special treat. He flew us to Tashkent, the home of his family of origin. We flew on a commercial flight to Samarkand, a major station on the silk road. We were segregated in the airport and in the airplane.



Interestingly, we went on a bus to the plane and they had to walk. When we arrived, Rashid had arranged an official Communist party car which was a black sedan that did not stop for red lights. My room was huge in some kind party "VIP" building with a dozen red telephones. (I did not know what to do if one rang. Rashid said, "Whatever you do, don't answer it.")

The Countryside

Rashid secured a mini-van for us to take a ride into a small town in the countryside. Foreigners were not permitted to travel there. The police pulled us over and began questioning Rashid. He had anticipated this possibility and gave them cartons of cigarettes and bottles of scotch whiskey. We were soon on our way. We stopped in a village and people came out to look at us. An old man approached me and began talking. Even though this was during the cold war, these people were just open and friendly. Then he presented me his hunting knife in a scabbard. I had a gold (colored) Hubble pin in my lapel which I gave him. He seemed to be very happy with the trade.

Sevastopol

Russia's most important naval base is Sevastopol on the black sea. This is because the other bases are so far north than winter ice is a problem. To the best of my knowledge, this base is so secret that a foreigner has never been permitted to enter. We not only entered, we walked around freely between the ships and submarines. Linda, blonde and very pretty, somehow convinced a sailor to give her his hat. (Or, he may have offered it, I do not recall.) Rashid pleaded with her to not take it as the sailor would get in a lot of trouble. She ignored him, and proudly displayed the hat back home. (I have no idea what happened to the sailor and I hope that Rashid was wrong.)



The Flight Back to Moscow

I had no idea that the best was yet to come. Unbelievably, Rashid arranged for a Soviet bomber to fly us back. The front was all glass panels for the bombardier to see his targets and prepare to align his bomb-sight. I flew back in



the bombardier's seat and noted that he used a slide-rule which was on his table! What a hoot! (They asked me to return to my regular seat for the landing.)

How To Take a Japanese Bath?

I was at Harvard during thanksgiving and invited Yuji Akita to come home with me. So, when I made my first trip to Japan, he invited me to stay overnight in his house. I did not know much about Japanese manners, so I stopped for a night in San Francisco to meet with a friend who I knew had a Japanese wife. She explained the Japanese bath to me. The water in the tub is for soaking, never washing. Instead, one sits on a small stool and using a hand-held shower or (traditionally) buckets of water dipped from the tub to thoroughly clean my body. Then, get in the tub. And, as the guest of honor, I would likely be first to use the tub. Traditional Japanese houses do not have central heat. Instead, there is a single Kotatsu, a table with a quilt with a heater in a pit underneath. When it's time to go to bed, people go to the bath, heat their "inner core" then get in bed.



Diving Into Yuji's Bath tub

Japan has convenient "city terminals," places where you check in just like you were at the airport with limousines (actually buses) to take people to the airport. So, when I arrived at Narita, I took a limo to Yokohama City Air Terminal ("YCAT") to meet Yuji. Exhausted, I repeatedly dozed off as he drove to his house. He drove rapidly down narrow streets. Since they drive on the left-hand side of the street, when I opened my eyes, I imagined that I was driving and panicked when I could not find the steering wheel or brake pedal! His wife, Akimi, made *sukiyaki* which was a little strange as you dip the meat into raw egg, a no-no in the US. Then bath time, and as expected I was invited to go first. I found the stool and washed thoroughly. Then, I went to the tub and saw that it had a cover on it. I rolled the cover back and saw that the tub was filled to the top. I had lived in two-story houses and apartments and the one thing that was absolutely forbidden was to overflow the tub! Should I drain some water out? I looked at the unfamiliar arrangement with Japanese characters and had no idea how to do that. Then, even my jet-lagged brain reasoned that water on the floor would not be problem since I just washed there. Still, I wanted to be polite so I thought I will put my first leg in very slowly so at least it would not be noisy. I could not see that the bathtub was much deeper than the US. My foot went way beyond where I thought the bottom was, I lost my balance and rolled onto the tub. I heard his two



young boys laughing. I suspect that they imagined the *gaijin* (foreigner) dove into the tub.

I Accidentally Enter the Women's Bath Naked

I liked a hotel in Tokyo that had Japanese-style rooms (I think mostly for weddings). The room had tatami mats, futons, and ikebana. I loved it. There was, however, no bath. The reason is that the public baths are great. There are lots of "washing stations" with soap, stools, hand-held washers, and mirrors. The soaking tubs are huge and communal separated by sex. One winter night I came in late and decided to take a bath. There were two doors, opposite each other going to the changing room and bath for each sex. I accidentally picked the wrong door. So, I go in the changing room, take a wicker basket, strip down, put my clothes in and go into the steamy bath area. There is a young Japanese woman in front of me! I think that she was going to scream except she saw that I was as surprised as she was. I exited and went to the changing room, hoping that another woman would not come in!



Yuji Takes Me to Akihabara

Akihabara is a giant electronics shopping area in Tokyo. Yuji took me there and I bought CJ a fancy watch. The instructions were only into Japanese, so I asked Yuji to translate the instructions into English for him. This was onerous for him as this was complicated and he completed it anyway. (I gave CJ the watch and Yuji's instructions. He never read them, quickly figuring the watch out!) However, that is not the point of the story. I was eating breakfast at the hotel when an attractive young woman came to my table. I realized that she was the same woman who waited on me in the electronics shop they day before. She said, "You left your credit card at the shop and I thought you might need it, so I brought it to you." I then realized that she got the hotel address from the customs refund form that I filled out. I then asked her how she came and how long it took. She said, "I took the subway, and it took me an hour." I tried to buy her breakfast and she said, "Thank you, but I have to leave now for work." The Japanese!



My Camera Comes Back

I mentioned that when I came to Japan I met my four colleagues from Harvard for dinner. We totally enjoy each other's company and drinking together. One evening we had a wonderful sushi dinner with lots of delicious sake. I was pretty high when they introduced "Nijikai," (second party), an unexpected taxi-ride to a nightclub. Typical Japanese, the black urinals were filled with ice. We were having a lot of fun when there was some kind of disturbance near the entrance and one of my colleagues went to see. He came back holding my (expensive) Canon SLR. He told me that the taxi picked up another ride and the passenger said, "Hey, there's a camera back here." So, after he dropped his passenger off he backtracked bringing my camera back! (Would this happen in any other country?)



You are Welcome to My Taxi if You Want

Junko and I were standing in the front of a Renaissance Hotel in Sapporo, Japan waiting for a taxi. One came and we walked toward it. A man approached us smiling and said, "That's my taxi as I called it, and if you want it go ahead and take it, as I can call another."



Diplomacy in the Executive Lounge

We were in the Executive Lounge in the same hotel. The Japanese are quite disciplined and formal. I went into the lounge wearing white slippers. The manager came up to me and said, "Charlie, could you please not wear the slippers next time?"



Rashid in Munich

After I retired from NASA, Yasuo Tanaka, who had moved to MPI in Garching (because he was forced to retire in Japan) treated me to a vacation in Germany. Rashid was also working there. He suggested that we take a trip to Florence and visit Galileo's house (photo) which is not open to the public. Rashid garners enormous respect as a scientist. There is a famous effect named for him, the Sunyaev-Zeldovich effect, the distortion of the cosmic microwave background radiation through inverse Compton scattering by high-energy electrons in galactic clusters. We spend the day in the house then hiked in the mountains. He was planning to leave the Soviet Union and had offers from several US Universities and MPI. He was leaning toward the



US. I explained to him, "Rashid, the people urging you to come have not been completely honest with you. They all own houses that they purchased cheaply years ago and likely have paid-off mortgages. Moreover, they all have fat pensions. How can you possibly have these things at your age? He thanked me profusely and stayed in Munich. With Joachim's help, he bought a nice house. Moreover, when Joachim retired, they made him director! He also continues to advance cooperation with his former colleagues in Moscow.

Cairo –Sakkara, Giza Plateau, Camels

Until Antarctica, I would have named this as our best trip. We (me, Junko, her sister, Atsuko and my son, CJ) arrived in Cairo late in the day in December. The city was made prosperous over millennia as a



stopover for Sahara caravans on trade routes to Byzantium. After a briefing by the staff from Viking River Cruises, we enjoyed a lovely dinner outdoors watching decorated ships on the Nile. The



next day our guides took us to Sakkara to see the world's oldest step pyramid, then onto the Giza plateau, very close to downtown, to see the pyramids, the Sphinx and take a camel ride, There was only one other tour bus, and our guide said that before the Arab Spring, there would have been 50! They split us into two groups of about 20 people each and the same guide stayed with us for the entire tour. They were excellent as they were trained Egyptologists. We noticed people with us who said little and were happy to take photos like the one above. CJ pointed out that they had pistols. They were our bodyguards! We were free to walk around and enter open pyramids. It was however illegal (and dangerous) to climb on them. I seemed like a fun thing to ride a camel with the pyramids in the background (photo).



Mosque, Museum, Market

The next morning, we visited the Ottoman Great Mosque of Muhammad Ali Pasha built in the early 1800's. We then did something I wanted to do even more than visit the pyramids, to visit the Egyptian Museum! It was amazing. There was a special Tutankhamen exhibition. After lunch we wanted to go to the Khan el-Khalili, Cairo's most famous outdoor souk (bazaar). I asked our guide whether we could hire a bodyguard? He said, no need. We got in a taxi which had a fender-bender on the way. He and the other driver argued for a few minutes then we went on our way. Nearly all the cars in Cairo were smashed somewhere. We walked around the market with no problems. Junko



found a pair of shoes that she wanted to buy a pair of shoes. The price started at \$60 and Junko finally bought the shoes for \$6. We took a taxi back without event.

To Luxor

The next morning, we flew to Luxor, a flight of about an hour. We visited Temples of Luxor and Karnak, long buried beneath desert sands, walk among monumental peristyles and obelisks, and learn how ancient hieroglyphics hint at the beliefs and lifestyle of ancient Egyptians. The Egyptians did not know that these existed until the 1800's when European (German) archaeologist dug them up. Luxor temple was the spiritual capital of Egypt for 15 centuries. Karnak is one of the largest temple complex in the ancient world. We boarded our boat for lunch, then visited the Luxor Library and Heritage Center for a historical perspective.



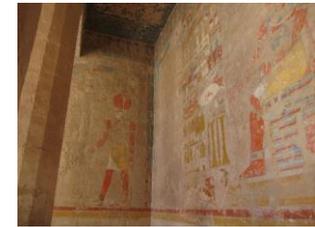
The Valley of the Kings



Our ship remained overnight in Luxor, and we took a hot-air balloon ride over the Valley of the Kings, with an especially great view of the Mortuary Temple of Queen Hatshepsut, one of Egypt's few female rulers and most successful pharaohs which we later visited.



Tutankhamun's mummy is in its original resting place in the Valley of the Kings in the KV62 chamber and in a sealed acrylic box. We were lucky that some archeologists were working on him out in the open and we were able to approach very closely!



Quena

Our ship sailed overnight to Qena to the sprawling complex of Dendera. Remarkably, it's fascinating Temple of Hathor was built not by the ancient Egyptians, but by Ptolemies and Romans in classic Egyptian style. We walked through its towering stone gate to view the columns and hieroglyphics of some of Egypt's best-preserved structures.



Esna

We sailed overnight to Esna and went on horse-drawn carriages to explore the red sandstone



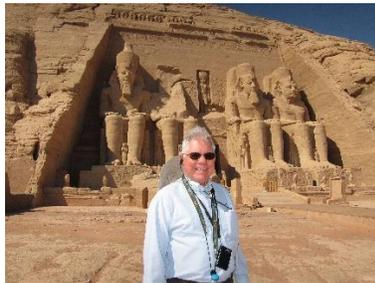
Temple of Khnum. In the 1st-century Hypostyle Hall, we saw its 24 columns, 6 across and 4 deep, each topped by a differently designed, intricately carved floral capital. The hieroglyphics depicted Roman emperors making offerings to the gods.

To Abu Simbel

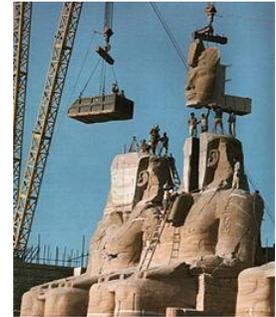
Our ship necessarily stopped on the down-river side of the huge Aswan dam and we flew to the northern-most end of the Egyptian Nile. We joined a much larger ship to cruise Lake Nasser as the water was much deeper than the shallow Nile.



For me, this was a real highlight. Ramses II built two temples in Nubia, which he controlled in 1265 BC. The intention was project power and motivate the population to obey him. The Larger temple was for him and the smaller for Queen Nefertiti. These and a very large cave are carved in rock. In 1959 an international



campaign to save the monuments from being submerged by the rising waters of the lake resulting from the Aswan dam. Incredibly, a team of archeologists disassembled the statues, then reassembled them, and remade the cave. There are not even visible seams! For me, this is as incredible as the original. The day that the ship sailed, CJ and I got up early to photograph the temples in the sunrise.



The Remainder of the Trip

There were many more interesting things on this trip, so many that to cover everything would be a book in itself. I just wanted to some flavor in case you were considering going. The large ship, of course had to stop on the upriver side of the Aswan dam. We then flew back to Cairo to the hotel and then home. Here are a few thoughts:

- The country is in great danger as three other countries control the headwaters of the Nile and they are sending less and less water out;
- When one looks out the airplane window, one sees a thin blue line, the Nile, enclosed in thousands of miles of unforgiving desert. That's how the pharaohs controlled the people. There was nowhere to hide or escape!; and
- There are mothballed boats everywhere as the Arab Spring scared the tourists away.

Our Travel to Antarctica

This is the best trip we ever took. I never had much interest until I looked into it. I chose Ponant, a French because I knew the food and wine would be extraordinary. We flew from Denver to Houston, then an overnight flight to Buenos Aires. As the travel is North-South there is little time change. Even though we had been in Argentina before (several times for me) we spent a week there sightseeing. I sprung for a nice hotel with a

happy-hour included. Some of the sights included: A spectacular opera house, Teatro Colon (photo); A huge private mansion from when Argentina had great wealth from exports; Eva Peron's grave; and Spectacular gardens. The hotel found a good nearby restaurant with early hours. As expected, we were the only people. We left early on the last and flew on a charter flight (nothing special) provided by Ponant to Ushuaia, the second-most southerly city in the world.



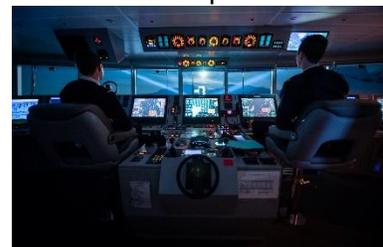
Ushuaia and Our Ship

We took a bus tour which included bar-b-que meal with wine in a forest, then boarded our ship. I was very impressed that the Captain personally welcomed each on the gangplank as we boarded. Soon after sailing, everyone practiced an "abandon ship" drill. There were two restaurants, a formal one that we preferred and a less formal buffet forward on the ship. We ordered from menus with many choices and the food was fantastic. We discovered a "prime" table next to a very large window. We were there for the opening and "snagged" that table every night (photo). The ocean's flow is unimpeded around the continent of Antarctica creating the roughest ocean in the world, the Drake Passage. We entered about dinnertime and were lucky, as the waves were only 6 meters (20 feet) high. And our window was repeatedly hit hard by the waves providing interesting dinner entertainment. Everyone looked drunk walking down the hall and I felt like I wanted a seat belt on my bed.



Daily Routine

This went on for the entire next day. I was never concerned as our ship was designed for weather much worse than this and the active stabilizers were working. We were welcome on the bridge when the ship was operating, and I visited frequently (photo). I got to know the Captain and when he heard my background, he invited us to his table for the farewell Captain's dinner! Here's the daily routine. The captain would make announcements about wildlife in our cabins starting with first-light. There were many throughout the day when we were moving. We would go ashore twice per day in Zodiacs (photo). The captain and the expedition team leader selected the sites the day before depending on the weather and communications with other ships. Although the ship could accommodate 350 passengers, we only had about 80, as smaller groups gave us priority landing.



Going Ashore

We were divided into groups named by colors. We were with the Americans and there were other groups of Germans and Japanese. When we heard, "White group to the marina," we donned our red parkas (We were free to take these home), put our expedition life-jackets on, picked our (loaned) rubber boots, and walked to the bar-lounge in our socks. We put our boots on and walked through disinfectant in trays. There were two deckhands assisting our boarding also aided by some steps. We sat on the side pontoons and an expedition team member drove us ashore. People were also there to help us disembark, and onto the shore. Parkas were all color-coded, so we knew who to go to if we needed something. They instructed us on where we could safely go and placed themselves between us and any danger, e.g., a large walrus. Their infection was so potent that a bite meant loss of limb or perhaps death. We loved walking around with so many animals, mostly Gentoo penguins that had no fear of us.



An Emperor Penguin!

We were cruising along when the captain announced, "We have a very unusual event. An Emperor penguin is floating by on a slab of ice." So, we went on the deck to take photos. Then we heard a call for our group to "go to the marina." I wondered about this as we were not near land. We took our boots and went to the Zodiac. Incredibly, the expedition team had gone to the slab, tested it, and chopped a landing site for the Zodiacs. When we approached we saw that they had also brought a sofa and a bar with cases and cases of French champagne and some fancy cookies. Junko and I loved sitting on the sofa, walking around the slab with the Emperor penguin drinking champagne!



Amazing Whale Breaches

A large humpback whale and her calf were near, so the captain stopped the ship. Junko and I were near the bow leaning out. The whale approached our ship and seemed to put her nose on it, directly below us. They hovered there for about 10 minutes then the whale shot vertically up, then crashed over making a big sound and splash. People near the front of the ship were splashed. She did this a dozen more times. It was my sense that she was trying to communicate with us. I believe that the krill, small shrimp-like crustaceans, are down 50% in Antarctica! Climate change is killing the whale's food.



A Whale Visits Us

We were returning to the ship after spending a few hours walking around the penguins. A passenger in our Zodiac said, "I see a humpback over there. Let's take a look." The Zodiac drivers were expedition team scientists, and they love the animals, too so he drove over by the whale and turned the motor off. The whale slowly approached our boat head-on, and I took the photo. When it was nearly touching us, it lifted its head high in the air showing us its face. We were astounded and were unfortunately in the back of the boat. The others in our boat stood up to take photos, blocking our view, hence the side-view photo. Then, the whale descended, dived under our little boat, never touching it! Wow! Even the smallest touch would have capsized us into the icy water! This whale, like the breaching whale, knew exactly what they were doing, and I believe was "speaking" to us, pleading for help.



Food on the Ship

I was wondering how fresh the food would be as there was no place to provision once we left Ushuaia. The food was excellent, and I told the chef so. I had asked about a tour of the galley and he said later. Several other people heard me and requested tours also. The next day at lunch he came to our table and said, "follow me." He said, "Please promise not to tell anyone, and I have a personal tour just for you." He spent 15 minutes introducing us and describing everything in detail. There were two sommeliers, one for each dining room. They described the choices for the "included" wines, which were plenty good-enough for us, and even more upscale wines one could purchase. I usually had a white choice with my meal, and a red with the cheese course, typical at the end of a French meal. We both love this tradition. There were special surprises like a huge assortment of specialty cheeses and one of our favorites, *Jamon Iberico*, a large leg with a chef slicing in the lounge as we returned from our excursion. (I think I went back 5 times!)



Going Home

Drake's passage was nearly calm for our return. We disembarked early and went to the airport. The cruise took all our luggage at the ship and loaded it on the plane. We

had a long wait in BA airport which we spent in a nice cafe. Then we flew overnight to Houston, then home.

Mexico City

This travel destination is overlooked by many, and it's super. I think airport taxis are OK, and to be on the safe side, you might want to arrange a car service or have the hotel pick you up. We stayed in the J W Marriott which is in a safe embassy area. The Executive Lounge is excellent and will like to make you special dishes if you ask. We had huevos rancheros for breakfast. The highlight is the massive anthropological museum. It begins with "Lucy," and goes forward. Allow 1.5 days as the treasures from across the country are there. You can walk there from hotel, and I suggest that you have the hotel get you a car, then call or pre-arrange a pickup. Do not enter a street taxi as they might take you to an ATM and shake you down for \$500! The Aztec ruins including two pyramids at Teotihuacán are about 25 miles away and make a nice afternoon trip. We also took a day trip to Tula, the capital of the failed Toltec empire. Finally, it's worth a day poking around the rapidly sinking city with incredible murals by Diego Rivera.

Spain

We have traveled to Spain many times and really like it. It is not crowded with foreign tourists like Italy. Plus, they drive like normal people. The first time was on a Silversea cruise. Then we did a three-week trip to beautiful old towns outside Madrid. On another trip, we focused on Madrid, Andalusia, and classic larger cities like Toledo. The last Moorish palace (and fortress), the Alhambra is worth a visit. The government's parador hotels are excellent, and we stayed in one inside the Spain was the richest country in the world in the 1500's and bought the best paintings and put them in the Prado. (My favorite art museum) And, probably our favorite trip was to the Basque country, with the 26,000-year-old cave paintings at Altamira and bars with "Pinchos" in San Sebastian, the food capital of the world. Everything is honest (unlike Italy). The transportation infrastructure, e.g., roads, trains and airports are excellent. We especially love the Jamon Iberico (Spanish ham from pigs fed acorns in the mountains), baked baby pigs and (seafood) paella.



Japan

Japan has been my favorite country for travel for many years. I think that I have likely been more than a dozen times. When people asked me why I said, "Because one can have an exotic experience in complete physical, sanitary, and food safety. There is, quite simply, no other country like it. The Japanese are xenophobic, hence there are very few foreigners living there. Thus, foreign tourists are interesting curiosities and

pampered. Restaurants have plastic models of food that you can point to, and I have pointed to other people's meals which also works. Taxi drivers wear white gloves and seats are covered with clean white covers. The driver has a lever that opens the back door on the curb side. Have someone write the destination and you will have no problems. By far, the number one tourist attraction is Kyoto (photo), Japan's capital from 794 to 1869, when it moved to Tokyo (just reverse the two Japanese characters). I prefer to stay in Osaka at the Marriott atop the train station as trains only take about 15 minutes to Kyoto. Osaka is about 2.5 hours from Tokyo on the Shinkansen. Be sure to shop for "O Bento" box meals in the station! I think foreigners can navigate Japan with little difficulty.



China

China is a different story. I think it is much more difficult for a foreigner. One can do Beijing pretty easily, especially if near the subway line, although very crowded during rush hour. There is a car app like UBER, however if you have some difficulty meeting the car it is unlikely that they can speak English. Taxis often will not stop for foreigners and be sure to have a "hotel card" if you can get one. The museums are incredible with artifacts from 5,000 years ago! The National Museum in Beijing is colossal and amazing. Many museums require a passport, although my driver's license has often worked. Most restaurant menus have photographs that you can point to. The next most important site to visit is Xian (photo). Once known as Chang'an (Eternal Peace), it marks the Silk Road's eastern end and was home to the Zhou, Qin, Han, and Tang dynasties' ruling houses. At archaeological sites in Xi'an's surrounding plains are the famed Bingmayong (Terra Cotta Army), thousands of life-size, hand-molded figures buried with China's first emperor, Qin Shi Huang. Best with Chinese accompanying you, and probably OK if you choose western hotels and book tours.



Italy

Rome is, of course, a fabulous city with the ruins of the Western Empire, Vatican and more. And of course, the Uffizi in Florence houses many Renaissance masterpieces. Venice is underwater part of the time and we prefer to stay in Padua, a university town with its own sights and take the 15-minute train to Venice. Milan has lots to see and our favorite sight is Da Vinci's Last Supper. (Likely best to reserve tickets ahead of time.) And

I think my favorite is a three-week trip we spent visiting the Tuscan "hill towns." These people preceded the Romans, who conquered them.

Chapter 35: China!

Beijing in the 80's

My first trip to China was as a science representative in a state department delegation intended to enhance cooperation with a professional translator. Needless to say, the hospitality was fantastic, including a "state banquet" with most food tuned for foreigners, except I think that we had shark fin soup. We stayed in a modern hotel and none of the electronics (soviet?) worked. The staff "learned" English in flight attendant schools with stock phrases. One morning at breakfast I had pancakes and asked for some syrup.



The waitress could not understand and brought a colleague. It took some time, and they finally "got it," "Oh, you mean 'maple syrup.'" They did not understand that "maple" was a modifier for "syrup!" The roads were full of bicycles and I worried that these poor people would resent us living in this fancy hotel. This was, of course, a needless worry.

Bus Home from the "Sick Duck"

One night we went to a huge Peking Duck restaurant, the "Sick Duck," which apparently no longer exists. Mildly inebriated, we decided to take a public bus back to the hotel as it was on the same street, I think W Chang'an Avenue. The bus rolled to a stop and was dark with no lights. We boarded, and the bus started the engine, the interior lights came on, and the bus accelerated to perhaps 20 mph. . Then, the engine turned off, it went totally dark and the bus coasted to a stop without ever using the brakes!



China Aerospace

Dr. Mao, a young engineer at China Aerospace contacted me and brought me to Beijing in the late 1990's. He was tasked to find a leadership program and loved my book. I came and made talks across China Aerospace with positive receptions everywhere. And, we had wonderful meals, with many dishes, Chinese-style. The "Lazy Susan" was electric, turning constantly, with a weak brake if one wanted to pause it. Dr. Mao brought me back the following year, I continued making speeches, and was made an "honorary



professor.” Like many space programs, the civil and military were combined. Everything was classified and their computers has no outside access. Thus, the effort fell away because they were unable to access my on-line tools hosted in the US.

1st 4-D workshop in China

In the Summer of 2010, I was approached by a Chinese project team who was trying to introduce 4-D into China through Dr. Paul Cheung. Amy Li and Cindy Yang was among the 4 members of the project team. I answered their questions about my slides through emails. Later on, they worked together on the Chinese version of my book *How NASA Builds Teams*. I was preparing to go to China for my first 4-D workshop in early Jan 2011. When everything is done, my doctor informed me that I should have cataract surgery for my eyes. Therefore, I sent Anne Choquette, my 2nd chair, to deliver the 1st 4-D workshop in China in my place.

My Publisher in Beijing

A publisher in Beijing had purchased rights to publish my book and wanted to meet me. Dr. Mao went with me to help me get there and support me. I expected Dr. Mao and myself alone on my side of the table and a large number of people on the publisher’s side. Instead, there were a dozen people on my side, and only two people on the publisher’s side. People showed me photographs of 4-D workshops they were providing in China! I met Amy Li, translator of my book into Chinese and Cindy Yang, the proofreader. They also brought their friend Michael. Later that week, Amy and Cindy arranged my first meeting with 30 Chinese coaches and trainers. I was delighted. This was a direct benefit of my earlier decision to make our intellectual property free to all years earlier. And people wanted the “real thing,” and I soon began doing 4-D workshops across China, for a month, twice a year.



A Bestseller

In May 2019, I had lunch staff from my Chinese publisher, China Industry & Commerce Associated Press Co., Ltd, they informed me that the book has been a top seller in leadership field, which was sold over 100,000 copies in mainland China. Each time when I was in China, I signed piles and piles of books.

Beijing in the 2000's

I usually stay in the (original) J W Marriott, a world-class hotel with English fluency everywhere. The lobby is gorgeous, and the Executive Lounge incredible. Breakfast and dinner includes dozens (hundreds?) of choices and all alcohol is "included." The staff know me and the manager, Hunter, is a close friend. I am usually in a huge, 2-room, 2-bathroom suite. The housekeeping is flawless and the "turn-down" service included mats by the bed, ice and "welcome back." There is nothing in the world comparable except a few J W Marriott's in Asia. I love staying there! The roads are filled with Porsches, Maserati's, and BMW's (all likely manufactured in China) with a smattering of pedestrians, bicycles, motor scooters, and "motor-cycle trucks." High-end stores, e.g., Gucci are everywhere. Pollution is an issue everywhere and slowly improving in Beijing.



Workshops in China

These are incredible, rewarding experiences for me. There is often a floor-to-ceiling blow-up of a photo of me in the front of the room. There are typically 50 to 250 enthusiastic and excited participants. I think that my decision to make all the 4-D IP free to all was important and smart. It demonstrates my integrity, my abundance mindset. Participants frequently applaud at breaks. It is not unusual for men and women to hug me and say, "Charlie, I love you." I receive thank you notes.



People even recite poems they wrote about me and the workshop during the closing. Participants often bring gifts, even after I ask them not to do so. One organizer asked participants to bring presents and I received many, many more things than I could take home in my suitcases. The following are some of the lessons-learned from these workshops.

Discouraging Group Questions

I learn a lot from these wonderful, appreciative clients and participants. A breakthrough occurred with a workshop with Sharon Gu some years ago. My clients encouraged group participation, and I was OK with that. However, I could never solve several difficulties with this. First, participants would bring up material that I thought we had closed off. More importantly, the same few people would ask all the questions. Finally, many of the questions were repetitive. I now discourage group questions in favor of people asking me during breaks. Then, we jointly



determine whether to share our conversation with the larger group. This saves an enormous amount of time.

We Discover the Power of 4-Person "Huddles"

Clients had been providing "facilitators" to manage exercises in groups which we thought we needed because I don't speak Mandarin. These people were often problematic because they wanted to "teach," which was counterproductive. Sharon came to me and said, "We have too many facilitators." I said, "Send some home." She said, "Charlie, I cannot do that." So, we proceeded with six facilitators with groups of four people each. What happened next was amazing. Everyone shared. The groups self-managed so no more facilitators! Finally, I can do arbitrarily large workshops, doing two recently with 185 participants.



My Red Underpants Go Viral

Chinese workshop asked me why not "red" for Directing? I explain that while red is a good color in China, it is not in the west. We think of stop lights and stop signs, and fire. My wife and I, however, understand the power of red. She packs, and I wear red underpants for every workshop. I told 250 participants in a Shanghai workshop about this. The following morning my translator, Sharon, said "Charlie, they want to see your red underpants." So, I turned sideways, lowered my trousers, and showed my red underpants. I had forgotten that there were 250 video cameras in the room in people's cellphones. This went quickly viral on WeChat. So, I suspect that in China I am more known as the foreigner who wears red underpants than repairing *Hubble*!



Context Shifting Worksheet Demonstrations in (early) Workshops in China

Chinese participants wanted a demonstration of the Context Shifting Worksheet ("CSW") Near the end of workshops, I asked for a volunteer to come up on the stage with me. I warned them to think carefully about this because I would "strip them naked," especially if I hear any blaming. I would listen carefully when we got to the place where they surfaced "Red" Story-lines as these are usually about Victim or Blamer.

Social Context Management - Context Shifting	
What's your Situation (problem statement)?	
What's your desired Outcome?	
What emotions do you experience when you think about your situation?	Old Mindset
What Red, limiting Story-lines have you been "running"?	
What Green, empowering Story-lines will replace your Red ones?	New Mindset
What emotions will you now express?	
Whom do you need to appreciate and for what?	What unpleasant realities must you acknowledge?
What shared "interests" with the other party will you address?	What Outcomes are you committed to, and at what level?
Whom should you include to help you attain your Outcome?	Any Victim, Rescuer, Rationalizer, or Blamer you must exit?
What agreements have you broken, and will you process them?	Are essential Roles, Accountability, and Authority clear & communicated?
Summarize actions will you now take and/or requests will you now make? Will these achieve your Outcome?	

Surfacing the "Blamer State"

Once I heard blaming, the "hunt was on," for their "role in creating the mess." Sometimes, this took a lot of time to break through the resistance. I persisted because, in my experience, the role was always there. Once it surfaced, I asked them how they felt.

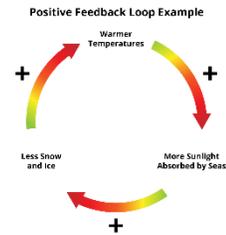


They said, ashamed, embarrassed. I (thankfully) figured out a better way to do the CSW as the focus required to do this with a translator was very tiring as you will see in later examples. The demos were, however, persuasive, and I confirmed that the Blamer dynamic was powered by an unacknowledged role "in creating the mess."

Chapter 36: Unique and Remarkable "4-D" Findings

Positive Reinforcing Feedback Loops

This is when an action produces more of the same action resulting in (exponential?) growth. Climate science brought these to my attention. In 1896, Svante Arrhenius, a Swedish scientist wondered why the earth was not frozen and discovered earth's most potent greenhouse gas, water vapor. It turns out that every 1-degree Centigrade rise in temperature adds 7% more water vapor, which heats more. The arctic is heating three times faster than the rest of the planet. Once it goes ice-free, which could happen next year if we have a strong El Nino, the reflectivity will change from 95% (ice) to 5% (open water) dramatically accelerating the heating!



Social Contexts & Self-reinforcing Feedback loops

Our species, homo sapiens ("wise ape") is unique in our domination of the planet. Ever wonder what about us enabled to do this. You might think that it's our individual abilities as that's what we reward (think of John's Nobel Prize). Wonder what enabled us to annihilate the Neanderthals who were smarter, larger, and stronger than us, despite a large head start, coming out of Africa much earlier. While no one can be certain, most scientists believe that our advantage was that we were more social, more tribal. This enabled us to share knowledge more effectively and perhaps share resources on a larger scale. political parties.



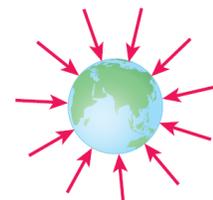
Measuring the Fields

4-D processes measure and manage Social Context fields! That is why 4-D Team development is so effective! The social context works the same way as the climate examples above. When we increase our expressions of authentic appreciation, people experience the enhanced social context field, and over time, express more appreciation themselves further enhancing the field! Round and round we go!



Social Context Fields

We know that other people's behaviors affect how we behave. But what is the mechanism? When Newton published his equations, scientists could calculate "classical mechanics," which is useful today. However, the mechanism for gravitational "action at a distance" was mysterious. The answer was the mathematical idea



of a “field.” Einstein finally resolved the mechanism question in 1915 with “General Relativity,” naming “curvature of space-time” as gravity’s mechanism. Caltech’s senior theoretical physicist, Sean Carroll says, “A field is something that fills space, taking on a value everywhere.”

Behavioral Change

As a physicist, I am always interested in what is most fundamental, and that is people’s behaviors. First, how to stimulate improvements? The process that we use is: “A, M, B, R.”

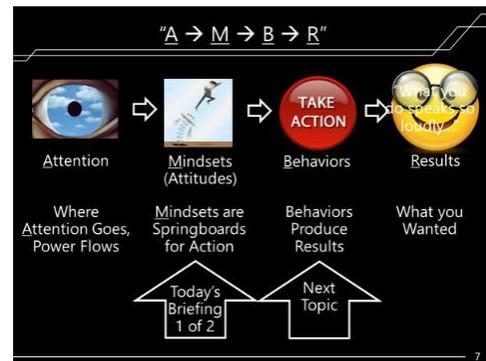
A → Attention, a most interesting and limited resource. “Where attention goes, power flows.” It is also the most malleable, changed by our beliefs and thoughts. Begin with a very limited resource, your Attention, because “where attention goes, power flows.” You can “turbocharge” this with the focus of 100% Commitment, ignoring everything less important than that which you are committed to. We shape people’s attention with facts and data that most are not familiar with. Magicians skillfully manage attention with “misdirection,”



M → Next, manage your Mindsets, your “springboards for action.” Begin by checking your emotional state. If you “feel good,” your emotions are likely providing the positive energy that you require. If “lousy,” change your limiting, likely drama-inducing, thought (“Red Story-line”) to a Response-enabling one (“Green Story-line”). For example, “Whatever it takes.”

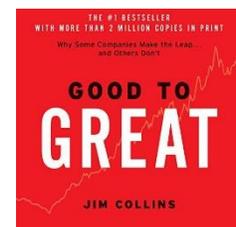
B → Behaviors, best learned with practice like, for example, musicians and athletes. And, we have on-line tools to measure and enhance these for both teams (behavioral norms) and individuals described below. Now, fully prepared, take the action that will bring you the Result that you want!

R → Results, completing the process with a positive outcome, creating a self-reinforcing feedback loop.



Ball Aerospace and Business Books

I had worked closely with Ball for many years as they built all the Hubble instruments and came up with the fix. I had an especially close relationship with Ed VanderNoord the Civil space VP. Ball contracted with me for six 4-D workshops per year as they were also in Boulder. A few years later, the CEO became enamored with a popular business book, “Good to Great” by Jim Collins, also a Boulder resident. It is essentially recommended actions and associated anecdotes. The book



did not appeal to me as the statistical analysis looked inadequate. They bought the book and gave it to the managers.

They Ignored the Simplest Recommendations

The first recommendation, "Promote from within," however made lot of sense and seemed well reasoned. So, I watched who Ball hired. I watched them fill vacancies when people left, particularly senior jobs. In the cases that I saw, they invariably hired from outside. This reinforced what I already knew. Business books are entertaining but (near?) useless for the only thing that matters, behavioral improvement.



The Relationship Between TDA Scores and Team Performance

There is no doubt there is a tight correlation between TDA scores and team performance given the anecdotes from the hundreds of team leaders who chose to use TDAs over and over. And here is a simple, intuitive argument. I suggest that a team where every person scored every behavior "never meets" could do little or nothing as a team. Thus, a score of "zero" could do nothing as a team and nearly all modern work requires teamwork. Similarly, a team where every member scored every behavior as "always meets" would perform optimally, matching their score of 100%.

The Line Connecting the Two Points

Now, the only question is what is shape of the line connecting the two points and establishing the relationship between teams' scores and their performance? I suspect it is an "S" curve exaggerating the effect at the two limits, and I have no way to determine the precise shape. So, I resort to "Occam's Razor" which says that the simplest solution is the most likely. So, we assume that the connecting line is a straight one.

About Bottom-Quintile Teams

Early on, I thought that the lowest benchmarking teams would get the most from workshops as they had the largest "room to grow." However, they gained little from the workshops as they were too dysfunctional to learn, habitually running "Red" Story-lines. In contrast, the top-quintile teams were a pleasure and seemed to benefit most. I wondered, "What causes bottom-quintile teams?" I had read that when mental hospitals hold social events, the most dysfunctional people find each other, and link up. I wondered whether dysfunctional team members were attracting similar others? At the time, NASA team members were all doing Individual Development Assessment/Accelerators ("IDAs") before workshops in addition to TDAs. So, I performed correlation analysis to test the hypothesis. It turned out that r , the correlation coefficient was <0.3 , indicating a lack of correlation.

Engaging My CPMs

So, what was behind bottom-quintile teams. I engaged my CPMs who had worked with hundreds of teams in the inquiry. We came up with common context

suppressing causes that I called the “Seven Deadly Sins,” again, you can read more about this in *HNBT*. The first “sin” was inadequate team leadership, followed by grossly inadequate funds and impossible technology. I made these into a list and placed it in front of the team leader, asking them which were in play. They could always name a few.

Ask the Managers If They are the Problem?

I asked them whether they were the problem. Referring to the first item in the list. They would say maybe surprisingly frequently. We would then run an IDA to check. If insufficient funds were the problem, I would teach them how to make a 4-D request to obtain more money, and so on addressing the limiting factors. Then, a few months later, we would re-run a TDA and they would have moved out of the bottom quintile and now suitable for a workshop.



Reducing the Behaviors from 12 to 8

Malcom Gladwell is the most popular non-fiction writer in the US. In *Blink*, he described the director of Cook County Hospital forcing doctors to limit their diagnostics to only four factors to improve the precision of detecting heart attacks. I then wondered whether reducing the behaviors we measure and manage from 12 to 8 would be beneficial. I worked with my eight coaches and selected the eight highest leverage behaviors, improving measurement precision and increased focus on a smaller number of behaviors.



Special Recognition from the Project Management Institute (“PMI”)

As I was frequently invited to provide keynote addresses at PMI events traveling e.g., to Rio, Brisbane, Boston, and Washington, D.C. The Washington event was particularly memorable. It was large with about 1,000 participants. I agreed to do the address gratis, with travel reimbursement. After I spoke, the president of the chapter approached me and handed me a check for \$4,000. I said, “What’s this?” She said, “A check, your talk was worth it.” Then, I received an e-mail from her saying, “Charlie, I have been in this business for 40 years and yours was the first OD intervention I have seen that did anything useful.”



TDA Repetitions Powerfully Improve Behaviors

In 2008, Skip approached me and said, “Charlie, we have nearly 200 teams who used TDAs four times. I want to group the teams by the quintile they started in, then chart progress with successive TDAs.” At the time, I believed that workshops were the



primary behavioral change stimulants and the TDAs did little more than measure progress. I told Skip that I thought this was a waste of time, and he proceeded anyway. (It is a good thing that people who worked for me ignore me when they choose to do so.) When I saw the data, I was astounded! The average TDA score (for 40 teams in each quintile) advanced with every TDA in every quintile, even teams starting in the top quintile!

Simply Amazing!

This was the most amazing thing I had ever seen. TDAs were the most potent behavioral improvement processes anywhere. Taking a median of 15 minutes for participants, then processed for 60 to 90 minutes in “action learning” by team leaders, performance improved about 4% on average for all teams! Some years ago, I calculated the Return-On-Investment (“ROI”) of this tool for an aerospace team because most of my clients were from this population, and the number was about 4,000 percent per annum. In recognition of our achievement, the International Coach Federation awarded us the “Prism Award.”

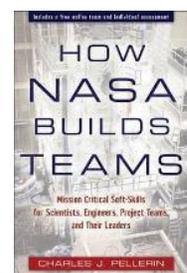


Must Make This Available to the World!

This was too important for us to hold, so we must make it available for the world. So, I decided to make all our Intellectual Property available on our web-site for free. This is one of the best decisions I made. This “abundance mindset” has sent the benefits of this marvelous system around the world. Indeed, providers have downloaded “assessment dashboards” in 75 countries!

Writing “How NASA Builds Teams!”

The second decision that I made that same afternoon was to write a book. I soon learned that the first step was to write a book proposal. I engaged San Horn as a consultant, then sent the proposal out to about a dozen book agents. I was told to limit my expectations as finding an agent as a first-time author might take a long time. Two hours later I had an “A-list” New York based book agent, Doris Michaels. In a few more weeks, we had a contract with Wiley publisher, Richard Narramore. In 2009, Wiley published “*How NASA Builds Teams.*” I enjoyed working with the Wiley people although we had some disagreements. They wanted a cover with rocket nosecones. I fought against that saying, “My readers will know that those are ICBMs, weapons and prevailed in getting a photo of Hubble instead.” I wanted, “NASA Teambuilding, It’s Not Rocket Science,” and they won that one in favor of “HNBT.”



My Book Goes International!

Doris insisted on retaining the international rights, which was fine with me. She “sold” my book in other languages at the Frankfurt international book fair. Today, *HNBT*

has sold about 20,000 copies in English and has been published in Japanese, Traditional Chinese (Taiwan), Simplified Chinese, 2nd edition (Mainland), Korean, Russian 2nd edition, with Spanish, German, and Ukrainian coming soon.

We Rely on a Collective Mind

I believe the best words are that we are “hyper-tribal.” Look at how we behave at, otherwise meaningless, sporting events. We are tribal at every scale, from family to nationalism. Moreover, we rely on a “collective” mind for our core beliefs and values, believing they are ours. This explains, for example, the rejection of clear climate science by the Republican party. I am guilty of this, too. I adopt the findings of peer-reviewed science as I have confidence in these processes, as I was a practicing research scientist for years and understand how this works. This tribalism also explains religions and political parties.

Measuring and Managing Social Context Fields

4-D processes measure and manage Social Context fields! That is why 4-D Team development is so effective! The social context works the same way as the climate examples above. When we increase our expressions of authentic appreciation, people experience the enhanced social context field, and over time, express more appreciation themselves further enhancing the field! Round and round we go!

Causes of the Failures

I organized the previous examples according to the specifics of the Social Context in play.

Blind Obedience To Flawed Direction:

- ✓ *Fukushima Daichi Explosion:* The management of TEPCO drove people to ignore advice from international experts to move the backup generators up the hill away from the ocean. I had communications with Chairman of the official failure review board who said, The accident was man-made and avoidable, rooted in the insularity and blind obedience to authority endemic to the Japanese culture.
- ✓ *Challenger’s Explosion:* The Space Shuttle was “sold” as “low-cost access to space, flying 50 times per year. At the time of Challenger, the shuttle was flying 10 times per year. With the year-to-year constant at this launch rate, the Shuttle was the most expensive launch vehicle! Perhaps believing that the future of NASA was at stake, NASA (political?) managers pushed for a launch, even though working engineers dissented.
- ✓ *737 Max:* Blind obedience to demands of Boeing’s CEO caused people (who surely knew better) to ignore years of history and violate proven processes. He demanded that they re-engine the (ancient) airplane with much larger engines, in half the normal development time, with no changes that would require simulator training!

Avoiding Criticism:

- ✓ *Hubble's Flawed Mirror:* Perkin-Elmer's management surely grew weary of criticism from NASA because of overruns when they had the toughest technical problems to work. They failed to disclose technical anomalies in the mirror to NASA rationalizing them away with "confirmation bias." And there were lots of vexing technical problems.
- ✓ *Tokyo Train Crash:* The driver overshot the platform by an amount that, if reported, would send him back to a humiliating "retraining." He then lost schedule trying to negotiate with the conductor to report a smaller error. To make schedule, he exceeded the speed limits, derailing the train.

Inappropriate Deference:

This is different from "blind obedience" as no one was directing people to do this.

- ✓ *Worst Crash In Aviation History on Tenerife Island:* In a dense fog at a small airport KLM's most prestigious Captain "spooled up" for a takeoff. The first officer said he did not hear a takeoff clearance and the Captain scowled at him and retarded the throttles. When this happened again, the first officer was silent, and the plane collided with a Pan Am 747 parked on the runway.
- ✓ *KAL Crashing at 17 times Norms:* KAL crashed because the Second Officers chose to ignore the captains' errors. Modern jets require two pilots: One to fly the plane and the other to manage the avionics.

"Unification" (Physics)

Physicists try to correlate and unite various universal laws and basic phenomena of nature to explain an activity. For example, Maxwell unified electric, magnetic, and optical phenomenon when he defined light as an electromagnetic wave. Einstein's life work was focused on unification of quantum mechanics with relativity, and he was not successful.

Maslow's Needs Hierarchy

I liked Abraham Maslow's "needs hierarchy," because 4-D Systems has a hierarchy, which people use to make a "4-D Request." And it is in the order of importance: Appreciation, Inclusion, Address unfortunate realities with 100% Commitment and Avoid drama-states. Maslow's needs are more complex, but generally align well. Moreover, while psychologists have near-universal agreement that our needs are in a hierarchy, there is less agreement on what these needs are.

Making Invisible Fields Visible

I bring a heavy, imaginary bar to a workshop participant and ask them to take it from me. I then ask if they can tell if it was magnetic using only their hands. Of course, they cannot. I take the bar back and place in on a table.

How Did You Do It In School?

I ask them to recall how they did this in perhaps the third grade. They likely placed a piece of paper on top of the bar, placed iron filings on top of the paper, then tapped the paper. Now, they could not only see that there is a magnetic field, they could see that it's a dipole field. They have used the iron filings as a tracer particle for the invisible magnetic field.

Tracer Particle for Social Context Fields?

What is the tracer particle for social context fields? Imagine that you are in the social contexts of making or receiving a marriage proposal, having dinner with the fiancé's family, at your bachelor or bachelorette party, or hijacked on your honeymoon. Would you automatically and unconsciously modify your behaviors to align with the norms of each? I suspect so. And, if I had some sensors on your body that measured your behaviors, it's likely I could tell which context you were in. So, behaviors are tracer particles for invisible social context fields.

How to Select the Behaviors?

How would you select the behaviors to measure the social context? You would choose behaviors that meet people's deepest needs, as described above and that's exactly what we do.

Shortcuts to Become a More Effective Leader?

I frequently get questions looking for short-cuts, or magic fixes – there aren't any – you must do the work, practice the behavior. Sports teams and musicians must practice. Physicists must practice, doing problems – absent the problems, physics would be easy. Malcolm Gladwell, in his book "Outliers" asserts that it takes 10,000 hours of practice to master anything. From Neuroscientist, Dr. Laura Boyd: So, the first lesson is that the primary driver of change in your brain is your behavior, so there is no neuroplasticity drug you can take. Nothing is more effective than practice at helping you learn, and the bottom line is you have to do the work. And in fact, my research has shown that increased difficulty, increased struggle if you will, during practice actually leads to both more learning and greater structural change in the brain.

Participant has a Giant, A'HA, Shouting, "I (finally) Enjoy Working Here:"

During a workshop at Marshall Space Flight Center, a participant leaped to his feet and shouted, "I have worked in the engineering division for 20 years and never looked forward to coming to work. Then I went away for 18 months on a detail to Headquarters. I returned to a completely different place and I now love coming to work. I was mystified about this until I attended this workshop! You have used 4-D to change the social context of the engineering division." Amazing!

MSFC Engineering Director Installs 4-D

The Director of engineering, "Rudi" Rudolphi, attended an early 4-D workshop and totally "bought in," bringing 4-D throughout his thousand-plus employee

organization. I suspect that had this been done earlier, Challenger's explosion and Hubble's mirror flaw could have been prevented as MSFC engineering was involved in both!

We Were Improving Behaviors Across NASA!

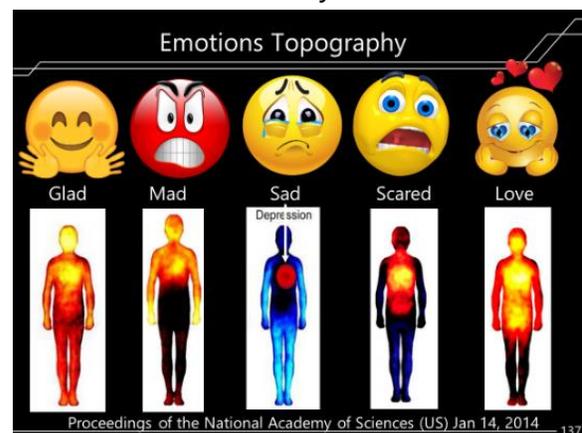
As we added teams to the database, we were updating the benchmarking curve believing we were improving its precision. As we added new "first-time" teams we noticed that it was slowly rising. What was going on? Was it possible that we were systemically changing the whole Agency?

Is It "Real"?

We first tested whether the rise was (statistically) real, using (I believe) a "chi-squared" test, and it was! Now, correlation is not causality, so could we do to see if our improvements in the Social Context was the cause of the rise? We knew that we had done twice as much work at Marshall than the average over all the NASA Centers, so we compared Marshall's trend-line over time to the NASA average. They (coincidentally?) improved twice as rapidly! We were changing the Social Context so profoundly that we were improving behaviors of people in teams we had not worked with! I know of no other evidence for systematic behavioral improvement in a 20,000-employee organization. Moreover, this validated our "Social Context Field" concept! This was a giant A'HA.

Emotions Topography

My somatic psychology teachers taught that emotions are body sensations that the mind interprets and names as emotions. This was useful in understanding why thoughts could influence emotions but not override intense ones. Our baby-blanket-sized cerebral cortex is no match for an intense body sensation. While I knew a lot about where emotions like anxiety appeared on one's body, I lacked topography maps, so I was glad to find these data. Scandinavian researchers took blank human panels and asked people from different countries to paint where they experienced emotions with brighter colors for more intensity. People were remarkably consistent, even from different cultures. Glad and love emotions were the most energizing, and since we like being energized, I work to live in these emotions. Mad uniquely energizes hands and the ends of arms preparing us to fight. Sad is, of course, low energy supporting contemplation and creativity. Scared shows up most intensely in one's chest. I was pleased to see that the results were published in a prestigious, peer-reviewed journal.



NASA Project Team uses 4-D Processes to Move from Failing to Outstanding

A Project team was overrunning, missing milestones and people were miserable. They asked me for 4-D help. I began, as always, with Team Development Accelerator ("TDA") and found, as expected, that they benchmarked in the bottom quintile.



Are You The Problem?

I showed the project manager the "Seven Deadly Sins," and pointed to the first one, "Ineffective Project Management," and asked, "Are you the problem." She said, "I might be?" I said, "Let's run an Individual Development Accelerator ("IDA"), and if OK, I will interview some of your staff." I did these things and sure enough, she was not up to the task. She revealed, "You know, I actually don't like this job. They put me here because I am excellent technically."



This Won't End Well

I said, "This is not going to turn out well for you, your team, or the project. Would you be willing to go with me to the Director of Projects, explain the situation and see if he can place you back in a technical job in a way that preserves your dignity. I know him well and believe he will be happy to do that."



Good Result For All

He did that and replaced her with a first-rate, experienced project manager. He embraced 4-D processes and used them to move the team from the bottom to top quintile. They soon had a successful project, good place to work, and a Social Context (environment) that develops/improves people. This is the "STEREO" project described in *HNBT*.



Context Shifting Worksheet ("CSW")

Several of my Master Certified Coaches said that this was the most important thing I had ever done.

- Albert Einstein said, "You cannot solve a problem with the level of thinking that created it."
- I (Charlie) say, "You cannot solve a problem in the context that created it."

When I worked as a consultant, clients would frequently pose problems that were, as defined, unsolvable. I began to play with the idea of context-shifting with a

Social Context Management - Context Shifting	
What's your Situation (problem statement)?	
What's your desired Outcome?	
What emotions do you experience when you think about your situation?	Old Mindset
What Goal, limiting Story-lines have you been "running"?	
What Crisis, empowering Story-lines will replace your fact ones?	New Mindset
What emotions will you now express?	
Whom do you need to appreciate and for what?	What unpleasant realities must you acknowledge?
What shared "interests" with the other party will you address?	What Outcomes are you committed to, and at what level?
Whom should you include to help you attain your Outcome?	Any Victim, Rescuer, Rationalize, or Blamer you must exit?
What agreements have you broken, and will you process them?	Are essential Roles, Accountability, and Authority clear & communicated?
Summarize actions: will you now take and/or requests will you now make? Will these achieve your Outcome?	

worksheet, and it worked. We will pick a Situation and process it through the remainder of the workshop, following the Context Shifting Worksheet (“CSW”) flow.

Participants in every 4-D Workshop Practice Shifting Story-lines

Intact teams select a “presenting dilemma” i.e., Situation to process. We write candidates on a flip-chart using “brainstorming” rules. We work with the team leader to combine similar items, then participants vote on the chart. (I like voting because people will frequently not vote for things that they argue for.) We then see which of the items with the most votes can command consensus. In “public” workshops like we provide in China, we use “I cannot communicate with, or motivate (my) children.” In either case, once we fill a flip chart, participants write their own responses in their workbooks.

Continuing the CSW Process

We do the same process for the rest of the CSW:

- Next we work as a group to brainstorm Outcomes;
- Experienced emotions likely Mad, Sad, or scared when one reflects on the Situation;
- Red Story-lines powering the emotions;
- Shifting these to Green Story-lines;
- Then the eight emotions:
 - Expressing authentic appreciation;
 - Address shared interests;
 - Appropriately include others;
 - Rigorously keep agreements;
 - Address unfortunate realities with 100% Commitment;
 - Avoid Drama; and
 - Clarify and communicate Roles, Authority and Accountability.

Summarize Actions

I Shift My Workshop Story-line from Red to Green to Exit Blamer State

I was providing a workshop in China when a participant asked me a question that I had answered twice already and had nothing more that I could say. The workshop ended shortly after and I went to the hotel. I did an emotional check-in, which I do as a matter of habit and realized that I felt frustrated, a nice word for angry. I checked for the Story-line that was powering that emotion and it was, “He was probably playing with his phone when I explained this the first two times.” I then realized that I had not actually seen this, so it had no basis in reality, solely an invention of my mind. I checked the behavior, which was blaming him, so it was a Red Story-line. The result was bad feelings, on both our parts and continued confusion for him.

Shift to Green Story-line

I asked myself what Green Story-line could move me into response-ability with empathy and chose, “He is trying his best to learn and it’s my duty to help him.” This

energized glad-group and love-group emotions which felt good. I then formulated a cheerful explanation which I delivered the following morning.

We all felt good and he deepened his understanding.

Managing "State-of-Being" When Named Too Expensive

I frequently do workshops with NASA organizations who must get funding from the flight projects. A participant who worked in a support organization complained that their customer said, "You are too expensive." Hearing this made them angry, which they named it as frustration. I asked them to identify the Story-line they were running which was, "I am tired of dealing with these ungrateful idiots, it's hopeless." Because they have named the situation hopeless, they plunge into Victim and do nothing.

Shift to Green Story-line

I asked them to shift to a "Green" Story-line to exit Drama and move to Response-ability. To help them, I suggested that they use empathy and accountability. This stimulated the Story-line, "They are under cost pressure & I must explain our cost/value more clearly." Now, they felt energized (Glad), supporting the Behavior of effective communication with the Result of mutual understanding.

Managing "State-of-Being" When Management Assigns too Much Work

Here is a common complaint we hear in our workshops "Our management assigns us far more work than we can possibly do." I then asked them how they felt, and they reported that they were frustrated. Now, what was the Story-line that they were running, and they said, "They won't listen, and they don't care about our wellbeing" moving to Victim-Blamer. The Behavior is to do nothing. Result is that the situation continues with bad feelings.

Shift to a Green Story-line

Mindset-shift to Response-ability with empathy and accountability, with Story-line shift to "They are overloaded, too and I can help them understand our situation." Now Response-able, and energized by glad, I will (B) openly and honestly communicate with the Result of deeper understanding.

Understanding My Ex-Wife's Interaction

I told my wife at the time that I wanted a divorce. She said, "Why, because I love you." I said, "Because I don't feel loved." I was perplexed by this, so I went to a psychotherapist. She said, "What does your wife appreciate about you" I responded, "Well, that I am there reliably for the family, have a prestigious job, make a good income, and repair the house." She said, "I see, what do you appreciate about yourself?" I thought for a moment and said, "My creativity, my ability to influence astrophysics, my love of physics, and my unconventional hobbies, e.g., racing sailboats." She said, "What does she think about these things?" I responded, "Fundamentally, she has no use for any of it. In fact, she regularly criticizes me for these things." I now see that she was

“Orange” and I am “Blue.” I understood one source of my marital disconnect and that it is important to appreciate people for things they appreciate about themselves.

Experiencing the Incredible Power of Authentic Appreciation

I was raised, in part, by a maternal grandfather who believed that people performed best when stressed. I also had a supervisor who criticized me because “my people were too relaxed.” So, I ignored people’s need to feel appreciated.

Jungian Archetypes

The trauma of my divorce motivated me to deepen my understanding of psychology. I attended a one-day seminar by the authors of Jungian psychology’s “King, Warrior, Magician, Lover” (of course, matching the four personality “colors,” Orange, Blue, Green, Yellow) which is about the development of the male psyche. I decided that I was in the highest archetype, the King. I was in a very important job influencing billions of dollars, happy with my life, and vigorous. The authors stated that the most legitimate function of the king was to bless the subjects.

I Experimented!

So, being trained as an experimental physicist I experimented with people. When I went back to work I imagined I was holding a scepter blessing people who came to meet with me. I suspended my habit of critical analysis and appreciated something specific about what they had done. The transformation was amazing. The division was energized as never before. Mutual respect increased and people were willing to openly address unfortunate realities. Appreciation has now become habitual for me. And I believe that it will for anyone who practices it as returns are assured.

The Immense Power of Gestures/Actions to Show Appreciation

Some years ago, I was doing a workshop in Shanghai that included my story about leaving two cases of champagne on my friend Ron’s front porch with no note. A participant raised their hand and said, “Charlie, you can do things like that, but I am in Shanghai with a wife, children and her parents in Beijing. At the end of the month, I don’t have two renminbi to rub together. I cannot buy something like that.

Experiences are More Powerful Than Words

When I returned home, I did some research and learned that experiences are more important than monetary or material rewards. I always confirm such findings with my own experiences. When I travel in China, I really appreciate the large and small things they do for me. When I go anywhere, for example in cars, someone always accompanies me. They carry my cases and open doors. Armed with this knowledge, I paid renewed attention to my relationship with Junko. She constantly does things to make my life better, constantly. And I look for opportunities to do things for her: Carry dishes to the sink, make coffee, and most importantly, do (nearly) anything that she asks me to do, immediately and cheerfully. Appreciation with actions/gestures keeps a marriage happy!

Making Authentic Appreciation Habitual

When one first starts appreciating, you and others might feel uncomfortable. The remedy for this, like any other behavior is practice until it becomes habitual. People ask me, "I am busy now, will expressing appreciation take more time? My response is, "I don't know. And I do know that if you make it a habit, you won't experience it as taking more time." So, make it habitual to look for opportunities to appreciate.

Air China

I was flying on Air China and the service (business class) was excellent. I appreciated with gestures, i.e., smiles, and words "thank you" throughout the service. Then I noticed that one flight attendant had a red dress, and this being China, assumed that she was the purser. I said, "I just want you to know that the service on this flight was excellent, thank you." She smiled broadly and said something that surprised me, "Thank you, but we can do better." Then, "Were you going to use the washroom?" I said, "Yes." She said, "Please go back to your seat so that I can clean it for you." I felt very appreciated.

Hainan Airlines

I was flying from Shenzhen to Beijing with Sharon on Hainan Airlines, again in business class. The purser came to my seat and introduced herself to me before the flight. (This happens frequently in China, and I am not sure why?) Again, the flight and service was excellent. As the plane was preparing to descend, I went forward, found her, and said, "I fly a lot with 1.5 million miles on United, so I know of what I speak. This flight was excellent, actually meeting standards for international flights even though it's a domestic flight."

She Became Flustered

She was so excited that she became flustered. She stammered, "I-I need to give you something." There was nothing left except a banana. She said, "Here, take this." I thought this was funny and started laughing. A few minutes later she brought Sharon a banana, too saying, "I did not want your friend to feel left out." There were glad-group and love-group emotions, everywhere.

Authentic Appreciation at the JW Marriott Hotel Beijing

(Although this is a 4-D request, appreciation made everything happen) This hotel in Chaoyang District is one of my favorites. Many years ago, while in the Executive Lounge, I noticed an individual I thought might be the manager, and when he was serving our table I asked him if that was the case? He answered in the affirmative and asked our room number. When I told him, he welcomed us by name and introduced himself as Jackie, aka "the Eagle," I was astounded and asked how many guests were coming to the lounge that night? He said, 140! I asked how he memorized our name. He said, "I just scanned the sheet earlier in the day." Amazing!

Meeting the GM

I stay at this hotel for many weeks each year. Later, Jackie said, "Our General Manager ("GM") likes to meet interesting people, would you be willing to meet him? I said, "sure," and Richard Saul met me for a glass of wine many evenings. He also visited one of my workshops, for the appreciation module. My close relationship with Richard (and the service-providers in the lounge), my many long stays at the hotel, plus my (lifetime) Platinum status assured "VVIP" treatment.

New GM Came

Richard left and was replaced by a new GM. I returned to the hotel and found myself in a plain room, on a lower floor, on (apparently) a less desirable side of the building, with no amenities! I asked the lounge ladies to arrange a meeting in the lounge at the end of a day, as I was generally out all day, with the new GM.

Priscilla and Hunter

GM Priscilla came the next day, with her "manager of rooms," Hunter. They looked worried when they entered, because the lounge ladies likely forewarned them that I was unhappy. We sat at a table and I began:

- Appreciation: I think that I have likely stayed in every Marriott in Beijing. I just need you to know how special your hotel is to me. I love everything about it: The Executive Lounge and the (mostly) ladies in it; the perfect housekeeping; the turn-down service with the foot pad so I do not have to step on the carpet before putting my slippers on – I could go on and on, and I think that you get the idea. The change was amazing. They both started smiling and relaxed. I continued, "My clients don't like to hear this, but if you didn't exist, I would be much less likely to be willing to travel on this long trip;
- Inclusion: Over the years, I have enjoyed friendships with many of the staff, and hope to have something similar with you;
- Unfortunate realities: During my past visits, I have become accustomed to very special and heartwarming perks: A room (suite when available) on the executive lounge floor, a (yellow) flower in my bathroom, a welcome bottle of wine (from exec lounge is fine), an air purifier;
- Make a Request: Could you please do as many of these things as you are willing and able to do. For my part, I will continue to insist that my clients place events in Beijing in locations that allow me to stay here and continue 5-star reviews on TripAdvisor.

From then on, back to "VVIP Status and more," and developed an especially close friendship with Hunter.

Addressing Shared Interests Improved Cross-team Performance

Michael and Fenny asked me to provide a 2-day workshop for a pair of teams building VW cars. I would not have agreed to such a short workshop with serial translation except that they promised to do additional 4-D work with the teams themselves. I decided to break the teams into two groups and named them the

“Mandarin-speaking” and “English-speaking.” I knew that a significant number of Chinese could understand English, so asked management to move some into the English-speaking group. I wanted to avoid making the Chinese-German separation worse.

Working with Linda

Working with my talented translator, Linda, before the workshop, I proposed “We must improve our cross-team collaboration to maximize performance.” The participants agreed and we began to process with the Context Shifting Worksheet as follows. I and Linda worked with the English-speakers and Fenny and Michael worked with the Mandarin-speakers. We each had two flipcharts. Linda wrote my version of the inputs from my group in English on one flipchart and she spoke the Mandarin translation which another person wrote in Chinese on the other chart. Fenny worked similarly with her group in Mandarin, with another person writing in English.

Presenting the Results

When we finished, we took all four flipcharts onto the stage. I read each of the items in English and Linda read the same ones in Mandarin. I am sure that the room was full of A’HA moments, and I was watching the A’HA facial expressions of the lead German manager and his Chinese counterpart when they saw that both groups wanted the same things! This was a complete surprise for them.

The Managers Appreciated What We Had Done

I suspect that this was a “turning point” for many. When the workshop ended, both managers spoke about how important and useful the workshop was and thanked me and Linda! Shared Interests exercise at a VW plant showed the Chinese and Germans that they wanted the same things, making working together much easier.

Shared Interests and a Mission-critical Hubble Hire

I realized that there were aspects of the servicing mission that I did not fully understand, particularly the astronaut operations in space. I set out to hire a space operations expert. We placed ads in aerospace magazines. A candidate, Tim, who looked perfect, applied. I went to see Karen, our head of administration. I had scarcely finished saying I wanted to hire Tim when she said, “No way. You look for any gimmick to grow your division and it will not work this time. Forget it!”

It’s Badge on the Table Time

My relationship with our mutual boss, Len Fisk, was great. I decided, “Its badge on the table time.” (People do this when they care so deeply about something that they will quit if they do not get what they want. Either they or the boss picks up the badge. If the boss picks it up, they are fired. I cared deeply about a Hubble service success. However, I did not want to lose my job.)

What does He Want that I can Want for Him Also?

Therefore, my question now was, "What does Len want that I can want for him also?" My first thought was, "A successful servicing mission." He wants that and I can want that too. That is obvious and he wants other missions in his organization to succeed also. I need to look deeper. What else does he want else? He wants "peace with Karen and the other Directors." Yes, I can want that too. Then I thought, "Len wants never to testify about another Hubble failure." This is good. The testimony in front of angry congressional representatives after the discovery of the failed mirror was bad for me, but much worse for him. He bore the brunt of it. Then, the decisive factor came, "Len wants, in the event of a failure, never to have to say he did less than everything he could to bring success." I am ready. It is time to go see Len.

What does She Want that I can Want for Her Also?

However, wait, I am asking him to roll Karen. I should also ask, "What does Karen want that I can want for her also?" This was harder. The first thought that came to mind is that she wants total power and control over me. Can I want that too? No way, that is not a shared interest. She wants about the ability to do her job without end runs from people like me. After a while, I could want that for her.

The Conversation

Can you now imagine the conversation? "Len, I am here because I want to hire Tim. I need to tell you the values that are in play. First, I want a successful repair mission more than a new car, and I really, really want a new car. I know you want a successful mission too. Further, I want to ensure that you never have to testify about a Hubble failure again. Moreover, if you did, I want for both of us to say that you gave me everything I asked for to ensure success. Furthermore, if the servicing mission fails, I will take full accountability and resign from NASA. Finally, please tell Karen that I will never end-run her on personnel or travel matters again."

Charlie, Pick up Your Badge

What do you think he said? "Charlie, pick up your badge and get out of here. You have your hire." "A'HA" I learned early that when you get what you want in a meeting, you stop talking, and leave as quickly as you can. I left.

Opening Space Cooperation with Japan

At Harvard, I worked closely with Japanese. Back at NASA, I wanted to explore cooperation. People told me, "It's impossible, they won't share data." I arranged a meeting with Yasuo Tanaka, and he explained that a small team of scientists and engineers do everything "in-house." And, that they could not share data per NASA policy because other scientists would write papers while they operated the satellite. I wanted to work with someone who could provide launchers, S/C, and operations, while I supply instruments and scientists. But, how to move forward if the Japanese are "dug-in?"

What does He Want that I can Want for Him Also?

"What does Yasuo want that I can want for him also?" Advancing science? "Yes" (but not enough to make progress.) For ISAS scientists to publish? "Yes" (this will work!) So, I asked, "The top journals are in English, right?" "And I suspect that the writing is difficult for Japanese scientists?" "So, suppose I issue a NASA Research Announcement soliciting scientists willing to relocate to ISAS and co-author papers with you?" "And you can select them." The first satellite was "Solar-A" (later "Yohkoh") which won Yasuo a commendation from the Emperor. This established a fruitful, long term relationship.

A Deep Experience of the Need to Feel Included

Trained as an experimental physicist, I like to observe myself to gain insights into human behaviors. We live in a small, gated neighborhood that has parties from time to time. My "Blue" wife and I hate these events, and do everything we can to avoid them, even going on travel. (Also, they are mid-day and we prefer not to drink wine then.) One year I heard a party was planned and we had not received an invitation. I noticed that I was becoming angry. Wow, the inclusion need is so powerful that it made me angry about not being invited to something I did not want to attend. Anyway, I called and asked about the party. She said, "Yes we put your invitation in your newspaper box." Since we stopped the paper, we never look in there. Now we are stuck with no way to avoid going to the party now. Uh-oh.

The Power of 100% Commitment to Purpose

I was wondering how I had accomplished so much in my extraordinary life. I do not recall any authority figures, e.g., teachers ever, telling me I was anything special, in fact, the contrary. I had an "A'HA" moment in a most unexpected time and place. Susan Shapiro arranged for me to make a lunch-time speech to a large gathering of businesspeople in Dallas. A reporter detained me in an interview until just before the speech. I sat and tried to quickly eat and focus, but the man next to me insisted on talking. The subject turned to our fathers and I remembered my father saying shortly before he died "that he never liked being a soldier."

He Surprised Me!

This surprised me as there was never a hint of that. It seems that he was so committed to the Air Force's purpose that he put his personal needs aside. I now realize that the "secret" of my success has been my ability to commit to purpose, when it mattered, be it Hubble servicing, the Great Observatories, or the 4-D Systems! I now believe that my ability to effortlessly move into the focused state of 100% Commitment likely came from my father.

Blamer and Aggressive Drivers

I use this story to demonstrate the "Discover Your Role Two-Step" in workshops. Recall that drama states are Mindsets that involve both mind (Story-lines) and body (emotions) Thus, any effective escape strategy must address the whole mind-body system. Recall the "emotions topography" maps with emotions as body sensations.

Moreover, in Blamer, we are dealing with an intense experience of the most powerful emotion, Mad-group's anger. I find it very useful to engage body movement to escape "Blamer."

Direct Me!

Demonstrate this by recounting an actual Blamer experience. Tell the participants that you cannot do this by yourself, so you need them to direct you back and forth between the two areas. Set-up: We live in the Rocky Mountain foothills 5 miles (8 km) outside Boulder city limits. The 2-lane highway we travel on from Boulder to the turnoff for our community has a 60 mph (100 kph) speed limit, no stoplights, and there are many entering side streets.

They Move Me to the "Blamer Spot"

Blaming: I am driving along, minding my own business when some idiot pulls in front of me causing me to "slam on the brakes." Where did these idiots learn how to drive? Unbelievable. (Participants move me to the "Blaming" area.) I continue to rail for a while. Finally, I run the Story-line, "Is this the hill I want to die on," to help me mitigate the anger.

They Move Me to the "Wondering Spot"

Wondering: I know that I have a role in creating this mess. What could it be? (Participants move me to the "Wondering" area.) I muse about this for a while.

They Move Me to the "Blamer Spot"

Blaming: Then, "And, how could people this stupid get a driver's license?" I continue to rant. (Participants move me to the "Blaming" area.)

They Move Me to the "Wondering Spot"

Wondering: I am SO ANGRY, that I MUST have a role in creating the mess. (Participants move me to the "Wondering" area.) I continue, "Let me think about this more. Wait, I think I might have something. When I see someone looking like they are getting ready to pull out, I speed up trying to intimate them. Because I am headed straight at them they cannot tell that I am moving faster. It's my increased speed that makes the situation.

This illustrates the most fascinating aspect of the Blamer-state – you ALWAYS have an unacknowledged role! As Freud said, "Blamer is self-anger turned outward."

Why Did Such a Successful NASA Teambuilding End?

Astronaut Charlie Bolden was named NASA Administrator. I knew him from my days in the "front office." And, ironically, he was the Space Shuttle Commander for Hubble's launch. Being a deep "Yellow," one of his first actions was to gather NASA's 500+ "Senior Executive Service" managers for a two-day conference in Washington. I was invited to speak for an hour. Charlie raved about how useful I was to him, and how often he sought my advice when we both in the front office. While I surely appreciated this, I do not recall it. He had a very troublesome Deputy, Lori Garver appointed by

Hillary Clinton's people. She refused to accept that she worked for Charlie, insisting that she also worked for President Obama. Several people at a NASA retreat reported this to me. NASA top management was dysfunctional.

Of Course, Start with a TDA

I ran a TDA and the result was as expected. I briefed Charlie, then her and the many issues were now apparent. She was better politically connected than Charlie, and freely contradicted him in public. Charlie told the Congress about the TDA and I think that the republicans wanted to use it to get rid of her. I was wakened in the night while in Japan by the Inspector General asking for the TDA report. I told them that I was in Japan, and they should get it from Charlie.

Garver's Unethical Behaviors

She went on a personal vendetta and as reported to by several senior colleagues, she forbade funding anything associated with me. She was so disliked throughout NASA that the program offices funded me "under the table." When she left, they quit saying that my original sponsor should resume funding. There was, however, no money in their budget for us, so that was the end.

My Miscalculation

The big mistake I made was assuming that Charlie, the NASA Administrator, would prevent such unethical behavior. He later invited me into his office and apologized. I could have tried to get political or legal remedies, but I was now 70 years old with an aging team, with no easy way to replace them. I decided to take a less-stressful route with more emphasis on my health and well-being. This kind of confrontation would have been extremely stressful, and I suspect she would lie, and others would be afraid to testify against her. I thought about the movie about Chief Joseph, "I shall fight no more, forever."

It's All OK

I am actually quite happy with my JPL, China and other international workshops, and the love I receive from the 4-D Community.

Scared-group, Not Afraid of Dying

Fear and Death: I engaged a fitness trainer who wanted to know my goals. I told her that I had no goals, and most especially not to live as long as possible. Rather I want to stop living as soon as my quality of life is too low, for example if I cannot read a book or understand a YouTube video. She introduced me to Atul Gawande's work on death and dying.

Trained to Operate, so That's What He Did

He is a surgical oncologist and said that he had no training or experience in talking to patients about death. So, even though his patients mostly died or became quadriplegics. He just operated because that's what he was trained to do. Then, he

realized that patients might have higher priorities than “more time,” as do I. So, he learned to ask questions.

Atul Speaks

Here's Atul in a video clip: *Here it is. People have goals and priorities besides just living longer. The way we can learn what those priorities are is a highly technical procedure, we ask them. (laughter) But we don't ask. In medicine we don't ask. Less than a third of the time, we ask what their goals and priorities are when their health worsens. When we do, people end up with less suffering because they tend to stop their aggressive therapy sooner, they have less days in the hospital or nursing home, they are less likely to die in an institution, they are more likely to go on hospice toward the end of life, and the irony is, they live longer. Lung cancer patients in a randomized trial lived 25% longer with one-third lower costs.*

And that just means that we are making bad decisions as we come to the end. The most important way that folks who are good at is by asking certain basic questions that allow you to tune the care appropriately. And those few questions are “What's your understanding of where you are with your health or your condition?” Prognosis is very hard as a subject, but people will often tell you what they are experiencing.

You Might Need These Questions Someday

I am including these because you will likely have to confront these with yourself or someone in your life, sooner or later.” These are the relevant questions:

- Do you understand your illness?
- What are your fears for the future?
- What is important to you if time is short?
- What are you willing, and unwilling to go through for more time?
- What would a good day look like?

He tells about a conversation with a patient and asking, “What would a good day look like,” given that becoming a quadriplegic was a significant risk. The patient answered, “When I can eat chocolate ice cream and watch football.” Atul proceeded with the surgery, and sure enough he became a quadriplegic and was OK with the outcome. And, with Physical therapy, he recovered use of his limbs two years later.

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I was wondering how I had accomplished so much in my extraordinary life. I do not recall any authority figures, e.g., teachers ever, telling me I was anything special, in fact, the contrary. I had an “A’HA” moment in a most unexpected time and place. Susan Shapiro arranged for me to make a lunch-time speech to a large gathering of businesspeople in Dallas. A reporter detained me in an interview until just before the speech. I sat and tried to quickly eat and focus, but the man next to me insisted on talking. The subject turned to our fathers and I remembered my father saying shortly before he died “that he never liked being a soldier.”

Ability to Commit!

This surprised me as there was never a hint of that. It seems that he was so committed to the Air Force's purpose that he put his personal needs aside. I now realize that the "secret" of my success has been my ability to commit to purpose, when it mattered, be it Hubble servicing, the Great Observatories, or the 4-D Systems! I now believe that my ability to effortlessly move into the focused state of 100% Commitment likely came from my father.

Authentic Appreciation of the Policeman "Pays-back"

I enjoy telling this story. My wife and I drive to "COSTCO" about once a week. When we enter the store, my energy begins to drain, and my wife's begins to increase. I am trying to leave as quickly as possible, and she wants to roam around looking for new things. One time, when we departed, I was exhausted. When we drove back into Boulder on the way home, I was "zoned out," and did not notice that the speed limit dropped abruptly.

The Policeman Pulls Me Over

Flashing lights appeared behind me and I pulled into a parking lot. The policeman came to my door and asked for my license and registration. I smiled broadly and thanked him. I wanted for the policeman to feel appreciated "for doing his job," and we both have glad-group feelings about the incident. He returned with my ticket and I said, "Officer thank you for doing your job. I am so grateful for you. I was zoned out and did not see the speed limit drop." (I habitually accept accountability for my behaviors.) I continued, "You have done me a great favor." He looked perplexed. Then, I said, "Here's what I know. When one gets a speeding ticket, the probability of having an accident falls by 50% for 18 months. So, thank you very much."

I Send the Money

I put a check in the envelope paying the \$100 fine and mailed it. I received a letter a week later returning the check saying that they had no record of the ticket. This worked because he experienced the appreciation as authentic, not as a ruse to void the ticket.

Doris & the Police in Florida

A few Months later, Doris Zhao, my Translator for Many Workshops in China, Remembered this: Doris was in Florida with her boss driving when they were pulled over for speeding. Her boss knew my story and he appreciated the police to get rid of the ticket. This had no effect. Then, Doris, living a 4-D life authentically appreciated the policeman with her heart. The policeman then tore the ticket up. Authentic, heart-felt appreciation works!

Chapter 37: Cindy, President & co-Founder of the "4-D Leadership Institute"

Cindy Yang, BA, English, ICF certified PCC, Mindfulness Meditation Practitioner, President, and co-Founder of 4-D Leadership Institute (Beijing, China)

I invited Cindy to NASA Workshop in 2011

In my trip to China early 2011, I enjoyed the meeting with Amy Li and Cindy Yang. Therefore, I invited them as my first partner in China and further invited them to come to Pasadena, CA to join my NASA/JPL workshop with NASA in September. They were the first Chinese people who worked with me on 4-D workshops. Cindy came back to Pasadena to work with me on 4-D workshops in 2016 and 2019 again. And we had wonderful trip in Boulder in March 2019.



No Need for Marketing

Following our meeting in Beijing back in 2011, Cindy found that as a "Green" personality, she was more passionate about spreading 4-D than staying in an orange management position in the Telecom company, Nortel Networks. So, she quit her job and became a full time 4-D workshop provider. Since then, she organized my "4-D Certification" workshops twice a year in China, together with Amy in earlier years. (Amy opened many very successful restaurants in China, and increasingly focused on that.) She also brought 4-D into many corporations, including Schneider Electric, Microsoft, Coco-Cola, Samsung, Greentown, 360, CITICPE, Nokia Siemens Networks, Geely, China Resources, SF Express, HP, DiDi, CreditEase, China World, NetEase, and more. Cindy told me that she did not have to market as customer's "4-D practice" produced wonderful business results, including reports in the media! The 4-D system has been really up-lifting for both Chinese people's lives, and Chinese organizations!



From "Asked to do" to "Wanting to do"

Yadi Media is a Chinese CCTV advertisement agency, who worked with more than 1000 companies to build their brand. The company hit a "bottleneck" in 2014 because the employees lost their motivation. Ms. Fu, the CEO heard about 4-D and decided to adopt it throughout the company. Charlie certified 3 employees in 4-D workshops, and they worked with Cindy on implementation. They also arranged for Cindy to coach

major executives. This changed the employees' mindset changed from doing what they were "Asked to do", to "Wanting to do." Over the following 4 years, their revenue increased 4-fold with 160 people making annual sales of 1.5 billion RMB in 2019. Their program of "Cultivating Management Through 4-D" was selected for Training Magazine's (China's Top) Golden Award in 2019. In 2020, they again won a similar award from the magazine!.



Every One Is a Leader

Cindy also worked with Boehringer Ingelheim Shanghai Pharmaceutical Co., Ltd ("BI"). They began to implement 4-D systems in 2014 and Charlie certified 32 employees in 4-D workshops. Cindy delivered 4-D workshops for the management team and internal trainers trained all employees. They also engaged 4-D coaching for their top executives. Before the implementation of 4-D in 2013, their international production index was 71%, below average. Then, in 2016, BI exceeded the international average!. Their employee engagement level soared from 57% to 88%, which was higher than the average of Best Employers China of 85%. Through 4-D and coaching, BI built the corporate culture of "Every One is a Leader." Their 2019 annual revenue was 3.2 billion RMB with total headcount of 240 people. The ICF Beijing Chapter awarded BI the Best Coaching Practice Prize in early 2020.

"Best" Embeds "4-D"

Best Inc. based in Hangzhou, started to implement 4-D system in 2015. Charlie certified 6 executives and Cindy trained the top management team of 90 Directors and VPS. Internal trainers then trained all employees. Now 4-D's 8 behaviors are embedded in their corporate culture. And 4-D training is mandatory for all would-be directors and they must pass a test on 4-D concepts before promotion. They found 4-D was a very practical tool to build effective teams.



"4-D" is the Best, Period

Cindy has been continuously distributing and organizing 4-D in China. The energy in her workshops organized is warm and authentic, supporting the students had deep learning. This comes from the fact that she lives a 4-D life. After one of my workshops, a gentleman from Wuhan walked with me to the parking lot. He told me that he had invested 1,000,000 RMB in all types of courses. And 4-D is the best and the most worthwhile activity, period. He then only used the 4-D system to serve Chinese organizations.

A Participant Wrote Me a Poem

At the close of one of a workshop sponsored by Cindy, a student went on the stage and read me a poem he just wrote, bringing tears to my eyes. This is Cindy's translation:

There are thousands and thousands of stars in the sky
But only one Morning Star
Among thousands and thousands of Human Beings
Dr. Pellerin using the Cartesian coordinate system
Revealed the 5th force on social context
Is like a light tower on the vast sea
We believe, 4-D system is like how
Hero Wallace said
Fire of freedom out of the eyes
Lightening of action out of bottom
Benefiting you and me
Benefiting China
Making our mother earth more abundant
Bring more color to this world

A 4-D Child

In May 2019, I was in a big conference room signing books for the students coming to Cindy's workshop. A pretty lady came in with a boy around 10. She said both she and her husband had attended one of my 4-D workshop. They were applying what they learned at work and at home. Their son is keen on outer space, so when they had a astrophysicist teacher, they brought him to meet me. He had some questions about space and a Hubble book that I signed. Cindy told me there were other couples in my workshop who would like something similar for their children.



Cindy's Private Driver was Ticketed for Parking in the Wrong Place

(Cindy, Doris's employer continues the story)After a late 4-D workshop, the organizer booked a private car for me and had the driver parked right in front of the building door in order to give me maximum convenience. This is forbidden by law. When I came out the building, the police officer was issuing a ticket to the driver. I approached and authentically appreciated the officer, saying "Thank you very much. You are maintaining good order for all the citizens in Beijing, including me. I very much appreciate your diligence and effort!" The police pointed to the driver and said, "You

should show an attitude like hers.” He felt authentically appreciated and tore up the ticket.

Wang Xin, Office Manager of China Hotel Development, Marriott International, Inc. & Part time 4-D trainer

The Full Payment of the Hotel Reservation Couldn't Be Refunded.

In early September 2014, I planned to spend National Holiday in October with my families in Guangzhou Yangjiang and booked a hotel room there. Due to the high occupancy during the holiday season, I was requested to pay for the reservation in full amount in advance. In late September, dengue fever was broken out in Guangzhou. For safe and healthy purpose, I decided to cancel the trip to Guangzhou. I called the hotel and asked for whether the pre-paid payment could be refunded. The hotel reservation associate replied me that they could and asked me to provide the bank account info for the refund. That's great, I thought the problem was solved.

However, on September 30, I received a call from hotel reservation and said that they can't proceed the refund because the hotel accounting department did not approve. I was so angry. Why didn't they keep the promise? If they couldn't refund the money, why didn't they inform me earlier? I was too late for me to make any adjustment at that moment.

I quarreled with the hotel associate over the phone. I couldn't persuade her and she neither. After a while, I realized that such quarrel couldn't solve the problem. How about 4-D method? When I was hearing the voice from the other end of the phone, I started to think about what the shared interests are between the hotel and me. The hotel wanted to keep the money. For me, I wanted the money was not wasted for nothing. A Ha, I got an idea.

I asked myself to deep breath to calm down. I told the hotel associate that: "Thank you very much for calling me to confirm the reservation. No matter what happened before, I believe we both want to well solve the problem. I understand that the pre-payment can't be refunded according to the hotel policy. I can't make the trip because of the dengue fever. How about I redeem the money to the hotel room voucher with valid date? Hotel agreed to my proposal and I received the hotel room voucher with the valid date of one year.

Micky Yang, Learning & Development Manager of United Family Healthcare
When I was with Hilton, I was in charge of a global event, where everyone was invited to express their appreciation for others by writing "Catch Me At My Best Cards."

Our department was responsible for the "Catch me at my best" program. And to lead our hotel to participate in the global competition as well.

The workload of this project was heavy, as we received snowflakes of cards every day. One day I read a handwritten card, "Dear Micky, I saw you preparing training

materials in the corner during the break giving me a comprehensive & in-depth understanding of our company and brand culture, Thank you Micky for such hard work."

Every day I saw so many cards that made me feel numb. I thought I can't be impressed. But unexpectedly... ten minutes, fifteen minutes passed, it still stayed in my heart. I was touched. So, I silently placed on the front of my desk.

Our gratitude and appreciation is more powerful than we imagined. But in our hearts, it likes hidden power, enhancing our sense of personal value and belonging. Gradually, it has become everyone's way of thinking, a habit, and even the culture of the whole enterprise.

On the day I received the card, I wrote a dozen "Catch Me At My Best Cards" to my colleagues to express my appreciation for them. And the card that so touched me remains on my desk, accompanying me through years.

Ms. Yisi Zhan, Associate Professor in the Center for Student Learning and Development of Tsinghua University, a certified 4-D trainer

Tsinghua University Students' Leadership: Top 5%

Ms. Zhan worked with other two certified 4-D trainers Rui Geng and Siliang CHENG to develop and provide the 4-D based course, *Emotional Intelligence and Leadership for College Students*. The course was very well received by Tsinghua students from the start! Among all 609 courses addressing these topics in 2019, the overall score of the course ranked in the top 5%. In particular, she got the highest score, 95%, for student approval in the college!

Professor Kan Yaling from Guangzhou Pan Yu Professional Technology Institute

Living with Clarity and Happiness

Professor Kan Yaling came to my workshop with her rationality and her discretion. When other students were enjoying experiencing and sharing, she stood back and watched. I knew her mind was "fixed" in critical reasoning and evaluation. However, by the end of the workshop, she had transformed into another person, full of passion and energy. When she returned to her institute, she developed a course for college students named "*Mindset and Behavior Upgrade*," using the 4-D systems. Her colleague commented, the course touches the soul, purifying people's, "tri-Dhyana, refining people's minds. And students' said, " The course is healing, teaching people to live with more clarity and happiness."

Chapter 38: Gerald, CEO & Founder, "Global Leadership School"

Gerald Huesch, Senator, CEO and Founder, Global Leadership School, CEO and Founder ZIB, Zurück in den Beruf, Investor (Berlin, Germany)

Addressing an Unfortunate Reality Motivated Life Changing Action

Since I was young I was 'everybody's darling', talented in many areas. Hearing that for 15 years straight got to my head that "I am special." Then, suddenly in high school, I was with 'bigger shots' than me all around. My Red Story Line was "I don't need you, because I am special." (Rationalizer) One Year later, now 16 years old, nothing happened. No friends. None. The unfortunate reality was that it did matter, so I accepted "It must be me! I am causing this!"

The 5:2 Rule!

I adopted a "5:2" rule "I must ask 5 honest questions – about something I am really interested in, before I am allowed to give 2 statements - maximum" to help me connect authentically with people. It took me 12 months to integrate this, failing lots of times. But I did not give up. I even punched my fingernail into my nail bed to remind me. After one year I had one real new and true friend. I was happy and full of joy, and from that moment I was 100% committed to learn to grow and get better at every angle of my life.

Addressing Unfortunate Realities by the Managers and a Board Member

A huge test-project from one of the biggest cell phone providers in the world challenged the company, as they never delivered this kind of volume. The head of the company said, "This is our acid test! "The Head of the company to me, "Gerald, I need you to guide this project systematically. We cannot allow us one misstep along the path, as this project absolutely time-critical!"

Three Actions

First: We clarified the Goal, Roles, Responsibilities in detail, eliminating any possible misunderstandings. A Board Member was in the room for the entire process which was unusual. I made it his presence mandatory and this had a huge effect on all!

Second: Every week on Monday morning, all levels of management reported critical concerns, i.e., unfortunate realities upward to the project manager. The project manager solved what he could and reported what was relevant to the Board Member.

One potential Unfortunate Reality, that we would run out of material, due to the scale of the project, came to the attention to the Board Member. Normally these kind of problems don't rise fast, if at all, to the surface. He immediately clarified that another material with the same quality would be fine too. So, one called confirmed that a Chinese factory had the relevant volume in stock.

Third: In the middle of the project, I asked them: "This is the biggest project in volume you ever worked on. Do you see any possible "Unfortunate Realities?" They answered, "No! Then I asked, "How about your suppliers? Is this the biggest project you ever asked them to do?" They answered, "Yes!" I then asked, "So what could be their Unfortunate Realities?" They grasped it and right away and visited all the suppliers, even on the weekend, and asked them to go their suppliers with the same question.

Success!

The result was a huge success! Fortunately, the Chinese had enough of material in stock. But without inquiring about Unfortunate Realities, the issue would not have come to the surface, and the solution might have never been found. This success is worth several 100 Million Euros.

Addressing Authentic Appreciation in a Workshop Improved Team-Spirit, Communications and Performance

A corporate team of a big retailer in Germany faced an important, complex organizational transformation. This team is in the center of the heat. Already a functioning team, they are blessed with an excellent manager and leader, who wants the team to grow together and being able to connect better with other teams. The 4-D Assessment revealed that Authentic Appreciation was very low. Apparently they received appreciation from their superior, but not from each other. All were in A'HA and agreed. During the first Appreciation Exercise, they wrote each other appreciation notes, read them out loud individually and thanked each other, with handshakes, or hugs. You could feel the joy in the room. In the second Appreciation Exercise, they included team members from other teams, superiors, board members, and other stakeholders.

Appreciation Works!

Expressing Authentic Appreciation among the team member, and outside the team, created a strong bond, stopped blaming and complaining and made them well balanced and motivated for the transformation ahead.

Shifting from Red- to Green-Story Line to Exit Victim State

One of the biggest global consultancy companies (>200.000 employees) bought a comparably small company to widen their portfolio, a couple of years ago, and tried to integrate them into their mothership.

This new company still feels not included but overwhelmed with all the rules and procedures. Some of the new rules towards bonus, still does not apply to their old business model, but cannot change at all. The problem is that parts of the team-members are still in the "old world", and complain, and victimize their situation at hand. My interventions were:

- #1 - I faced the unfortunate reality with them and shared the risk of staying with this separating-feeling "we & they".

- #2 - I shared with them appreciation part of the 4-D, and asked if they ever honestly thanked the major consultancy taken them on board? If they ever appreciated what happened to them. We dived deeper of how to appreciate on a deeper level.
 - #3 – I shared with them how to avoid blaming and complaining: “Where is my part in it of my complaint, or my feeling as a victim?”, “And then, about what I could speak up and announcing to take responsibility, to address it.”
 - #4 – I shared the tool ClarityCycle of how to get crystal clarity with the headquarter. Basically, you double check on each word of the assignments, procedures, rules, weather there is any potential of misunderstanding, then you define and state what is in scope and out of scope. Finally, you bounce that back to the headquarter to get their consent on understanding and clarity. With this we avoid any misunderstanding and misinterpretation, double work, and frustrating and complaining and blaming.
 - We closed the circle with a repetition of 1 – 2 – 3 – 4.
It showed that this was a marvelous approach in this sequence with this customer, in this situation.
-

Clarifying Roles, Accountability, and Authority

A major energy corporation in Germany, is hiring an outside company delivering services. The collaboration between the internal and external team developed to a momentum that was not bearable for both parts. All felt misunderstood and went as well into the blamer state, because of the lack of clarity at so many fields. Plus, people are interrupting each other during almost every conversation. So, we had a two day - workshop with 40 participants. At the beginning and the end of the event we measured the “Collaboration-Pain-Index”. In other words, wow much does the collaboration hurts – before and after.

Results: Highly significant improvements!

Interventions:

- #1 - I made them express their Shared Interests, and appreciation of the other side.
 - #2 - Then I told them how to work in any kind of meeting and being inclusive to any idea and thought, and not jumping to evaluations and comments. I was very strict on this separation. Method: 9 Chambers.
 - # 4 – We collected the Unfortunate Realities, the pain points, the “could-become-critical”-points, and the “already-critical”-points. Method: Laser Meeting.
 - #3 - I shared the tool “ClarityCycle” of how to avoid any unclarity with the other team. and applied that to all “could-be-critical”, and “already-critical”-points. Most of them around assignments, roles, and authority.
 - Effect: Once we established the procedure of “How we work on the subjects.” it was a ‘Walk through the park’.
-

Managing One's State of Being

A client called me that he is mad about the motivation and performance of his team. He said that he tried everything – reasoning – money – purpose – logic. Now he planned to be tough, and just wanted to let me know, and I would not be able to stop him.

Interventions:

- I just said: "Be MAD and TOUGH but fuel it with COMPASSION – out of the position of CARING."
 - Effect: He stopped breathing. His eyes filled with tears. His tone of voice changed. He delivered one of his best speeches ever. Things changed.
-

Rigorously Keeping Agreements

At the first day of every Masterclass I talk about stress management, and how to be in control of it. I always turn to their "Open Agreements." in their business, private and personal life. Tool: Open-Loop-Technique.

Interventions:

- #1 - I explain that every open agreement is like a heavy rock in your backpack – and everyday it is getting heavier. If too many rocks are carried around, burnout is around the corner.
 - #2 – In each segment: Business, private, personal life the participant will then write down all open loops – all open agreements. And during the whole Masterclass they have to close everyday 3 agreements for others and 3 for themselves.
 - Some of the agreements were closed, some of them were re-negotiated.
 - Effects: Significantly less stress. More energy. More joy. More sensitivity to promises. More aware, that the agreements with oneself were lacking attention since quite a while.
-

Making a 4-D Request

Part of the classes with Executives is: Making Major Deals. Executives and C-Levels "pitching" as well for double digit million projects / contracts, Other competitors are pitching in the same arena, with cheaper offers, better quality in some cases and areas. In order not to lose ground we focus on how to win others over – even in resistance.

Interventions:

- #1 – They pitch their real case like they would do it naturally.
- # 3 – We worked on, what they really want.
- # 4 – Worked on the metaphor expressing it.
- # 5 – Worked on the facts and figures and the full-swing of the 4-D Request.
- # 6 – They applied all they learned in a final pitch.

- Effect: Overwhelming difference. A huge shift, even for the really “bullet-proof” experienced Executives.
-

How 4-D Saved My Company

One of my two companies is a state certified institution, charged with helping unemployed people find jobs. Unfortunately, most need to find their way back to normal life first. The name of this company is “Z I B Zurück” in den Beruf, Brandenburg, Germany.

At the Beginning of the Pandemic, the Government Closed all State-certified Institutions

Thus, the unemployed in Germany, about 2,4 Million people, had no support. That is problematic as many have difficulties, e.g.: *Depression, Dry alcoholism; Family issues; Motivation issues; and Financial issues*. Plus, my 15 employees would lose their jobs.

The Unfortunate Reality is That We Would Go Out of Business

As Charlie has said, “Acknowledging unfortunate realities stimulates creativity and innovation.” We shared that unfortunate reality with the government (and got their attention).

We Included the Employees

We gathered everyone weekly, sharing the facts, possible next steps and solicited ideas and options with “brainstorming rules.” We discussed what was possible, what was not now, and what not ever. Our goal was to stay open as long as possible, as we provided a solution for Germany that nobody else had.

We Clarified and Adjusted Our Roles

We became crystal clear about what we would and would not do to meet client’s needs. For example, if they needed toilet paper and food, our “teachers” brought these to their doors.

We Addressed the Interests We Shared With Our Clients

We asked, “What do they want that we can want for them also?” They want the best possible support. Sure enough, customers said, “No-one has ever supported me better, these ‘teachers,’ are excellent.”

We Expressed Authentic Appreciation

We appreciated the employees’ openness about their fear of losing their jobs or becoming sick if they continued to work. We gave them permission to stay home if they wanted, only coming to work if they felt safe, joyful, and motivated to help people in trouble. Even though my dad was dying, I wrote each one a letter, appreciating their time and work with us. I included people we had to lay off for a while, apologizing that we had to take such measures in order to continue, and giving them an honest outlook for the future. We appreciated the work of the government employees on the phone. We appreciated the unemployed people for overcoming their fear and contacting us.

Two employees are freelancers, so they would not get any money from the government. I told them that I pay them as an appreciation of their devotion all these years. They lowered their fees in return.

100% Commitment to Employees and Customers

We provided a detailed 30-page proposal describing a new program for the pandemic time.

Rigorously Kept All Agreements

We kept every agreement with employees, clients, and the government.

We Chose Response-ability Over Blaming and Complaining

We did not allow ourselves to blame and complain about the virus or the government and focused instead on two questions: Who or what can help us change the status quo? My director communicated with the government organizations and I wrote to Chancellor Madame Merkel and received a positive letter back.

Results Realized!

We survived, the only state certified institute to do so. Even the employees who we had to lay off for a month were positive and supportive. Our image with the government for the quality of our services and entrepreneurial spirit grew dramatically. They urged us to call potential customers on their behalf, to provide support as we were the only institution still open. We demonstrated that we are reliant, trustworthy, creative, engaged, and an excellent partner for years to come. Moreover, we were named as the most outstanding institute in Germany and Europe by an external source.

Chapter 39: Michael & Fenny, "Excelland"

Dr. Michael XU, PhD, MBA, Executive Coach, 4-D Master Facilitator, Chairman and Founder, Beijing Excelland Leadership Center, Center for 4-D development in China (Beijing)

Michael: The Power of 4-D Systems

Charlie is a great 4-D Leader, he is my Model. Every workshop, Charlie always talked about our first meeting that I showed him photographs of 4-D workshops I were providing in China when Amy, Cindy and I accompanied him to the publisher in 2011. Every time he was full of appreciation and excited smile, which always inspired me in the last ten years. His example led me to change a lot, and changed many people around me, which also encouraged us to work harder to promote 4-D in China.

The 4-D Innate Personality Assessment Changed Me

First, the 4-D Systems changed me and my family as I learnt and taught 4-D since 2011. I deeply realized the advantages and weakness of my "Blue" innate personality, I was always full of vision, creativity and risk taking, but relatively little attention to others and listening, so I decided to do my best to be a 4-D leader like Charlie. I deliberately improved my yellow part by paying attention to including and listening every day. Several months later, many friends said Michael had an amazing transformation of more patience, more inclusion and listening.

The 4-D Innate Personality Assessment Changed My Wife, Fenny

In addition, my wife Fenny was also profoundly changed by the 4-D Systems. She quit her CFO position in a high-tech company shortly after she had a 4-D innate personality assessment, because she found that her innate personality was green, she preferred to interact with people, and engage in coaching and training. We also had a better understanding of each other's personality traits, and a better respect and including of each other since then.

4-D Workshops Changed Hundreds of Businesses and Tens of Thousands of Leaders in China

The 4-D Systems transformed hundreds of businesses and tens of thousands of leaders over the past 10 years in China. We have held eleven 4-D opening certified workshops with Charlie in Beijing, Shenzhen, and other cities, cultivating hundreds of 4-D certified facilitators. Every workshop was remarkably successful, and Charlie received a score of 9.8 points in opening workshop in May 2019. "As a physicist, Charlie attracted so many elites with his profound wisdom and vision, so we built a magical field together in this workshop. Here, everyone is appreciated, embraced, inspired, and stretched." said Shi Rui, a leadership expert. "I thought leadership was an art that was hard to learn," said one corporate university leader. "now I knew from Charlie that leadership is also a science that can be broken down, measured, predicted and managed."

Speeches to Chinese Companies

Charlie gave speeches to many Chinese TOP 100 companies, like FAW-Volkswagen, China telecom , Alibaba, Baidu, Meituan, Xiaomi, Sinovation Ventures , as well as Tsinghua university in the last 10 years. Charlie also gave a wonderful and successful speech in China's Enterprise Training and Development Annual Conference for more than 2000 participants in 2015, widely influenced Chinese enterprise leadership talent development.

The Amazing Power of 4-D workshops (1)

In China, we have delivered more than two hundred 4-D lectures and workshops over the past 10 years and were amazed by its power. One was for an important department of China Everbright Bank. We held two day 4-D workshops and 12 sessions of one-on-one coaching services for 12 managers for 3 months in 2011. This was very successful that quickly improved the team member's eight behaviors and transformed the team context. This team became the best performing team in the bank and produced several new leaders during the next 2 years.

The Amazing Power of 4-D workshops (2)

The second case was a 4-D workshop and a certified program for China telecom College. China telecom group is one of the largest in China with 650,000 employees. We held a 2-day 4-Systems workshop for about 50 participants. When we asked the participants to practice authentic appreciation, the Dean of the college suddenly stood up and said appreciation is very important to cooperation, but I seldom expressed it before. He then said that he would do better in the future, deeply moving the others. Later, we delivered a 4-Certification program for more than 40 facilitators from China telecom group, who trained thousands of managers for China telecom group over the next several years.

Fenny, MBA, Finance, 4-D Master Facilitator, CEO of Beijing Excelland Leadership Center, Center for 4-D development in China (Beijing)

I Quit My CFO Job

One weekend morning, Michael, my husband asked me to do the 4-D innate personality assessment. I amazed to find that my innate personality is "Green." which explained why I wasn't happy in my CFO position. I resigned from the high-Tech firm and joined Excelland Leadership Center founded by Michael in 2008 to explore myself and support others. I transformed to a 4-D system Master Facilitator, executive coach, and mentor in the last 8 years. I had chance to design and implement the 4-D system programs for dozens of enterprises which led to great achievements in China.

EQ, Appreciation, Drama inspired me the most

The 4-D system is very rich, full of wisdom, knowledge, and tools, which had a profound impact on me at different times. What inspired me most were three parts: emotional intelligence, appreciation , and drama.

Emotional intelligence is more important than you think.

I realized the importance of emotional intelligence from Charlie's simplification of mindset into two manageable parts: emotions and story -lines. And I regret that I didn't study EQ earlier as it determines half of our mindset. In order to improve my EQ knowledge and skill, I spent more than 30 days to take part in several EQ international certified programs. Now, I can skillfully use emotional intelligence to inspire participants when I facilitate the 4-D workshop and coach a leader. I even found that this part is powerful and important during the 4-D Workshop.

The Key to Expressing Authentic Appreciation

Appreciation is a topic that cannot be overemphasized. Almost every leadership program emphasizes appreciation, but I realized I just focused on the surface of appreciation for a long time . Sometimes I got confused. I tried to find and appreciate the virtues of other person, but sometimes they don't seem to resonate. It was not until last year when I accompanied Charlie to the Chengdu Volkswagen to do the 4-D Workshop, that I was impressed by the words Charlie said, "appreciate what others appreciate about themselves." I suddenly became enlightened that this is the key to appreciation, it is about connection from heart. Truly understanding what he wants to be appreciated is a deep insight into the needs of others. This insight was great significance to my practice of appreciation since then.

Awareness of the Drama

After studying the 4-D Systems for several years, I realized that I had been stuck in a "victim" and "rescuer" state for a long time. And this has had such a profound impact on my relationships with my husband, my friends, and my team. The pattern is to give as much as I can and expect understanding and appreciation. I immediately fall into the victim's grievance when other people can't see my efforts. In the discussion of "personality mask" in 4-D system, I felt my strong desire for love from the outside, saying "NO" was so difficult for me. With several months learning and deliberate practice, I gradually shifted my attention from the outside to the inside, learned to "love" myself, and stepped out of the "rescuer" mode. I was pleasantly surprised to find that the symptoms of "victim" automatically reduced. Many thanks for Charlie's great thoughts and warm supports, many thanks for so many friends in my life journey!



Chapter 40: Brett, "B Inspired Finance & Leadership Groups"

Brett Bourgon, Registered Corporate Coach, CPA, CMA, 4-D Consultant, President and Co-founder of B Inspired Finance Group, and B Inspired Leadership Coaching. (Toronto, Canada)

Shifting from Red to Green under Extreme Stress

I agreed to deliver a 4-D workshop to a new client and unfortunately miss out on a once in a lifetime opportunity; attending Dr. Charlie Pellerin's 75th birthday celebration. The airline delay would lead to me missing both. Sitting in Amsterdam while the celebration was happening in Berlin just added to the red story lines I was running:

- Why would a top airline have three separate problems with a plane that just landed?
- How does this airline at their main hub not know how to replace the lemon of a plane with one that was functioning properly?
- If I chose to go to the party I wouldn't be sitting through this painful delay!
- I need to get home to my family; this flight better not be cancelled, or I'll lose my shit!
- I'm going to lose a client because of this airline!

Detect and Exit Blamer

This ran in my head remarkably for only a short minute. Coming off a 4-D workshop myself I realized I was in Blamer state. How do I shift to run Green story lines in an exhausted and famished state under extreme stress? With a CSW in mind I started a 4-D flow.

- Green (Cultivating)-I appreciate the pilots ensuring we don't get on a plane that isn't safe. I'd rather lose a day than lose my life and not see my wife and family again. With empathy I realize that the pilots and crew are doing their best to ensure we get home on time but would risk our lives over what amounts to be a speck of time on our lives. We both have the shared interest of getting home in a timely manner, but safety overrides timing anytime and always.
- Yellow (Including)- We were told the flight was cancelled. I was in this situation together with 300 others. Waiting for the shuttle back I offered a couple the use of my gloves as I noticed they were not prepared to be standing outside the airport at midnight in zero degrees Celsius. Talking to people calmly about how happy I was that the airline put safety as a first priority hopefully helped out those in my temporary tribe with a positive perspective.
- Blue- I addressed the unfortunate reality that I was going to miss my client's important offsite. I called the client and explained the situation, without giving any excuses I offered to help. I was 100% committed to our client having a good offsite and offered to shift the workshop component to the next month.

- Orange – I ended up writing out leadership discussion topics at 1 am back at the hotel, with only a few hours of sleep ahead before heading back to the airport. I delivered multiple talking points to ensure my client had a good offsite without blame on the situation.

Shifting Takes Awareness and Effort

Shifting from red story lines to green takes awareness and effort, I was able to do so to alleviate my stress. Managing stress is a great way to stay healthy and I have 4-D to thank for helping me through a situation that many of us have painfully endured. Taking one of the most stressful situations and meeting it with a 4-D process allowed me to run green story lines:

- The pilots did an excellent job prioritizing my safety.
- I made the right decision to prioritize the needs of my client over my own and did as much as I could under the circumstances to ensure their offsite was a success.
- I'm happy to hear the birthday party was a wonderful event, Charlie and Gerald deserve it!
- I have the rest of my life to be with my family, I'm pleased that we didn't risk all of those future days together at the expense of losing one.

A 4-D Request Ensured that a Leadership Workshop had Maximum Impact

An "Introduction to 4-D workshop" had a large amount of content. It was delivered via video. At the end of week three of the four-week program we were asked if next week was going to cover off more NASA stories and content. This didn't match our program design. With limited time we felt strongly that the detailed context slide on the genesis of 4-D was sufficient for course purposes. After careful review and contemplation, we decided to make a 4-D request to Jason directly to ensure the course program stayed on track for the rest of the group.

"Jason,

- I appreciate your excitement around the NASA content and relevance to 4-D. It clearly has caught your attention and is a critical part of you enjoying this course (authentic appreciation).
- I wanted address your input directly to ensure you get maximum impact for your time spent on this course (appropriate inclusion).
- We are fully committed to ensuring everyone in the course has a blueprint to take forward either independently or with our team for an advanced session on 4-D (100% committed, addressing unfortunate realities).
- I will send you some research and materials directly from Charlie's website. I also recommend the book and am available to you if you have any clarifying questions on how to tie the course to the specific NASA content. (directing, clarifying RAAs)"

I received an appreciative email from Jason thanking me for the extra material and it was implied that he understood the course design better by my clarification email. The course continued on with what we viewed as our most effective agenda and he was happy with the bonus material sent to him directly.

Applying 4-D Processes to help Transform a Finance Leader

I was coaching a finance leader recently, let's call her Darla for confidentiality purposes. Darla was an excellent finance leader with regards to compliance and fiduciary responsibilities and was also a pleasant manager. When I asked her about her business partnering abilities, she thought they were good but could always improve.

Illustrating with 4-D

I decided to illustrate her current situation using 4-D. Her innate personality preference was Directing. She was excellent at command and control and did a good job resisting blaming and complaining. Her road to growth though as an excellent finance business partner came with enhancing her visioning, cultivating, and including dimensions. Darla participated in strategy sessions but didn't help *drive* them and there was a gap to her being 100% committed to the vision. She had a larger gap in having shared interest with her business leaders because of the perception of getting too far away from her fiduciary responsibilities. And although she included her team on many things, we discovered she over-included her team on many things and had challenges in this area.

Finance's Challenge

The challenge in finance will always be serving an orange function with balance and a 4-D approach. Darla is committed to adding more strategy (blue), cultivating deeper relationships with the business leaders (green), and appropriately including her team (yellow) going forward. We've already seen an improvement as awareness is the first step in the journey towards being a better leader.

Influencing Emotional Control for a "Green" (Cultivating) Personality

During my first coaching session with Orville, he admitted to having a conflict with another employee. Without getting into too many specifics he had the uncanny ability to speak first and think second. At other times he admitted to losing his temper, and letting anger getting in the way. I described Orville as a popcorn machine. He couldn't control getting heated quickly and then would "pop off" at his co-workers (hence the alias Orville). The funny thing was he always regretted it.

Limiting 1-D State

We had a few good sessions explaining his innate personality - cultivating. He realized the positive impacts of the strengths that resonated with him the most (feeling his feelings, having lofty goals) were being overshadowed by his negative 1-D state (hypersensitive, victim, overly emotional). We were able raise Orville's level of self-awareness so that when he was in these stressful situations, he'd have the tools to cope.

A Communication I will Never Forget

Charlie points out that under stress we are tend toward to our 1-D state. Orville learned how to keep his cool before the popcorn (his negative reaction) started to fly. A month or two later I received a communication that I'd never forget: "I was in this meeting the other day when an issue came up that without our coaching would have had me spin completely out of control." Orville was put into a stressful situation in a meeting and was able to catch himself in a moment of self-management. He used 4-D to raise his EQ level. He recognized entering a victim mindset and calmed himself, then learned from the meeting.

The Tools for a 4-D Life!

Orville can't change his innate personality type, but he now has the tools to experience a 4-D life which removes the limits he previously had by living in an elevated state of self-awareness and self-management. Controlling his emotions under stress has contributed to significant improvements at work and likely home as well.

Chapter 41: Sharon, Jian & Bin, "4-D Leadership Lab"

Sharon Gu, MD, Applied Psychology, SHRM-SCP, Certified Leadership Coach, IBM's Executive, Learning and Knowledge Mgmt., Kingdee's CHO, Founder of 4-D Lab (Beijing, China)

&

Jian Lin, MA, Economics, MBA Student Adviser, 4-D Master Mentor, CEO of two IT companies, Co-Founder of 4-D Lab (Beijing, China)

&

Bin Hu, PMP(PMI), NPDP(PDMA), CDP(NCDA), Co-Founder of 4-D Lab (Beijing, China)
Not just a Leadership Course, 4-D System is a New way to Resolve Business Crises (Sharon)

In December 2012, a colleague and I began coaching a mobile phone service company's senior management team. The leader and founder of the company looked like his hair was on fire. We asked whether there was a crucial issue to resolve. He responded that the company might be facing a 12-million renminbi (~2-million USD) penalty from Apple because 3,000 mobile phones were not returned within the contracted period resulting in a cashflow shortage of 8-million renminbi. Although this team had not been trained in 4-D, we believed the CSW might work. We saw Charlie do a miracle-turn-around case in a public 4-D workshop in October 2012 and knew of his success with proposal teams.

Using the CSW

Participants wrote the Situation (above), then their desired Outcomes to not only find the solution for the 8-million CNY crisis, how to prevent the same mistake in the future, and produce another 8-million CNY in business in the next year. We watched the tension in the room alleviate. We presented the result to the founder was surprised and encouraged by the team's self-motivated desire to do better. A'HA

Checking In

We asked how his first realizations of the Situation made him feel and his thoughts (Story-lines). He said that he felt lousy, and "No one thought it was important dam it." He realized he was in blamer! He then shifted his story-line, "Actually no one here expected this low probability event to happen. Fortunately, it was discovered early. If we found it three days later, the problem would have much worse."

Moving Into Response-ability

We asked other participants how they could shift to a Response-able state. They said, "We have good connections with Apple and can negotiate a better deal. We will show them how we improved our systems so this kind of thing will never happen again." The room was alive!

Next, we took the participants through the 8 behaviors:

- They appreciated the person who exposed the issue, and those already engaged in the crisis management;
- They recognized their shared interests with Apple in preventing future crises;
- They acknowledged a prior broken agreement in previous year, and planned to process it with Apple using the five-steps;
- They decided to clarify Roles, Accountability, and Authority (“RAAs”) to prevent the unfortunate “buck-passing” that led to this crisis;
- They assigned action items with dates and deliverables to move forward;
- Everyone recognized their own responsibilities and was committed to proceed with the SMART action plan to mitigate the risk associated with the crisis right after our session.

Appreciation and Follow-on

At the end, the founder appreciated the team for their efforts and described his personal improvement plan to “rigorously keep his agreements. The results showed that CSW is useful in dealing with the business crisis although on our first try with a team with no prior experience with the 4-D systems. Furthermore, the management team immediately scheduled a three-day 4-D workshop. Their objective is to establish a high-performance and low-risk team social context as their new business strategy. After 3 months, the founder valued the 4-D changes as 10-million renminbi. A’HA

Joint Project Team uses the 4-D CSW Process to Create Productive Social Context (Jian)

A high-tech software R&D team under the Communication Service Group, ranked 5th in all China, was tortured by a very difficult situation by. They failed to finish the new system as scheduled. The more than 60 people needed another 12 months to finish the replacement system. The crisis of trust between the owner and subcontractor, namely the F Project Team, needed to be tackled off immediately.

Some A’HA Moments

Mr. Zhang, the head of the Carrier BG and the manager of the F Project asked our 4-D coaches to provide a 4-D workshop. Here are some of the “A’HA” moments:

- After learning 4-D basics, the manager of F Project stood and expressed appreciation to the owner’s side project managers. This initiated SEEs launching appreciation everywhere, filling the classroom with laughter and warmth;
- They each wrote “what they want that we can want for them also,” finding lost shared interests (e.g., timely handover of the new system, replacement of the existing system, success of pilot introduction of the new methodology in the software development by CCS team),
- Both sides demonstrated deep inclusion by patiently listening to other’s ideas about how to make the project successful;

- The project team acknowledged their broken agreements with the owner's people, then processed them with the 5-step 4-D process. They then negotiated new agreements (no serious breakdown of the existing system, date of the first milestone, timely response to the owner's request) that they could keep;
- They acknowledged the unfortunate reality of lack of cooperation and a lack of coordination between teams of new system development and the existing system. They then worked on remedies with a senior 4-D coach.
- They helped the owner replace their red story-line "they are incapable and always break agreements" with a green one "they really want to solve the problem with brand new methodology;"
- They helped the project team replace their red story-line "they always ignore our efforts and blame us" with a green one "they are helping us solve the problems by proposing a new development methodology, uplifting our productivity and quality."
- They became even closer related after the innate personality test. People from both sides were energized and agreed to keep practicing 4-D in the workplace, sharing their practices in the A,M,B,R format every day on WeChat.

TDA's Tracked the team's Performance Improvement and Validated Economic Benefits: (Jian)

"F" Project Team was in a difficult situation. The owner blamed them for breaching their contract for delivering the new system and fixing the existing systems. They lost the owner's trust. The team also had difficulties with internal cooperation. The score of the first TDA conducted in July, was 73% with 4 people in the bottom (red) quintile. The team's Social Context needed immediate remedy.

Good Progress In Second TDA

They conducted a second TDA two months later which scored in the top (green) quintile with no individuals in the bottom quintile! What accounts for this progress?

After their 3-day workshop, the owner and team continuously practiced 4-D in their workplace, sharing A'HA moments on WeChat.

Here are some of them:

- On the first day following the 3-day workshop, a female project manager from the owner's side shared her experience of shifting red Story-lines to green in the A, M, B, R format of as follows:
 - o A: I requested a process report from the contractor's project managers. I focused on their lack of response.
 - o M: I became annoyed. I felt "lousy" and checked my Story-line. It was, "they should be punished for that." Then I realized that I was in blamer state. What is my role in "creating the mess?" Then I got it. I never asked them why they did not respond?

- B: So, I asked them for the reason over WeChat. They were apologetic and had a good explanation. Then I understood their situation. So, I said to them, " Would you please tell me when you could provide it".
- R: They responded with a pleasing answer. A'HA! I met my needs without conflict. Later that day, the contractor's project manager of the contractor told us secretly that it was wonderful she could behave this way, as she had never done before.

Effectiveness of 4-D can be seen in the numbers! Four months later, they accomplished a milestone one month ahead of the schedule. Considering that there more than 60 people involved costing 1-million CNY per month, every 1% TDA raise saves 12-thousand CNY and 4 days of schedule!

*"We are forever accountable for what we do, fail to do, or ask others to do:
(Sharon)*

I delivered a 4-D workshop for a prominent Chinese cybersecurity technology company. Although this was not an intact team, they wanted to set up a "class committee." This looked like a good opportunity to implement the "Roles, Accountability, and Authority" material that I had just taught. I had explained that most focus on roles (job descriptions) and authority (reorganizations) when accountability is more important because it is about results we are expected to deliver. Accountability is a choice, choosing to answer for the consequences of our behaviors.

RAA Worksheet

We used Dr. Charlie's RAA Worksheet, with each study group writing on the whiteboard the results they were accountable to deliver, followed by their roles (their function in their team's context), and their delegated authority and the power granted to them by others. Then, they presented their results to the rest of the class.

As expected, at the beginning, they assigned accountability for their roles rather than the results! Therefore, I emphasized again that one must be accountable for the results. This gradually became clear. For example, the accountability of the "study committee" was not to leave one student behind (100% graduation rate). The responsibility of the "disciplinary committee" was that every student abide by the workshop agreements. As Peter Drucker said, "Rank does not confer privilege or give power. It imposes responsibility," which is what we term "accountability."

"Blue" Customer Questions "Orange" Solution: (Bin Hu)

As a team, we presented the educational solution to an important customer demoed the development platform. The customer had not been satisfied with the previous two presentations and demanded improvements to the platform functions. This time was our third presentation, and the customer furious, saying that our solution was too basic, and they will not apply for budget from his management. We were

confused. Why was the customer dissatisfied with our solution? In the previous two presentations, they levied more detailed requirements on the platform. We thought that the customer was an “orange” innate personality, thinking rationally, and focused on details. Therefore, our solution focuses on presenting detailed function descriptions and utility. What’s going on?

Matching Their Personality

We investigated the customer's evaluation of previous projects and found that they focused on forward-looking. We then realized that the customer is actually has a “blue” innate personality and wanted a visionary proposal. We adjusted the presentation strategy to address three phases over three years with amazing possibilities. The customer was delighted! A’HA! We addressed the correct innate personality The customer loves our forward-looking solution and is now willing to explore the current stage, and near-term budget size.

Chapter 42: Galina, "Erfolg Academy of Management"

Using 4-D Processes in an Energy Corporation (Galina)

We implemented our standard process to manage team social contexts.

Participants: enhanced their interactions, addressed the causes of conflict, adopted common goals, focused on what's important, and reached performance targets:

- We ran a Team Development Accelerator ("TDA") to measure the social context. The average measurement of all behavioral norms was 68%. The participants' opinions were in the range of 50-90%;
- After the TDA we met with the leaders and discussed the influence of "7 Deadly Sins" on the situation. They found a flawed organizational structure as the root cause. Based on this insight they addressed this, and set milestones for team performance improvement with the help of 4-D processes;
- During the training session the team voted for the TDA results they wanted in 9 months with interim results in 6 and 3 months. They chose to imbed 4-D processes in their working environment and life in general;
- They used the report data and by voting chose a Situation to process with the CSW. At the end of the workshop the team had a 3-month action plan for all behaviors with elected "process owners;"
- We conducted 2-hour team meetings both online and offline twice a month, sharing team achievements, identifying growth areas, and focusing their attention. All participants chose to take IDAs.

Communications improved and the two teams united in one which was awarded a big long-term contract. The movement from the bottom to top quintile took about 9 months from the score of 68% to 79%! They stay committed to regular TDAs and 4-D processes ever since. A'HA's galore!

"Authentic Appreciation Motivates the Surgeon to Take Action!"(Galina)

I broke my leg and needed an operation to fix misalignment of the bones. Before the operation, my leg was set in a plaster cast. I was conscious when the complex surgical procedure began with an epidural block. So, I began singing to mitigate my anxiety before becoming unconscious. When I awoke at the end of the surgery, I heard a doctor decide to put back the old plaster on my freshly operated leg. After some time in intensive care, I began to feel excruciating pain. Painkillers were useless and the staff started to be worried as nobody could find the reason for such pain.

I understand What Happened

When the pain mitigated, a clear picture formed in my mind: The cast on my leg was in the wrong shape as my repaired leg was shaped differently than my pre-operated leg. I shared these observations with the intensive care staff begging them to take some action, but they ignored me. It took a lot of courage and determination to insist on

calling for a surgeon on duty. It seemed that the medical staff were annoyed and just couldn't believe that such a simple solution was possible.

Appreciating the Surgeons

When a surgeon finally came up I said, "Late at night, your colleagues performed an extremely complicated surgery joining bone fragments. I admire their professional qualities and feel very grateful to them for their commitment to this profession. And I really appreciate it that they stayed in the operation room longer than usual although they have a lot of things to care about besides me. Their work deserves due respect and that is why I ask to change the plaster as it may thwart hours-long efforts of a unique team of surgeons."

He Heard Me!

The surgeon listened to me closely, then something changed in his face and that was the A'HA moment! Immediately he performed all the necessary actions and removed the plaster. He left with a thoughtful expression on his face without saying a word. The pain immediately disappeared, my overall state improved, and the recovery process started.

Appreciating the Department Head

In a few days, the head of the department came to see me. He looked tense and worried. I felt it and said, "I'd like to thank the team of surgeons and their assistants for the excellent operation in challenging conditions. And I'd like to express a special appreciation to the surgeon on duty and emergency room staff for doing everything possible for me and finding the problem." My words immediately changed the context. All the tension disappeared, and a feeling of peace filled the room. The doctor shook my hands with gratitude and said with a smile that they admired my singing during the operation..

Special Caring

I made new friends and received genuine care through the whole rehabilitation process. At the time of the second operation when they were removing a titanium structure, I entered the operation room to the sound of music. I was surprised and asked what the reason for it was. The anesthesiologist answered with a smile that it was specially designed for me, as I was fond of singing. That time I was singing to music. The surgery was successful and due to the elaborate rehabilitation procedures planned by the doctor I managed to come to Berlin for the first 4-D Systems Summit. Yeah, appreciation rules!

Understanding Innate Personality Boosts Career Growth

Following his Workshop, the "Blue" manager discovered that the personality foundation of his associate was "Orange." This was an A'HA Moment! The manager swiftly rearranged RAAs delegating the work he disliked, e.g., reading detailed reports,

filing documents, and improving processes and procedures to him. The manager now focused on strategy for long-term growth.

They were both happier and more effective with the new arrangement. The associate was so happy that he treated himself to new business suit. Their Glad-group emotions and energy flowed into the larger team. The top-management noticed this and promoted both of them.

"Authentic Appreciation Restores our Tranquil and Happy Life

They installed a new transformer vault in our apartment building courtyard. However, it so noisy that people could hardly open their windows. At night even closed windows could not stop the buzzing sound harming peoples' mental and physical health. The tenants were complaining that nothing could be done, and we would have just to suffer this situation. (Victims) I didn't want to accept such state of affairs and prepared a letter to the Public Consumer Protection Service asking for action. (Response-able) I contacted my neighbors to collect their signatures. Most refused to sign, some were adamant that I would not succeed, that I was at war with windmills, and that my actions were a waste of time and effort.

I Generated a Letter

After a while, I collected the necessary number of signatures and handed over the letter to the public service. More than a month passed and there was no answer. When meting me, neighbors asked with a smile "how things were going with my letter," as they were sure of the negative result. After waiting a little longer, I called to find the result of my appeal. Either the nobody answered, or the line was busy. I did not give up and one evening, a man answered in a rather tired and irritated voice, likely not in the mood for a conversation.

Just Excuses!

I introduced myself and briefly outlined the case. In response, I heard only excuses, that due to the large flow of appeals, our issue will be resolved someday in the future. He was ready to hang up, then I asked how I should address him. The man introduced himself and he turned out to be the head of the service. He happened to be near and picked up the phone, as usually all the calls were received by the secretary who had already left. I was happy to speak directly to someone who could have a real impact on the situation.

Authentic Appreciation

I said that I understand how much he has to work and how difficult it is to deal with so many complaints and to take responsibility in difficult situations. 'I am very grateful that there are people like you who are ready to protect people's right to a safe and fulfilling life. I respect your work and I am ready to wait for my letter to be considered'. There was a pause. That was A'HA Moment!

Everything Changed

When he spoke to me again, I did not recognize his voice at first. He had changed and became friendly and warm. He said, "In the many years of my work, for the first time I hear words of gratitude and feel respect. I have been working here for more than 20 years and every day I listen to accusations and reproaches from all sides, and most of it I get from those whom I help in this position."

Situation Resolved

He shared his regrets and needs, he kept talking and it was an open and honest conversation. I listened to him with a sincere understanding of how his activities influence the context in the city and how much personal energy he puts into improving environmental and social aspects of people's lives. At the end of the conversation, he said that he assigned a specialist to my request and was going to control the whole process. The next day I got a call from the specialist and the process of transformer vault repair started. All is good, neighbors are surprised and satisfied, and the power of authentic appreciation is revealed again!

Chapter 43: Frank Martin's Contributions

Frank Martin, PhD, Physics, Science Operations, Apollo Missions, Director, Astrophysics, Head of Human Space Exploration, Director, Hubble Space Telescope Servicing (Bowie, MD)

Adoption of 4-D Processes at Marshall Space Flight Center ("MSFC")

Over the past two decades I was privileged to conduct well over one-hundred workshops for 4-D Systems. Most of these events were for NASA teams and organizations with about one third of them for MSFC in Huntsville AL. I was always impressed at how supportive the senior leadership and the employees at MSFC were for 4-D Systems.

Why Multiple Workshops?

I'd often ask senior leaders who had been in three, four, and sometimes more of these events as members of teams or as team leaders, why they kept coming back. Especially, since they knew enough to lead the workshop themselves. I received similar responses. Almost to a person they said they got something new each time because they came with different perspectives and expectations, and their teams had different members. And they appreciated that 4-D Systems provided a common language across Marshall Space Flight Center to address social context problems, to help them improve how they manage their personnel, and better manage the risk associated with the human element of doing complex spaceflight systems.

Lunchtime Speakers

One of the things that Charlie Pellerin instituted for the workshop events was to have the team leaders invite senior management to come in at lunchtime and address whatever they'd like to discuss with their teams. This provided good opportunities for leadership to discuss financial status, some political change that may impact the centers, new policy changes, and in some cases, to get the team members views on specific issues leadership was addressing.

Center Management Praises Us!

Being a former NASA employee going back to the Apollo Program, I was considered "family" by many at NASA, and often invited to sit in and listen to these discussions. A few years ago, I did my most recent three-day workshop for a MSFC team. We were privileged to have the Center Director and the Deputy Center Director come and talk with the team on different days. Both had been in several 4-D Workshops. Their sessions were fascinating and a bit surprising. Instead of talking about center policy issues, some major project, or the future of the center, they both took all their time and talked about 4-D Systems and how important it was to them in their personal lives and to MSFC. They were so 4-D! While giving two of the best 4-D sales pitches I have ever heard, they showed appreciation for what Charlie Pellerin, Jim Odom, our 4-D Systems manager for MSFC, Barbara Walton, our lead Coach for MSFC, and I

had helped them achieve. And they had not coordinated their presentations. It was completely organic and from their hearts and very moving, definitely an "A'HA moment.

4-D Folks in Top Management

So, it was never surprising to find users of 4-D Systems in NASA leadership positions. In fact, the most recent Acting Administrator, Robert Lightfoot, came to NASA HQ from Marshall Space Flight Center where he was in 4-D Workshops. I was privileged to speak with him on several occasions during his final year at NASA. He had nothing but respect and appreciation for the importance of Charlie Pellerin's creation.

Cut the Bullshit and Pick-up the Chalk!

It is usual for technical teams to have one or more (usually "Blue" Visionary) personalities who resist participating in the exercises. You might relate this story to motivate them as I have used it when presenting 4-D workshops from time to time.

I have a PhD in physics and preferred technical classes when I was an undergraduate. Nonetheless, I was at a small liberal arts college and required to take liberal arts courses to graduate. In my Senior year, I chose a course in art history thinking it would be totally about the history of art. When I arrived for my first class, I found charcoal and paper on my desk. I had wanted to read about art, not draw it. Grudgingly, I worked with the charcoals, hoping this was not going to happen every class.

When I arrived at the second class, I found pastels on my desk. I decided that "enough was enough" and sat at my desk reading the textbook. The professor was walking around the class and noticed that I was just sitting. He said, "Mr. Martin you have not done anything. Is there a problem?" I responded, "I signed up for an art history class, I am not very good at drawing and coloring and just don't feel like doing this."

The young first-year professor, not much older than me, leaned down and spoke quietly in my ear so no one else could hear. What he had to say was just for me! His words turned out to be a big gift, "Mr. Martin, cut the bullshit and pick up the chalk." I sat straight up and began to draw.

Many years later I gave the commencement address at the college. The luncheon for commencement speakers and other dignitaries was set up in the Art Building. I thanked the professor who was now the head of the Art Department for the "Gift," telling him that ever after, I "picked up the chalk." I also noticed and appreciated the beautiful art created in the professor's classes. Then, the professor and I looked at my records from the class and enjoyed that I made an 'A-' grade!" This was my only 'A' in a Liberal Arts class.

Chapter 44: A Better Life? A Vignette on "Attention"

Pay Attention to Your Attention – This is a presentation that I made for colleagues of Larisa (engineers and students) in Scotland. I only had 25 minutes, so I decided to focus on "Attention." The slides on me and the 4-D System (above) are there because Larisa requested that I add them. You can download the PowerPoint slides and video clips from my Dropbox "Shared Folder."

About Charlie

Charles (Charlie) Pellerin, PhD, MBA

In 1970, NASA/Goddard Space Center gave Charlie their highest patent-related monetary award for a "Two-axis Fluxgate Magnetometer" (US patent). He published in *IEEE Transactions*, then earned a PhD in *Astrophysics* from Catholic University publishing in *Solar Physics* and the *Astrophysical Journal*. He then received Catholic University's *Alumni Award for Outstanding Achievement in Science*. Charlie earned an "Executive MBA" at the Harvard Business School's *Program for Management Development*.

In 1983, Charlie became NASA's Director, Astrophysics. He led this multi-billion-dollar program for a decade building and launching 12 satellites. NASA awarded him the *Creative Management Award*, then an *Outstanding Leadership Medal* for excellence. Charlie invented the *Great Observatories Program* garnering over \$20 Billion for space astrophysics. For this, the *American Astronautical Society* gave Charlie their highest award, the *Space Flight Award*.

In 1990, Charlie's team sent *Hubble Space Telescope* into space with a flawed mirror. He then mounted the space repair mission that fixed the telescope. For this NASA awarded him a very unusual 2nd *Outstanding Leadership Medal*. NASA then awarded him the *Distinguished Service Medal*, "when the contribution is so extraordinary that other forms of recognition would be inadequate" for leadership of the *Astrophysics Program*. Charlie received a "Presidential Rank" award from Ronald Regan and from Bill Clinton for "sustained superior accomplishment."

In 1993, Charlie joined the *University of Colorado's Business School* as a professor of Leadership. He created and delivered a course called "21st Century Leadership" to undergraduates, MBAs, and executives. His classes had the highest ratings in the college, consistently "A+."



In 1995, Charlie founded "4-D Systems" with sales of \$50 Million during 2002 to 2012. His team won the International Coach Federation's 2007 *Prism Award for "enhanced excellence and business achievement with quantitative measurements..."*

His book, *How NASA Builds Teams* (Wiley, 2009) sells well in English and nine other languages. Charlie's current passion is supporting human-developers worldwide in using his "4-D processes" to manage team Social Contexts, enhancing business performance and peoples' lives.

China Aerospace recently made Charlie an "Honorary Professor," and Asia America Multi-Tech Association of China made Charlie a "Professor," the 1st foreigner and 9th person ever to receive this honor.

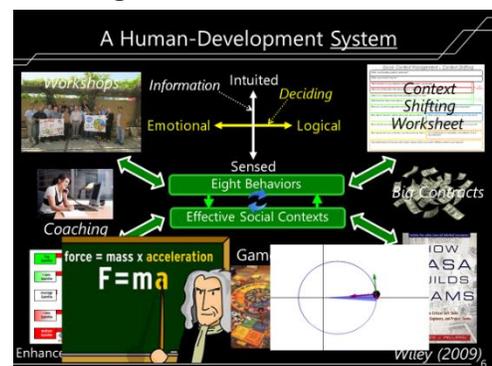
Finally, David Frigerio, a LA-based screenwriter wrote a movie about Charlie's life and *Hubble*. Screenplay completed, we have a production company, All3 Medi and they made a "Sizzle Reel" to market to networks. We are awaiting a network sponsor to enter production.

Charlie lives a fulfilling life with his wife, Junko, in Boulder Colorado's foothills.

Why is 4-D Systems So Named?

(This is repeated from above to make the briefing coherent.)

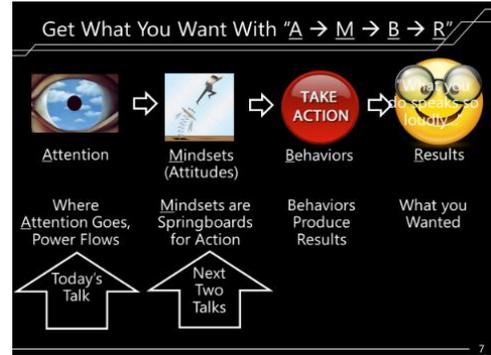
People sometimes ask me to compare 4-D to other methods, like DISC. This is like comparing a narrative about the nature of gravity to Newton's equation, Force equals mass times acceleration. With this equation, physicists can derive the entirety of "Classical Mechanics," so named to differentiate it from Special and General Relativity. Similarly, 4-D is an analytical (simplifying) tool providing many insights. A Human-Development System This is the system I developed in contrast to the Covey approach!



All parts work together, reinforcing each other to habituate necessary behaviors! The first was a workshop that evolved from my classes at CU. Then, we added coaching when we discovered how quickly people forget without repetition. Next, on-line tools for stimulating, benchmarking, and tracking behaviors of both individuals and teams. Then, the context-shifting worksheet that goes through the entire workshop in about an hour and integrated into the workshop processing participant's troubling "Situation," making the workshop "about them." Soon, I had lots of work with a huge NASA contract! Then, Wiley published "How NASA Builds Teams" Finally, my friends in Novosibirsk, Siberia invented a "boardgame" that teaches 4-D. Here are some examples of the coordinate system applied to various social contexts.

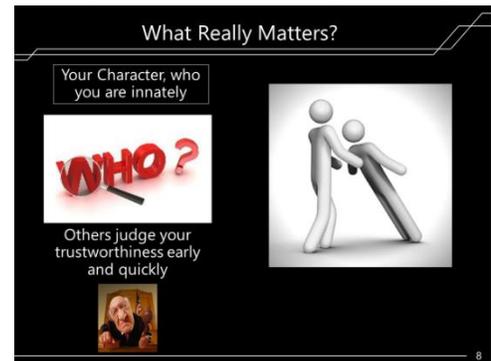
How To Get What You Want With A→M→B→R

Begin with a very limited resource, your Attention, because “where attention goes, power flow.” You can “turbocharge” this with the focus of 100% Commitment, ignoring everything else. Next, manage your Mindset, emotions plus thoughts as follows. Begin by checking your emotional state. If “lousy,” change your limiting, likely drama-inducing, thought (“Red Story-line”) to a Response-enabling one (“Green Story-line”). For example, “Whatever it takes.” If feeling OK, confirm Story-line anyway. You now have the “platform” for the Behavior that will bring you the Result that you want!



What Really Matters?

First, your character, who you are, because it informs you about the “right thing to do,” and is who you present to the world. Moreover, it sets your level of trustworthiness, which research shows that people judge very quickly, long before they assess your competence. Your character is up to you. You can give it away, but no one can take it away.

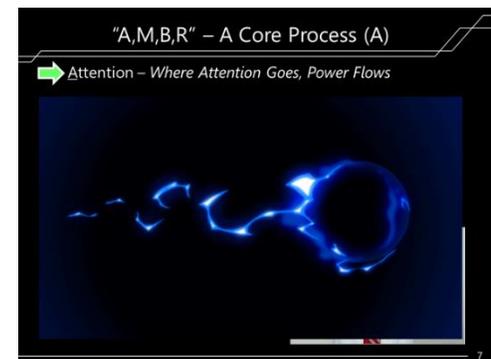


Trust Fall Fail (video)

We are going to do an exercise in building trust between one another, so Harrison if you don't mind going first, step up here and get on this chair, close your eyes. Alright then, everybody fill in and we are going to ask you to fall, and they will catch you, so you are going to have to trust us. I am going to count to three, so just relax and fall. One, two, three – NO WAIT, NO, NO (He falls forward on his face and they are behind him)

“A,M,B,R” – A Core Process (A)

Attention, Mindset, Behavior, Results is a sequential process that you can use to get what you want. Attention is a very limited resource. One's eyes alone generate far more information than the brain can process. Magicians exploit this with, for example, misdirection. We have an ‘attention’ budget that we can spend as we choose just like our financial budget. And, like our financial budget, what we choose to ignore is as important as what we choose to attend to!



Animals Need to Feel Included, Too

This sets up a video. Like appreciation, participants sometimes ask me, Charlie, I know that people in the US need to feel included, and how do you know that we need this too?" Like, appreciation, other animals need inclusion, too. What happens when a Capuchin monkey feels excluded?

Feeling Excluded → "Mad-group" (anger)

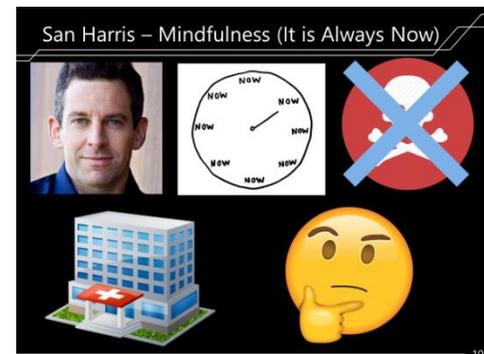
Video Clip: "So she gives a rock to us, that's the task, and we give her a piece of cucumber and she eats it. The other needs to give a rock to us, and that's what she does, and she gets a grape, and she eats it. The other one sees that gives a rock to us and gets again cucumber. (She then throws the cucumber at the researcher, and the audience laughs.) The other one gives a rock and again gets a grape. The other one gets a rock, and tests the rock against the wall, and needs to give it to us, and gets cucumber again. (Again, she throws the cucumber at the researcher, and the audience laughs.)"

San Harris – Mindfulness (It is Always Now)

It is Always Now – Sam Harris: Mindfulness is another form of attention management. This video, suggested by a workshop participant, moved me. Sam talked about how we avoid thinking about death, even though some part of us knows this day is coming. Then, we are forced to confront this with ourselves or another in a struggle to stay alive. In time like this we wonder about things we wasted our time on "when life was normal."

It is Always Now – Sam Harris

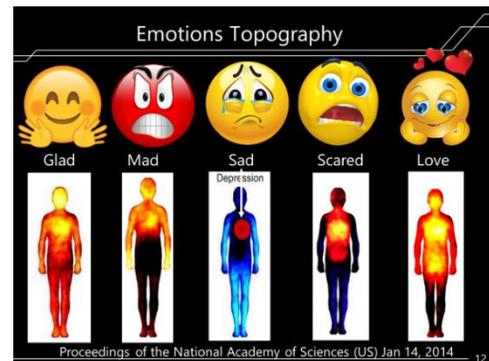
I actually want to talk today about death. Now, most of us do our best not to think about death. But there is always part of our minds that knows this can't go on forever. Part of us always knows that we are just a doctor's visit or a phone call away from starkly reminded of the fact of our own mortality, or those closest to us. Now, I am sure that many of you in this room have experienced this in some form. You must know how uncanny it is to suddenly be thrown out of the normal course of your life, and just be given the full-time job of not dying or caring for someone who is. The one thing that people tend to realize at moments like this is that they wasted a lot of time when life was normal. It's not just what they did with their time, that they spent too much time working or checking e-mail, it's that they cared about the wrong things, they regret what they cared about. Their attention was bound up in petty concerns, year after year when life was normal. And, this is a paradox, of course, because we all know this epiphany is coming. Don't you know this is coming? Don't you know that there is going to come a day when you'll be sick, or someone close to you will die, and you'll look back on the kinds of things that captured



your attention and you'll think, what was I doing? You know this, and yet if you are like most people, you will spend most of your time in life tacitly presuming you will live forever doing things like watching a bad movie for the 4th time or bickering with your spouse. These things only make sense in light of eternity. There better be a heaven if we are going to waste time like this. There are ways to really live in the present moment. What's the alternative? It is always now. However, much you may feel you need to plan for the future, to anticipate it, to mitigate risks, the reality of your life is now. Now, this might sound trite, but it's the truth!

Emotions Topography

My somatic psychology teachers taught that emotions are body sensations that the mind interprets and names as emotions. This was useful in understanding why thoughts could influence emotions but not override intense ones. Our baby-blanket-sized cerebral cortex is no match for an intense body sensation. While I knew a lot about where emotions like anxiety appeared on one's body, I lacked topography maps, so I was glad to find these data. Scandinavian researchers took blank human panels and asked people from different countries to paint where they experienced emotions with brighter colors for more intensity. People were remarkably consistent, even from different cultures. Glad and love emotions were the most energizing, and since we like being energized, I work to live in these emotions. Mad uniquely energizes hands and the ends of arms preparing us to fight. Sad is, of course, low energy supporting contemplation and creativity. Scared shows up most intensely in one's chest. I was pleased to see that the results were published in a prestigious, peer-reviewed journal.



Breathe & Shift to "Exit" Drama States

Pay attention to your emotional state, If you feel "lousy," you are likely in one of four "drama states." These are Victim, Rescuer, Rationalizer or Blamer. Ask yourself which thought ("red" story-line) is powering the emotion. In this example, the story-line is "It's hopeless, there's nothing I can do." The word 'hopeless' indicates that the person is in victim. The remedy is to replace the thought ("red" story-line) with a new thought ("green" story-line) that supports action and moves one into the state or response-ability, able to respond. That is, "I'll turn my complaints into 4-D requests to support taking action." Being able to respond changes one's emotional state into "feeling good."



Microsoft CEO, Satya Nadella on Empathy

When he became CEO, Microsoft was in big trouble. He turned the company around moving it back into success. As he describes, his capacity for empathy played an important role.

Microsoft CEO, Satya Nadella on Empathy (video)

When I think about empathy or compassion, I think it's a business essential. We are in the business of meeting unmet, unarticulated needs of customers. There's no way you are going to get that consistently right if you don't have that deep sense of empathy or being able to see what others are seeing.

Before You Criticize Others...

Walk a mile (1.6 kilometers) in their shoes, because: 1. *You will be a mile away* (too far away for them to hit you) & 2. You will have their shoes
Bring your Attention to What You are Grateful For

Charlie's Gratitude = Glad (happy) and Love (appreciation) + Green Story-lines: I like to set an example of sharing personal information, hopefully making it easier for others. Circumstances: I am grateful to live in a time of so much opportunity and abundance

In my work-life: I won the lottery, actually not the normal one, I was hired by NASA, I have three degrees in physics and an executive MBA from Harvard, the 4-D System and all the wonderful things it has brought into my and other peoples' lives, and my workshops.

In my family life: My wonderful wife Junko, and our life together (that is New Year's dinner, Japanese style), and daughter, Jules, and son CJ

In my broader life: Grateful to live in perhaps the only time in history that too much to eat is a problem, and for being able to eat all the healthy food that I want, can travel the world and, above all, waking up in the morning "ready to go!"

Appreciate People in Your Life Now!

I was speaking to an FBI agent shortly after he returned from the World Trade Center 911 disaster. I asked him what he learned. He said the

Microsoft CEO, Satya Nadella on Empathy




- ✓ I think empathy is a business essential;
- ✓ We are in the business of meeting unmet, unarticulated needs of customers;
- ✓ There's no way to get that consistently right;
- ✓ Without a deep sense of empathy;
- ✓ To see what others are seeing.



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Before You Criticize Others...

Walk a mile (1.6 kilometers) in their shoes, because:



1. You will be a mile away (too far away for them to hit you) & 2. You will have their shoes




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Charlie's Gratitude = 😊❤️ + Story-lines

Circumstances: I am grateful to live in a time of so much opportunity and abundance

Work life: 

Family life: 

Broader life: 

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Appreciate People in Your Life Now!

Many words were spoken into the ears of the dead that they yearned to have heard while they were alive.




Tonight, begin habitual appreciation before it is too late.

"Charlie, I don't need any of this." "When I married my wife, I told her I loved her and would let her know if anything changed."

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words on the slide. I say them twice, slowly. We ask workshop participants to appreciate someone they deeply care about that evening and report what happened in the workshop the next morning. Many reports are from spouses who say something like, "I am really glad that you are in that workshop."

On one occasion, a person raised his hand and said, "That was a really bad idea." He continued, "I stopped on the way home and bought a dozen roses. I knocked on the door my wife appeared I hand her the roses and said I love you so much." She gave me a nasty look and said, "Forget it – you are not getting any tonight, buster." Apparently, appreciation was so rare that she mistook his appreciation for manipulation.

An engineer in a workshop once said to me, "Charlie I don't need any of this. When I married my wife, I told her I loved her and would let her know if anything changed."

Address Unfortunate Realities with 100% Commitment

Reality based Optimism with 100% Commitment: I looked for years at how to stimulate creativity, with no success. I even bought (worthless) decks of cards and other gimmicks. Then I read an (otherwise uninteresting) book referenced in the slide and saw what I was seeking. The key is something unexpected and unnatural for humans – fully embrace Unfortunate Realities.

I was wondering why the US political system is so paralyzed. For example, WW II lasted about four years and the Iraq war went on for 10 years.

The reason is that the two political parties could not agree on the reality.

Ray Dalio runs a hedge fund, Bridgewater and is a billionaire, recovering from near bankruptcy in the 80's when he shorted the stock market. He now dedicates his life to "giving back" by helping others. He wrote a book including Life Principles." Life Principle #1 is embrace reality and deal with it, especially the realities we wish weren't true!

As you will see in upcoming videos, addressing unfortunate allows you to take actions that render them moot, as I did in moving to Japan to find my wife, or remove them, taking them out of play.

People sometimes have difficulty in being 100% Committed. I do this by deciding what to ignore. I was working with a Dutch 4-D provider who had played on a championship handball team. He said they were trained in "perception regulation," thinking about the ball and players on the field as a circle, and everything else, referees, fans, family, etc. as circles outside that. So, when they are on the field, their attention is totally within the inner circle.

Andy Grove and an Unfortunate Reality



'Andy' Grove (1936 – 2016) was a Hungarian-born American businessman, engineer, author, and a pioneer in the semiconductor industry. He escaped from Communist-controlled Hungary at the age of 20 and moved to the United States where he finished his education. He was one of the founders and the CEO of Intel, helping transform the company into the world's largest manufacturer of semiconductors.

This is a great story about him. Andy gathered his management team and said, "The Japanese are *hammering us* on the cost of manufacturing RAM." (RAM is random access memory.) They said, "*No problem, we can beat them!*" Andy, then called his two most trusted managers into his office and said, "The *Unfortunate Reality* is that we cannot beat the Japanese on cost. If we try, the Board *will fire us*, and rightly so. Let's imagine that we are the people *they hired to replace us*, so what would we do?" The idea for manufacturing microprocessors came from that meeting and they now dominate the world. in this area. For the Love of the Game

This is an excellent example of the power of ignoring things that do not matter. This is a 1999 sport drama following the perfect game performance of an aging star baseball pitcher, Billy Chapel, as he deals with the pressures of pitching in Yankee Stadium in his final outing by calming himself with memories. The pitcher reaches a crucial point in the game. He must throw the ball, so the batter doesn't hit it. It's hard to ignore the jeering crowd. He faces the batter and says "Clear the Mechanism" to himself. He moves into the focused state of 100% Commitment. Nothing exists except his pitch, saying "Hello Mike," to the batter. He throws, the batter misses, with a "strike."

Andy Grove and an **Unfortunate Reality**

"The Japanese are **hammering us** on the cost of manufacturing RAM."

Management Team: "**No problem, we can beat them!**"

"The **Unfortunate Reality** is that we cannot beat the Japanese on cost. If we try, the Board **will fire us**, and rightly so."

Let's imagine that we are the people **they hired to replace us** – what would we do?"

For the Love of the Game

The pitcher reaches a crucial point in the game.

He faces the batter and says "Clear the Mechanism" to move into the focused state of 100% Commitment.

Saying "Hello Mike," **nothing exists** except his pitch.

He throws, the batter misses, with a "strike."

The Apollo 1 Fire

The Apollo 1 Fire: A cabin fire during a launch pad test on January 27, 1967 at Launch Pad 34 at Cape Canaveral **killed all three crew members**. Gene Kranz gathered his team at Mission Control in Houston to discuss **Accountability**.

We Are Forever Accountable (video)

Monday morning after the fire, Gene Kranz speaks to the team. Decades later, he can still recite the words from that day.

The Apollo 1 Fire

Set-up: Apollo 1 – A cabin fire during a launch pad test on January 27, 1967 at Launch Pad 34 at Cape Canaveral **killed all three crew members**.

Gene Kranz gathered his team at Mission Control in Houston to discuss **Accountability**.

Space Flight's terrible unforgiving of incapacity, carelessness, and neglect. I don't know what the Thompson committee will find as the cause of this accident, but I know what I find. We were the cause. The simulators weren't ready. The software in Mission Control didn't function Procedures weren't complete, nothing we did had any shelf-life, and no one stood up and "Damn it, Stop." Now, from this day forward, Mission Control will be known by two words, Tough and Competent. Tough meaning that we will never again shirk from our responsibility because we are forever accountable for what we do or fail to do. Competent, we will never again take anything for granted, and will never stop learning. When you leave here today, you will write these two words on your blackboards, and they will never be erased. They will serve as a constant reminder of the sacrifice of Grissom, White, and Chaffee. That's all.

What Matters?

The second element is "competency." If one wants to be a physicist, you likely need a PhD which is basically training to be a researcher. And decline tasks you are unable to successfully perform. My good friend, Frank Martin went to the Russia and negotiated agreements for Proton Rockets for Lockheed Martin. When he returned, they asked him to manage the program. He declined, saying "No way. I know nothing about this!"

Which Outcomes Should One Commit To?

Elon Musk inspired this chart when he was musing about his decisions to enter the auto business with Tesla (to electrify transportation and trucks to mitigate climate change) and space rocketry with Space-X (to colonize mars). People told him that his idea was ridiculous as it cost \$600 per kilowatt-hour to make a battery. He said, "You are reasoning by analogy. I reason from first principles. The cost to buy the materials for such a battery is \$80. So, the difference is just a packaging problem."

Chapter 45: Our Cars and Tesla "Model 3"

Uncle Frank's Cars

When we lived on Ferry Point Road, I was driving to downtown DC and back every weekday, a lot of driving. Fran's Uncle Frank bought a new car every two years. Because he worried about black people stealing the car, he bought the exact same car every time, a Chevrolet Impala with no options, i.e., no interval wipers and only an AM radio. He thought that if the cars were the same, nobody could notice that he had a new car. While I was surely grateful for this generous help, these overweight, gas guzzling cars are not fun to drive. Even though I had given Frank advance warning about the divorce, he apparently had not heard it. And he refused to answer my letters or talk with me, something I did not anticipate. So, I chose to return his car gift and buy something myself, despite the fact that I was going broke.

Acura Legend

By now, I had left my downtown apartment and moved to the Maryland suburbs to be closer to my girlfriend at the time. I usually bought "accountant's cars," cars about 2 years old at about half price. I saw an ad for an Acura Legend and went to see it. Turned out the seller, Ken Davis, had lost his job as a manager at a major dealership and was selling cars that he bought at auction out of his house. The price was good, and I bought the car. The house I rented was in Kensington, MD, about a 15-minute walk to the subway with a multi-level (free) parking lot with lots of space. I would walk to the subway most days, only driving if late or bad weather.

Where's My Car?

One day I got off the subway and went to where I thought I had parked my car, and it was not there. My first thought was that I must have walked instead of driving. I went home and, no car? I went back to the garage and checked everywhere, and no car. I called the police and then my insurance company. The insurance company provided me a rental car and said that they would pay me for my lost car after 30 days. On day 28, a police holding lot in Baltimore called me and said that they had my car. I went and got my car, trashed in and out. I took it to the dealer for repairs.

An Epiphany

I watched the news and saw a similar car "carjacked," with an infant in the back seat. When I went to pick up my car, there were several people in line in front of me. I was shocked to see that everyone was there because they had a stolen Legend! Then, I saw an interview with a young black man in TV saying, "When I see a Legend, man, I got to have it!" So, I suspect that the people who stole my car took the train from Baltimore then subways to the parking lots. There are no attendants at the lots and most people

are going to or from work. So, there is nobody around most of the day and one can leisurely choose and steal cars!

I Need A Car Nobody Wants to Steal

I went back to Ken, now with a small warehouse, and told him what had happened, and then said, "Ken, I need you to buy this car back and sell me a car nobody wants to steal." He took me to a boxy BMW 525 and said, "This car has been repainted so I can sell it to you cheap." I had been impressed with quality of BMW's as I had a friend in graduate school with a "Bavaria" who drove very aggressively, and had seen these cars going very, very fast on the autobahn. I soon learned that BMW's have a very interesting feature, as they monitor everything, e.g., every bulb, and the levels of oil and coolant, not just the pressure and overheating. After some time, I sold the 525 and Ken found me a nice 535 stick shift. I sold it to CJ, then bought an Audi A6, twin-turbo, AWD, which went to Junko when I bought a BMW 745!

Nissan "Leaf" & Autonomous Driving

At a neighborhood party I overheard Ron Alberty telling about the incredible discounts and tax breaks on a Nissan Leaf. A new \$35,000 car cost just over \$15,000. With a BMW and Audi nearly 20 years old, we bought one. It was a great "basic," car with a 100-mile range, fun to drive and very economical to operate. I became concerned about having an accident and began investigating self-driving cars. I watched a YouTube video comparing Google's cars with Tesla and was "blown-away." Tesla's suite of cameras and radar made much more sense than Google's Lidar! Then I learned about Tesla's use of the fleet of 500,000 cars providing input for the advanced neural network computer in every car! This is the first self-driving strategy that I had seen that would likely work!

Why Am I Talking About the Tesla Model 3?

First this is such a unique and interesting "robot with four tires that amazes me;"
Next, there is a Tesla "Gigafactory" in Shanghai that went from mud to first car out in 9 months and is manufacturing "Model 3" cars faster than any other factory in the world; and

Finally, Tesla has empowered a Chinese team of designers to design a low-cost "Asia car," that can make exciting electric cars for many more.

Model 3 - Starting Up!

Tesla contacted me when our car left the Fremont factory and gave us the option of coming for it, or them delivering it to our house, which we preferred, The Tesla phone app does many things and actually works really well. It shows me the miles

remaining, and if I plan a route, it will predict miles at destination taking into account the speed, traffic, and elevation change. Also, the car senses the presence of my Pixel phone and energizes the car. (I also have a credit-card sized backup key in my wallet.) Our car is a dual-motor, AWD with a 320-mile range. I generally charge at home with a 220V charger. The charge starts slowly, then, as the battery is conditioned goes up to 30 miles-per-hour. If I bring the charge probe near the car, the charge port opens. And, when I remove the probe it automatically closes. The newer Tesla Superchargers can charge 200 miles in 20 minutes. When I open the door, the seat and steering wheel are in my preset "easy entry" position, the climate control is running, and the radio is playing. The central screen is on with an image of the car and status in the left 25% with the map in the rest of the display. When I put on my seat-belt and touch the brake, the seat moves to my preset "driving position." I lift the right-hand stalk, the car shifts into reverse, the image of the car on my computer rotates to "backing," the rear camera images on the screen, and the 12 ultrasonic sensors turn on indicating objects near the car and their distance away. There are many, many choices for everything, including neutral, creep, or hold (brakes on) when the car stops. I chose "hold," so when the car is stopped the brakes remain on, until I touch the accelerator.

Driving the Model 3

I back up, then push the stalk down shifting into "Drive," which is OK with the car still moving. I manually drive until I turn onto the highway with lane markings. (The capability to drive unmarked streets is coming "soon.") While the automatic collision avoidance is on all the time, there are three driving choices. One can stay in Drive, flick the stalk down once for Cruise Control, or twice for Autopilot with the radar and eight cameras controlling the car. In these latter two modes, the right-hand button on the steering wheel changes the speed when scrolled up or down and following car-lengths when pushed right or left. The button on the left side controls the sound system with 14 speakers, 1 subwoofer, 2 amplifiers, and immersive sound. The car shows when autopilot is available with light-blue image of a steering wheel and two bright blue lines marking the lanes when it is on. When I add auto-navigate, the two blue lines change to one line in the center. I drive in autopilot 95% of the time.

Other Details

When driving in autopilot, one must keep a hand on the steering wheel which the car senses by feeling the light resistance as it steers. One can take control back by turning the steering wheel or touching the brake. I set the car to not let the cabin get hot in the summer with automatic cooling, as necessary. The windshield wipers can be set to automatic, using the cameras to detect rain. The Leaf had good acceleration from

a stop and was scary when passing. The Model 3 goes from 0 to 60 in 4 seconds and has tons of power at all speeds. The entire roof is glass, much stronger than sheet steel and the car has the best collision ratings in all directions! Even the braking system is unique. When the car detects very cold or wet conditions it engages "automatic brake wiping" repeatedly applying an imperceptible pressure to clean the disks and pads. If it detects less performance from, for example, going down a very long steep hill it automatically compensates, increasing the pressure. And, of course, most of the braking is the regenerative braking charging the battery, which can be set to "low" for very slippery conditions. When I raise my foot on the accelerator, the brake lights come on (and so indicate in the "avatar" on my screen), as this is very powerful braking. Finally, my car is set to automatically apply the brakes, holding the car stops and automatically releasing them when time to move forward either manually or automatically.

Other Options

One can choose to auto-fold the mirrors, or not depending on location. One can choose to have the mirrors look down when reversing or not. When in reverse, the rear-view mirror automatically dims in proportion to the glare of headlights behind. One can set the headlights to automatically dim for oncoming traffic or not. One can adjust the angle of the headlights from inside the car. One can allow the wheels to spin at a limited speed with "Wheel Slip" in e.g., snow. One can choose to "navigate on autopilot," and the bright blue lines in the car display, will change to a single line. One can chant the "standard" lane change to "mild," or "Mad Max." One can set the steering modes to "comfort," "standard," or "sport." One can set the acceleration to "mild," "standard," or "ludicrous." One can backlight the buttons on the steering wheel. One can turn of fog lights, front, and rear.

Updates

Tesla updates the firmware/software every 30 to 60 days. I receive a notification that an update is available on my phone. I then choose the update time as the car is unavailable for about 25 minutes while it is in process. The car uses the house Wi-Fi for the update. A recent update allows viewing of the "sentry mode" and "dash cam" images in the car. Sentry mode turns on and records anybody near your car when it is parked, except when at home (a choice) as we have a garage. The dash cam records multiple cameras and (a choice) saves the most recent 10 minutes when the horn is honked. The most recent automatically stops at stop signs and stop lights, the latter requiring a downward push on the right stalk to continue through green lights. Cars send video and other data to Dojo, Tesla's training supercomputer running hyperspace arrays. I suggest that it is better to think of this as a "robot with four tires," than a "car."

Driving Home

Pressing the right-hand button on the steering wheel down makes the car listen and there are many commands, e.g., change the volume, temperature, navigate. I like the fact that the car is not listening all the time! So, I press and say, "Go home" and it plans the route. When I approach the turn-off to home, I take autopilot off and drive. I have a "HomeLink" that will automatically open the gate and garage at preset distances as it integrates with the car's GPS. (Tesla came to our home to install the HomeLink.) The ultrasonic sensor images guide me into the garage. I press the button that electrically opens my door and the car goes into "Park." As I enter the house, the car senses that I have left, and "honks," automatically locking itself!

"Easter Egg Tray"

This is a collection of "toys." One looks like a "whoopie cushion" and you can choose from a number of "fart sounds" and locate them under a selected seat or changing seats to "fire" randomly or with a turn signal. If you press the stalk four times the road turns into a rainbow accompanied by a "cowbell sound," a reference to the Saturday Night Live skit with Will Farrell. If we go to "Mars" we are on there with a special Model 3, and a high-resolution image of the surface. The "Romance Mode" turns on the heaters with the image and sound of a crackling fire with music. There is a sketchpad mode. "Trax" provides synthetic background music and a keyboard. There is also an arcade with games like chess with an electronic opponent. There is a Netflix, as well.

Summon!

If you want you can have your phone "summon" the car. Your phone will show the planned route, including curbs and the car will continue as long as you hold the button on the phone down. If it needs to back out of the parking space, or backing up for a better route, it will do so. You can also direct it to any point you select on the phone map. Using the HomeLink,, the car can automatically open the garage door and meet me at the front of the house if I want. I have only seen videos of this, and not tried it myself.

Parking

I have not used the parking feature, and here are things the car can do. It can self-park with you in the car or not, parallel park, or drive into a space forward or backward as you tell it, which is useful if the space is too tight to open the doors.

Expectations

Tesla hired the world's best people to custom-design a replacement computer optimized for autonomous driving with the Tesla sensor-set. It is 40 times faster than the previous version (with a completely different set of capabilities), and like all other important systems, e.g., steering, braking is fully redundant. And, rather than taking the (whole) trunk, it fits in the same bracket behind the glove box as the previous computer. Everyone who bought autonomous driving previously gets the new computer for free. The new computers are currently running the software designed for the old computer using an emulator. New software to use the advanced GPUs more fully (Graphical Processing Units) and neural network is being coded now. It is coming "soon," and promises a major leap in autonomous driving capability!

Chapter 46: Human Risk and Response

Fear and Action

When I was a young, recently graduated physicist, I subscribed to *Physics Today* and read most of the articles. I was impressed by an article that discussed the disconnect between human fear and actual risk. We are, simply put, irrational. I believe that this is because we carry beliefs in our brain's limbic system, an emotional brain. I think that this understanding helped me do some of the personally risky things described earlier in this document. My colleague Frank Martin once said, "Charlie, you are the most fearless person I have ever known." I said, "I don't know if that's true, and I think I can overpower fear in favor of doing the right thing."

Rational Fear

I think that it is useful to organize information into three categories: Facts, which require and are supported by evidence; Opinions which may or may not be based on facts; and Beliefs which are matters of faith generated by social interactions, i.e., our 'tribes.' You will know when you are challenging beliefs, as people likely express emotions, e.g., anger, when you do this. I believe that rational fear, fear arising from facts and logic can be very useful. For example, we used to take cruises. The penalties for not going at the scheduled time are high, going to 100% a month before, irrespective of reason. The tickets are not transferable. So, I take this fear and convert it into action by avoiding things that might injure me e.g., climbing on ladders. As singer Joan Baez said, "Action is the antidote to despair."

Fear and the Pandemic

The evolving pandemic, the unbelievably inept response of the Trump administration, the economic fallout, and the sloppy research are all matters of concern. I do not think a vaccine will solve much, particularly with respect to air travel. If it is like the flu vaccine it is somewhere between 20% to 65% effective depending on the year. And, with people like Trump and his ilk (falsely) claiming that vaccines cause autism, fully half of the country will likely refuse them! The understanding of how to treat this is also rapidly evolving as it seems more like an inflammatory blood disease than a respiratory disease. Our strategy is to take precautions not to become infected until there is a routine and hopefully simple treatment.

Anticipating a Pandemic

About 15 years ago, we were having breakfast in the Sydney Marriott and the newspaper headline said, "The Prime Minister's Committee on Risk to Australian Citizens has Completed." The finding was that the number one risk was a flu pandemic! It continued, "terrorism is number 10, so why are we spending so much money on

terrorism and so little on flu pandemics?" Why indeed? When we returned home, I prepared us to "hibernate" for three months or more. I installed a natural gas generator with back-up propane tanks. I placed 12-volt solar panels across the roof with a charge controller, deep-discharge batteries, and an inverter in the basement. Several large water storage tanks with 12-volt pumps provided water. And, more. In 2013, Boulder had a "thousand-year flood." The creek between us and the city raged, severing all utilities for 18 days. We were fine!

Our Fun Exercise Program

Life for Junko and I is not very different during the pandemic except that we are not travelling internationally. And that's a big difference! We live in a gated community of only seven homes with lots of pine trees. Our driveway is steep and curved and we walk up and down six times, twice per day. We start with a "bow" and the *Nihongo* (Japanese) word for zero, "rei." There is no "l" in the language, so the pronunciation is kind of a blend of "r" and "l." (Otherwise, the pronunciation of the language is straightforward.) When we turn at the bottom, we say, "Rei-ten-go," or "zero-point-five," which we jokingly pronounce as "let-them-go." At the top, we scratch ourselves and say "itchy," as the *Nihongo* for "one" is "ichi." At the bottom, we scratch and say "Itchy-ten-go" for "one-point-five." The pattern continues as we pat our knee for the word for two is "ni." We point at the sun and say, "sun," as "san" is three. Then, we yawn for the word for four, "yun," emphatically "go," for five, and "row, row, row your boat" for "roku" or "six." We have lots of fun with this!

Human Thinking Limitations

Humans have several thinking habits that limit our ability to understand our predicaments: First, we think linearly, most unable to grasp the exponential function, e.g., R_0 of the pandemic. Next, most are not "systems thinkers," ignoring the interplay between, for example, energy, economics, and the environment. This is a stark reality, generally unacknowledged in the current crisis. And people tend to ignore things that change gradually over long-time scales, e.g., climate change because things changed gradually in our evolutionary development. Also, we tend to unconsciously "deny" things we wish were not true.

We Are Wiped Out!

I invested nearly all our money in a local hedge fund, the "Safety Fund," because it looked like lower risk than the stock market with 50 managers using different strategies. The first years were good, and I was meeting frequently with the top management who repeatedly assured me that "my money was safe." My contact, Tim Barnett, at his peril, urged me to diversify into other assets and I gave notice for a major

withdrawal at the end of the next quarter, on September 30, 2008. On September 28, the bank that was making the overnight loans the company for leverage of about 2.5 called the loan in! Of course, the bank had the first call on the firm's assets. To our horror, we discovered that a significant amount of the investments were in Ponzi schemes like Maddow's! Junko and I were broke! When I told her, she said, "Charlie, I love you more than ever." I said, "Wow, why?" She responded, "Because you are so calm, and not contemplating anything like suicide." I have never worried much about money, having been broke twice before: My senior year in college, and during my divorce.

Learning From This

Fortunately, I was over time (and with the large NASA contract), able to make all the money back and more. I began to learn about macroeconomics mostly from watching YouTube videos. I saw a world with interest rates manipulated down by central banks to avoid recessions. This is unfortunate as recessions are a natural consequence of the "business cycle." I saw enormous increases in debt worldwide that are *impossible* to pay back with future taxes. The situation seems like two tectonic plates pushing on each other. Deflation, which is natural, driven by e.g., demographics (boomers retiring, millennials broke), automation and flat productivity. Inflation, which is artificial, driven primarily by central bank's ability to print unlimited "currency," which is not "money" as it is not a "store-of-value." If natural forces prevail, deflation will require default, leaving the creditors penniless. If the central banks prevail, they will inflate (hyperinflate?) the debt away. The "Macro" folks who made the most sense to me see the situation as "bubbles everywhere in search of a pin."

My Approach

It was obvious to me that if we were wiped out again, at my age recovery would not be possible. Precious metals, particularly gold looked like the way to go. Simply put, the dollar has lost about 98% of its value, depending on what you want to buy, since the creation of the US central bank, the "FED," in 1913. An ounce of gold buys the same number of hotdogs in Times Square today as it did a century ago. There are basically three (easy) ways to own physical gold (and silver): 1. Purchase physical gold from a reputable dealer (e.g., Miles Franklin) and store it in their vault, a vault of your choice, a vault at home (we don't do this), or a vault in a bank; 2. Use on-line services to buy and sell gold in their vaults (e.g., Hard Assets Alliance, Billion Vault); and 3. Buy shares like stocks of Sprott Physical Gold (and Silver) Trust. Do not buy Exchange Traded Funds ("ETFs") as these do not have enough physical backing when redemptions start.

Prognosis

I have read several books by prominent scientists on the many ways humans become extinct in the near term. The timing is near impossible until it is upon us. I find it difficult to see how humans are on the planet for more than five years. I will employ the

standard “risk management matrix” for project management. Items with high likelihood and grave consequences must be mitigated, if possible. Here are a few examples:

Climate Change

Likelihood is certain, consequence is loss of habitat, leading to extinction. “Habitat” means the natural environment that our bodies experience, sourcing our drinking water and food. We die within hours if temperatures exceed 36 degrees at 100% humidity. Significant departures from recent norms of rainfall, snowfall, temperature, or humidity will prevent “growing grains at scale,” the source of nearly all our food, and our drinking water. The carbon dioxide that humans have added to the atmosphere during the industrial revolution is stable for thousands of years. Slowing emissions does not reduce the heating, only the *rate of increase* of the heating. In fact, there is significant evidence that the dimming effect of industrial aerosols may reduce heating by as much as three degrees Centigrade. (We will find out this fall as scientists predict that the Covid-19 reductions will raise global temperatures from 2 degrees C to 3 degrees C!) The easiest “tell” is the Arctic. When it goes ice-free, we get an immediate 50% increase in heating and everything changes.

The Covid-19 Pandemic

Likelihood is certain, consequence is end of “normal” society, leading to possible revolution. I do not see how this virus ever goes away, with no means to deal with the asymptomatic spread. A vaccine, if possible, will most likely be marginally effective as the flu vaccine varies from 20% to about 60%, depending on the year. And a large segment of the population will refuse them. I do not think the virus will extinct humans. I worry more about the “knock-on” effects of a non-functioning US government, owned by wealthy oligarchs, and the massive loss of income and employment everywhere. The economic disaster was predicted by macro-guys like Jim Rickards. He saw the ever-increasing debt like a huge, building snowfield above the lodge. At some point, a final snowflake causes an avalanche, destroying everything. Thus, the economic collapse was unavoidable, and the pandemic was that snowflake (or maybe more aptly a snowball). Finally, a “memetic” virus promulgating misinformation compounds the threat.

Nuclear War

Likelihood is certain (sooner or later, unless we all disarm), consequence is likely immediate human extinction. We have a pugnacious US president with rising right-wing politics, and nuclear proliferation everywhere. This looks a lot like just before WW I, an unexpected war that people would never have started if they saw the consequences. An upstart nation, Germany was challenging the British empire. Today, China is challenging the American empire. The “Bulletin of Atomic Scientists” monitors the risk level and has moved the “doomsday clock” to the *riskiest* level ever, 100 seconds to midnight.

Other Risks

- The next killer-virus: (There will surely be another, and likely much worse, more like H1N1 in 1918.)
- A "bot" shutting the "grid" down: (Easy to do, and many people willing.)
- A virulent man-made virus: (Can make in a college chemistry laboratory)
- A virus attacking the internet: (Easy to do, and many people willing.)
- A revolution: Growing wealth inequality and Corona-virus economic impact. (300 million guns in the US)

A Better Pandemic Experience With Gratitude and Appreciation

Move into the mindset of gratitude by reflecting (writing?) what you are grateful for, e.g., being alive and living in a time with so much abundance. Bring more love into the world, as you never knew your "expiration date," anyway. As Warren Buffet said, "When you get to my age, you'll measure your success in life by how many of the people you want to love you actually do love you. The trouble with love is that you can't buy it...The more you give love, the more you get." How do you do this? Express appreciation for someone you are in "lockdown" with, either verbally, or more powerfully, with gestures, e.g., relieve them of a chore that they normally would do.

A Better Pandemic Experience With Contribution

Contribute your time or money, e.g., to food banks, in this difficult time to increase your serotonin, the neurotransmitter of happiness (in contrast to dopamine, the drug of pleasure).

A Better Pandemic Experience With Unfortunate Realities

Ray Dalio is the CEO of "Bridgewater," a hedge fund. He went broke in 1980, shorting the market. Today, he is worth \$18 Billion. He has now devoted himself to enhancing people's lives. His life principle #1 is to embrace reality and deal with it, especially the realities we wish weren't true. I completely agree, as I believe that addressing unfortunate realities is essential to creativity. Here are some that I hold:

- This is going to be a permanent aspect of life as a vaccine, if found, is unlikely to be 100% effective and it's near certain that not all (Americans) will take it;
- The central-banks-enabled debt load makes it far more difficult for economic recovery;
- 80% of American families are already living paycheck-to-paycheck;
- Junko and I love (international) travel and it is likely that we will never travel (for pleasure) again;
- The coming climate change catastrophe is not a "problem," but a predicament with no solution;
- This is a solvency problem, not a liquidity problem, which more debt cannot fix;
- As the current US government is callous and insensitive to ordinary peoples' needs, massive suffering is (near) inevitable; and
- Junko and I may have to financially support others.

Chapter 47: Electrical Energy Independence

Human Thought Processes

I was describing our plans to install solar panels as a mitigation against (extended) power outages to a colleague. She said, "Charlie, are power outages common where you are? They are rare here and I see little need to prepare." I am reminded of when Junko and I were "wiped out" in 2008, two days before a very large scheduled withdrawal from the "Safety" hedge fund. I talking with my friend, CU professor Ron Billingsley about this and he said, "Charlie, it doesn't matter, I guess that you have never heard of Chris Martenson?" I had not, went to his website, "Peak Prosperity," and viewed his full "crash course." (There are shorter versions since.) A basic message is that humans tend to ignore strategic trends believing that "today" is an accurate predictor for tomorrow. This is like barreling down a highway with eyes closed believing that the road will be straight forever. It won't. Moreover, people are far more influenced by their direct experience than ideas and concepts. The idea of exponential growth and consumption of everything (growing by any positive percent each year is exponential) on a finite planet is near universal and nonsensical!

How the Grid Can Go Away

Author Neil Howe wrote the "Fourth Turning" as a time of massive upheaval every 80 years or so and we are in the middle of such a generation now. The US government does not function, our infrastructure is aging, and a poorly-understood virus is ravaging the world. At this writing, there is rioting in the street protesting racial discrimination by the police. Reflect on the supply-chain for most electricity. It begins with energy-intensive resource extraction mostly coal or natural gas. Then transportation to generation plants via train, pipeline, or truck. Then operators must manage the generation and high-voltage transmission lines that take electricity to the power companies. They then provide electricity to retail users including meters and billing. This is (skilled) labor intensive at every step. A computer "bot," or more virulent virus (likely to come) could dramatically reduce capacity. The first step would be rolling outages, of increasing duration. Electricity, it seems to me is second only to water for household survival. Without it, households simply don't function. And it is the only resource that I can literally acquire perpetually.

"Preppers?"

"Preppers" is a term used for people who (excessively?) prepare to survive catastrophes. When you see me urging preparation, you might think that's what I am advocating. Not at all. I believe Guy McPherson's, "Nature Bats Last," assertion that climate change is not a problem, which implies there is a solution, but a predicament with no solution. As I have argued above, humans will surely be extinct in the fairly near future from loss of habitat as climate change crosses "tipping points." Rather, we are desiring to remain "comfortable" if possible. And that requires electricity. Conventional

solar power disconnects when the grid (power company) goes down and is therefore useless in this regard. I addressed this some years ago with 12-volt solar arrays, deep-discharge batteries, an inverter to produce 112-volts, 12-volt water pumps, and a whole-house natural gas generator. (Note: what follows next can only be done if you own a house. And you might find this interesting anyway.)

Tesla Energy

The 12-volt system was aging, and if we lose all utilities including natural gas as we did for 18 days during the 2013 flood the generator would at some point exhaust the propane tanks. Enamored with Tesla automobiles, I began to investigate the energy company now also owned by Elon Musk, with similar people on both boards. I learned that if one purchases batteries called Powerwalls, not only can one use the solar panels when the grid is down, the batteries can replace the grid at night. And, like the Tesla cars, all parts work together as an integrated system.

Tesla Solar Panels

The solar panels are made in partnership with *Panasonic* in Tesla's Gigafactory 2 located in Buffalo, NY. They have a black tint to make them more appealing to the eye. They are also very efficient at 21.8% efficiency. Ours are in two segments facing south-southeast. At the time of this writing, May 2020, the morning sun coming from the east-northeast illuminates them beginning about 7 AM. (Photo is smaller set on the garage in the late afternoon) We bought the "medium" size of 7.6 kw, producing an average of over 30 kWh per day. Boulder County required that the panels be spaced away from the roof edge with special fasteners because we have occasional high wind loads. The panels are combined with some serially connected and some in parallel to output about 500 volts. Each panel has an "optimizer" that takes it offline if output is low, e.g., shade or snow. The panels have a 25-year warranty.



Powerwalls

The "Powerwall-2" units that we also bought use the same batteries as our car, manufactured in Gigafactory-1, near Reno, NV. While they can be placed nearly anywhere including outdoors, ours are in our basement. While they can be hung on walls, that makes little sense to me. Moreover, wall mounting can only hold one Powerwall at a time. We bought three, the first anchored to the wall with the other two attached and all on the floor in a tight package. The inverter is fully integrated and the "round trip efficiency" is 92%. Each has a capacity of 14 kWh, giving us a total of 42 kWh. A green line lights up on the edge to show that a Powerwall



is on and operating. The warranty is unlimited cycles for 10 years. I have heard that the charger in our Model 3 is bi-directional and that a software update will make our car with 75 kWh an additional Powerwall. This would add an additional three days. Moreover, in an extreme case one could drive to a Tesla supercharger, fill it up, and use the full charge at home. In many places, e.g., large cities, the price for electricity varies according to the time of the day. (Ours does not.) In that case, you can have your Tesla buying electricity when it is cheap and selling it back when it costs more, silently making you money.

The System

There are five "control boxes" mounted on the north and west sides of the house. All the cables are in solid conduit. Solar energy flows into a master controller with an antenna that connects with our Wi-Fi. Another box manages each of the Powerwalls. Another assesses the quality and availability of the grid electricity, and immediately switches to the solar/Powerwalls if necessary. I manage everything with my cellphone using the same app as our Model 3, using a "swipe" to move between them. I can monitor our instantaneous energy use and manage the system from anywhere with internet access. I have the minimum energy for the Powerwalls set at 20%, although I doubt they will ever get that low in ordinary times. And, if a big storm is forecast, I will raise them to 100%. I heard that the system automatically does this if there are warnings from the National Weather Service. That will give us about 48 hours before we need the grid or backup generator. And, if we limit consumption to, for example, our three refrigerator/freezers and laptops we could easily stretch to 10 or so days. Here's how things work, When the sun comes up, the solar panels supply the house taking over from the Powerwalls. Then, with more solar energy, it charges the Powerwalls. When they are full, it automatically sells electricity back to our supplier who pays us "retail," at about 10 cents per kWh. There is also a "black box" plugged into our router that monitors our system and notifies Tesla if anything is amiss.



Some Energy Numbers

These, of course, vary by season, and here they are (approximately) for now:

- Daily solar electricity production, 35 kWh;
- Daily energy consumption, 24 kWh;
- Assume 60% of energy use at night, or 14 kWh;
- Battery depth of discharge (DOD) of 33%;
- Batteries are already good for 5,000+ cycles with deeper DOD (automobiles);
- We sell electricity back to utility, 10 kWh per day, for a profit of about \$30/month.

Financial Numbers

- System cost, up and running, Gross, \$35,500, Net after Fed tax credit, \$26,300

- Savings: \$100+ per month utility bill, all home power, plus car
- Payback time: ~15 years (not why I bought it)
- Value of continuous, reliable electricity in a collapsing empire & climate change (for us), infinite!

Chapter 48: "Piloting" a United 767-400

My Love of Aviation

Aviation has a large presence in my life. My father was a USAF military pilot. This is why I lived as a child in Germany during the Berlin Airlift and grew up on Okinawa after the Korean War ended. And I find airplanes fascinating and love to understand them reading books like "Flying the Big jets." I listen to air traffic control on United and visit with the flight deck crew on international flights where I am always warmly welcomed. The captain frequently offers me his seat for photo-ops. (Some of my friends believe that I am actually flying the plane!) My daughter, Jules, has a delightful new boyfriend, Jens Peter Weselmann ("JP") who does simulator training for United Airlines. He mused that he might be able to get me into a 767 simulator. I was psyched. His boss's first reaction was "We don't do visitors, period." Then (not sure how) he knew about me and *Hubble* and said, "We are excited to host Dr. Pellerin."



Start-up

We met at the United Training Center in Denver, which has 41 simulators, the largest number in the world. I took the captain's left seat and Jules the first officer's right seat while JP began starting-up the simulator just like the real airplane. He explained that the simulators cost as much as an airplane and were just as expensive to maintain. Our cockpit view was being parked at a gate at SFO with a human figure holding the crossed flashlights that stopped an airplane taxiing into the gate. I turned on the "APU" (auxiliary power unit in the tail of the plane) as I had done on real airplanes when a flight crew offered me the opportunity. We used the printer at the end of the console to print out the relevant data. JP read them out and instructed Jules to load them into the "FMC" (Flight Management Computer). "V1," the go no-go speed, the speed at which we commit to takeoff no matter what at 143 knots. "Vr," the quickly following speed at which one pulls the yoke backward, lifting the plane off the runway at 148 knots. "V2," the lowest speed that a plane can safely climb on one engine (I did not pay attention). Then, JP set the air temperature at 54 degrees centigrade, an artificial way to downgrade the engine during auto-throttle takeoff, minimizing stress on the engines.



Push-back

When it became time for "push-back," I released the parking brake by firmly depressing the brakes on the top of the rudder pedals. (Took a moment to understand that the secret was to press hard.) We heard the roar of the tug and the plane lurched backwards. (Everything was so real that I found myself drifting into believing we were in a real airplane, over and over!) JP explained that there was a pin in place that prevented me from controlling the steering that one should make sure was removed when the tug left. Jules then started the engines by turning a switch that sent compressed air from the APU into an engine, then opening the fuel feeds when each fan's speed ("N1") hit 20% starting the engine. We then had to moderate the thrust for the sake of people and airplanes behind us.



Taxing to the Runway

JP and Jules swapped places and he mimicked ground control directing me to taxi to runway "1-right." The plane fairly quickly picked up speed to about 20 knots as indicated on my "flight director" display with the engines idling. I struggled with the "tiller" to smoothly move along the correct orange line not doing too well. (The rudder pedals only provide small steering, e.g., for takeoff and landing.) He said that I should align my right knee with the orange line to have the plane properly lined up. Anybody in the back of my plane would likely be sick by now with my erratic steering. PJ told me that, for the sake of the tires, I should slow to 10 knots for tight turns, so I applied braking and slowed. Then I lined up on the runway 1-right for take-off. JP set the flaps for 20 degrees and we were ready.



Take-off!

I advanced the two throttles all the way forward, which JP had set for "auto-throttling." The engines roared; we were pushed back into our seats. and there was a sense of high speed with the runway rumbling, the engines roaring, and wind noise increasing. PJ called "100 knots." I focused on the rudder pedals to keep the airplane straight, ignoring the fact that I was a bit "off-center." He then called V1 and I removed my right hand from the throttles (after a reminder) and with both hands gently pulled back on the yoke. The plane rose and I had not scraped the tail, so I pulled back a bit more to enter a climb. My job now was to keep the airplane level keeping a magenta line in the flight director



aligned with two black lines. I wandered around a bit and JP assisted, as necessary. He suggest that I turn left toward San Francisco with a 30-degree bank. (This is twice the bank of a "standard rate" turn.) I did so, and then had an "excess bank" warning. I soon understood the indicator in the flight director and could manage this. Then, JP noted that I was losing altitude and had to compensate by bringing the nose up. Of course, I knew that this would happen – and things happened with this huge airplane much more rapidly than a Cessna "172," the only powered airplane that I had ever flown before. Then, I turned right and got some "terrain" warnings as there were hills ahead. JP took over and engaged the autopilot to head toward a waypoint that set up our first landing.



Landings

We did a "Cat 3" automatic landing (with three autopilots on) so I could get the feel of the controls. I was surprised at how active the responses were both in the rudder and yoke. JP then reset us immediately back in flight preparing for to runway 28 right heading, 6 miles out and I followed the ILS "localizer" to the runway threshold. JP managed the flaps and put the gear down, announcing "stable" at 500 feet as required. This means that checklists have been completed, the aircraft is in the planned landing configuration (gear down and full flaps), and on the guide path with the right power and speed. I drove in fairly smoothly and began my flare when I heard the "50 foot" callout. I touched down nicely, first with the main gear then the nosewheel. I then engaged the thrust reversers and used the rudder pedals to keep us straight on the runway. As the autobrakes slowed us, I turned the thrust reversers off, and we soon rolled to a stop. He pointed out that the "PAPI" (Precision Approach Path Indicator) lights had three "reds" and one "white." (I felt pretty good about this.) I had been totally focused on the ILS indicator in the flight director. JP reset us flying over San Francisco Bay, turned off some safety systems, and hand-flew



just above the water, then (unbelievably) flew us under the Golden Gate bridge! I then made another landing but overcompensated introducing “pilot induced oscillation.” JP helped me stabilize and I landed us again!

Jules Becomes Captain

Jules and I switched places and she did a “JP-supported” landing. Then we did a “Cat 3” landing in zero-zero fog conditions! It was amazing as we could see nothing until just before we felt the wheels hit the runway. JP confirmed that he had made many actual landings in such conditions. Jules then drove us to a gate, not the originally planned one, as she missed a turn, and it did not matter.



Summary

This was unlike anything I have ever experienced. This did not feel like a simulator. Incredible as it may seem, my mind went to this being reality, and I treated it accordingly. I occasionally realized this and reset. JP was wonderful, constantly encouraging and appreciating. I am most grateful for him and his management for this extraordinary opportunity. It was the dream of a lifetime come true.

Chapter 49: Some Things to Ponder

Japan's Edo Period

Japan had independent warring states much later than China. The Tokugawa Shogunate defined modern Japanese history by centralizing the power of the nation's government and uniting its people in 1603. This "Edo" period of isolation, samurai, kimonos geisha are nostalgically romanticized in modern Japan. It abruptly ended when US Admiral Perry entered Tokyo bay in 1853 with two steamers and two sailing vessels. The Japanese (peacefully) ended the shogunate and restored the emperor with the "Meiji restoration." The nation then modernized at an incredible rate culminating with the unexpected victory over the Russian fleet in 1905. This imbued an unfortunate sense of invincibility, leading to the later occupation of, for example, Manchuria and the Philippines.

Getting the US To Go War

US President Roosevelt wanted the US to enter WW-II, but the US public wanted no parts of another European war. German U-boats were freely sinking commercial ships off the east coast with little press attention. Roosevelt knew that if he blockaded Japan they would have to attack as they had no oil and needed it for their army. As expected, Japan attacked, but not at the Philippines, rather Hawaii. Roosevelt pronounced the "sneak attack" as unexpected, mobilizing the public to war. At the time, the agrarian country had a small army and limited industrial infrastructure. President Bill Clinton described using an "outhouse" (outdoor toilet) when he was a child. I know people whose parents did not use currency; trading produce for goods in "general stores." Depression-era citizens had considerable savings and capitalized industrialization by purchasing "war bonds."

World War-II

WW-II was a relatively positive experience for Americans. Our homeland was never bombed and with the exception of the sinking of cargo ships unscathed. Casualties in Europe were relatively small with the worst being the "battle of the bulge." Victories in Europe and the South China sea were romanticized. The industrial capacity far exceeded the entire rest of the world which had been bombed to smithereens. Advertising was encouraged by the government to stimulate consumption which has continued to this day. The "military-industrial" complex donations and lobbyists gripped the Congress, particularly in the southern states. Thus, we spend ever more on military (and corporations) with less and less for the needs of the common people. These oligarchs control the country.

Japan Had No Choice

The Japanese understood that they would not win a war with the US, particularly admiral Yamamoto, educated in the US, and leader of the attack on Pearl Harbor. Faced with an embargo and only 18 months of oil, they saw no alternative except to attack and hope that the US would leave the region. Indeed, it might have worked if the US aircraft carriers had been in port at the time of the attack. This is because, as a practical matter, the war ended at Midway Inland when the US carriers sunk the Japanese carriers which they had no means to replace. It is widely believed that the two atomic bombs caused the Japanese to surrender. Most westerners fail to understand the Japanese code of honor, "bushido." It is more honorable to die than to surrender. They surrendered because the Soviet ground forces were rapidly advancing through Manchuria and they saw what happened when Germany surrounded four months earlier. They preferred to take their chances with US governance.

"Good" and "Bad" Debt

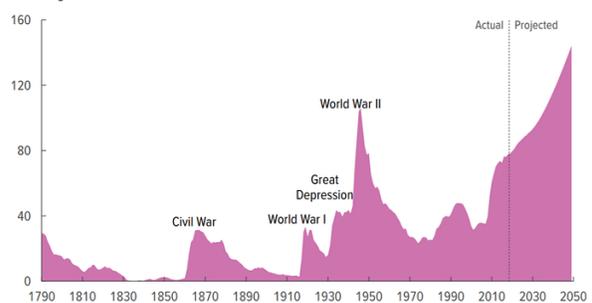
Debt is an interesting macro-indicator of the health of a society. In a healthy economy interest rates are set by markets, e.g., 6% and businesses borrow money when it will return more than the cost of the loan with increased productivity. Because of excess spending on the Vietnam War and "Great Society, the dollar, tied to the price of gold was depreciating relative to other currencies. Other countries, e.g., France were buying the now inexpensive US gold. To stop this, and continue deficit spending, Nixon took the dollar off the gold standard. This removed all constraints and today the "on-the-books" deficit (Treasury bills) is about \$20 Trillion and an "off-the-books" debt (Social Security and other entitlements) of about \$100 Trillion. This is against an annual income stream of about \$3 Trillion. It is obvious that this debt cannot be paid with future taxes leaving only two alternatives as discussed earlier: 1) Inflate it away which is currently impossible; and 2) default.

Wars and Debt

Wars require funds and debts necessarily run high. With the exception of the WW-II industrialization, war spending does little to increase productivity. Business executives in the Military-Industrial complex make a lot of money in wars. The US has been in a near-continuous war since WW-II. The Vietnam war, the Korean war, the war on drugs, the Iraq war, the Afghanistan war. Why? As the bible says, "The love of money is the root of all evil."

Federal Debt Held by the Public Since 1790

Percentage of Gross Domestic Product



The Coronavirus

I am surprised at how poorly we understood this disease. Nonetheless, I tell you what I think about this. The COVID-19 virus is:

- Like all viruses is not "alive," in that it cannot self-reproduce, requiring a "host;"
- Most troubling, has a long period, up to 25 days when people are asymptomatic with high viral loads and contagious;
- Looks more like a "blood" disease than a respiratory disease;
- Affects all ages, and worse for elderly and people with comorbidity;
- Do not know if people who get it have antibody immunity and are immune in the future and for how long (my guess is less than about a year);
- Enters through "ACE-2" receptor which are in nearly part of the body;
- Also, like HIV, it can enter cells through "T" receptors;
- Vaccines require time as one must wait for effects to play out with multiple doses, then large-scale manufacturing, and distribution etc. (I do not think that we will have anything useful for a long time);
- Vaccines are only useful if they have a long duration, (nearly) everyone chooses to use them, and they remain effective against mutations (None of this seems likely to me);
- People who recover from deep sickness are permanently damaged with needs a long-term medical (And financial) support;
- The US has no strategy (e.g., herd immunity), more like a sailboat pointed into the wind weakly taking side to side;
- Different states are handling it differently and interstate travel/commerce continues; and
- I do not think, by itself, extincts the humans from the planet (although combined with climate change and economic impact, who knows?).

The Economy

- This is unique in that it is much more damaging for small to medium businesses than large ones with about 50% closed (largest employer);
- These smaller businesses have much smaller cash reserves or ability to borrow;
- Many of these cannot survive with the social-distancing requirements;
- 80% of Americans live paycheck to paycheck with rent delays and financial support expiring;
- This is a solvency, not a liquidity, problem;
- This is a demand problem, aggravated by people living at home and less going out for services (restaurants);

- People working from home hits commercial real estate and all the nearby concessions;
- I think that the only thing that can help is a (means-tested) guaranteed minimal income, which is highly unlikely at this time;
- The demographics of the coming "baby bust," is the worst in 500 years as over the next 10 years every developed country's adult working population will fall from 8% to 12% creating a demand shock that the system cannot tolerate (very deflationary); so
- This is not a short-term event, more like 1929-1933 all over again, with three huge macro problems: The corporate debt bubble; the pension crisis with all the baby boomers which governments cannot pay; the demographics, and now the virus!

The US Stock Market?

With the economy collapsing, consumer spending which is 70% of the US economy in freefall, and riots in the streets, the stock market is unphased. What is happening? No one seems to know for sure. Value trading, e.g., price to earnings ratio does not correlate with price as companies losing money are moving up. The other widely-used methodology, "technical analysis," does not work either. The "experts" have differing views on what's happening. Some believe that this is a "bull trap," an ill-conceived burst of optimism that historically precedes a colossal drop. Others believe that it is the "wealth effect," powered by the conviction that the FED will prop up the market. Others believe that 5 large companies (Amazon, Apple, ...) dominate the popular indices and that the smaller collapsing companies are rotating out per the rules. Others believe that the market is driven by huge funds with algos doing the trading. The only thing that everyone seems to agree on is that no one is sure what's next and the safest place to be is in gold.

Thoughts on Racism in the US

My first thought is that the term is technically nonsensical. We are all the same species of the genus, *Homo*, specifically, *Homo Sapiens*, "wise ape," and hence the same race. We are the only remaining species of *Homo* as our near predecessors, *Homo Erectus* and *Homo Neanderthals* are extinct, and I think that we are soon to follow.

Slavery is condoned in parts of the Bible and was legal in the in the Roman Empire with perhaps 40% of the population (I have seen estimates as high as 90%) enslaved. It was not, however, based on race as slaves came from many places. European countries gave large "land grants" in America for the purpose of establishing settlements, missions and farms beginning in the 16th century. These large tracts in the hot and humid southern states were perfect for farming cash crops much desired in Europe. Winds and currents were favorable for the "triangle slave trade." The first leg was Europe to West Africa trading supplies like guns, copper, cloth, and trinkets for

slaves. In horrible conditions, the slaves were taken to the New World. The ships were cleaned then loaded with goods like molasses, rum, and tobacco. Thus, the southern economy, which was much larger than the North, was totally dependent on slavery. Greed was at the core of the Civil War, which continues to this day!

Why are White People White?

Did you ever wonder why we are white? Early humans first migrated out of Africa into Asia probably between 2 million and 1.8 million years ago. They entered Europe somewhat later, between 1.5 million and 1 million years. Species of modern humans populated many parts of the world much later. For instance, people first came to Australia probably within the past 60,000 years and to the Americas within the past 30,000 years or so. The beginnings of agriculture and the rise of the first civilizations occurred within the past 12,000 years. We know that early humans walked upright, had fire, and did not wear clothing. Thus, the dark skin protected them from the African sun. Vitamin D-3 which is essential for human health is manufactured by sunlight interacting with our skin. With much less sunlight in Europe, skin evolved to become "white" to gain sufficient D-3. Thus, our white skin is an evolutionary departure from our early ancestors.

Modern Racism?

The conventional wisdom is that "civilization" began about 10,000 years ago following a comet impacting the earth during the last ice age creating a great flood. There is, however, interesting evidence that an earlier advanced civilization preceded the flood. For nearly all of existence, we were hunter-gatherers in tribes of about 50 people. Material wealth was not very important as we were constantly moving, and we personally knew each other and our leaders. Cities led to houses and desire for wealth, particularly more than others. So, hierarchy and modern caste systems came into play with some necessarily on the bottom doing the work nobody wanted to do. How to pick the people? Choose people who are different and disadvantaged. Then use your money and influence to keep them disadvantaged. Europeans saw Native Americans as sub-human. We have seen this for immigrant groups, although we are all immigrants. Japanese-Americans were forced into internment camps. And this recent death by the police is not an incident, rather an ongoing disgusting, unacceptable situation. I do not recall any racism in my family, perhaps because my father was a military officer. Moreover, my professional success as a physicist/manager/teambuilder never benefited from exploiting anyone, particularly because of race!

4-D Providers: What To Do When Social Distancing?

I wrote this for the head of procurement of a large aerospace company who wanted to include a 4-D workshop (2-days) as part of a training event for their "capture managers."

Individual and Team Performance Enhancement (During a Pandemic)

Assumptions:

1. There is a desire to employ "4-D Systems" to enhance effectiveness;

2. The participants, although not an intact team, have shared interests and goals;
3. The participants and Lead Presenter ("LP") are geographically distributed, and (air) travel is problematic; and
4. Client wants to institutionalize "4-D" with in-house process managers, trainers, and coaches.

Phase 1: About 6 weeks before the workshop:

Objective: Familiarize the participants with the core ideas, initiate the behavioral improvement process, benchmark current behaviors, and provide a reference point to measure future progress.

1. Provide each participant a copy of *"How NASA Builds Teams;"*
2. Share 4-D Intellectual Property, e.g., Workshop slides, video clips, 4-D Workshop Textbook (slides narration);
3. Offer each participant the opportunity for an Individual Development Accelerator ("IDA");
4. To set this up, each participant will provide "4-D" a list of about 10 people's e-mails to initiate the process, including people who know them well enough to evaluate their behaviors (colleagues at present and prior jobs, family, spouses, and themselves so they understand the process);
5. IDA reports will only be provided to a designated and trained "Internal Coach," who will only share contents with the participant, briefing them, and providing them a copy; thus
6. Making IDA reports rigorously confidential unless the participant chooses to share them. (We recommend discussing the report with spouses.)

Phase 2: The Workshop

Objective: Enhance learning with experiential exercises, process a "Situation" with the Context Shifting Worksheet ("CSW"), and learn the CSW process.

1. Before the workshop, the "event sponsor" will solicit candidate "Situations" to process during the workshop and bring a broadly supported one to the event;
2. The Lead Presenter ("LP") will present the workshop slides, optimized to the needs of the participants;
3. As in "regular" workshops, questions from the participants will only be addressed by the LP during breaks;
4. The LP and questioner will jointly decide whether to brief the question and answer to the group when the workshop resumes;
5. Participants will gather in local settings observing "social distancing;" Some companies are limiting meeting sizes to four people in a room. Perfect!.

6. Each setting will have a designated Teaching Assistant ("TA") to ensure organization and compliance with the workshop agreements;
7. If three or more people are present, the TA will organize them into 4-person standing "huddles" if possible, with some 3-person or 5-person huddles if necessary;
8. If less than three people are present, we will use Zoom to form "electronic huddles," before the workshop;
9. The TAs (or individuals) will notice when all have completed the exercise then ask everyone to return to their seat; and
10. There will group exercises that will be processed on flip-charts in the main camera view or typed onto PowerPoint slides.

Phase 3: Post Workshop

Objective: Reinforce the learning and sustain the behavioral improvement.

1. Run Team and Individual Development Assessments/Accelerators every 3 to 6 months;
 2. If you train an operator, you can do these yourself with a "4-D dashboard;"
 3. The downside is that this person can see all the data.
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Intelligent Life in the Universe?

I am reminded of Carl Sagan's response about UFOs, "I find it easier to believe in the irrationality of humans than the rationality of extraterrestrials." Alternately, the question is not whether there is intelligent life in the Universe, but whether there is intelligent life on Earth? The numbers are staggering: 2 trillion galaxies, each with 100 billion stars and nearly 14 billion years to evolve. Yet, there is no evidence that extraterrestrials have communicated with Earth, much less visited. Enrico Fermi raised this question at a lunch many years ago, and it became known as "Fermi's Paradox." The most famous attempt to mathematically address this is the "Drake Equation," from Frank Drake. It multiplies all the relevant astrophysical probabilities, which are not difficult to estimate, and a final factor, "How long does an advanced civilization last?" This starts from the date that they can build a large radio telescope and communicate and is the least accurate parameter because nobody knows how long ours will last! Thoughtful people debate this, and opinions vary considerably. Here's mine.

It's the Tribalism, Stupid

My friend going back to CU days, and now next neighbor, Kathy Kelly, invited me to one of her workshops, "Creating Powerful Relationships ("CPR") in the Workplace." She presented a module, "Our greatest weaknesses are overdone strengths." Human "tribalism" is surely our greatest strength, enabling us to dominate (and ruin) the planet.

And surely overdone, it is also our greatest weakness, polarizing our politics and society. I suggest that it is natural for tribes to compete for status, resources, and territory often moving to war. Yet, there is no way to design and construct complex machines, e.g., automobiles, trains, airplanes without tribes (teams). No unassociated people could develop these machines no matter how many people. And, as "consumer" technology advances, weapons technology advances also. I suspect that since all advanced technological societies are necessarily tribal, self-extinction may be inevitable!

Collapse of Civilizations

An American anthropologist, Joseph Tainter examined the collapse of civilizations in *The Collapse of Complex Societies* (1988). This phenomenon also interests me, as it is common on a typical timescale of perhaps 35 years. I have visited lots of these, as two are near here (Chaco Canyon and Mesa Verde) and we travel frequently (Or used to). Tainter noted that, on average, we have only the energy we get from the sun. In other words, in a given day, unless we access some stored energy, we only have the energy we can extract in a day. Moreover, when we access stored energy because we are tactical rather than strategic, we use the excess energy to increase complexity and overpopulate. Then, the stored energy is exhausted and civilization, reverting to daily energy, collapses. The Western Roman Empire used it's army to enslave, and take food, gold, and structures from others. The spent the increased wealth to dramatically increase complexity, particularly of their political system. When there was nothing new to take, they collapsed. Similarly, today we are using the stored energy of fossil fuels to increase complexity everywhere. How much more complex is a jet airplane than a stagecoach? Legislation that our Congress passes is thousands of pages when it used to be only a few. What will happen when these fuels run out? Since this is so common with humans throughout the ages, is it possible that other life forms have the same difficulty? Is this why we have had no known visitors?

Chapter 50: Special Birthday in Berlin

Best Birthday Ever!

Gerald Huesch (Berlin) and I spent a lot of time together doing workshops for JPL in Pasadena and in Boulder. One day, I mentioned that my 75th birthday was coming at the end of the year, on December 11, 2019. Gerald suggested that I celebrate in Berlin with a "Summit," including a 4-D workshop. I loved the idea and we made plans.

Chinese Who Came To Honor Me!

Many of the people closest to me came to Berlin, especially from China. Cindy Yang, the proofreader for my book, was the first that confirmed coming to Berlin from China and I invited her to co-lead a part and share her 4-D success application in the workshop with participants from all over the world. Attendants had quite some questions on how to start 4-D workshop, etc., and she answered authentically and gave many practical ways. Michael had met me at my meeting in Beijing with my publisher nearly a decade ago. Michael delighted me with photographs of him providing 4-D workshops in China! He had downloaded the workshop slides and related materials from my website. (I made all our IP free to all in 2008.) His wife Fenny, who quit her job and joined in 4-D several years later after him, also came to Berlin. A bit later, I met Sharon Gu and her colleague, Jian Lin. (And her assistant, Bin Hu.) I traveled to China every year since the meeting, twice a year, for about a month at a time, doing delightful 4-D workshops for these folks. Also, Sharon (eight times) and Cindy (three times) came to Pasadena for my JPL workshops!

Other Wonderful People Came

Jonathan who I only met on Zoom, and Brett who I had never met came to Berlin from Toronto! Fahri, who lives in Frankfurt, could not come so he sent an ambassador to meet me.

Weihnachtsgans

Junko and I are very fond of a German Christmas dinner with roasted goose, red cabbage, and a dumpling. I wanted something special for my colleagues who travelled so far, so I asked Gerald to arrange this dinner at a restaurant and he did. Then Michael contacted me reporting that his visa was more limited than he expected and he and Fenny would arrive after the scheduled dinner. So, I asked Gerald to reschedule the Birthday dinner later until December 12 so they could attend. Interesting, given the time change, a significant amount of time was still December 11 back in the US.

Thank You Gerald and Lavie

Gerald tried and because the German companies have Christmas parties, no restaurants were available. So, he contacted "KaDeWe," a top luxury department store and hired one of their chefs to come to their apartment and cook the meal. He then rented tables and chairs so everyone who came to the workshop could attend the dinner! Thank you!

A Surprise Wedding

I asked Gerald how long he and lovely Lavie had been married, as they had a three-year-old daughter. He said, "We are not married." I asked, "Doesn't anybody in Germany care?" He said, "No, nobody cares." (Don't you love Europe!) I asked, "Are you committed partners for life?" (As that appeared to be the case.) He said, "Yes, of course." He continued, "I have an engagement ring and have been waiting for a special occasion." I said, "I am an ordained Minister in the *Church of Universal Life* and can marry you." He said, "Fantastic." So, once the party was underway, he asked Lavie, Junko and I to move to a small room. He spontaneously faced Lavie, went down on one knee, held the ring in front of her and proposed. She immediately accepted and I married them!

Chapter 51: The "Calwood" Wildfire

When Junko and I fell in love and bought our home in early 2002 on Foothills Ranch Drive, fire was not a concern. In fact, our roof and several others were "cedar shakes," wooden shingles that would burn like crazy in this hot, dry climate. We then had several years of severe drought and I led the community in replacing these with fire resistant "composite" shingles. We invited the local, "Lefthand," firefighters to advise us on how to lower our risk. They recommended cutting the lower branches of our trees so grass fires would ignite them. The neighborhood worked together and rented a woodchipper and dumpster for the chips. I soon figured out that this was nonsense as the chips were no problem just lying on the ground as they simply disappeared.

Then, a bit more than 10 years ago, my friend Hank Feinberg, and I were on our way to Rocky Mountain National Park to see where he frequently saw bears. An attractive young lady flagged us down while we were still in the neighborhood, and said, "Can you tell me where we are?" We told her that she was on "Foothills Ranch Drive," and asked why. She said, "Because the hill is on fire and I want to call it in." We watched it for a minute or so, fascinated. I then asked Hank to take me home so I could get Junko. We watched the fire from the "Martini Deck," off our bedroom as the fire moved up the hill, exploding Ponderosa Pines as it moved slowly up.

By now, the crew from Lefthand had arrived and shouted at us to evacuate. We got in our BMW 740 and went down the drive. The firemen stopped us and said, "We are going to place a pumper truck filled with foam in your driveway next to the house. If the fire comes close, we will protect your house but do not care if the hill burns." The wind blew mildly uphill and tanker planes came and dropped retardant. After we gave statements to the police, our neighbors went to a shelter and I booked us into the Boulder Marriott. Junko and I had a pleasant visit to the Executive Lounge, followed by a nice dinner from room service. The next morning, we returned home. The hill had indeed burned and there was little visible damage to even the trees from our house.

As the years went on, we became ever more proactive in preventing fire damage to our homes, culminating in a rare "Firewise Community" rating from Lefthand. This even included "birds-eye" maps for each of our houses delineating the area we each had to cut the grass low for protection, sometimes extending onto a neighbor's property. We all complied with this. Moreover, we all contributed to the construction of a large "firebreak," on the hill behind our houses, with additional funding from a grant, constructed by the Lefthand fire-persons.

The "Calwood" Fire

Then, on Saturday, October 17, at 2:30 PM, we received a "reverse 911 call," and simultaneous e-mail to evacuate immediately. I noticed that a strong wind, perhaps 30 to 40 knots, was blowing black smoke downhill through our yard. I sensed that our safety might be jeopardized and said to Junko, "Let's just go and quickly." I went looking

for a laptop, as they were still packed from our last trip to China, found one, and we left.”

We checked into the same Marriott as before and, of course, the Executive Lounge and the restaurant were both closed. The top (4th floor) room faced north, and I could see an enormous cloud billowing into the sky. I watched the immense, but narrow, fire move down the hill and realized that it was in the general direction of our neighborhood. And did not imagine that our house was in any likely danger as our neighborhood had Firewise status. Then, I noticed that our Tesla solar/battery system went dead at 4 PM! This was a bad sign as the system would continue to function in a power outage. Then, a neighbor sent a night photo that showed the outline of our house with flames coming out the top. Our house was gone!

Anatomy of the Fire

Absent strong winds, wildfires generally move up hills. As they burn, the heat causes a local updraft that prevents the fire from moving down. We get “Chinook” (Native American for snow-eater) down-winds that can blow 60 to 70 mph. We believed that these are so strong that they would blow fires out. The biggest risk in this part of the country is drought, as our drinking water comes from snowpack in the mountains. This year we received 100% of normal, then lost 50% due to the hot, dry late summer. Indeed, there had been no precipitation for 30 days before the fire. Apparently, something (never heard what) ignited a fire high in the foothills near Jamestown, a small mountain town.

The combination of dry trees and brush, and a 30 to 40 knot “downslope” wind created a fire 🔥 unlike any seen before. It moved so quickly and was so intense that the firefighters were unable to do anything. A night image showed hundreds of small fires in the woods. The fire blew a sea of cinders ahead, so nothing we had done locally had any effect! Although the fire travelled more than 10 or 15 miles down the mountain, it was extremely narrow due to the high winds, perhaps less than a half-mile across. This led to very selective damage.

Only 26 houses were destroyed in an area that contained hundreds. The highest houses were destroyed and the lower houses spared. I think that this was because the danger was a wall of airborne cinders. They hit the higher houses on the decks, siding, and perhaps the attic vents. (I had fine screening installed on our attic vents.) The lower houses took the brunt on the fire-resistant roofs.

Our neighborhood had seven houses. The three highest, including ours, burned to the ground. Three others, including our next-door neighbor, were unscathed. The only house on the south side of our entrance road was badly damaged.

I do not believe that this was a “freak,” incident, rather a harbinger of what’s to come with unrelenting climate change. The greenhouse gases we have placed in the atmosphere are unfortunately stable on any timescales that matter. No matter what we do, the heating will continue as surely as excess blankets on a person in bed will make

them hotter and hotter. Moreover, as we cross 'tipping points,' more and more self-reinforcing feedback loops are triggered causing exponential changes. This means more frequent and more intense floods, fires, storms and sea-level in our near future.

For example, we had a so-called "thousand-year" flood in 2013. We built deep trenches that would prevent damage to our house should this recur. In other words, local measures can be effective against such risk. Similarly, we took all possible local mitigations against fire. These were effective against "normal" fires, but useless against the extreme fires of increasing global heating!

Thus, we are the "lucky ones," I think. Our insurance company will likely give us more than one million dollars, cash. This is more than enough to purchase a smaller, more manageable house in an area more resilient to climate-change risk. Our insurance premiums were about \$1,000 per year. That means that about one-thousand homes had to be loss-free just to cover our loss. Why would insurance companies write coverage in areas where the fire risk is likely high and increasing? What will be the value of the remaining homes in a neighborhood with visible fire damage and expensive or unavailable insurance? None of the three of us who lost our homes are intending to rebuild. Thus, there will be three long, steep "driveways to nowhere," until someone buys our lots and builds replacement houses on them.

So, one of the few unilateral choices one has is one's attitude or mindset. We choose to focus on what we are grateful for and the "unfortunate realities" of the situation. We are *grateful* that we have:

- Our health;
- Each other in a loving and mutually supportive relationship;
- The emotional and financial resources to deal with this; and
- Free of the burden of too much "stuff," we can live anywhere that we choose.

Our unfortunate realities:

- The fire was a harbinger of what coming in the future;
- Home insurance would likely become ever more problematic;
- The house was an increasing maintenance burden, exacerbated by COVID;
- The steep driveway was problematic in the winter;
- Our "mountain" of accumulated "stuff" had become, on balance, a burden; and
- We may need to leave the US and move to Japan if the political/health situation continues to deteriorate.

Challenges ahead:

Our current rental house is spacious and modern. Our landlord is wonderful and we are looking for a more suitable replacement. However, our neighborhood is surprisingly full of Trump supporters. Moreover, many have huge, noisy pick-up trucks and we are close to a noisy street. Finally, we have more ties to Boulder than we thought. So, with our three-month lease expiring on Jan 31, we are actively

looking. Most of the homes in Boulder are either old or small, and on really tiny lots. We have been investigating where we most frequently go and the answer is the COSTCO in Superior, CO. The town of Louisville, just on the other side of Rt. 36 looks promising and we are focusing our efforts there for now.

Update: We now have a one-year lease on a wonderful house on a cul-de-sac on a dead-end street. It is on the fringe of the city of Lafayette, in the direction of Boulder. Indeed, the central and modern Boulder hospital is only 10 minutes away, and the rest of Boulder easily accessible. We are excited!



Demolition: We are required to clean up the residue of the fire as it is likely toxic. Moreover, as the heat was sufficient to melt aluminum and warp the steel beam, it is likely that the concrete and re-bar foundation is unsafe to rebuild on. We were fortunate to have a company, "Solid Landscaping and Construction LLC/Denver Demolition" owned by (female) Jess Logue who will remove everything. She found out that the regulations were less restrictive if the material was wet. I turned the water back on and she installed a "freeze-proof" faucet in the front yard. (This also provides water for watering plants in the spring.) This is a huge job involving repeatedly maneuvering heavy equipment up and down our steep mountain driveway! She is doing a great job for us! We are hoping to place the lot on the market in the spring and that a builder will buy it.



Chapter 52: Cryptocurrencies

Financial Transactions in the Internet Age

In 2008 a whitepaper was published under the name Satoshi Nakamoto for a system designed to transfer value (money) between individuals without intermediaries like banks or credit card companies and called it "Bitcoin." People who deeply understand this and its implementation name this *"the most important technological event in human history."* In summary, anyone with a cell phone can operate as a private bank anywhere in the world with an internet connection. They can purchase goods and transfer funds nearly instantaneously.

One is tempted to lapse describing into the exquisite technical underpinnings of Bitcoin (which is not actually a coin in any sense) with terms like "blockchain," "mining," "proof of work," and "private/public keys." This would be like explaining how an electric or internal combustion engine works when most just want to know what it's like to drive the car. While I will explain these at the end of this chapter, let's jump to the user experience.

Begin by downloading an app for an "exchange" onto your computer and/or cellphone. I use two, "Coinbase" and "Gemini," both based in the US. With the possible exception of China, these exist in every country in the world. To inhibit illegal use, they require proof of identity with a driver's license or passport, particularly as I chose to fund these with transfers from our checking account. I can do smaller amounts with an "ACH" transfer and larger amounts with telephone "wires" that usually "post" within an hour or so, making the funds available as US dollars.

I can then use my phone or computer to buy one of a multitude of "cryptocurrencies" into my account. I am only buying Bitcoin and a smaller amount of Ethereum. From this point of, I'll focus on Bitcoin as it is our core holding. The key to use is our "private key" that the exchange assigns to us.

Suppose I want to pay for a product or service? The key is the other party's "QR" code. A restaurant, hair salon, grocery store, etc. that accepts Bitcoin would display this on a cardboard display, iPad, or cellphone. I would take my cellphone, open the app for an Exchange where I have funds, enter the amount, and hit "send." This would "push" the funds to them avoiding the third-party fees for credit cards of 3 percent (or more).

Alternately, one can buy Bitcoins from a kiosk (our grocery stores have them) or a vending machine. The latter provides a plastic coin with a holographic cover on a "QR" code. You peel it back, scan the code and the funds move into your account. As there is no intermediary your funds are "gone forever." I do not see this as a problem as any legitimate business will address any post-transaction difficulties. From the merchant's perspective, the problems with fraudulent credit cards, fees, and delays in payment are removed improving efficiency.

Last year, Gerald wanted to pay me for the workshop I provided. We spent a month trying to move the money. First, he visited Deutsche Bank twice in person to no

avail. Then, he tried PayPal which failed and they kept nearly 10 percent in currency exchange fees which they promised to refund and never did. How would he do this with Bitcoin. He would open his exchange app and e-mail the money. He can choose any currency in the world. He can set a "refund" link in case I never claim the money. When his e-mail arrives, I can scan the QR code with my phone app, or the link with my computer and transfer the money instantly.

Similarly, Japan does not use "checks" or signatures like the west. Cash and credit cards are common, and seals with a person's name in *kanji* called *hanko* (判子) or *inkan* (印鑑) are used instead. (I had these and lost them in the fire.) Most smaller shops and restaurants only take cash and people are comfortable carrying it as the country is so safe. (I have seen cash withdrawals of \$200,000 in yen (pronounced "en" in Japan) carried out of a bank in a paper bag.) I have tried to wire \$10,000 to Junko's sister, Atsuko, on occasion. This required three banks (mine, an intermediary to do the currency exchange, and Junko's bank to receive it) with a \$45 "wiring fee" plus "currency exchange" costs. Another problem is that the local bank branch called her demanding an explanation! Recently, we tried to avoid this by sending the funds to Junko's account which Atsuko can access. Now, the bank required an in-person conversation with Junko on the phone. (We finally learned how to avoid this with an annotation on the deposit.) Think how much more efficient and less expensive this would have been with Bitcoin. I made a recent transfer of \$16,000 to my hardware wallet and instead of taking days, it completed near instantaneously (it can take up to 10 minutes for the miners to decode) and cost 75 cents. (How many international transactions happen every day?)

Is my money safer in Bitcoin or in the bank? There are several risks with Bitcoin, the biggest that I am now responsible for the safekeeping of my money, not a third party. There is a small, but finite possibility that the exchange is "hacked," and a thief gets our private keys. The way to mitigate that is with a "hardware wallet" that I will describe later. How about the risks at the bank? Aren't deposits insured by "FDIC" to \$250,000? They are until we have another financial crisis. The FDIC does not have the funds for a large-scale bank emergency. Moreover, the bank considers deposits as "unsecured loans," a low priority for repayment in a crisis. And do you recall the "bail-ins" that allowed some banks to seize depositor's funds to remain solvent? And people in line for hours to get funds from ATMs that finally ran out?

How about long-term preservation of capital? The ratio of government debt to GDP has been rapidly increasing worldwide. Debt is simply future consumption brought forward. It is useful to make a purchase that repays itself. In the case of a business, to increase productivity or profitability. Similarly, debt used for education or infrastructure may be necessary and appropriate. Thus, all debt should be analyzed in that manner. If we did that we would increase debt to fund military adventures, particularly foreign wars.

How do governments resolve debt? The best way is to grow the economy faster than the increase in debt. There are basically two ways to do that, increasing productivity and/or increasing population, e.g., by increasing immigration. When these are not possible, governments debase their currency which is possible with "fiat" (only backed by faith) currencies. The US dollar has been debased by something like 99% in the past hundred years. Indeed, there is no currency in the world tied to a hard asset, historically gold.

I am most interested in Bitcoin as a "store-of-value." We are also interested in keeping physical gold that we have. I have (nearly) always been able to keep one foot on a proven "rock" while stepping on a new one. I suggest that we are entering a perilous financial period which has been building for some time with Central Bank interventions everywhere. What will they do now with interest rates near zero or negative and bloated balance sheets? Is the IMF the only solvent central bank? Will their "Special Drawing Rights" basket of currencies become the world's reserve currency? I read recently that the IMF has requested "Bretton Woods-II" referring to the meeting after WW-II that tied the dollar to gold at \$35 and the other currencies to the dollar. This would surely include physical gold and, likely, Bitcoin. Bitcoin's market cap is about \$600 B and gold's is \$10 T. I know that the price of gold would have to raise to \$10,000 to avoid a breakdown and Bitcoin, who knows?

In this environment, things that are scarce will most likely hold value and things that are plentiful will not. Bitcoin has important features:

1. There is a fixed amount, 21 million coins, forever. Even the supply of gold increases about 2% per year. (The "miners" receive a decreasing number of coins each year, stopping in 2040);
2. As the adoption increases, there are demands for currency to make up for the "frictional costs," the up to 10 minutes that transactions can take;
3. One of the defining characteristics of a suitable cryptocurrency is the breadth of adoption by its "network." Bitcoin is rapidly moving from a techno-curiosity to adoption by business, hedge funds and (perhaps) retirement funds with a large, rapidly expanding world-wide network!

I followed a "macro-trader," Raoul Pal, on RealVision which he co-founded with Grant Williams for years. He worked at Goldman, formed his own hedge fund, then "retired" in the Cayman Islands to avoid taxation. Some months he was shorting US banks (because of the Covid-driven small-business failures) and long on gold and Bitcoin. More recently, RealVision hosted a three-day (on-line) crypto event with the world's experts. (Their crypto interviews are free.) I was astounded to hear that he then sold all his gold and bought Bitcoin (and some Ethereum). He thinks that Bitcoin will go up a factor of 10 this year (\$200 Thousand per coin) and to a Million dollars within a few years. (These would bring its market cap near gold's.)

Fiat Currencies

Is Bitcoin just another “fiat currency” which will go away in an average of 40 years like all the others? The problem is not that the currencies were backed by faith. The problem is that they were backed by governments that spent beyond their means (taxes), debasing (diluting) the currencies with more and more. For example, the Roman Empire did this by gradually diluting the silver in coins, replacing it with base metals. Governments have “done this experiment” many, many times with the same result. (21% of all dollars ever “printed into existence” were “printed” this year.) Why has gold, which has little “useful” value been a reliable “store of value” for thousands of years? Yes, it is inert, beautiful, and fungible. Most importantly, it is rare, only increasing at 2% at this time so governments cannot dilute and debase physical gold! (Do not buy the ETF, the COMEX is far oversubscribed like the banking system’s “fractional reserve banking.”)

I suggest that Bitcoin is likely a better long-term investment than gold although I will continue to hold more physical gold (with geographic disbursement). While the supply of gold is growing at 2% per year, the supply of Bitcoin is fixed at 21 million coins. Physical gold is not very useful as it is difficult to transport. Thus, the “network” of “users” is not large and growing like Bitcoin’s. Moreover, “young societies,” like the US do not have the history of personal loss from failed currencies that societies spanning thousands of years hold in their collective consciousness.

Individual Vs. Group Decisions

Early on, we were surprised that team behaviors scored significantly lower than individuals’ behaviors. We should not have been. Group behaviors tend to revert to the “lowest common denominator.” You can see this in a US political party that has abandoned its core values in ways that were unthinkable only a few years ago at the behest of a pathological narcissist. Would we have a better society if, for example, individuals negotiated interest rates for money they loaned or rates set by Central Banks? Our genus, homo, has existed on earth for millions of years in small tribes of perhaps 50 people. I suggest that we lack the innate abilities to function effectively in groups of many millions. Who can make better choices to delay our extinction due to climate change? Individuals or governments? Arguably, the most important power is not military but finance. Would we have a better world with more individual power over the use and transfer of money? Would individuals spend their money to bail out “zombie companies,” companies like the fracking companies which lack the free cash flow to pay the interest on their debt? And borrow more and more at government-suppressed interest rates which punish savers and pension funds with increasing wealth inequality?

Time Value of Money

The biggest danger for rapidly growing companies is liquidity. There is a time-lag between costs to suppliers and revenue from sales. Consider Amazon. When I make a purchase, Amazon charges a credit card “on-file.” The card-issuers charge Amazon a fee and interest costs that approach usury for any carried balances. More importantly, Amazon’s reimbursements are delayed, perhaps by months, also delaying payments to

suppliers, Would the world be better if all this friction and non-value-added overhead was replaced by Bitcoin? Transactions (payments) become near instantaneous for everyone!

Some Mechanics

Blockchains: This is a core idea. I will explain it with an analogy in ordinary life. If a dispute arises about ownership of a property, one can go to the county records on-line. There will be entries describing the property's transactions over time authenticated by an authority (Notary Public?). The act of placing this in the public domain assures authenticity as many would notice discrepancies and report them.

Bitcoin transfers are gathered in blocks with encryption codes that "miners" try to guess using specialized computers. When they succeed, they share the solution with others who use the code to open the "blocks" and make them public and spread them across the global network. Thus, the record is placed on many, many computers around the world. This is the inverse of the conventional system, with records controlled by a central institution, e.g., a bank.

Hardware Wallets: One of the things one worries about is the exchanges being hacked and losing their crypto currency. I don't know whether the hacking risk is worse at, say Schwab, but once they are gone, they're gone. So, I purchased a "Trezor Model T - Next Generation Cryptocurrency Hardware Wallet" for about \$150 direct from Trezor via Amazon. I confirmed that the packaging was not tampered with.

Here's how it works. I plug it into my computer and open the Trezor software. The first instruction was to confirm that the holographic strip covering the female USB-C port was intact. This was sufficiently difficult to remove that I was certain that it was intact. Next,

The only thing the wallet does is generate the all-important private key. This is a 256-bit "word" with numbers and letters generated with just 12 common English-language words that I can view (once) on the Trezor and write on paper (not digital media). This might not seem like enough but sequencing 12 distinct items from 1,200 generates an enormously complex code. So, how to keep my 12 words safe and have backups for safety?

Then, I discovered that this device supports "Shamir" backup. I am able to choose a number of 20-word documents that, when combined in some chosen number can replicate the key on a new device. I chose to generate seven documents, any two of which can be combined to recreate the all-important key. Thus, no single document has any use.

Trezor software interrogates the "wallet" and uses my stored "private key" to generate a unique address. The same key shows in the Trezor am asked to confirm that the key my wallet display is an exact match to that on my computer screen. I then copy and paste this "address" into my exchange app and, it then sends my crypto assets to

my wallet. I can see that it arrived in the wallet's screen. (Actually, nothing moves anywhere as a "block-chain" entry is published validating my ownership.)

Although the Trezor is protected by a "pin" that I provided, I will, after the present round of purchases, store it with a single 20-word document in our safe deposit box. I will then distribute the six remaining documents to trusted friends and relatives. In the event that I cannot access my wallet, any two collections of 20 words can re-generate my coins!

Intergenerational Differences

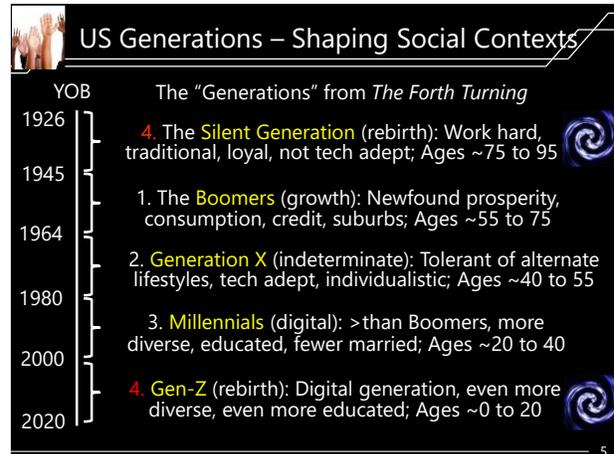
William Strauss and Neil Howe wrote an influential book, *The Fourth Turning: What the Cycles of History Tell Us About America's Next Rendezvous with Destiny.*

They look back five hundred years and uncover a distinct pattern: Modern history moves in cycles, each composed of four eras—or "turnings"—that last about twenty years and that always arrive in the same order.

First comes a High, a period of confident expansion as a new order takes root. Next comes an Awakening, a time of spiritual exploration and rebellion against the now-established order. Then comes an Unraveling, an increasingly troubled era in which individualism triumphs over crumbling institutions. Last comes a **Crisis—the Fourth Turning**—when society passes through a great and perilous gate in history. Together, the four turnings comprise history's seasonal rhythm of what they call growth, maturation, entropy (disorder), and rebirth.

The difference in perspective between the "grey beard" titans like Jeremy Grantham, Warren Buffet, Janet Yellen and Christine LaGarde and the "younger generation is profound and intergenerational. These low-tech "traditionalists" badmouth Bitcoin, and revere gold. They value stocks by dividends and P/E ratios and are generally perplexed by the younger crowd's preferences.

The "avant-garde" is represented by people like Raoul Pal (trader), Jeffery Booth (entrepreneur) and Michael Saylor (tech CEO) who see Bitcoin as a better store-of-value than gold and are buying it, big time. They like its limited supply (21 million coins), transferability (easy and near instantaneous, at least compared to gold), and diversification (no central authorities). They value companies (and other things) more by the size and growth rates of their networks than their earnings. Current rapid network growth is yet another big plus for Bitcoin. Consider your cellphone. If you were the only subscriber and there was no internet what would be its value? Also, I was noticing that



Yo-Yo Ma could pack very large concert halls. While he is surely a great cellist, are there others nearly as talented who are "just getting by" because they had no similar network?

What to do? In normal times, one would select assets that are uncorrelated and undervalued (over sold). For example, gold looks good to me now relative to common stocks and tends to be only weakly correlated. Also, commodities, in general, like uranium, and copper look historically cheap. I would avoid long-term bonds the returns are lame and they will lose value if interest rates creep up. After going broke in 2008 when a hedge fund with all of our money collapsed, most of our "money" is now in physical gold. Age is also a factor as I am too old to gain losses back from my business income. (Not to mention COVID.) Will it continue to be a premiere "store-of-value" as it has for thousands of years? The central banks, e.g., China and Russia are aggressively buying gold. Why? I suspect that they see "Bretton Woods-II" on the near horizon and want a "seat at the table" expecting the IMF to take the lead as the Central Banks have massive debts on their balance sheets. The new reserve currency will be a "basket" and likely contain gold, as it has backed current for nearly all of history. People like Jim Rickards (author, investor) argue that gold will have to be revalued to \$15,000 for this to happen. (I would prefer for this not to happen.)

I am in an unusual situation with a large cash settlement from the insurance on our house. I can buy assets without selling anything. I deployed most of it into more physical gold and a considerable amount into Bitcoin and Ethereum. (I also have cash in short-term T-bills as we will be looking to buy a house within the next year or so. This also provides dry-powder for any near-term dips.) I believe that the older, traditionalists will control the construction of the new reserve currency so gold will be OK. As the older generation fades, the perspectives of the younger will grow as will the importance of cryptocurrencies. I see this as a natural evolution of finance in the same way the internet changed information and communications. My time horizon is fairly short as I suspect that climate change will extinct humans within a decade. (I wonder what will happen to society when (and if) this is broadly recognized?) The "tell" that I like is when the arctic goes "blue water," meaning less than 20% ice. This will cause an immediate and irreversible heat increase.

Chapter 53: Grateful for My Good Fortune

A Life Well Lived

So, I am taking this quiet time to reflect on my journey over the past 75+ years. What amazes me most is how many “inflection points,” abrupt changes in curves, had favorable outcomes! So many times, things could have gone the other way.

You may have heard of “string theory.” It has the attractive feature (for physicists) of “unifying” (explaining with single formalism) the very small (Quantum Mechanics) with the very fast (General Relativity). This was a lifetime goal of Einstein’s that he never achieved. Physicists are very conflicted about this theory as there is no experimental test, an essential requirement for any viable theory. The theory predicts an infinite suite of Universes called multiverses. If that’s the case, I was surely lucky to land in this one!

Here are a few things I am grateful for:

- My father surviving WWII and the Korean War;
- Living in Okinawa, Japan;
- Waterfront living with a boat when 13 years old;
- Being bullied increasing my resolve to excel;
- Attending Randolph Macon Academy;
- Attending Severn School;
- Pete Hommel “saving my life;”
- Drexel and the Co-op at Mel (GS-2);
- Social fraternity Alpha-pi Lambda;
- Graduating, BS (Physics);
- Hired by Bud Hudgins into NASA’s Sounding Rocket Division;
- Acceptance into Goddard’s “Three-quarter” Program;
- Children, Jules, and CJ;
- Life-long friend, Mario Acuna;
- Published Magnetometer Model in *IEEE Transactions*;
- US Patent for a “Two-axis Fluxgate Magnetometer;”
- Completing Coursework and passing “Comps” at Catholic University;
- Designing and launching Sounding Rockets from the North (magnetic) pole;
- Publishing “SPICE” results in “*Solar Physics*;”
- Graduating, PhD (Astrophysics);
- Flying an Electron, Positron experiment across Canada;
- Publishing in the “*Astrophysics Journal*;”
- Staff Scientist (Astrophysics);
- Office of Planning and Program Integration;
- Branch Chief, Office of Space and Terrestrial Applications;
- Deputy Director, Spacelab Flight Division;
- Catholic University’s Alumni Award for Outstanding Achievement in Science;
- Executive MBA, Harvard Business School;

- Director, Astrophysics Division;
- *"Creative Management Award;"*
- *"Rank Awards"* by Presidents Regan and Clinton;
- Invented the Great Observatories Program;
- *"Outstanding Leadership Medal;"*
- Hubble's Launch;
- Mounting the Hubble Servicing Mission;
- Deputy Associate Administrator, Safety and Mission Assurance;
- Associate Deputy Administrator;
- *"Distinguished Service Medal;"*
- Professor of Leadership, University of Colorado;
- *"Outstanding Leadership Medal (2nd);"*
- American Astronautical Society's *"Space Flight Award;"*
- President, 4-D Systems;
- Marrying Junko;
- *How NASA Builds Teams* (Wiley, 2009);
- *"Honorary Professor"* by China Aerospace;
- Screenplay for movie about Charlie's life and Hubble completed.

While I have no use for the idea of a personal god, this is one hell of a string of good luck! Thank you for reading this!

Chapter 54: How to "Live Forever!"

I am fond of a podcast by an MIT Artificial Intelligence ("AI") expert, Lex Fridman. (His PhD is from my undergraduate alma mater, Drexel University.) He was interviewing a famous physicist, Max Tegmark. Max described a talk by Richard Feynman that motivated him to study physics by describing the extra pleasure he gets from a physicist's perspective when watching a fire burn.

When asked about whether he was afraid of dying, Max said, "No, it's the natural order of things." He noted that they had been reminiscing about Richard Feynman and therefore, he still lived in their consciousness. It occurred to me that I frequently thought about people who were important in my life and now deceased. (I do not like the term "passed.") I realized that they lived in my grateful thoughts and that this was more important than whether their protoplasm continued to function.

This crystallized something I had been thinking about for a long time. When my time to die comes I will rest easier knowing that I will live-on in the minds of the people whose lives I have enhanced. (And hope that the others soon forget me.) I changed my e-mail signature to, "With a legacy of contribution, one can live forever."

Appendix – Coordinates (Places I've Lived)

Coordinates by ("years old")

Shreveport, LA (Dec. 11, 944, birth)
Gunter AFB, Montgomery, AL; Dothan, AL; New Bruansfels, TX (1)
Shreveport (2)
Bamberg & Heidelberg, Germany (2-3)
Southern Pines, GA (3)
Fayetteville, NC (4)
Turner AFB, Albany, GA (5)
Possum Island, GA (5-8)
Lafayette; Shreveport, LA (8)
Kadena AFB, Okinawa (8-13)
Bywater Road; Annapolis Junior High School (13 -14)
Randolph Macon Academy (14-17)
Dulaney Lane, Annapolis (15-22)
Severn School (17-18)
Drexel University, Philadelphia, PA (18-23)
Goddard Space Flight Center, Greenbelt, MD
Sounding Rocket Division & Catholic University (23-26) – *Inventor*
Laboratory for High Energy Astrophysics (26-31) – *Research Scientist*
NASA Headquarters, Washington, DC
Astrophysics Branch (31-32) – *Staff Scientist*
Spacelab Utilization Planning (32-33) – *Specialist*
Spacelab Integration & Research Aircraft (33-35) – *Branch Chief*
Spacelab Flight Division (35-38) – *Deputy Director*
Harvard Business School, Boston, MA (16 weeks) – *Executive MBA*
Astrophysics Division (38.2-48) – *Director*
NASA Administrator's Office (48-49) – *Associate Deputy Administrator*
University of Colorado, Boulder, CO
Business School (49-51) – *Professor of Leadership*
Small Business Owner, Boulder County, CO
"4-D Systems" (51- present) – *President*