Last September was the 20th anniversary of my graduation from Purdue University. It was on September 22nd that I defended my Ph.D thesis. I remember very well the immense relief I felt when grabbing the doorknob and leaving the room where I was just questioned for about two hours about the importance of "The Quantum-Mechanical Analysis of Ultra Small Devices", the title of my Ph.D thesis. At that time, this was the most important day in my life as I had long aspired to living the American dream since I was in 5th grade. Back in the late 80s, I felt pretty good about my choice of topics for my thesis since I was fully aware that the fields of nanoscience and nanotechnology were inevitable. Indeed, at the time, Moore's law, which describes in various forms the exponential evolution in scale and performance of past and future generation of semiconductor chips, was gaining more attention and scrutiny. In 1987, the 0.1 micron or 100 nm chip generation or node was around the corner and there was very little doubt that the 21st century was certainly worth calling the Nanomillenium.

After joining the University of Cincinnati in 1989, I started developing several graduate level courses about the modeling of submicron devices, including the popular CMOS, HBT (Heterojunction Bipolar Transistor), and HEMT (High Electron Mobility Transistor) technologies. Since those classes were open to both first year graduate and senior students, I had to spend a fairly large amount of time explaining some rudiments of quantum-mechanics (QM) needed to fully appreciate the working principles of each device. Many of the students (and not just the undergraduate students from UC) were struggling with basics concepts in QM. At UC, the only exposure the students had received was a course in Modern Physics dating back to the sophomore year and some exposure to the concept of energy band in solids taught in two classes in solid state electronics based on the book by Streetman. The level of knowledge was roughly the same for foreign students joining the graduate program.

Starting in the mid-90s, our faculty has made significant efforts to include more classes into the curriculum dealing with the fields of nanoscience and nanotechnology. At the graduate level , we have now many classes being offered yearly, including:

ECES 622: Introduction to Quantum Computing http://www.ececs.uc.edu/~mcahay/qubit.html

ECES 628: Introduction to nanoelectronics

ECES 647: Submicron Device Modeling for VLSI http://www.ececs.uc.edu/~mcahay/EE647.html

ECES 678: Micro/Nano Fluidics Biochip Lab

ECES 753: Specific Topics in Quantum Computing http://www.ececs.uc.edu/~mcahay/753.html

MTSC 641: Nano-Structured Powders: Synthesis, Structure and Applications

CHE 698: Molecular Engineering of Functional Nanomaterials

ECES 758: Quantum Mechanics for engineering students

Nearly ten years into the Nanomillenium, one cannot stress enough the importance to expose undergraduate students to the fastly growing appearance nano-related issues in our daily life. It seems as if we are midst of a new, knowledge based, version of Moore's law in which each generation of newly trained scientists and engineers need to keep track of an exponentially growing and far-outreaching new phenomena being explored at the nanoscale level.

At UC, a consortium of faculty members from the colleges of Engineering and Applied Sciences have recently obtained research funding from NSF to implement two new courses in the undergraduate curriculum which has been offered to wide variety of students:

Winter Lecture: **ENFD 278** Introduction to Nanoscale Science & Technology

Spring Laboratory: **ENFD 279** Experimental Nanoscale Science & Technology

There are two new NSF-funded interdisciplinary courses in Nanoscale Science and Technology for Engineering, Physics, and Chemistry undergraduate students. For a more detailed description, go to the following website:

http://www.eng.uc.edu/ucnanoinstitute/education/education.php3

This teaching effort has also led to cross-fertilization of various research efforts among various departments and colleges. Similar efforts to revitalize the undergraduate curriculum in the science and engineering programs are now well under way across the U.S and abroad and some examples can be found in some of the links attached to this newsletter. Considering the importance of this endeavor to stay competitive on the international market with the production of a work force ready to tackle the future challenges of the nanotech revolution, a collaborative rather than competitive effort between academic institutions should certainly be encouraged and accelerated. The NSF has appreciated this much needed paradigm shift in our educational approach for several years. One should applaud the appearance of various websites with free access, such as the Nanohub website initiated by Purdue University, the recent launching of the Journal of Nanoeducation, and the various efforts to expose K-12 students to the richness and vast outreach of nanotechnology (see the links to this newsletter). In addition, the more recent advance in the areas of nano-medicine and nano-biology also stress that we could keep abreast of the important ramifications and inevitable humanitarian impacts of the field.

It seems as if Moore's law is here to stay. It may have to be rephrased as follows:" Nanotechnology will keep its exponentially growing infiltration on our daily life for many decades to come". For instance, the importance of the phenomenon of giant magnetoresistance (GMR) discovered in 1988 has led to a tremendous revolution in the new generations of hard drives and memories in the semiconductor industry. This important discovery has brought the highest honor to the two team leaders who pioneered the field, Albert Fert and Peter Gründberg who co-shared the 2007 Physics Nobel Prize. The physics being this phenomenon can only be appreciated with enough knowledge of the ferromagnetic properties of materials and transport through heterostructures at the nanoscale level. There is very little doubt that many other Nobel Prizes in nanorelated areas will be given to future generation of scientists and engineers. Now is definitely the time to train them as quickly and efficiently as possible!

This newsletter was written in collaboration with G. Ramanath from the Materials Science and Engineering Department at Rensselaer Polytechnic Insitute (Tel.: (518) 276-6844; Fax: (518) 276-8554; Email: Ramanath@rpi.edu; Web: www.rpi.edu/dept/materials/GR). He will be taking this responsibility from now on. Please feel free to send him suggestions for entries to the various links attached to this newsletter.