

**Opening Remarks 3/22/11**  
**Dr. Lawrence D, Woolf**  
**General Atomics**

**SAN DIEGO SCIENCE FESTIVAL ANNOUNCES 3<sup>RD</sup> ANNUAL EVENT**

***Tuesday, March 22, 2011***

***Celebrating 50 years of Science***

***Time: 6pm***

***Location: California Institute for Telecommunications and Information Technology (Calit2) Auditorium on UC San Diego Campus, 9500 Gilman Dr, La Jolla, CA 92093***

Details: In celebration of UC San Diego's 50 years of extraordinary education, research, and innovation, this event showcases five panelists and their views on the future of STEM (Science, Technology, Engineering and Mathematics) education.

*"We would like each of our panelists to prepare a brief (no more than 10 minute) statement on your view of the future of STEM (Science, Technology, Engineering, and Math) education."*

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I would first like to thank UCSD for inviting me to participate on this panel "Celebrating 50 years of Science at UCSD" and I would also like to wish UCSD a very happy 50<sup>th</sup> birthday!

First, some background. I received my PhD from UCSD in 1980 and have been at General Atomics since 1982. I've been involved in education activities since 1993, currently as chair of the American Physical Society Forum on Education. My original involvement resulted from General Atomics starting an education outreach program in 1993, but my real immersion into science education resulted from my realization that as an industrial scientist, I had some unique knowledge and perspective that could prove useful to others in understanding scientific concepts. For example, I had done extensive research on the electrical properties of graphite in the mid-80s, and in the mid 90s realized that I could use the graphite in pencil lead to help students understand the electrical properties of simple circuits by drawing them on a piece of paper using a pencil. This led to numerous middle and high school teacher workshops, and ultimately the publication of an educational module. And it initiated my continuing involvement with a wide variety of science education initiatives.

Industry has a role to play in K-12 Science Technology Engineering and Mathematics (STEM) education. Industry needs to engage with the K-12 system by talking to students about their careers, giving demonstrations of their technology, judging at science fairs, or even providing professional development to teachers and developing unique educational materials – something I

have been extensively involved in, as previously mentioned. Locally, the San Diego Science Alliance has performed an exemplary role in fostering interactions between educators and industry and we are fortunate to have such an innovative resource in our community.

Industry also has a role to play in higher education. I'd like to use my experience to provide some ways that we can do better. UCSD graduate school prepared me well for doing original research, a skill most useful for me in a future role as a university professor. It prepared me less well for my career in industry. My classes generally consisted of listening to the professor, taking notes, doing homework problems, and memorizing for tests. Memorization is not a useful skill and solving well defined problems has utility, but it's limited. I think we need to ensure that students are prepared for non-academic as well as academic careers, for example, by ensuring that they have an awareness of a wide range of topics not generally taught such as program management, skills for solving ill-defined as well as well-defined problems, and the ability to innovate, so they can develop new ideas and convert those ideas to products for the marketplace.

We also need to improve student learning using recent research on how people learn. Physicists have taken a leading role in improving physics education via the new field of physics education research. However, these results have only been sporadically adopted and much more can be done. Education research is needed in other STEM areas and also needs to be incorporated in higher education STEM curricula.

More generally if we want to prepare our students for their future careers, there should be some sort of consensus standards or learning goals that guide departments in determining what their graduating students should know and be able to do. This occurred in K-12 education in the 90's for the same reason – so that schools could prepare their students for their post high school trajectories. There must also be continuous communication and feedback between those that provide the STEM education – higher education - and those that utilize the results of that education – namely industry. Here, industry can play a critical role. Industrial scientists and engineers have real world knowledge of ever changing critical skills and abilities. That knowledge should feed back to the educational system so that their graduates are prepared for their future careers and can “hit the ground running.”

So why should we be concerned with the current state of STEM education? The National Academy of Sciences report: *Rising Above the Gathering Storm* was initially prepared in 2005 in response to the following request from Congress: What are the top 10 actions that federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century? The *Gathering Storm* report concluded that a primary driver of the future economy and concomitant creation of jobs will be *innovation*, largely derived from advances in science and engineering.

What is the national consensus of what should be done to address these issues? The *Gathering Storm* report offered four overarching recommendations, 2 of them related to STEM education. The first recommendation was “Move the US K-12 education system in Science and Engineering to a leading position by global standards, and the number 3 recommendation was: Encourage more US citizens to pursue careers in STEM.

It also noted that to maintain or enhance our future standard of living requires that we lead the world in innovation. Innovation consists of being the first to acquire new knowledge through leading edge research, being first to apply that knowledge to create products and services, and being first to introduce those products and services into the marketplace.

We also need a population, including politicians, who can make informed decisions based on evidence and reason.

So how we can further improve K-12 STEM education?

First, we need to interest more students in STEM. We can do this in two ways: expose more students to STEM disciplines, and improve their level of understanding of STEM using quality curriculum and associated professional development. I am always amazed that any students at all choose to major in engineering in college, since most have never been exposed to any engineering courses in K-12.

We need to eliminate rote memorization and promote long term understanding that is transferrable to new situations, namely expert knowledge. Much research has indicated that this can best be accomplished by having students actively acquire their knowledge using design challenges, inquiry, and other research based programs that have demonstrated effectiveness. On a personal note, my oldest daughter Rebecca, a budding biologist in 9<sup>th</sup> grade, lost all interest in biology and science when her class became an exercise in non-stop memorization of topics – some of which were at the advanced undergraduate level. This was so disturbing to me that it was another major reason that I became involved in K-12 science education.

We need to increase understanding across disciplines to create more agile learners. For example, students could read *The Boy Who Harnessed the Wind*, the incredible story of William Kamkwamba, a 14 year old boy in Malawi, who amidst a famine and near starvation, figured out how to make a windmill to create electricity for his family using pictures from a science book in the library and half-buried junk. This is the type of book that would serve to meld the diverse disciplines of science, engineering, English, economics, history, and sociology and could inspire many students to consider STEM careers. Read the book or look at his TED videos and you'll see what I mean.

Jack Welch, the former CEO of General Electric, stated that to successfully compete in a global economy, he wanted GE to be either first or second in the world in any market in which they were engaged. I think we need to bring this thinking to the individual level. In this new global economy, the world is flat and information and technological knowledge flow at the speed of light. We need each worker in this new economy to continually adapt and transform themselves so that they are one of the most capable and innovative STEM workers in the world in their particular area of expertise. The future of STEM education should be guided by this goal. If we all do our share, I think we can reach it.