Education and Research

A Personal Perspective

Lui Sha, CS, UIUC
lrs@cs.uiuc.edu

"Whatever be the details with which you cram your students, the chance of their meeting exactly that detail is almost infinitesimally small; and if they do meet it, they will probably have forgotten what you taught about it. … The really useful training yields a comprehension of a few general principles with a through grounding in the way they apply to a variety of concrete details. " Alfred North Whitehead

"As a mathematical discipline travels far from its empirical source, or still more, if it is a second and third generation only indirectly inspired by the ideas coming from 'reality', it is beset with very grave dangers. … the subject will develop along the line of least resistance, that the stream, so far from its source, will separate into a multitude of insignificant branches, and that the discipline will become a disorganized mass of details and complexities." John Von Neumann

I began my research in real-time systems around the mid-80. The protocols developed by my team and I are now supported by open standards on real time computing and by most of the commercially available operating systems designed to support hard real time or multi-media applications and it was cited in the National Research Councils' 1992 report's Selected Accomplishments section. In recent years, I focus on challenges from reliable system integration and evolution. In March 2001 Rockwell Collins has adopted my analysis methods for their next generation avionics systems with support from FAA management. Since last year, I started looking at computer security issues in computer-controlled infrastructures, and at QoS issues in next generation HDTV in cooperation with Philips Research. A paper by Liesbeth and Clement that introduced my work to Philips' consumer electronics R&D was awarded the "most influential paper" by Philips Research in 1998.

While I have diverse technical interests, I have a

Ever since Pathfinder landed on Mars July 4th, 1997, *this* world has never been quite the same. (Courtesy NASA/JPL)

"The Mars Pathfinder mission was widely proclaimed as 'flawless' in the early days after its July 4th, 1997 landing on the Martian surface. … But a few days into the mission, not long after Pathfinder started gathering meteorological data, the spacecraft began experiencing total system resets…

When was the last time you saw a room of people cheer a group of computer science theorists for their significant practical contribution to advancing human knowledge? :-) It was quite a moment. … For the record, the paper was: L. Sha, R. Rajkumar, and J. P. Lehoczky. Priority Inheritance Protocols: An Approach to Real-Time Synchronization. In IEEE Transactions on Computers, vol. 39, pp. 1175-1185, Sep. 1990." by Michael Jones in catless.ncl.ac.uk/Risks/19.49.html

"*The navigation payload software for the next block of Global Positioning System upgrade recently completed testing. ... This design would have been difficult or impossible prior to the development of rate monotonic theory*",

L. Doyle, and J. Elzey, *Successful Use of Rate Monotonic Theory on A Formidable Real-Time System*, Proceedings of IEEE Workshop on Real Time Operating Systems and Software, pp. 74, 1994.

lasting interest in understanding how we learn, how we formulate and solve research problems, and how we transfer specialized technical knowledge. To me, research means "re-search": searching again and again in the product space of problem formulations and solutions until high impact technologies are found. The efficiency of any search depends greatly on the methods that we use, no matter the search is for oil under the ground or for knowledge in the abstract. In this talk, I will share with you my research on research and education in the context of my technical work.

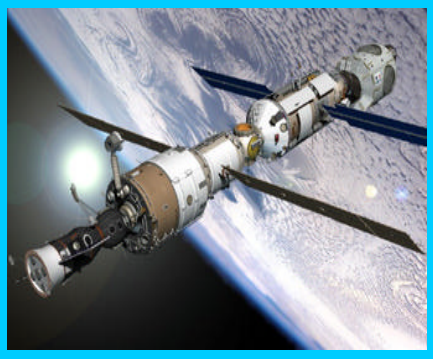
- How to help students to transition from lower levels of learning to higher levels of learning: a shift from a focus on "recite, apply and solve" to a focus on "categorize, critique and create".

- How to help graduate students to improve the skill of technical communication: keeping papers and presentations interesting, informative and insightful.

- How to help young researchers to cultivate a research agenda centered on the intersection of one's interest, talent and societal needs.

- How to develop a portfolio of complementary research problems for a team and to develop a shared vision of research through which everyone in the team can see a brighter future.

- How to systematically formulate candidate research problems and estimate their potential impacts. All problems are not equal. The theorems and homework problems to be proved by students in a textbook are all proven to be correct under the same set of axioms. What makes them so different in values? Why is it so important to develop the ability to abstract messy real world challenges to well-formulated model problems amenable to academic research?



"*Through the development of Rate Monotonic Scheduling, we now have a system that will allow [Space Station] Freedom's computers to budget their time, to choose between a variety of tasks, and decide not only which one to do first but how much time to spend in the process*",
Aaron Cohen, Deputy Administrator of NASA, October 1992 lecture, *Charting The Future: Challenges and Promises Ahead of Space Exploration.*

"*Dear Dr. Sha,*
I hope this finds you doing well. I frequently recall your efforts on everyone's behalf in convincing IBM on RMS principles for the Space Station Software ..."
International Space Station C&DH Architecture and Software Manager, David Pruett, NASA Johnson Space Center, January 19, 2001. (When ISS became operational.)

"*The bottom line is that now we are basing the mathematical analysis on work done by Dr. Sha...*"
report to FAA by Greg Shelton of Rockwell Collins, March 2001.

"*There is a need for a reliable real-time software center …Dr. Sha and the UIUC are eminently qualified to contribute in this area.*" Charles W. Kilgore II, Program Manager, Software & Digital Systems Safety Program FAA William J. Hughes Technical Center, Flight Safety Research Section, August 2001.