Focusing on the interface of business and technology

Forward-Thinker Builds Bridges to the Future

An interview with Dr. Steven R.J. Brueck, conducted by Dr. Milton M.T. Chang

Steven R.J. Brueck is director of the Center for High Technology Materials (CHTM) at the University of New Mexico (UNM), where he also is a professor of electrical and computer engineering and of physics. He received his BS from Columbia University and his MS and PhD from MIT, all in electrical engineering. Prior to UNM, he was a staff member of the Quantum Electronics Group at MIT Lincoln Laboratory.

Brueck is actively involved in numerous professional societies, serving on conference committees and society governing boards, and in editorial offices. He is editor of the IEEE *Journal of Quantum Electronics*, founding editor of IEEE *Journal of Selected Topics in Quantum Electronics* and general chairman of CLEO. He is the author of 350 publications in refereed journals and holds 30 patents. He has received many honors, including the UNM School of Engineering Senior Faculty Research Award and the IEEE Third Millennium Medal, and he is a fellow of OSA, IEEE and AAAS.

Milton Chang is managing director of Incubic Venture Fund, which invests in businesses related to photonics technologies. Former CEO/president of Newport Corp. and of New Focus Inc., he sits on the boards of AviaraDx, OpVista and Rockwell Scientific. He is a fellow of the Optical Society of America and the Laser Institute of America and a past president of the IEEE Laser Electro-Optics Society and of the LIA. He has received many awards and is a member of California Institute of Technology's board of trustees and the Committee of 100.

Milton Chang: Tell us about CHTM.
Steven R.J. Brueck: CHTM was created by the state of New Mexico in 1983. The concept was to enhance the economic development of New Mexico, particularly in high-tech areas, by taking advantage of the vast resources that are available as a result of the large federal research presence in the state, and transforming those resources into jobs in the private sector for the citizens of New Mexico. The state gave us about $10 million in six years. We have now brought in over twelve times that in research grants and contracts and have established an international reputation for quality work.

Mostly from which agencies?
We're still Department of Defense-oriented. One specific program that's very important to us is the NNIN, the National Nanotechnology Infrastructure Network, a network of user facilities making nanoscience research widely accessible. We are one of thirteen sites around the country that the National Science Foundation is supporting.

> **"In engineering schools … we have a very serious enrollment problem for American students at the graduate level."**

Any technology transfer successes?
We've had six or seven companies spin directly out of CHTM. We've done lots of work providing intellectual input to both start-ups and big companies, and the technology we've developed is being deployed around the world.

So how do you help companies?
We try hard to be user-friendly. Within NNIN, we have a very simple intellectual property policy with an easy contract that any vice president can sign without having to get it reviewed. It basically says 'Don't tell me anything you don't want to tell the world' and you own it. You own everything that you do if we have no intellectual input.

What are your core competencies?
One of our strengths is MBE [molecular beam epitaxy] growth, particularly MBE growth on quantum dot materials, and we're making them available to everybody through the NNIN mechanism. Another one that personally I'm very involved in is interferometric lithography, which today gets us down to below-30-nanometer structures.

What can you do for me as a company?
At the research stage, we provide the pieces of the puzzle which you don't have. When it gets to real manufacturing, then it is not an appropriate place for the university to be.

Don't you want products downstream?
Yes. There are a number of very large market opportunities where people are coming to us to get the initial work done; for example, nanoscale patterning for magnetic disk drives, structure-dependent nanoscale polarizers. Another one is photonic crystals for light extraction from LEDs.

What about in the area of photonics?
In photonics, we've done extensive work in diode lasers. Right now, that's moving to femtosecond mode-locked lasers. In detectors, we're growing both quantum dot infrared photodetectors and plasmonic

antennas on strained-layer superlattice detectors.

What does this technology do?
In principle, you can reduce the size of the detector without reducing the effective area over which you collect photons. That's a big advance in reducing noise in infrared detectors.

Where are the opportunities in photonics?
There's going to be increasing need for nanoscale things that are affordable. You'll need optics or some derivative of optics, maybe a nanoimprinter, to do parallel processing. We have to learn how to integrate these things and reduce the cost dramatically. Figuratively, we're still making individual transistors and wiring them up instead of being in the integrated circuit world; that's far too expensive a manufacturing process to get us anywhere. Optics has a very strong role to play there.

Sounds like manufacturing is a hot button. Any other hot buttons?
The overall research-to-product cycle in the US. Industry laboratories have been scaled back dramatically from where they were 20 years ago. In order for the US to maintain the same level of world-leading innovation and product generation, universities have to pick that up, have to be part of that process.

I agree with you 110%.
National laboratories are very important, too. They have the resources to bridge the gap between small-scale research programs and industry's need for proven technology. Universities tend to have a more free-wheeling attitude toward new ideas. And we have this constant influx of new students looking at the same problem and coming up with new ideas.

How can industry better capitalize on that?
We need to find ways to build stronger partnerships between the universities, the labs and industry. We have to work together more closely, and all of us need to understand the requirements of the other parties. Industry has to relax some ... constraints and make universities partners in the inventing process and reward them. I am amazed that some leading people in our industry hold the view that universities should make their inventions freely available to industry.

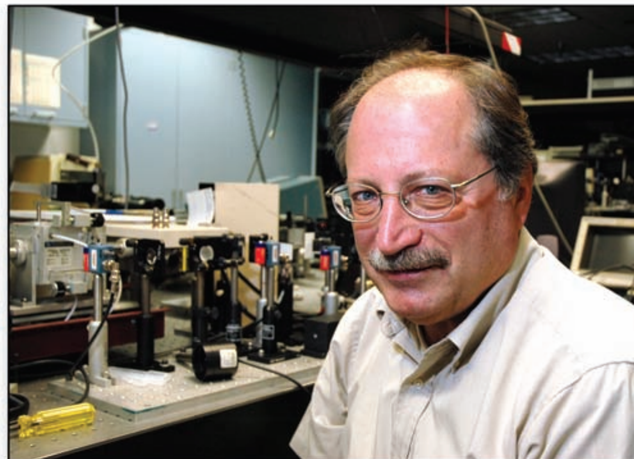
Photo courtesy of Greg Johnston

Steven R.J. Brueck

Any other technology frontiers we should pay attention to?
It's clearly nano-bio. We're now able to fabricate things on the scale at which biology operates. I take photons and use them to sculpt things. I use the photon as my ruler to get down to some small fraction of the wavelength, using it as a way to define distances so that I can make things. The other direction is self-assembly coming from chemists. The really exciting thing is what I call directed self-assembly by meshing these two technologies, using lithography to capture scales all the way from the microscopic down to something on the order of 10 nanometers and then using self-assembly to go from 10 nanometers down to 1 nanometer and below.

Any career advice?
The most important thing is to be involved, to find something that you like doing and do it. I think as a student you shouldn't worry too much about money. Find what you love, and go after it with a passion. The rest will tend to take care of itself.

Any solution to not having enough engineering students in America?
That's a very serious issue. That relates to our whole educational and reward systems. We don't have a particular enrollment problem in engineering schools at the undergraduate level; we have a very serious enrollment problem for American students at the graduate level. We have to do more to entice the students who have already declared an interest in technology to get them to go further in their educational process.

What's going to change the trend?
One is capitalism — pay them more. At their age, they're thinking about buying a car and having a life, and about having families. All that they should be able to do as graduate students. The reward structure is skewed — the current model is you get no money for however many years it takes you to get your PhD, and then all of a sudden, we pay you a lot of money. Another one of my hot buttons is the whole immigration thing. I've had many outstanding foreign students, and most of them get to stay here, but they have to agonize over it. The system is neither easy nor sure. These are the people you want to stay, the youth with chutzpah who come to start a new life because they're excited about things and about the opportunity the US represents to them. We shouldn't be trying to make them leave the country or make them go through multiple years of dealing with an uncertain legal system to stay here.