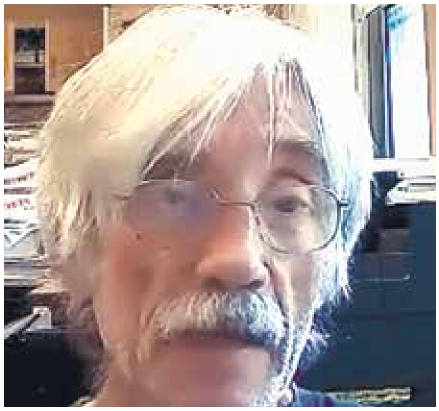
Dr. Edward Calabrese

Discard the Linear No-Threshold Model of Radiation Dose-Response

This is the edited transcript of the presentation of Edward Calabrese to Panel 3, "Principles of Science for Durable Economic Progress," of the Schiller Institute's June 18-19 Conference, "There Can Be No Peace Without the Bankruptcy Reorganization of the Dying Trans-Atlantic Financial System." Dr. Calabrese is a Professor of Environmental Health Sciences at the University of Massachusetts, Amherst. He is co-editor of Hormesis: A Revolution in Biology, Toxicology and Medicine (2010).


Schiller Institute
Dr. Edward Calabrese

Dr. Edward Calabrese is the author of over 750 published scientific papers and 10 books. He has studied extensively the historical underpinnings of the LNT (Linear No-Threshold) model and its application to cancer risk assessment and how we think about radiation exposure today.

He has documented that LNT was made policy based on fraudulent research, manipulation of scientific literature, and scientific misconduct by the U.S. National Academy of Sciences.

Instead, Dr. Calabrese supports the view that there is a non-linear, threshold-based dose-response for ionizing radiation and chemicals, arguing that low-dose exposures can provide health benefits. His work has recently been the subject of a widely viewed, 22-part documentary by the Health Physics Society.

His presentation is in the form of an interview, conducted by the Schiller Institute's Kynan Thistlethwaite. Subheads have been added.

Dose-Response Is Non-Linear and There Are Thresholds

Kynan Thistlethwaite: Thank you very much, Dr. Calabrese, for giving us your time and the opportunity to talk with you. Just to give a sense to the audience, can you say something about the LNT model, your research concerning the historical underpinnings of that model, and the way we think about it today?

Dr. Edward Calabrese: The LNT model is a dose-response model, a very general type of dose-response model. And just for the general public, the dose-response model is something that we all experience every single day: It's how much we do something, whether it's exercise, or consumption of alcohol, or anything—just, how much you do, and how that translates into an effect. It also relates to not just how much, but how quickly you do it. Say, for example, somebody has a glass of wine, and if they drink the glass of wine too quickly, they may feel light-headed very quickly. That's an example of a dose-response, and a dose-rate response. It relates to common experiences. When we do certain activities, we see certain effects, and those are plotted on graphs. That's the kind of the work that pharmacologists, toxicologists, and epidemiologists tend to do, when they try to figure out dose-response relationships and how drugs or pollutants, or anything, work on biological systems. That's the general idea of a dose-response relationship, and it's just something that one learns, probably by the time one is six years old. Except we put numbers around it as we get older and make it a bit more sophisticated.

In terms of the common-sensical situation, most people, I think, would believe that things tend to act via a threshold. It means that you may have to exceed a certain level of exposure before an effect may become perceptible or measured, or somehow register on whatever scale you're trying to register it on. That's how the belief systems tended to work 120, 150 years ago. And then, in 1930 or so, radiation geneticists in this country began to look at radiation and how it may affect the genome differently. An idea arose that there was no safe level of exposure, that there was no such thing as a threshold, that the effects of radiation were really different from chemicals or other things, and that every single exposure would cause a genetic change and was not repaired. And that the effects would be cumulative, that they would be irreversible, that they wouldn't be repairable.

And when you linked all those three things together, what you ended up getting was a linear dose response. That linear dose response assumed that any amount of exposure would cause damage, and ultimately even a single ionization from a single radiation particle could have the potential to cause damage. Over time—I would say from about 1930 when this idea was first floated, until let's say the late 1950s—it took about 30 years for this idea to resonate and to grow, and to get its following, and to take advantage of certain international situations, like the atomic bomb, like the above-ground testing, like fear of radioactive fallout; and ultimately, politicians and scientists and the world community moved from a threshold model to an LNT type of model, mostly on the basis of fear. Ultimately, fear has come to drive politicians and others, moving the country forward—or backward, however you might want to see how fear deals with our behavior and policies.

Weathering Peer Opposition

Q: Once you had published your findings concerning the foundations of the LNT model, and revealed its flaws, did you receive any opposition from your peers and other scientific institutions?

Dr. Calabrese: Well, I'd have to say that my challenging of the belief system of the scientific community, the toxicology community, the radiation community, began probably in a serious vein in the early 1990s. But I really wasn't taken very seriously until the early 2000s.

If people don't take you seriously, then you don't become the object of a lot of attacks. Whoever is in the bullseye, people tend to think that person is significant. If you're not really being attacked, then you probably realize you're not very significant in the eyes of the opposition. I knew that in the 1990s I was onto something that was exciting, and was going to be hot, but I knew that I had to do a lot more work to get there—put it that way. I worked kind of quietly in many ways, you know, the way a researcher works, basically, by playing the game you're supposed to: doing my work, publishing articles, and so forth.

And then, what happened for me was kind of a breakthrough, in both positive and negative ways. In 2003, I got a paper published in the journal *Nature,* and I was put into their publicity package. I had never published in *Nature* before, and I had never been in a publicity package before, but, wow!—I saw what that actually did. The paper didn't just attack LNT, it also attacked the threshold model. I was claiming that this phenomenon called *hormesis*—which is a biphasic dose response, where low doses of harmful things could actually be beneficial—was I believed the dominant dose-response model that should be operating in toxicology.

That was really a radical statement! It was like saying the field got everything wrong, right from the very beginning. And because it was so quirky and so challenging, I think it got the attention of the editorial board at *Nature*. They wanted to float the idea, that is, they wanted to allow me to float the idea. As I was to learn later—because some insider on their editorial board told me this—the big fight was over how many words I would be allowed, and how many figures. They were fighting over 2,500 words with two or three figures, and they ended up giving me 1,500 words and one figure. So that's what I got in my paper.

When I got the article into *Nature*—and I got into the press package—I ended up getting a lot of publicity—frontpage articles in multiple newspapers. In my hometown, you might say, the *Boston Globe* ran one; I got a bit story in the *Wall Street Journal*. *U.S. News & World Report* did a very big piece, put my picture in there. Eventually, later on, *Science* journal did a four-page story, with my picture in there as well. Lots of other things happened, all kinds of debates. And so, I went from kind of a non-entity into a known commodity, or "new kid on the block," so to speak.

What happened after that was that people began to get concerned, because here was somebody who was saying that not only was LNT wrong, but in fact toxic substances at low doses, he's saying, could produce even beneficial effects. He must be crazy, and if he's not crazy, he must be dangerous. In any case, he has to be challenged, and probably stopped. We'll see how serious he really is.

Advice to Science Students

Q: America should produce many more people capable of doing what you did. You are also a teacher. What do you think any student who wants to discover something in science has to understand to prepare themselves?

Dr. Calabrese: I'd have to tell you that my development in this area really happened after I was 50 years old, OK? I'm very broadly trained. I'm a very traditional person, a very traditional scientist, a very traditional lab-oriented person. I've taken a broad range of courses, and so I'm very "old school." I'm very old school when it comes to the breadth of my reading, but also in terms of being "hands on" in the laboratory, so I kind of, hopefully, paid my dues and understand the process, and am very self-critical.

But I have to tell you something that was very significant for me, that might be very useful for students: When I was a young Ph.D. student, there was this publication called *Current Contents*. We'd have a journal club meeting every week, and we'd try to take a look at the most recent papers, and see what's happening today.

After I got through graduate school and started to become a faculty member, I had to keep up on everything, but I actually developed a very inverted way of learning: When I was to write anything—and I wrote a lot of books and so forth—instead of looking at what was current, I went down and got the very first thing that was ever written on something, and then got every single thing that happened since that time.

I would never read the most recent article first! I read that last! I'd go to the very first thing, and I'd read what they discovered, then I'd say to myself, "What should the next experiment be? How would I do it?" And then I'd look to see what was done. Most often, what I thought should have been done, was never done!

I kept making this inverted cone step going forward, and it changed entirely the way—I began to see science as history. And I began to see science as biography. And I'm saying, most of our good ideas were lost along the way.

Whereas, the way science is taught today, and all days, is a straight line, from the beginning to right now. It's a straight line. Actually, science is anything but a straight line! It's a jagged line, there are gaps in it. I think the best ideas were never even thought about or followed up on. And yet, all we do is think it's a straight line and we go to the most recent things.

Somehow, I picked that up on my own, and this was actually at the core of how I believe I've made these historical discoveries on LNT—just doing something differently, and thinking about it very differently than the impatience of scientists today, who just have to read the most recent thing.

I'm all in favor of recent: I look at things every single day, what's happening today. But I don't forget that you really have to go back to the original—original stuff—and then you track it. Then you track it. You have to do twice as much work, but it's synergistically better than if you don't. So, I believe that's part of what's led to my lucky discoveries, along the way, you might say.

Conditions for Future Scientific Breakthroughs

Q: How do you believe new fields of science will be opened in the future? What do you think are the conditions required for new breakthroughs to happen?

Dr. Calabrese: It's interesting you raise that. In some ways, I've had a chance to experience both the negative and also the positive sides of it—how quickly theories develop. I'm going to give you an analogy, all right? The analogy is: I read a book a good number of years ago, and was looking at how an idea gets accepted, and how it gets spread through the colony or the society. But in this case, it was anthropologists who were studying two colonies of baboons. The two colonies were geographically isolated, but the researchers knew the social structure from the highest-ranked male to the lowest female baboon, in terms of their power structure.

The investigators were going to teach the baboons a very new and important way of acquiring food, and they wanted to see how long it would take the idea to be learned and adopted by all the other members of the colony. And so, in one case, they taught this knowledge to the top male. It took about three hours for all the other baboons to learn, observe, pick it up from the top male and do it. The anthropologists then went to the other baboon colony, and taught this knowledge to the lowest female. It took months and months for this great idea to be adopted.

I said to myself, "Wow! This is amazing, it depends on—good ideas, it's the same idea, but it depends on who has the idea as to how quickly it gets picked up." So, what's happened with me? This idea of hormesis, radiation hormesis and the like, was a revolutionary idea back in the 1980s. This big database, called Web of Science, had about 10 or 15 citations per year then. Forty years later—and I've been working on this extremely intensely—the citations are over 18,000. You might say, that's an awful lot; it's been really, really slow on the uptake, but now it's now going up quite fast.

As the equivalent of the female baboon, the lowest-ranked person, it has taken me 40 years to get my great idea going. If I had been, I'm going to say, the Dean of the Harvard School of Public Health, or if I had been somebody else of some notable something or other, and had the idea that I had early on, it would have revolutionized this world by now!

And so, I think that one of the big issues here is that there are certain social structures that can accelerate good ideas and social structures that make it very difficult for ideas to be adopted. It tells you something about either the political structure, the social structure, or something, but I can tell you, my ideas, either because of my low standing in society, or whatever else is going on, have taken an awful long time. OK, that's the negative side, all right?

On the positive side, I have believed in my ideas, I have studied them, and I can tell you that I understand what I am talking about far better because I've worked out all kinds of various problems by myself, with nobody even giving me a thread of encouragement! They mostly shun you, they reject you, they do all these things. But eventually, what will happen, as in this case, is that, I know—in fact, I'm being proven correct over time on these other ideas. The same thing is true on this LNT thing.

In the beginning, when I brought out that [Herman Joseph] Muller probably lied in his Nobel Prize speech, and that Muller probably didn't actually induce gene mutations, and I got bopped on the head, I got flushed down the toilet, and I got treated with, "You're a marginalized scientist, you're kind of a nothing." They really specialize in name calling and other ways to marginalize one. I've always taken great solace in the fact that the criticisms that I got were that I'm not as smart as Muller, and I didn't go to an Ivy League school, and I'm a marginalized scientist because I work on this hormesis thing. But eventually, when the name calling was all done, I said, "Well, all these things are true, but would you do me a favor, and tell me where my mistake is?" they just went back to recycling the personal attacks, rather than addressing the issues of science that I would raise.

So, you have to listen to what the criticisms are. If the criticisms are just how stupid you are, or the fact that you don't have a Nobel Prize, or the fact that you didn't go to Harvard University—well, all those may be true, but that's not the relevant question! You have to look at the relevant question.

There are different ways in which people try to prevent you from going forward, and to marginalize you. And you just have to try to understand what the basis of the arguments should be which are valid, and those arguments which aren't valid. And then hopefully people will get around to—but you have to be strong, and you have to be courageous, and you have to be self-critical. You know, you have a lot of critics out there, but the most important critic in your life is, guess who? It has to be you! You have to be your own worst, toughest, raunchiest, most difficult person to satisfy. And if you can be all those rough, tough things, to yourself, the rest of the world's going to seem kind of easy when you face it.

Prof. Sergey Pulinets

We Should Unite To Survive

This is the edited transcript of the presentation of Sergey Pulinets to Panel 3, "Principles of Science for Durable Economic Progress," of the Schiller Institute's June 18–19 Conference, "There Can Be No Peace Without the Bankruptcy Reorganization of the Dying Trans-Atlantic Financial System." Prof. Pulinets is Principal Scientific Researcher at the Space Research Institute, Russian Academy of Sciences in Moscow. He has more than 40 years of experience in space physics and radio physics, the physics of the ionosphere, and also geophysics.


Schiller Institute
Prof. Sergey Pulinets

Some graphics used are not shown here, and references to them have been removed.

Good afternoon, or, to those of you who are to the west it is good morning.

I would like to share with you my ideas about the relationship between the development of science and the present state of our society. I will start with similar things that were described in the first [Jason Ross'] presentation about Academician Vernadsky, whose ideas, I consider, paved the way for what I am doing now, especially two things: He was