



## Scientist Spotlight with Martin Hellman

Q&A with prominent FAS-affiliated scientists and engineers

*E-mail interview conducted by Allison Feldman, FAS*

**Dr. Martin Hellman** is an Adjunct Senior Fellow for Nuclear Risk Analysis at FAS and a member of the FAS Board of Experts. Hellman was at IBM's Watson Research Center from 1968-69 and an Assistant Professor of EE at MIT from 1969-71. Returning to Stanford in 1971, he served on the regular faculty until becoming Professor Emeritus in 1996. He has authored over seventy technical papers, twelve U.S. patents and a number of foreign equivalents. Along with Diffie and Merkle, Hellman invented public key cryptography, the technology which allows secure transactions on the Internet, including literally trillions of dollars of financial transactions daily. He has also been a long-time contributor to the computer privacy debate, starting with the issue of DES key size in 1975 and culminating with service (1994-96) on the National Research Council's Committee to Study National Cryptographic Policy, whose main recommendations have since been implemented. Hellman has a deep interest in the ethics of technological development. With Prof. Anatoly Gromyko of Moscow, he co-edited *Breakthrough: Emerging New Thinking*, a book published simultaneously in Russian and English in 1987 during the rapid change in Soviet-American relations. Breakthrough outlined how the equations of survival had changed in the nuclear age. Hellman received his B.E. from New York University in 1966, and his M.S. and Ph.D. from Stanford University in 1967 and 1969, all in Electrical Engineering.

### 1. What made you want to become an engineer and what is your primary field of focus?

When I was in third grade and we were studying the explorers of the sixteenth century, I wanted desperately to be an explorer. But, somehow, even at that tender age, I knew I had to be a scientist. (Engineering was unknown to me then.) I don't know how I knew that, but I did. Back then, it saddened me that I couldn't be an explorer, but I now can see that my technical work (and my personal work connected with it – see below) has taken me to new frontiers I couldn't have imagined when I was eight years old. So I didn't have to choose between being an explorer and being a scientist. Scientists, when they push the limits, are explorers.

### 2. What major milestones have you personally reached?

While I'm proud of the traditional honors I've received for my technical achievements, the milestone I am most proud of is having Dorothea, my wife of 48 years, feel that our relationship is where she's always wanted it to be (but wasn't for many years). Since we both agree that she is "the princess and the pea of relationship conflict," that's quite an accomplishment! Surprisingly, the scientific spirit played an important role in reaching that goal. One of my mentors on that journey, the late Prof. Harry Rathbun of Stanford University, defined the scientific spirit as "a zealous search for the truth, with a ruthless disregard for commonly held beliefs when contradicted by the observed data." Einstein's 1905 explanation of the photoelectric effect is a good example, since he had to break with the established dogma that light was a wave, and therefore could not also behave like a particle. But Harry applied his definition far beyond its usual physical domain,

extending it to human and international relations. I learned to do the same, and by opening up to some seemingly crazy ideas – especially Dorothie’s when she disagreed with my deeply held beliefs – I was able to accomplish what previously seemed impossible in our marriage. I have applied the same approach internationally, but understandably haven’t met with as much success. One international example that fits well with FAS’ goals concerns national security. Conventional wisdom holds that the nation with the most powerful weapons is most secure. Yet, “the world’s sole remaining superpower” can be destroyed by nuclear weapons in under an hour. How secure is that? Society needs to undertake a “zealous search for the truth,” rather than basing its actions on its currently held, but incorrect belief.

**3. Tell me about your current project, *Defusing the Nuclear Threat*. How great of a risk is an actual nuclear catastrophe? How can policymakers and the public contribute to this effort?**

I’ve been concerned with the threat posed by nuclear weapons for almost 35 years now, and tried a number of different approaches to awaken society to the need for radical action to avert disaster. Almost 10 years ago, I realized that a key question had not been asked: How risky is nuclear deterrence? How risky is it to threaten to destroy civilization in an attempt to preserve the peace through mutual terror? Amazingly, no one knew.

Let’s suppose that nuclear deterrence could be expected to work for 500 years before it failed and destroyed civilization – a time horizon that seems optimistic to most people. Even then, relying on nuclear deterrence would be equivalent to playing Russian roulette with the life of a child born today. That’s because one-sixth of 500 years is roughly equal to that child’s expected lifetime.

Because that’s a largely subjective estimate of the risk, I looked into more objective ways to estimate it, and discovered Quantitative Risk Analysis (QRA). QRA breaks down a potential catastrophe into a number of smaller mistakes. A sequence of such smaller mistakes that results in the catastrophe is an accident chain. Even though we’ve never experienced the catastrophe, we usually have a lot of empirical data about excursions down various accident chains. That allows us to objectively estimate how often we will visit various states in the various accident chains, except for the last few states just prior to the catastrophe. There’s still uncertainty, but a lot less than just guessing at the overall risk. QRA also identifies ways to reduce the risk that otherwise wouldn’t be recognized – preventing the early steps in the accident chains. A good example of QRA’s value is that it got me looking at Ukraine as a possible spark for a nuclear crisis months before it came into most people’s view. I’ve been trying to get Congress to authorize a National Academies’ study of QRA applied to nuclear deterrence, but so far have not succeeded. Instead of Harry’s “zealous search for the truth,” (see Q2), society seems to be engaged in a “zealous effort to hide from the truth.”

**4. What do you believe is the single, greatest challenge that scientists or engineers have in conveying information to the public and political spheres?**

Where nuclear weapons are concerned, one of the biggest challenges in communicating with the public is getting society to recognize that low probability, high consequence events deserve our attention. Instead, people seem to behave as if low probability is the same as zero probability – a phenomenon that allowed Nicholas Taleb, author of *The Black Swan*, to make a fortune by betting on far out of the money options. Unfortunately, where a failure of nuclear deterrence is concerned, the consequences of complacency are much more dire. A related challenge is getting society to see that, even if an event has a low probability each year, over time, the risk builds up. Even if nuclear deterrence had a 500 year time horizon – so that it’s risk of failing each year was only 1-in-500 – that would build up to roughly one chance in six over the expected lifetime of a child born today!

**5. What kinds of things do you do beyond what “normal people” see? What do you actually spend the majority of your time doing?**

I am as much concerned with improving interpersonal relations as I am with improving international relations. In fact, I believe progress on the personal level is necessary for progress on the international level – including reducing the threat posed by nuclear weapons.

**6. What are the top issues that FAS should focus on in the next five years? What can FAS do to help prevent or mitigate catastrophic events such as nuclear war (a founding objective of the organization)?**

The global challenges facing humanity, particularly the nuclear threat and environmental degradation (including climate change) all seem to have a common root cause: the chasm between our god-like physical power through technology and our at best irresponsible adolescent behavior. We think we're immortal. We party like crazy with no concern for the hangover we'll have tomorrow. In general, we have far too little concern for the consequences of our actions. Narrowing the chasm between that maturity level and our god-like physical power is what FAS should focus on in the next five years.

**7. Complete this sentence: Science is \_\_\_\_\_.**

For the reasons given in question #6, science is forcing us to speed up the maturation process of our species. Science's “zealous search for the truth” is the solution, not the problem. The only question is whether we will heed its call.

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