IChemE Presidential Address
by
Dr. R.A. Mashelkar, FRS
(London, 16th May 2007)

I deem it a special honour and a privilege to have this opportunity to serve this great institution, our IChemE. I accept this honour with all the humility at my command.

I am particularly proud of the fact that I will be the first ever President of IChemE from a developing nation, or better from an "emerging economy", or perhaps even better, from a "re-emerging economy". After all that is what one will call India, which had one third of the share of GDP of the world just a few centuries ago!

Revisiting the Charter

As we celebrate the 50th anniversary of the granting of the Royal Charter to IChemE, let us recall some of those inspiring words that were penned by our visionary founders then.

> *"To promote, foster and develop the general advancement of the science of chemical engineering in all its branches as an end in itself and as a means of furthering the scientific and economic development …….. the Institution may consider likely to conduce to those ends and to the benefit of the community at large."*

We can feel proud that IChemE has lived up to all these expectations. "The Roadmap for 21st Century Chemical Engineering", which we have released is an excellent testimony to this.

Towards "inclusive growth"

This Jubilee Report shows our sensitivity and concern about the societal needs, and also an astute understanding of the key role that the chemical engineers will have in fulfilling these. And then "The Technology Strategy Roadmap" shows our strong commitment to do our very best to fulfill that role.

Let us, however, look at the Royal Charter again. It charges us to work for the benefit of the "community at large". Let me focus on the words 'at large'.

We do know that there are three billion people in the world, whose income levels are less than two dollars a day. There are 800 million people, who will go to bed hungry tonight as we await the gala dinner at the end of this lecture.

I know it was to go to bed hungry. Because a poor child, whose name was Ramesh Mashelkar, did not have the luxury of two meals a day everyday in early fifties. Yes indeed, born in abject poverty, I walked barefoot in the streets of Bombay until I was twelve and studied under streetlights. I have seen it all.

So when we talk about the "community at large", are we also looking at this 'bottom of the pyramid' comprising millions of such young Mashelkars?

We need to fairly face the challenge of "inclusive growth"? By this, I mean "including" those unfortunate billions, who have been excluded so far in terms of accessibility, availability and affordability of the goods and services, which we all enjoy.

For instance, we need to be concerned that one billion people do not have access to drinking water, something that Sir David King referred to in the morning. Over two billion people are deprived of an access to modern forms of energy.

I do believe that IChemE can provide leadership to the global chemical engineering community to inspire them to help "engineer" the future of this "community at large", as our very own Charter has charged us to do.

I must congratulate IChemE for launching an imaginative "whynotchemeng" campaign. The wonderful results are there for all of us to see.

The enrolments in chemical engineering in UK have gone up so remarkably. These served the interests of our profession admirably. Why do we not now launch a campaign called "whynotoneworld" , with a plea for an "inclusive world?"

I believe this is the first challenge before our profession. What are the other challenges ? Let me enumerate the other challenges that we as a profession face now.

Transitioning to a sustainable future

I had the privilege of presiding over the Blackett Memorial Lecture delivered by Prof. Martin Rees, the President of Royal Society in Delhi early this year. His lecture was titled , somewhat provocatively, and I would say, thoughtfully, as "The last century : Will the civilization survive the 21st century?"

This serious question mark about our common future is due to a variety of crises that we are facing today, be it global warming, climate change, stratospheric ozone depletion or the way biodiversity has been ravaged by the modern society. All these formed the cornerstone of Sir David King's concerns in the morning, when he talked about our future into the twenty first century.

I strongly believe that chemical engineers can lead the process of our globe transitioning to a sustainable future – be it in terms of a sustainable energy future, or a sustainable water future or a sustainable ecological future.

As an example, let us look at the challenge of the world transitioning to a sustainable energy future. And I will, for want of time, only speak about sustainable energy future. We have to secure energy supplies for our future needs by meeting three challenges.

The first is the issue of preserving the integrity of our natural systems. This will mean, among others, our dealing decisively the catastrophic climate change issues.

The second is the issue of dealing with the basic energy needs of over two to three billion people around the world, who lack access to modern forms of energy.

The third is the issue of "resource nationalism". Although "technonationalism" has moved to "technoglobalism" due to the mobile nature of information, knowledge and human capital, this has not happened in the case of resources – resources connected with energy supplies – be it oil, gas and so on.

"Resource nationalism" has the potential of increasing the competition for unevenly distributed energy resources around the world and potential conflicts as a result, something that we can ill-afford.

The social, technological, economic and political dimensions of the sustainable energy future are mind boggling. I believe, however, that it is our chemical engineering profession that can provide the leadership in facing the challenge effectively. But we need a sense of great urgency.

The global greenhouse emissions increased by 70% between 1970 and now. They will continue to rise. These emissions must peak and start falling now. Sir David King again mentioned about the thermal fly wheel – if we stop at the

current levels, the effects of this action will start showing up only after thirty years. The disturbing question is what happens, if we do not ?

'Low carbon economy', 'no carbon economy', 'carbon neutral home' will remain buzzwords, if chemical engineers do not spring into action.

I firmly believe that twenty first century is the defining century. What we do now will determine the future of the planet earth. Indeed I dare say that the next two to three decades will have to be the decades of determined global engagement, commitment and action.

Towards sustainable consumption

Let me take a bit of a holistic and a bit of a philosophical view. What is our real challenge? We are a "consumer society" today. How do we make this society believe in and practice the principles of 'sustainable consumption'? How can we do it at a time, when nations around the world that had never experienced material affluence, are beginning to get a feel of it, and rightfully, enjoying it.

As per the World Bank publication entitled 'Global Economic Prospects 2007: Managing the Next Wave of Globalisation', the global economy is expected to grow from $35 trillion in 2005 to $72 trillion in 2030. The developing country share is supposed to triple up, from $8 trillion to$ 24 trillion.

This means that the developing countries are going to consume "more" and not "less". How do we then modulate the aspirations for a better quality of life in the rapidly emerging economies with vast populations such as China and India with this notion of sustainable consumption?

In fact, the big challenge is to make the society as a whole agree to adapt to lifestyles that are within the bounds of the ecologically possible.

It is obvious that we cannot impose policies that will lead to substantially expensive energy supplies, deep economic recessions and job losses. This will be counterproductive for the world as a whole.

On a holistic basis, we need to clarify the global, regional, national and local constraints to consumption and production. For this a shared understanding of the social, demographic, economic, ethical, cultural and technological driving forces of consumption patterns is needed.

In short, we require a global engagement, consensus and more importantly, a firm commitment on all these issues.

From global engagement to global commitment.

Do we see any evidence of such a commitment? We heard about these commitments, in the context of, for example, the Kyoto protocol. We heard about the first commitment and now we hear about the second commitment.

The troubled journey from the Rio earth Summit in 1992 to the 1997 .Kyoto protocol continues further. There was a vigorous engagement in Bangkok on the Intergovernmental Panel on Climate Change earlier this month. You must have followed this drama of meetings with two thousand delegates going on until four in the morning!

A fortnight long meeting in Bonn this month itself of the UN Framework Convention on Climate is intended to start hammering out the draft proposals for moving Kyoto forward into the so called second commitment. But let me come to the first commitment itself.

Let us not forget that the first commitment period is due to expire in 2012. Again there will be deep engagements with meetings later in Vienna and then in Bali. So from Rio to Bangkok to Bonn to Vienna to Bali – from 1992 to 2007 – for fifteen years – the engagement continues.

But what about the commitment? And that is where I feel what happened after the 1987 Montréal Protocol on engagement – dialogue – commitment – action – an CFC phase out is interesting. There, we achieved the results. Why can it not happen in the case of energy then ? We certainly see the evidence of continued global engagement but not a firm global commitment.

Can we not, as a chemical engineering community, have a say in creating a climate for such a global commitment? My sense is that in raising such a global voice, we cannot remain on the periphery.

Should we as scientists and engineers remain silent? Should we not have our voice? Shall we leave it to politicians, to businessmen and to NGOs? I do not think so.

As President of Indian National Science Academy, during the past twelve months, I have been signing interacademy statements on climate change. These are leading science academies of the world including UK, USA, India, China, Brazil, etc.

I would dearly love to do and sign such a statement in my role as IChemE president, if we all agreed. I am confident that we can galvanise all our chemical engineering institutions around the world together for this great cause. And perhaps then the engineering profession as a whole.

Our collective voice must be heard, wherever it matters, in the parliaments, in UN, in the world Bank, in The World Economic Forum, wherever we can make a difference.

And why will our voice be heard? We can proudly promise that we, the chemical engineers, are the “solution providers” to the world in these times of crises.

I have focused so far on the ‘bold print’. In other words, the grand challenges before the humanity as a whole.

Public perceptions and reality

Let us move nearer to home and that is to our own industry. Our chemical industry. This industry is the second largest contributor of the world GDP.

With more than 70,000 commercial products, its complexity and diversity that our industry presents is not matched by any other industry. What does the future hold? I believe it is very bright, but there are challenges too.

The first challenge is that of managing the perceptions about our industry. I read that according to risk expert Paul Slovic, people in the US and other industrialised nations see themselves as increasingly vulnerable to the risks posed by the chemical technologies.

Down the Bhopal memory lane

The reasons are not far to seek. I have personally been involved in looking closely at human tragedies in India due to the accidents in Indian chemical industry. And they were the worst two in our history.

The first was the Bhopal gas tragedy. An accidental leakage of the deadly methyl isocyanate in the early hours of 3 December 1984 killed and incapacitated thousands of people.

This is rated as the worst industrial disaster in human history. Some have called it the “Hiroshima of chemical industry”.

I served as the technical assessor for the inquiry commission that was set up by the Government. I remember, within two days of the accident, I was standing on the accident tank, which was emptied. Next to that was another tank with 40 tons of MIC. We did not know, whether it was a ticking time bomb?

We had to deal with a society that was scared – people that were angry. For a 39 year old engineer, it was a sobering experience.

The second was the accident at Maharashtra Gas Cracker Complex almost ten years later, which killed thirty four people. I was appointed as the Chairman of the Inquiry Committee to investigate the cause of the accident and suggest measures so that such accidents could be prevented in future.

Responsible Chemical Industry

These were challenging assignments for me. They taught me as to what 'responsible chemical industry' should be and what the duties and obligations of 'responsible chemical engineers' should be.

I am therefore very happy to see the roadmap, we at IChemE have drawn up for the twenty first century, which makes an explicit statement:

IChemE will engage with corporate leaders, regulators, and other professional bodies to create cultures that deliver real improvements in health, safety and environmental performance, and have benefits to all.

The future of our industry

This firm commitment augurs extremely well for the future of this industry. A continued engagement with the society alone can restore the confidence. That alone will ensure a great future for our industry that is beginning to unfold. And there are many exciting pointers – about this great future.

The spectacular advances in life sciences are creating new opportunities, which are unprecedented with many chemical companies reinventing themselves as life science companies. DuPont, Dow, Monsanto – they are just starters – others are following.

Both value creation and volume creation will continue to be the key determinants of the competitiveness of our industry. In fact the chemical industry has the

opportunity of creating new value domains by reinventing itself at the interface of life sciences and material sciences.

The quest for volume creation will see the factors of organization, finance, specialization, synergy and technology leading to fewer large companies. I will not be surprised if we are left with only half the companies of those that we have in existence today, in the next decade.

Changing geography of science and economy

The industry will be influenced by two profound changes. The first is that the skills, capital and markets have become increasingly global, transcending the earlier barriers.

Secondly there is a change of geography of science, technology, innovation and economy. A “new atlas” is already being drawn. Let me explain.

If I was not going to be in London for our IChemE meeting, I would have been in Pune in India inaugurating the R&D centre of Dow Chemicals today that is on 17 May.

This centre will engage 600 scientists and engineers in cutting edge research. But it is not Dow alone. Greg Lewin and I talked about the Shell R&D Centre, which is about 400 strong in Bangalore. General Electric, Du Pont, indeed over 200 such companies, have set up their R&D centres in India. These centres are not small. Some of them employ over two to three thousand researchers!

Why is this happening? As Jack Welch said, while inaugurating the GE’s R&D centre in Bangalore, ‘we get the highest intellectual capital per dollar here.’

But it is not just cost cutting. The R&D agenda in these centres is not simply serving the needs of the local markets. It is finding competitive solutions for their global businesses.

The rapidly expanding economies are also driving this shift. For example, when China is setting up one coal based power plant per week, it is no surprise if ABB shifts their energy R&D centres to China.

These shifts are dramatic. Two of the six largest petroleum refineries in the world are located in Jamnagar. Jamnagar has become the refining capital of the world. Would you have imagined this to happen in a perennially oil deficient country? But it has happened thanks to the majestic enterprise of Reliance.

Up to thirty to forty percent of the US patents of some of the leading global players are being generated in Bangalore. This city is establishing its reputation as a knowledge capital.

It is clear that these shifting geographies of science, technology, innovation and economy will have a profound effect on our profession as a whole.

We at IChemE have demonstrated that we are proactive in terms of reacting to these shifts. The Malaysia initiative is wonderful. This has to be spanned further.

We need to move aggressively forward in pushing our international presence. Especially in these emerging centres of global action, namely China, India and so on. During my Presidential year, I will take this up as one of our major thrusts.

Towards a borderless profession

I like Gregg Lewin's plea for making this profession a truly 'borderless profession'. Indeed, borderlessness should become the language, the behaviour definer, the culture and the soul of our great profession. This borderlessness should cover geographies, markets, customers, industries, disciplines and so on.

This borderlessness must transcend in such a way that the spirit of 'science of chemical engineering' enshrined in our Charter must continuously find a new meaning ever so creatively every single day.

I continue to be stunned by the explosive advances in adjacent sciences that are reshaping our lives like never before.

In June 1994, I had the privilege of giving the 9th Danckwerts Memorial Lecture in London. The title of my lecture was "Seamless Chemical Engineering Science: The Emerging Paradigm".

I had then articulated the phenomenon and the consequences of the disappearance of the borders between chemical engineering and adjacent sciences. The happy consequence of this "borderlessness" is that a chemical engineer was dealing with diverse domains ranging from "cell and tissue engineering" to "molecular information engineering" with equal ease.

As a chemical engineer, I feel proud and confident that we can quickly position ourselves at the centrestage and not at the periphery as soon as new

breakthroughs take place in adjacent sciences, be it in stem cell research or plant sciences.

From hydrocarbon based economy to carbohydrate based economy

Let me illustrate this positioning by looking at the challenge of creating a "bioeconomy" as a part of the grand challenge that the chemical engineers might take up for creating a "biofuture" for mankind.

We require many fundamental breakthroughs in plant sciences. For instance, the current efficiency of capture of light energy by the process of photosynthesis is less than 2%. Can engineered genes from plants and photosynthetic bacteria increase this efficiency?

Can we manipulate the genes involved in nitrogen fixation to increase biomass content of plants? Can plants be engineered for rapid growth with drought and high and low temperature stress?

Can co regulation of lignin and cellulose biosynthesis be achieved in such a way that lignin content can be reduced and cellulose content increased?

These advances in plant science can form the foundations of advanced biorefineries These can be positioned as "future processing complexes" that will use renewable agricultural residues, plant based carbohydrates and ligno-cellulosic materials as feed stocks to produce a wide range of chemicals, fuels and bio – based materials.

But this task will put to test the ultimate system engineering and integrative skills of the chemical engineers. Advanced bio-refineries will have to creatively integrate the knowledge in plant genetics, biochemistry, biotechnology, biomass conversion chemistry, process engineering and separation technology.

An equally challenging task will be forging creative partnerships between enterprises dealing with fuels and energy as well as chemicals and materials with enterprises managing agriculture, agro-marketing and food chain.

In short, there is every possibility that we will be able to mastermind and manage a transition from the non-renewable hydrocarbon based economy to a renewable carbohydrate based economy.

But to succeed, the chemical engineers will have to manage advances in fundamental science with the complex interplay between energy, materials, environment and society associated with a carbohydrate based economy. Once again, it is the “borderlessnesss” of our profession, that gives us a hope that this dream can be converted into a reality.

The future engineer and engineering our future

I am proud to be an engineer. I firmly believe that leadership in engineering mankind’s future will have to be provided by we engineers. But what kind of engineers do we need in the twenty first century?

I have noted that recently there has been a concern and a debate on the issue of who should be called an engineer in the first place. One finds that the word “engineer” originates from a French word namely "ingenieur", this actually means one, who is ingenious.

What should an engineer strive for? There is a famous medal that the Institution of Electrical and Electronic Engineers US awards each year. It is called Lemme medal. There is an inscription on that medal. It says “engineer views hopefully the hitherto unattainable”.

But how can engineer reach the “hitherto unattainable”? For this he has to be an innovator.

There are two definitions of an innovator that are close to my heart. One is “innovator is one, who sees what everyone else sees but thinks of what no one else thinks”. The other is “innovator is one who does not know that it cannot be done”. Then only he can view the “hitherto unattainable”.

Sir Francis Bacon had once said: “It would be an unsound fancy to expect that things which have never yet been done can be done except by methods which have never been tried”

I hope our profession will continue to achieve things, which everyone thought cannot be achieved. And we will continue to use methods that have never been tried before.

There is no limit to human achievement. Technological disruptions such as steam engine, internal combustion engine, transistor and PC changed our lives.

We do not yet know as to how the new technologies like bluetooth broadcasting, optical switching, code morphing and proteomics will change our lives.

Can chemical engineers contribute to such ‘life changing’ technologies of the twenty-first century? I feel confident that we will. In fact we already have. But in our own silent ways.

Let me give you a telling example. But for our Haber Bosch process, the world would not have had the fertilizers to fuel the food production and support the billions, who inhabit our planet today.

In fact at the dawn of the twenty first century, there were several attempts to identify the technology, which made the greatest difference in the twentieth century.

I remember someone mentioning this as the defining technology that made the exploding population survive in the first place!

And one can provide several such examples, where chemical engineers alone have made a difference. I am sure our great profession will continue to provide a hope for the future of our planet earth.

When next time a doubt is raised about whether the civilisation will survive the twenty first century or not, I hope some one will confidently get up and say, “It will not only survive but it will thrive. After all there are chemical engineers around, you know. Our future is safe with them.”

Ladies and gentlemen,

That is our mandate – to justify this confidence
That is our challenge.
That is our inspiration.

We as a profession, we as a great institution, can take these bold and confident steps into the twenty first century, a century of knowledge, a century of mind and a century of hope. And we should make it a century of hope, not for a select few – but for everyone.