Grand Challenges for Computer Science and Engineering
By Ruzena Bajcsy
CITRIS Director
University of California
665 Soda Hall
Berkeley, CA 94720

I divide my position paper into two sections:

1. Computer Science: The Science of and about Information and Computation
2. Computer Engineering: The Impact on Society

Computer Science: The Science of and about Information and Computation

In the March, 2002 issue of Communication of the ACM, Vol. 45. No. 3, I espoused some ideas under the same title. My main point has been that while physics has the domain of inquiry into the physical world and biology has living nature, the Computer Science has its domain of inquiry: Information.

The difficulty, yet at the same time, the opportunity with the Information world is that it is both synthetic and analytic. One can create synthetic worlds as in Virtual Reality, while also having measurements and reflection/models of the real world, both coming from living and non-living real worlds. So the opportunity we now have is that we can create new worlds - domains, as combinations of the measurements and synthetic data. Given the information domain of inquiry, the challenge is to find the theoretical foundations and tools that are the most suitable for this domain in order to analyze and make verifiable models?

My next assertion is that these models depend on physical implementation, in which the information resides and, hence the computation is performed. The current possibilities are analog computers, discrete/digital computers and hybrid computers. Only the future will tell if we are right to reduce all our models to only one, especially digital models. We also do not know if and when the computation will be performed at the Planck's level of granularity.

Computer Engineering: The impact on society. CITRIS Agenda

The University of California, Berkeley has begun an ambitious multidisciplinary program to investigate the impact of Information Systems at Societal Scale, in areas such as energy conservation, disaster (man made and natural) management , health monitoring especially for the elderly, transportation, environment monitoring and education.

While the Institute's gravity centers on small, energy efficient wireless sensors which can be connected into adhoc networks and their applications on the above mentioned societal

problems, we are recognizing that the long term goals and challenges go well beyond these technologies. For example, large databases and digital libraries serve many different social science investigations, such as making economic predictions on various geographical, migrational and ethnographical trends. Similarly large census data provide a new laboratory for making political discourse more factual. Visualization techniques offer an important tool to display and analyze a wealth of data shared for research in archeology and anthropology for making not only more quantitative measurements and comparisons, but also for teaching purposes.

The challenge we face is how to create conducive environments in which both engineers and non-engineers can work on common problems on an equal footing. It is clear that technology, especially IT, never stands alone and independent of the users. Hence the challenge is how to set up the research environments, which enable study of the interaction between people and the technology. For example, disasters such as hurricanes and earthquakes are a research domain. The technology can alert people to the onset of such a disaster. However, how will people react to it? Will they follow the call for evacuation? If not, what are the reasons, etc.? What technologies can help/hinder public safety? What studies should be conducted to better understand this interaction?

DR. RUZENA BAJCSY

DIRECTOR CITRIS
(CENTER FOR INFORMATION TECHNOLOGY RESEARCH
IN THE INTEREST OF SOCIETY)
UNIVERSITY OF CALIFORNIA, BERKELY

Dr. Ruzena Bajcsy ("buy chee") was appointed Director of CITRIS at the University of California, Berkeley on November 1, 2001. Prior to coming to Berkeley, she was Assistant Director of the Computer Information Science and Engineering Directorate (CISE) between December 1, 1998 and September 1, 2001. As head of National Science Foundation's CISE directorate, Dr. Bajcsy managed a $500 million annual budget. She came to the NSF from the University of Pennsylvania where she was a professor of computer science and engineering.

Dr. Bajcsy is a pioneering researcher in machine perception, robotics and artificial intelligence. She is a professor both in the Computer and Information Science Department and in the Mechanical Engineering and Applied Mechanics Department at Berkeley. She is also a member of the Neuroscience Institute and the School of Medicine. She is also Director of the University of Pennsylvania's General Robotics and Active Sensory Perception Laboratory, which she founded in 1978.

Dr. Bajcsy has done seminal research in the areas of human-centered computer control, cognitive science, robotics, computerized radiological/medical image processing and artificial vision. She is highly regarded, not only for her significant research contributions, but also for her leadership in the creation of a world-class robotics laboratory, recognized world wide as a premiere research center. She is a member of the National Academy of Engineering, as well as the Institute of Medicine. She is especially known for her wide-ranging, broad outlook in the field and her cross-disciplinary talent and leadership in successfully bridging such diverse areas as robotics and artificial intelligence, engineering and cognitive science.

Dr. Bajcsy received her master's and Ph.D. degrees in electrical engineering from Slovak Technical University in 1957 and 1967, respectively. She received a Ph.D. in computer science in 1972 from Stanford University, and since that time has been teaching and doing research at Penn's Department of Computer and Information Science. She began as an assistant professor and within 13 years became chair of the department. Prior to her work at the University of Pennsylvania, she taught during the 1950s and 1960s as an instructor and assistant professor in the Department of Mathematics and Department of Computer Science at Slovak Technical University in Bratislava. She has served as advisor to more than 50 Ph.D. recipients. In 2001 she received an honorary doctorate from University of Ljubljana in Slovenia

In 2001 she became a recipient of the ACM A. Newell award.