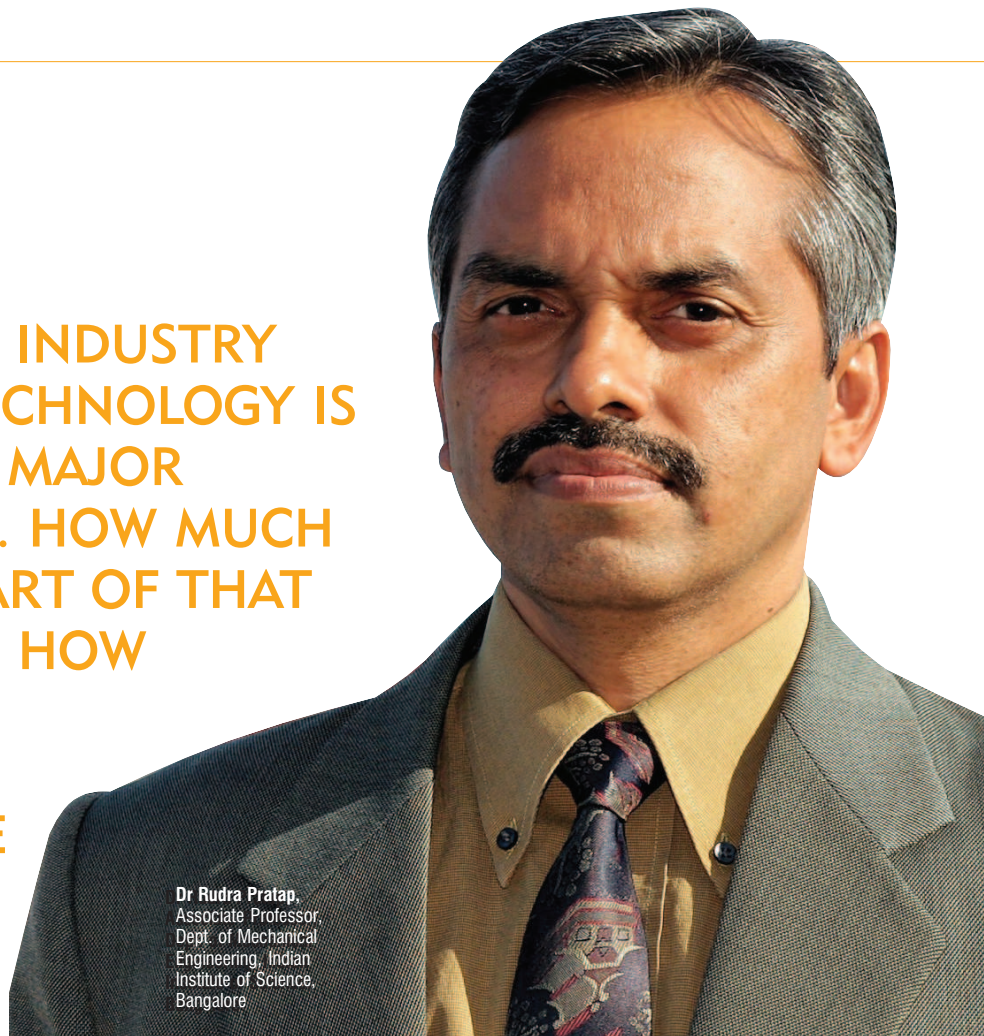"WITHIN THE IT INDUSTRY ITSELF, NANOTECHNOLOGY IS GOING TO BE A MAJOR DRIVING FORCE. HOW MUCH WE CAN BE A PART OF THAT DEPENDS UPON HOW FAST WE CAN BUILD OUR INFRASTRUCTURE FOR NANO-TECHNOLOGY."

Dr Rudra Pratap,
Associate Professor,
Dept. of Mechanical
Engineering, Indian
Institute of Science,
Bangalore

Dr Rudra Pratap, an acknowledged expert in the areas of micro-electromechanical systems (MEMS), computational mechanics and non-linear dynamics, is an Associate Professor of Mechanical Engineering at the Indian Institute of Science, Bangalore. Dr Pratap is the Chairman of Cranes Software International Ltd. He is a B.Tech from IIT Kharagpur, an M.S. from the University of Arizona and a Ph.D from Cornell University.

Over a period of 20 years, Dr Pratap has had his work published in prestigious international journals and has authored the book, 'Getting Started With MATLAB'. EFY correspondent, Dipti Agarwal spoke to Dr Pratap about the trends in nanotechnology. Here are his views.

Q **Besides developing analysis tools and software for the specific needs of engineers, Cranes Software Lab is currently working on MEMS sensors for acoustic applications and ultrasound imaging. What is the importance of these sensors?**

A microphone is something you already know of. Our idea is to produce something that's better and cheaper than the existing device. There are two things one looks at in a

technology—is there something new and exciting in it for a researchers and what are the potential long-term benefits? When we started looking at the microphone, we were looking at a totally different sensing element. The microphone developed is so small that it can be implanted in a pair of spectacles too. The MEMS microphone gives a better response over a wide frequency spectrum, at a lower cost. There is the possibility of forming an array and then getting better output

sensitivity. In MEMS devices, there can be several dynamic components, such as the vibrating membrane in the MEMS microphone. Active devices are now on the same chip as passive electronics devices. Since manufacturing of MEMS devices is done on a wafer and the same IC technology is used to produce them, making one device is the same as making a thousand devices, which lowers the ultimate cost.

Q What about areas other than information technology? Are there ways that nanotechnology can help us deal with basic human needs, such as food and fresh water scarcity?

Nanotechnology is a promising technology that can address the needs of the common man. Most of the research is now concentrated on producing nanomaterials. Nanostructuring, which is the patterning of materials with nanoparticles, changes the surface texture and produces an absolutely different effect. Take the example of a lotus leaf that is made up of the same organic material as any other leaf. But due to its texture it becomes hydrophobic. If our fabric has that nanostructuring, then it will be textured to use less detergent and less water. There's a solution to a common man's problem.

Nanocrystals, nanomolecules and nanomonolayers are used basically to bring out new effects and new phenomena that can be exploited for the common man's benefit.

Coming to food, the distribution channels are not proper due to transport and preservation problems. Just imagine if there was a nano spray that preserves food by forming a washable coating over it. It seals the moisture of the food and keeps it fresh for a longer time. If you can do it successfully, you can cut down on refrigeration costs, thereby leading to huge savings in terms of electricity and energy. Photochromism, which is used to produce films that change according to light conditions, can be made affordable by nanotechnology.

At present, the amount of energy spent to produce solar cells exceeds the amount of energy you derive from it. Nanotechnology can increase the efficiency of solar cells from the current 12-15 per cent to 50 per cent, saving huge amounts of energy and money.

Nanoelectronics is a major emerging field of nanotechnology. Storage and processing power increases manifold in processors and chips built using nanoelectronics. If you want the devices to do a certain amount of work, then there should be a certain amount of intelligence in them. Application of nanotechnology turns passive devices into active devices.

Q Can this technology solve the problems of farmers?

Certainly, some of them can be addressed. During irrigation, based on data given by distributed sensors, farmers can easily find the optimal requirement of moisture content at different sections of the land. This helps them to save water and energy, and increase yield by applying only the optimal amount of water to the plant. Thus uniformity can be achieved through a network of built-in energy efficient sensors and actuators, with automatic monitors for computation.

We can make the environment intelligent by using nanotechnology to make autonomous systems with embedded power.

Q What is the role of nanotechnology in the country's growth within the global economy?

In the field of nanotechnology, we have a long way to go. Now is the right time for us to get on to a technology platform other than IT, which is as powerful in terms of what it can deliver. In the IT industry, we haven't created any technology as such. But in nanotechnology, we have to create that technology and then make money. So first of all, within the IT industry itself, nanotechnology is going to be a major driving force. How much we can be a part of that depends upon how fast we can build our infrastructure for nanotechnology.

Q To quote you, "…a lack of coordinated effort between the government, industry, academia and the people in developing countries meant that nanotechnology has not been channelled into programmes on industrial development." Can you suggest some ways to overcome the problem?

Nanotechnology requires system integration people. Developing the material is an easy part, but how to use that material in a system that reaches the end consumer is a much bigger challenge. How much work is required to develop a product! How much money is involved… our country doesn't have this experience. This is where I think the government should put its focus on. It needs to encourage entrepreneurs and engineers to work in this area by providing money and infrastructure. We train students and then lose them due to the lack of proper facilities, where they can experiment on making products.

This technology requires you to actually work on the technology and not just publish research papers. So we must work closely with industry, and enthuse them with a belief in nanotechnology. Industry needs to understand where we stand, where the research is going and how much work is involved in the productisation phase. We develop conceptual products but to convert that into a complete product, we need time and money.

I think the awareness of coordination has just started happening in this country. CII is arranging meetings of this nature where they are bringing in people from academia and industry to talk to each other. The government should spend more money on technology creation and productisation. In the beginning, the government can do this in the same model as adopted by the US. There the government offers monetary support to small entrepreneurs under its small business initiative called SBIR. Some amount is given initially to explore

> Nanotechnology requires you to actually work on the technology and not just publish research papers, so we must work closely with industry, and enthuse them with a belief in this technology.

your idea. Once you come up with the result and get some industry interested enough to invest some money in it to take your idea further, then the government gives you further support and incentives.

Thus, the government is helping not only you but also the industry by subsidising the productisation process. It has been realised that though we do have these types of initiatives, there is little awareness about it. Why can't the government spend some money to create awareness through the media? The programmes remain unutilised. I think productisation should get a big push. There should be a separate body, or one under DST, to concentrate on this issue.

The government should look at bigger infrastructural support and the massive funding required in a new technology that companies are not in a position to provide. You have to find people who have made a genuine effort, and that effort needs to be backed by a serious desire to succeed.

Q As mentioned by you, the toxicity of nano particles and the uncontrollable self-replicating nano-machines or 'grey goo' are some potential future threats posed by nanotechnology. What is required to be done to avoid serious and unexpected harm arising from them?

The existence of 'grey goo' has not yet been scientifically proved, but nano toxicity is a real threat. We haven't explored the fallouts from the materials we are excited about. For example, in drugs, nano toxicity is of direct concern. We don't know the impact or effect of this on our body. These are problems that we must address. The problem of toxicity is being studied by toxicologists. There is no shortcut to it. Then there is this scary scenario of lethal nanoparticles—those particles can be surreptitiously fed to people, affecting society. But nanotechnology is like any other technology. Take the example of atomic energy, which could be used for generating electricity or for making atom bombs.

But a different problem is that there is a lot of hype in this field, which leads to more expectations. So even though technology is delivering at the rate at which it should deliver, your expectations are so high that it looks like a failure.

Q What advice would you give to young people who are interested in getting involved in nanotechnology?

Young people should learn to dream big. They should look at the problems of scale. Students should concentrate on the existing problems of the country that could be solved by using appropriate technology. Nanotechnology has arrived with a bang. Students should dive into it. Today, as a society we are becoming more affluent. So now we are in a position to encourage our students to take bigger risks and challenges. We need to encourage our students to be entrepreneurs. Do research, come up with technology and run with it. Set up your company and make money. *i.t.*