Interview: “HPS, a New Microarchitecture”

Patt, Yale

1. *What is the essence of the contribution for which you received the Eckert Mauchly Prize?*

One can never be sure what it is that makes a Jury of Award decide to honor one's achievements. The citation says it is for my contributions to instruction level parallelism and superscalar processor design. If I take this at face value, then the award was for HPS, a new microarchitecture for obtaining high performance processing of irregular applications, and for my branch predictor which enhanced the capability of HPS.

That is, the HPS microarchitecture with the branch predictor formed a major part of the implementation of the microprocessor which is at the heart of every computer system. Improving the capabilities of microprocessors make computer systems execute applications faster.

However, there are many people's work that deserve strong recognition. So one must humbly ask why my work was singled out for extreme praise, rather than someone else's. I do not have an easy answer for that.

2. *What are the impacts of this contribution?*

Prior to HPS and the branch predictor, many of the pseudo-gurus in the computer architecture community were putting an artificial ceiling on how much performance one could obtain from a microprocessor. Our work showed that we have a long way to go before we approach the real ceiling. One immediate result of our work was that some important applications were able to be carried out faster by computer systems that used the results of our work than that ceiling suggested. The more important long-term value, I think, was that we showed that one should not be so quick to put an upper bound on what human ingenuity can produce.

3. *What are the applications of your contribution that may change the everyday life?*

Two things. First the obvious, that tasks can be performed by a computer faster, perhaps twice as fast. What used to take two days takes one day. But far more important is the mind set that we helped to create: that the limit is a long way off. Today, what took a day, takes less than an hour. This impacts many new uses for computers, from predicting weather earlier to allow ships to navigate seas better, to displaying medical data in a way that allows physicians to save lives, to someday providing computer-controlled automobile operation that will eliminate auto accidents. Hardly any part of human life is not touched and helped by higher capability computers.

5. *We learned a lot from your lectures in L Aquila. Can you tell us, what are the issues that we have to teach our kids, so they become creative when they finish studies?*

Tell them to ignore the fads, and master the fundamentals. Fads come into fashion and then go out of fashion. Fundamentals last forever. Fifteen years ago, the programming language of choice was C, which gave way to C++. Today it seems to be Java. Soon, perhaps C#. Perhaps in five years it will be D-flat. The point is that the fads change. One prepares much better with a solid foundation, with lots of math, physics, statistics.

Second I would tell them that to be creative, they need to really understand the fundamentals, not simply memorize some set of equations. Certainly, we need to memorize some things, but the fewer things the better in my view. They need to be able to use what they learn if they are to be creative, and memorizing does not really help accomplish that. Students often complain about exams with "trick" questions,

when in fact the questions were not "trick" questions at all. They were geared to test whether the student really understood the concept or simply memorized some formulas he hoped to apply.
Deep understanding of fundamentals, is in my view, the key to creative research downstream.

6. *What are the major things to keep in mind, when you form a team for a scientific experiment, or similar?*

That you pick members of the team that are individually strong, both in their intellect and in their resolve. But it is also necessary that they each have respect for the other team members and are willing to listen as well as talk.

7. *What are the people to avoid, when trying to generate a break-through achievement?*

People who are mired in yesterday, unafraid to take risks, afraid to fail. People who never listen, who totally know it all -- or at least think they do. People who spend a lot of time posturing.

8. *What is your opinion about the impact of math?*

I already answered that in one of my answers above. Incredibly important. For several reasons. It obviously provides you with a set of tools, and that is important even though you may not use these tools every day. But more important is the reasoning ability one develops from studying math.

9. *When targeting a major breakthrough, how sensitive one has to be about the direct interests of tax-payers?*

I guess you are asking me how much one should consider the interests of those who are paying for the research in selecting what research problems to work on. That should depend on how the funding arrived. If it came with no strings attached, then the researcher is free to work on whatever he finds fascinating. If the source of funding is very explicitly to do x,y,and z, then I believe the researcher is compelled to work on x,y,and z. The problem arises when the funding is not accompanied by explicit instructions, but rather implicit intentions. In that case, one can not give a blanket answer. Each situation needs to be dealt with on its own. I do believe the researcher does share the responsibility of determining how unconstrained the donor's intentions are.

10. *What is the major driving force that motivates a person like you to continue to create and generate results after he-she receives such a big prize?*

I guess I do not spend a lot of time looking in the mirror being pleased with myself, and that frees up time to do other things.

Seriously, there is a thrill that one gets when one comes up with new knowledge that changes how the world sees things. In fact, as you perform the experiment or prove the theorem, and are traveling on seas heretofore uncharted, the heart pounds harder as you get closer to the result, and when you get there, all your senses reach a crescendo that is indescribable. It does not happen often, but when it does, wow! It makes you come back for more.

I should also say that research is only part of my life as a professor. I also get to teach. And teaching is really my first love. I get to walk into a classroom and explain things to students, and I get to see their eyes light up when they understand. That is number one with me.

The good news is that research and teaching go hand in hand. They are mutually very symbiotic. I am not sure I would be any good at either if I could not do both.

11. *For small nations like Serbian, what is your advice, which road to take, when it comes to science?*

There are many ways to make a difference, some of them are capital intensive, others require very little capital investment. I would say a country that is not laden with research funds to spend should concentrate on those topics which do not require huge capital investment. In fact, I would go one step further. If a small nation can demonstrate its creative prowess in science that does not require large amounts of capital, it is more likely to attract partnerships with nations that have more capital than creative talent.

12. *What road to take, when it comes to its general future development plans?*

That depends on where that country wants to be in 20 years, and I would be very presumptuous to tell anyone where they should be in 20 years. I do think that an educated work force would be helpful regardless of a nation's goals. So, I would certainly argue for that. But beyond that, I think I will pass.