

A Roundtrip Journey Off The Career Track: Having a Successful Career Despite Your Best Efforts

Ray Ladbury

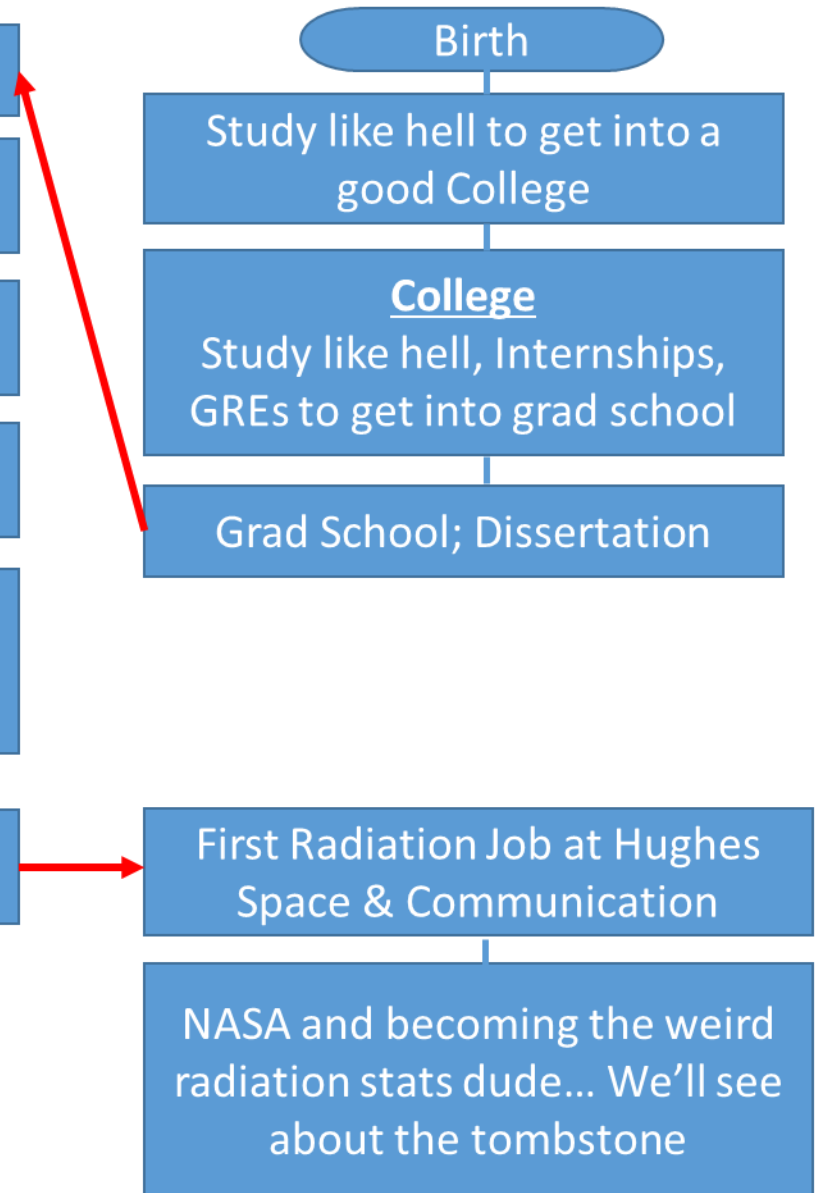
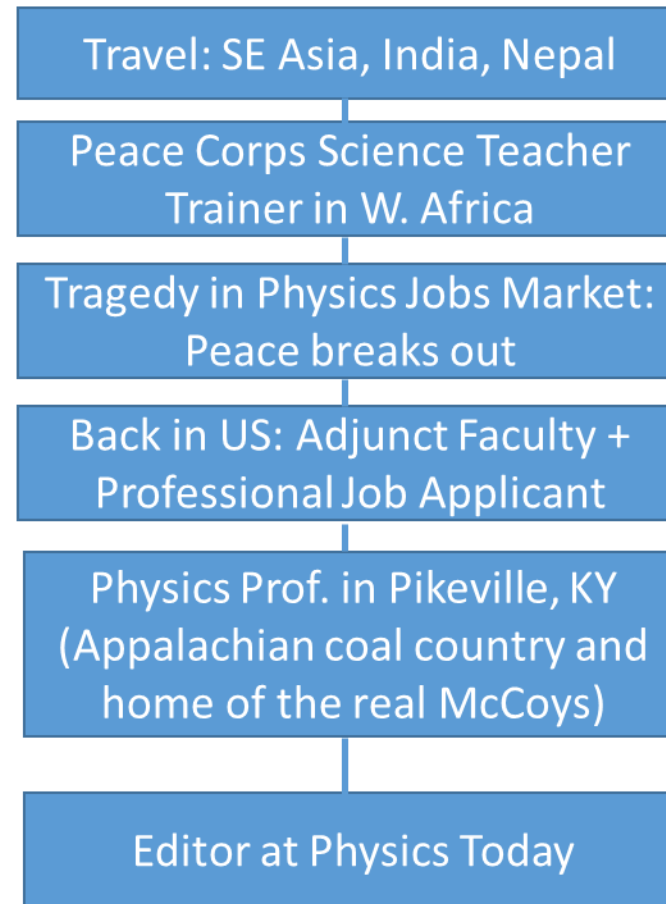
Radiation Effects and Analysis Group

NASA Goddard Space Flight Center

Highlights From Last Year's Breakfast!

- Last Year's Speaker was Georgia Tech's John Cressler
 - Distinguished scientist with hundreds of publications
 - Books, papers, popular lectures
 - Author of historical novels
 - Popularizer of science and technology
 - Philosopher on interface between faith and science
 - Polymath and renaissance man
- The beignets were good, too!
- So you may be wondering: Why is the guy who asks all the weird statistics questions up here?
 - A. They wanted a real contrast in speakers
 - B. To make the point that you can arrive at your career via many different paths

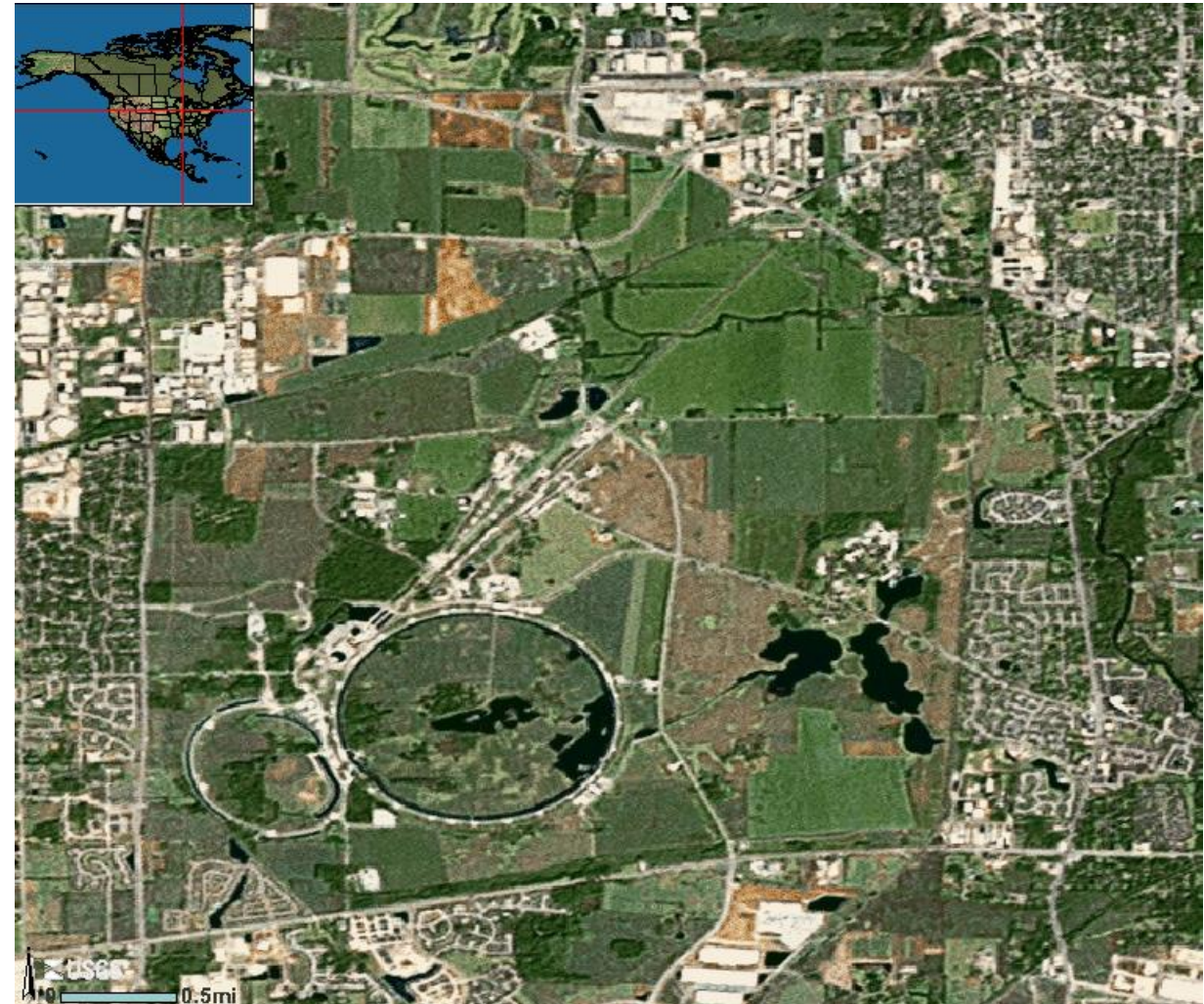
Scientist Career Paths



Why The Detour?

- First, what it wasn't
 - Physics was not the wrong field for me.
 - It wasn't that I didn't understand what I was getting into.
 - Did internship with neutrino-oscillation experiment
 - Particle physics: the original "Big Data" discipline...Cool!
- Standard path didn't lead to what I loved about physics
 - Understanding of the world
- Most full professors were grant-writing machines
 - Little time to do physics or be creative
 - Many perform the same role experiment after experiment
- Experimental particle physics: huge and getting bigger
 - Then: Fermilab was 4 mi. circumference
 - Now: CERN's LHC is 17 mi in circumference
 - Author lists as long as village telephone directories
- I wanted a career that emphasized breadth of physics
- I also wanted to see some of the world
- Solution: Start my career with a sabbatical

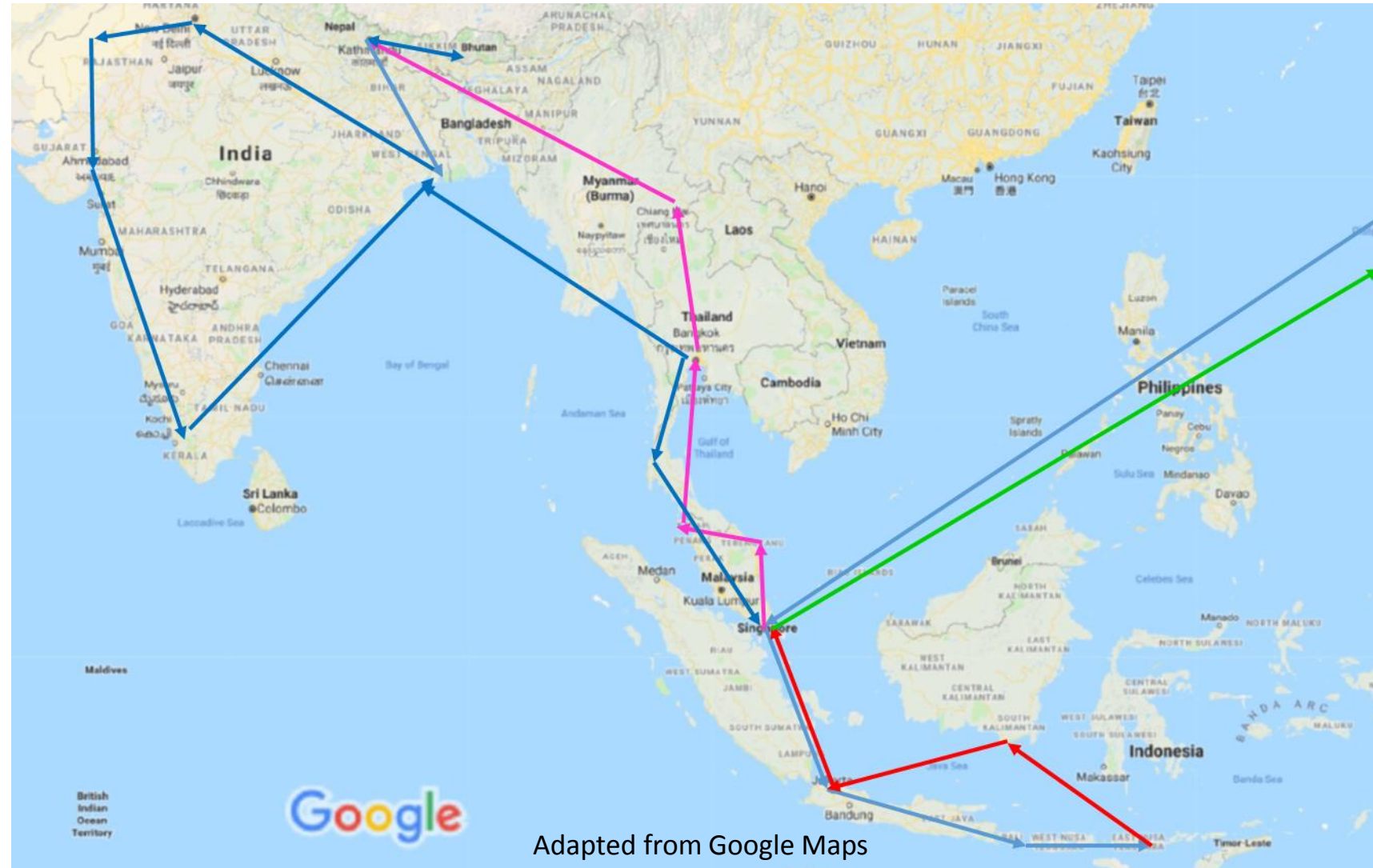
Satellite View of Fermilab



US Geologic Survey—Public domain

1988: A First BIG Step Off The Career Track

- 7½ months, 6 countries
- Travel by plane, train, boat, bus, car, three-wheeler and foot
- July—Fly to Singapore
- July-September: Indonesia
 - Java, Bali, Lombok, Sumbawa, Flores and lots of fish heads
- Sept.-Oct.: Malaysia, Thailand
- Oct.-Nov.: Nepal
 - Trek to Everest base camp
 - Dysentery, bronchitis, broken toes, trashed knees, great time!
- Nov.-Jan.: India
- Jan.-Feb.: Thailand to Singapore
- Mid Feb: Return home and replenish cash



Lesson 1: Be Prepared to Go It Alone

- When you plan the trip of a lifetime, everyone wants to go. If you wait for them, you never will.



- Don't worry, you will meet people along the way...some of them again and again and again...

You Can Make It... Just Maybe not today.



- **it happens. You get sick. Transport breaks down. Volcanoes erupt. Military coups occur...
 - Know your limits—believe it or not, you're supposed to be doing this for fun.

- Keep moving forward. Deflection is better than giving up—and may take you somewhere great.
 - Serendipity is sometimes the best travel guide.



Your good experiences become memories; your bad ones, stories



- Peak moments sustain you, but who wants to hear it.
 - Think “Double rainbow—all the way across the sky”

- A train breakdown the middle of nowhere!
- Who doesn't love a good projectile vomiting story?
- Charged by elephant!
- Playing chicken with a troop of baboons.
- Almost getting into a fight with the taxi driver who cheated you on the fare to visit Gandhi's Ashram.
- These are stories!



Every trip is a scouting trip

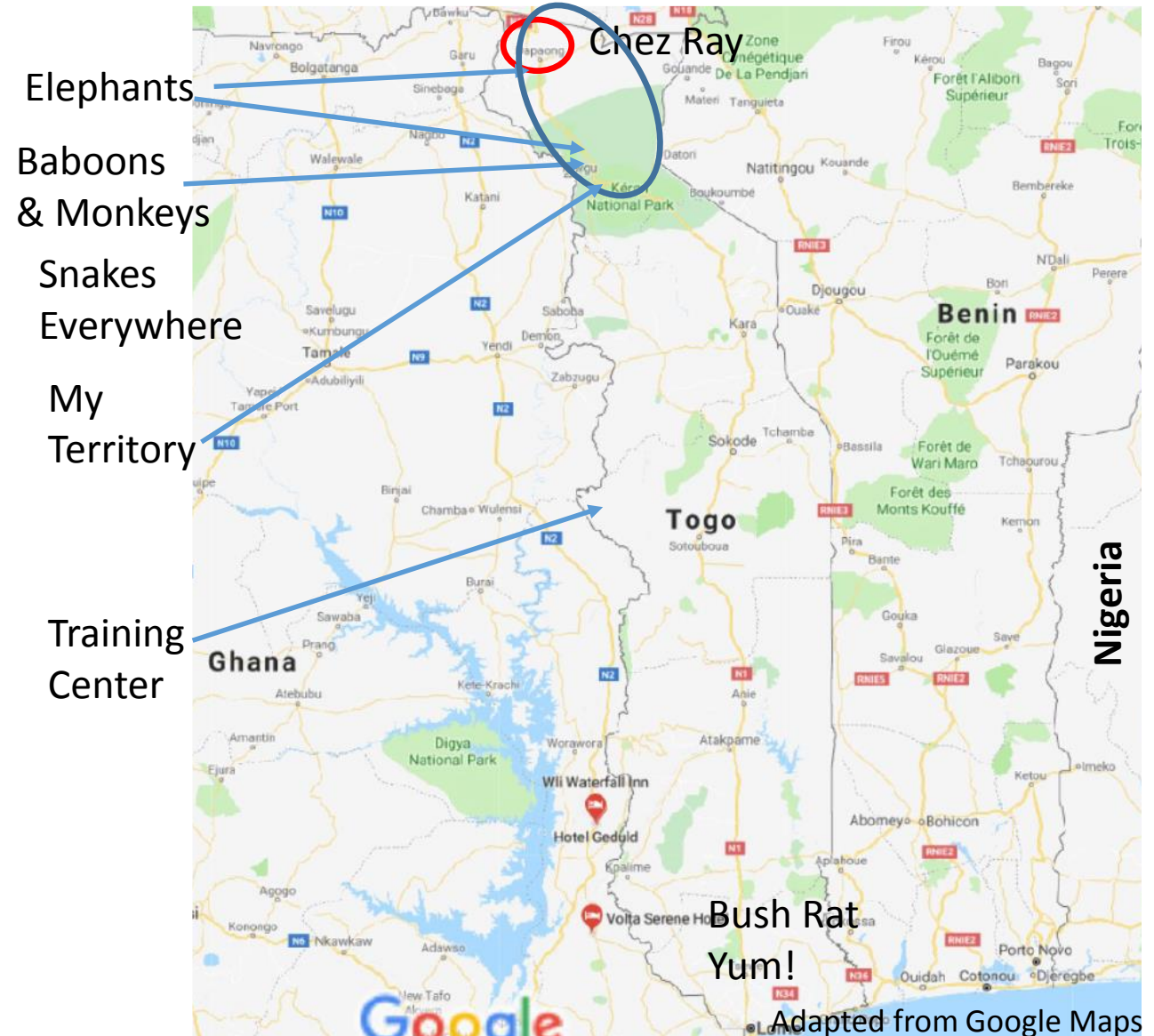
- If this is your last chance to see everything, you will drive yourself crazy



- Also, it's probably true—if you like a place enough, you'll probably get back
- I've visited
 - Brazil 6 times
 - Sri Lanka 4 times
 - Madagascar twice

Peace Corps: When You're Still Not Quite Ready to Grow Up

- A little bit about Togo
- Area: 56785 km² (About the size of W. Virginia)
 - About 60 km wide at it's widest; ~600 km long
- Population ~8 million—Largest tribes are Ewe (Voodoo comes from an Ewe word) and Kabye
 - Nearly 40 different tribes/languages
 - French is an official language
- Originally a German Colony (1884-1914)
 - British and French colonists invaded during WW I
 - Western half eventually became part of Ghana
 - Eastern half became independent in 1963
- Educational System is based on French model
- Economy mainly agriculture and mining (phosphates)
- Food—rice and/or yams w/meat in spicy sauce
 - Hope you like peanuts and warm beer!
- Trivia: Lomé is the only capital on international border



So What Does a PhD Physicist Do in The Peace Corps

- Peace Corps involves
 - 3 months of training (language, culture, technical)
 - 18-24 month assignment + additional projects
- My Assignment: Physical Science Teacher Trainer
 - Training science teachers at 7 middle schools
- Also organized 1st AIDS Awareness Tutorial in Togo



- Proof that I was once:
 - 1) Young and thin
 - 2) In Africa

Development Work is Humbling

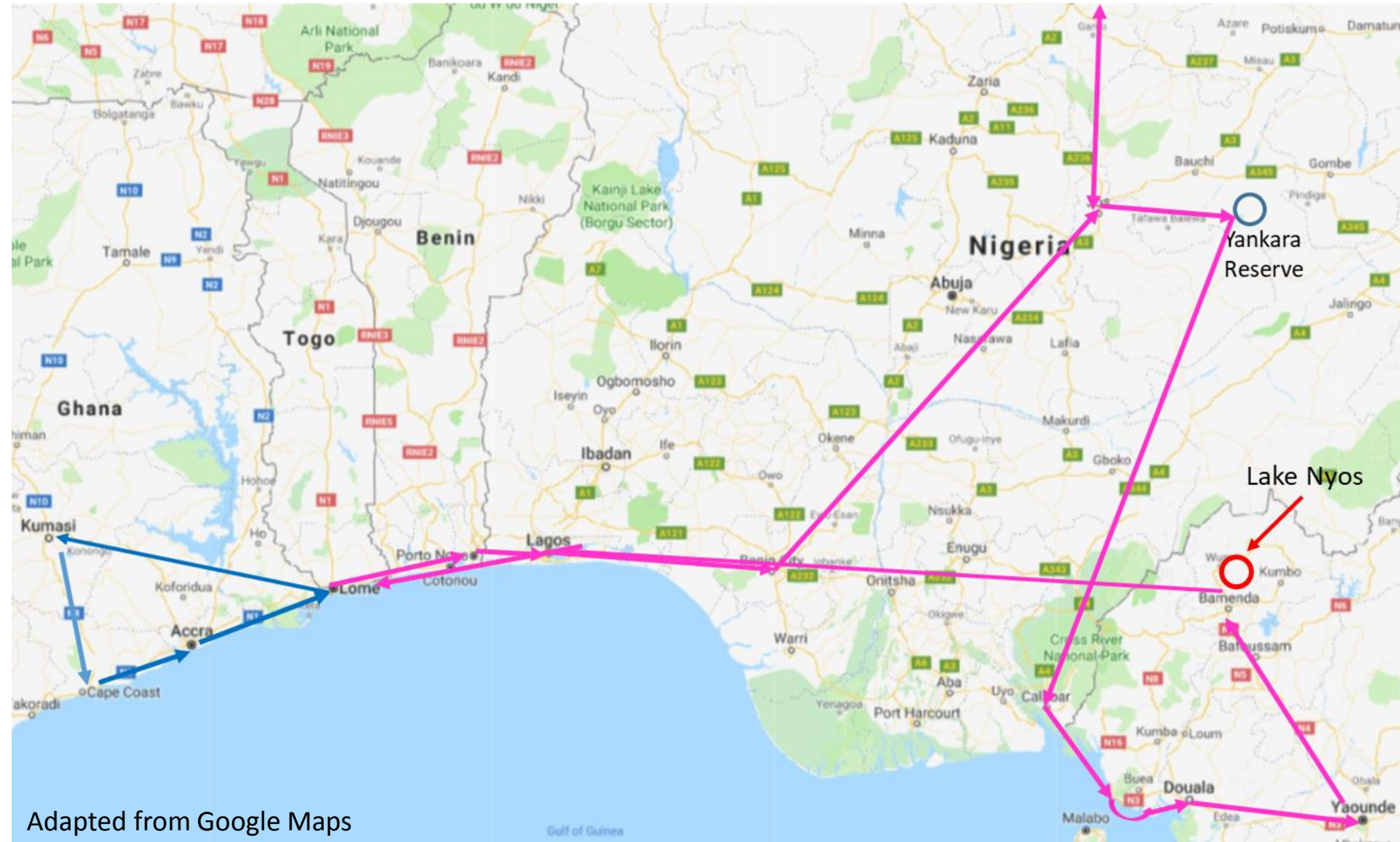
- Momentum Conservation: In person-continent collisions, the person gets scattered much more
- Resources lacking and change is slow
- However, we know Peace Corps works, because
 - Every person brings a unique style to problem solving
 - People have only positive memories of past volunteers
- Why are you the most competent to do the job?
 - You're there.



- Savannah Region Middle School Science Fair Projects
 - Taught students and teachers how to make kaleidoscopes
 - Illustrates optics of reflection, basic geometry, symmetry
- Also introduced concept of analog computers
 - Center of mass to determine where to dig a well
 - Levers, pulleys, etc. to add, subtract multiply and divide

Things I Wouldn't Know Without Journeying to Nearby Countries

1. The feeling of looking out of the door of no return at Ghana's Cape Coast Slave Castles.
2. The colorful confusion of the Kumasi, Ghana market
3. How nice people in Nigeria are.
4. The world's worst roads.
5. The towns and people on which Boko Haram preyed.
6. The scariest boat trip after the Titanic.
7. That in a game reserve lions walk through your campsite at night!



Homeward Bound: East Africa and Its Predators Teach a Lot about Survival



You Can Go Home Again—It Just Won't Be How You Remembered It

- My journey home began with one of those days when nothing goes right
 - Two bus breakdowns
 - One bus running over a dog
 - Getting caught in a tropical downpour—twice
 - Having to walk the last 3 miles back to my room because of a bus breakdown
 - Arriving in town after the last shops and restaurants closed
 - Having to look for the YMCA desk attendant for 30 minutes to get my key
- 20 minutes of very creative profanity brought a revelation
 - Little voice in my head: “Well, you could go home.”
- Journey home took 3 months through 3 more countries
- Arrived November 1991, in time for
 - Thanksgiving and Christmas
 - My brother's wedding
- The next Journey: Become employable again
 - Interesting is not necessarily an adjective you want describing your Curriculum Vitae.
 - Especially with world-class Russian physicists applying for the same jobs

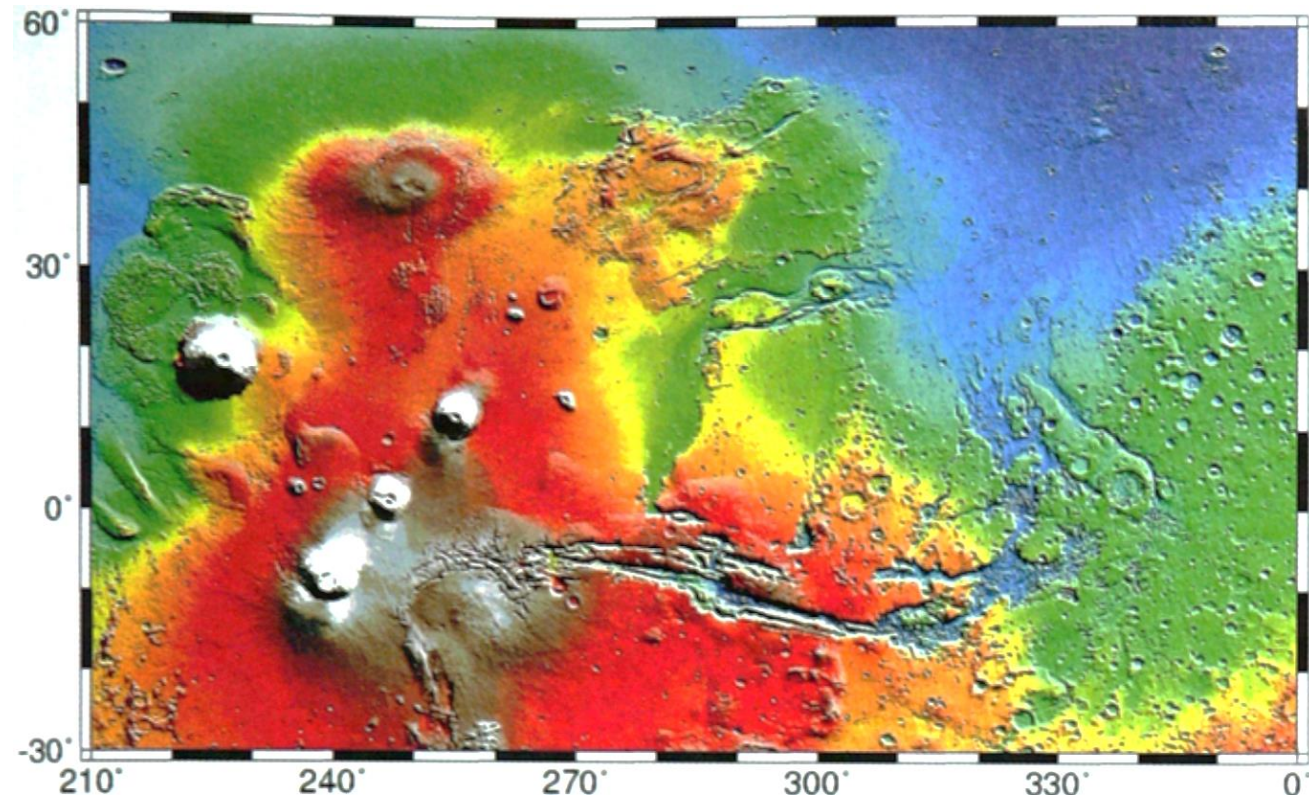
1992: A Tough Time to Look for Work

- US coming out of recession (1990-91)
- Peace had broken out
 - All those Star Wars jobs went away
 - Collapse of Soviet Union meant world-class Russian physicists competing for same jobs
- Superconducting Super Collider on the verge of cancellation (1993)
- Agenda for 1991-1992:
 - 1) Return home
 - 2) Meet future wife (Note: She's the reason why the photos improve from this point forward)
 - 3) Send out >150 resumes
 - 4) Support yourself as an adjunct faculty member
 - 5) Take education classes just in case you never work in physics again
- Result was two positive responses
 - Physics professor at Pikeville College (only 4-year college in Kentucky's Appalachian region)
 - In Appalachia, Peace Corps is actually relevant experience for a physics professor
 - Won't talk about this due to time—but stop me later...lots of stories
 - Physics Today—Pikeville got there first, but Physics Today came back after I got married and before Michelle found gainful employment in Pikeville...plus, it's Physics Today. How cool is that for a nerd?

Physics Today: Like Drinking From A Different Fire Hose Every Month

- Physics Today is a general physics magazine for the 10 member societies of the American Institute of Physics
- Editors responsible for
 - Soliciting and editing articles on research and historical subjects from experts. Mine included
 - Writing news stories on the latest discoveries and results in all fields of physics
 - Tracking of developments in one or more specialties
 - Mine were particle physics and geophysics
 - Other duties as assigned
 - I was editor for New Products and the Physics Today Buyers' Guide
 - Just try to keep that interesting!
- Advantage: You get to spend your time reading and writing about cutting edge physics!
- Disadvantage: There's no time to do any actual physics.

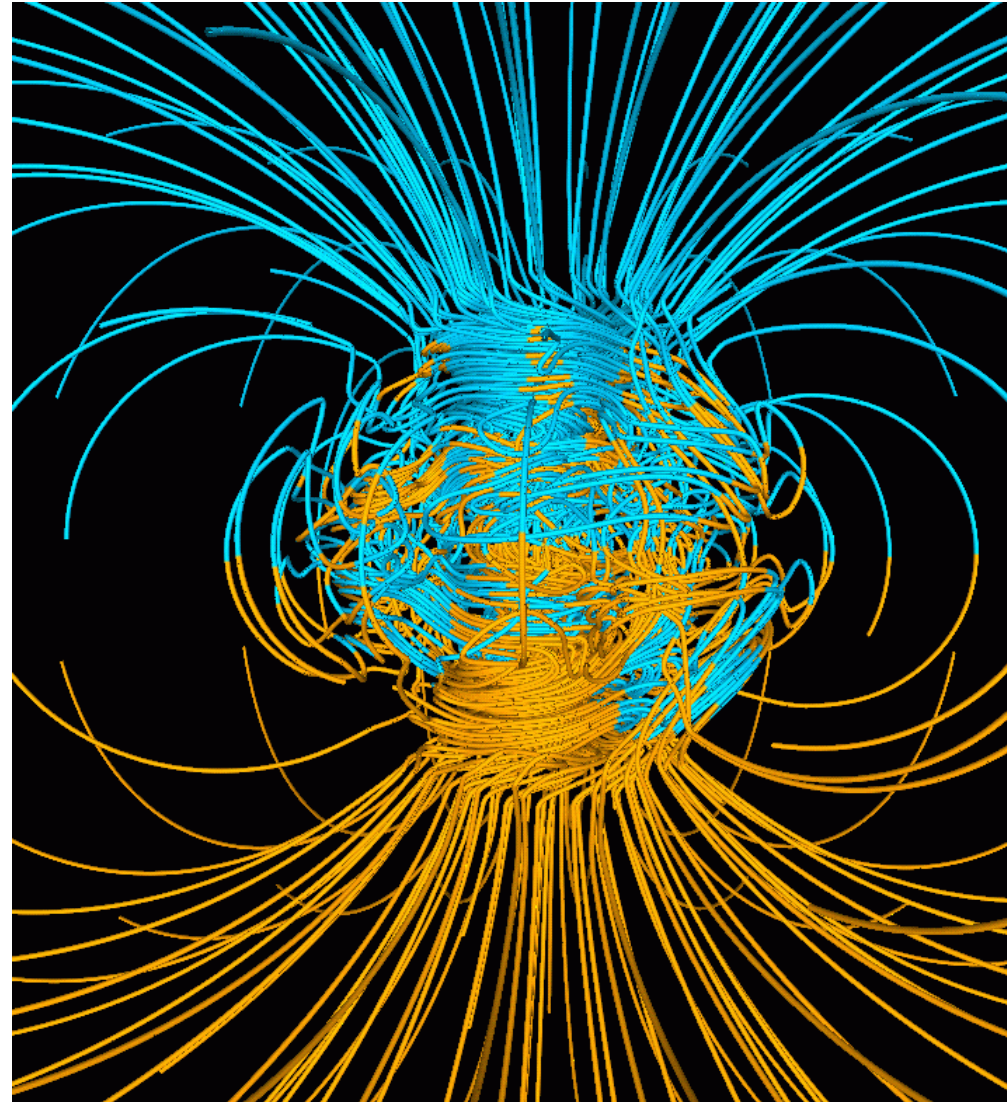
Topography around the Tharsis region of Mars.
Courtesy of NASA Goddard Space Flight Center.



Every month A Crash Course In A New Subject

Subjects of Articles I edited	Subjects of News Stories I wrote
Physics of baseball	Geophysics
Physics education	Planetary Physics
Optics	Condensed Matter
Particle accelerators	Astrophysics
Fluid Mechanics	Acoustics
Oceanography	Atomic & Molecular Physics
Astronomy	Oceanography
Medicine	Instruments and Methods
Acoustics	Materials
Materials Science	

For each article or story, I had to become sufficiently conversant to discuss the subject with experts (sometimes Nobel Laureates) without looking like a complete idiot.



Earth's magnetic field is generated by flow of liquid Fe in the outer core. The solid, metal inner core serves as an inductor, making the dipole much more stable. Without this induction, the field would flip on a timescale of 1000 years or so, rather than 100s of thousands of years we now enjoy.

Used by permission of Gary Glatzmaier, UC-Santa Cruz

Lesson from Physics Today University

- 1) It's amazing how far you can get just by understanding the fundamentals!
- 2) You don't have to be the expert on everything. Experts usually love to teach.
- 3) There are often synergies between different fields—knowing one helps you learn the others.
- 4) Not all experts are created equal.
 - a) Few know the entire field as well as their own work
 - b) Even fewer will set aside their own political agendas
 - c) Writing articles in a semi-prestigious magazine is a good way to identify the subset $a \cap b$
- 5) Even the most objective research is political.
 - a) Don't believe me? Just wait 'til a Nobel Prize is at stake.
- 6) Never trust a single source.
- 7) The difference between the right word and the almost right word is the difference between the lightning and the lightning bug.—Mark Twain



The “Fountain” at Lake Nyos a volcanic lake in Cameroun.

In 1986, Lake Nyos expelled roughly 1 km³ of CO₂ from the deep waters near a volcanic vent where it had been accumulating for decades. The heavier-than-air gas rushed into the valley below, suffocating nearly 2000 people, along with livestock and wild animals.

The fountain is powered by a self-sustaining, controlled venting of CO₂ from these deep waters so that such an eruption will not recur.

Courtesy of George Kling, University of Michigan

From Physics Journalism to Radiation Effects? Sure. Why Not?

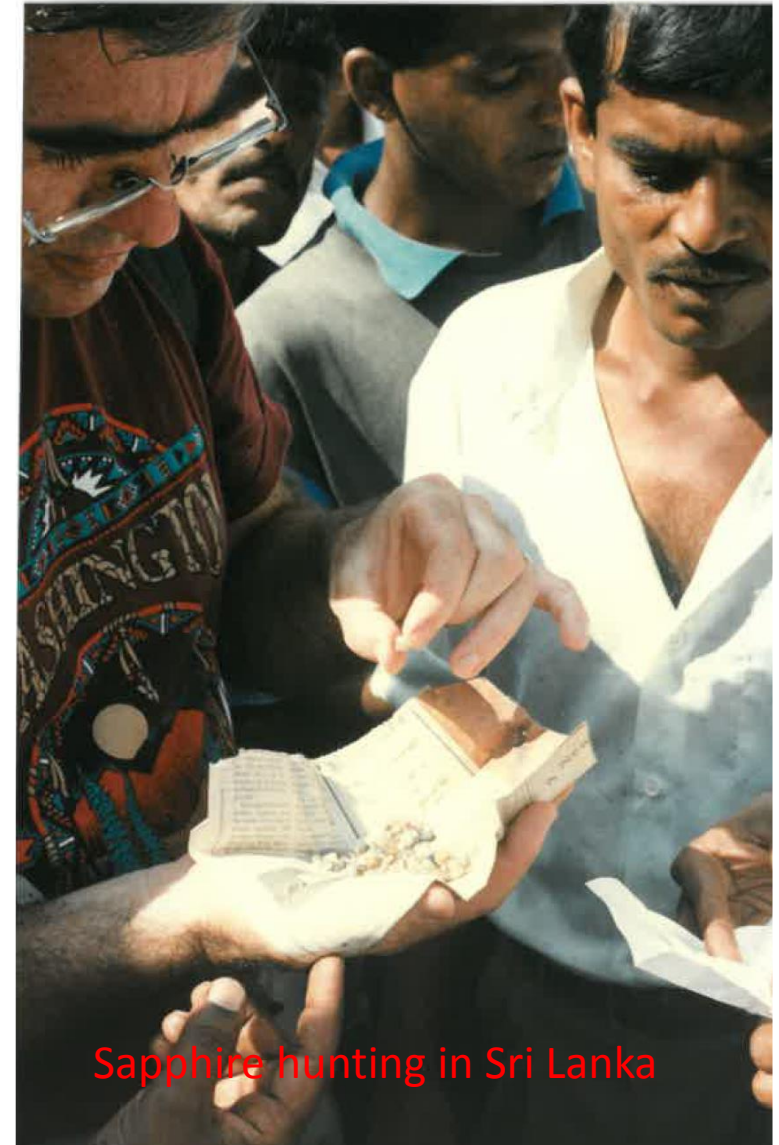
- How and why I became a radiation physicist
 - 1) Shameless Nepotism—How you get an opportunity matters less than what you do with it.
 - 2) Opportunity to **do** research again.
 - 3) Shameless greed—got a 72% pay raise with the change.
 - 4) Requires knowledge of a broad range of fields.
 - a) Semiconductor physics
 - b) Radiation-material interactions
 - c) Materials science
 - d) Space environments
 - e) Nuclear physics
 - f) Statistics and data analysis
 - g) Many others helpful as well
 - 5) Field is relatively small, so you get to do different things
 - 6) Single journal of record (IEEE Transactions on Nuclear Science) makes it easier for a beginner to learn.
 - 7) Opportunities
 - a) Young field
 - b) Single journal of record means there are opportunities for cross fertilization for techniques from other fields



- Waiting for a career opportunity is a lot like fishing—you have to be ready when the fish are.—Unawatuna, Sri Lanka

How Did My Previous Experience Prepare Me?

- Willing to take risks
 - Leaving a successful career to start in a new field one knows little about
- Able to spot opportunities to potentially improve current methods
- Able to spot experts willing to put politics aside and help a neophyte
- Having the audacity to think I could contribute to the field
 - No more audacious than thinking you can change a continent
- Able to learn and assimilate a complex field rapidly
 - Concentrate on fundamentals
 - Map out how CRÈME-96 error rates depend on fit parameters (you should do this!)
 - What are the assumptions underlying the test methods, models and tools we use?
 - What happens when those assumptions are violated?
- Able to find creative solutions with scarce resources
- Willing to go it alone if necessary
- Ability to communicate complex technical concepts in writing
 - If you discount this, consider: the person who comes up with the final wording gets the last word

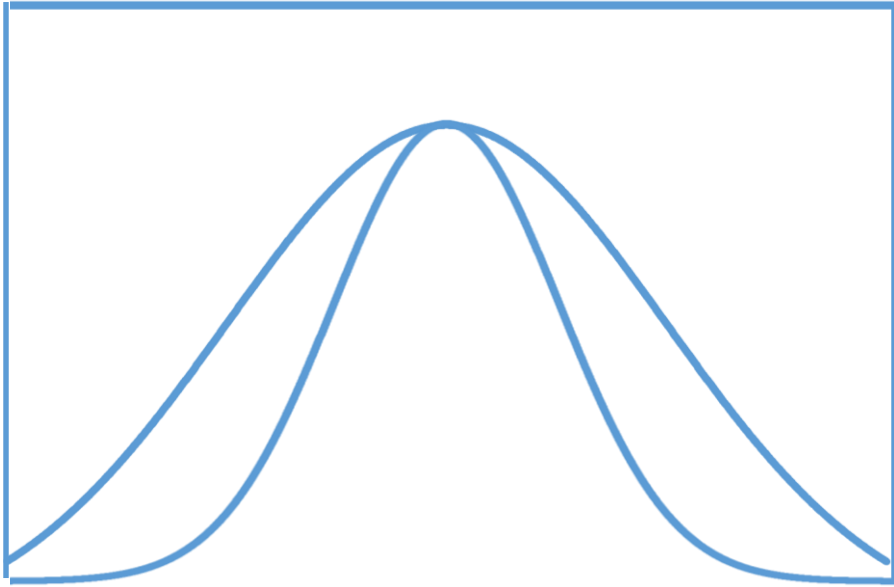


Spotting Opportunities: Why Statistical Techniques?

- Confession: I'm not a statistician, nor do I play one on TV
 - First statistics text I read was the one I was teaching out at Pikeville College (Note: Just try to find a pack of cards to do probability demos with on a Baptist College Campus)
 - I learned stats techniques as I needed them for research
 - But...Statistical reasoning does come naturally for me
 - Blame Paul Marshall—he encouraged me
- Statistical reasoning is powerful
 - Really the only way to tackle many problems
- Statistics has advanced significantly since original RHA approaches were developed
 - Original TID/DDD approach —near normality of lot variation
 - Original SEE approach: Minimizing Poisson errors
- Approaches are immediately useful to flight projects
 - Require little outside funding
 - Often you have people coming to you with data to analyze



Anything Can Happen—The Scariest Words in The English Language



- 2nd Law of Thermodynamics tells us far more bad things can happen than good things
- Data take us from the possible to the probable
- Data and analysis tell us what is real in the space of possibility

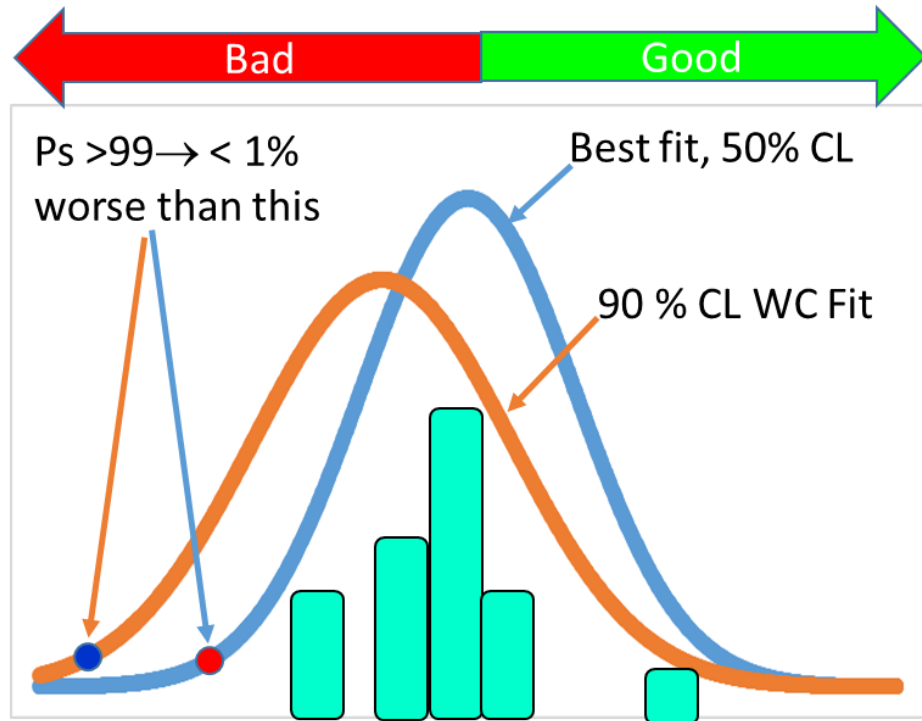
Michelangelo's Pieta, photo by Stanislav Traykov



Every block of stone has a statue inside it and it is the task of the sculptor to discover it.-- Michelangelo

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There's an Opportunity: Example of TID Hardness Assurance

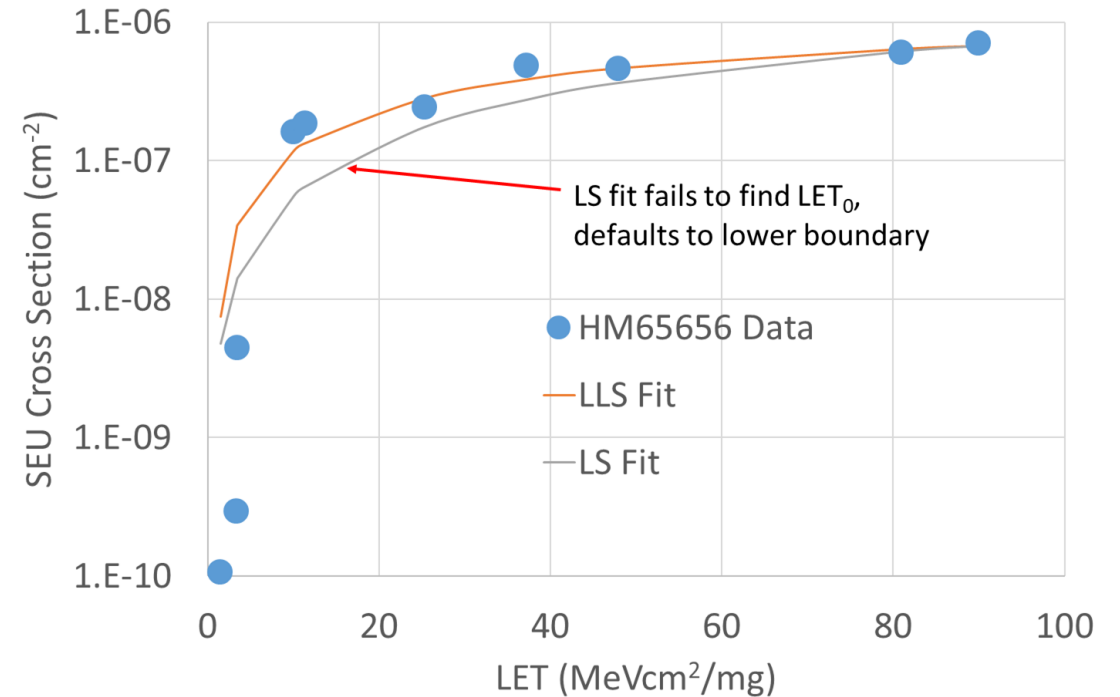


- TID problem—no idea how failures distributed
- Assume wafer-lot failure distribution \sim normal
 - Usually at least approximately true
 - Can select confidence and success probability
 - Doesn't require huge test samples
 - But, deviations from normal lead to systematic error

- Finding a niche when an existing model/method *usually* works
 - Understand conditions required for model/method to work
 - Determine whether/when these conditions fail and develop alternative approach
- TID Example: Conventional approach works very well when
 - Data available for specific flight lot
 - Failure distribution well behaved
- Assumptions violated
 - No flight-lot data
 - Method to use data for several generic lots—(2009 publication)
 - Method to use data for similar parts (2010 publication)
 - Bayesian method using generic lots or similar parts (2011 publication)
 - Failure distribution not well behaved
 - Identifying pathologies with small datasets (Aggregate distribution—2005)
 - Identifying right model (Model Selection and Averaging—2009)
- CRÈME-MC is another example
 - Indispensable when CRÈME-96 assumptions fail

Not Everyone Has Research Funding; Not Everyone Needs It

- My main career emphasis was work on NASA projects
 - Often little research time, but new tools/methods needed
 - Model selection paper started as attempt to bound margin needed for non-lot-specific TID data
 - Bayesian TID approach was attempt to model and bound gain degradation in bipolar junction transistors
- Advantages
 - I knew techniques were relevant because I was using them
 - I had a ready-made problem and data set as an application
 - I had a reputation—folks came to me with challenging issues
 - Developing new methods requires deep familiarity with existing methods
 - Little or no outside funding required
- Challenges
 - Must make method general and useable by the community to justify publication
 - Eats into personal/family time
 - Not always easy to persuade community of method's utility



- Seemingly trivial tools might lead to a paper
 - Example: Fitting Weibull to SEE cross section σ vs. LET data
 - Least Squares does a poor job determining onset LET because it depends on absolute differences of fit $\{\sigma_f\}$ vs. data $\{\sigma_d\}$
 - $LLS = \sum \sigma_{if} [\ln(\sigma_{if}) - \ln(\sigma_{id})]^2$
 - Usually does better job when data vary many orders of magnitude
- By itself, maybe not worth a paper, but combined w/ other results, analysis of how fit affects rate...

A Career Does Not Preclude Travel—Wanderlust Is Incurable



Costa Rica
Sri Lanka
Brazil
Madagascar
New Zealand
France

...



Best Path Isn't Always The Straight One

- Many—maybe even most—paths contain deviations
 - Mine: Three years to start seeing the world
 - Many other possibilities
 - Some Noble: raising children; caring for a loved one, military service...
 - Some maybe less so: politics, prison, Wall Street
 - All pose the same problem: How do I get back to a career track?
- You got a lot o' 'splaining to do!
 - You may have to convince some your experience is relevant.
 - But, your experience can make you a better scientist/engineer
 - Dealing with different people
 - Creativity in overcoming obstacles and limited resources
- Approach your return strategically
 - Know your chosen field, its fundamentals and its weaknesses
 - Capitalize on the strengths your background gives you
 - Look for opportunities to make things better in your field...and your life
- Your path may not be straight or smooth, but it can be beautiful

