The Iris lecture
in Memory of S.S. Nadkarni
by
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Dear Friends,

I am happy to be here this evening. I thank Investment Research and Information Services, or IRIS as it is popularly known, for this opportunity.

In January, Shri Swaminathan approached me to deliver the SS Nadkarni Memorial Lecture. I was delighted. For here was a unique opportunity to publicly acknowledge what Shri S. S. Nadkarni meant to all of us in Reliance. Here was an occasion to pay a tribute to this extraordinary personality.

Mr. Nadkarni was an engineer who gravitated into development banking. He marched in step with India's progress. He saw Reliance grow from a Rs. 10 crore company to a Rs. 20,000 crore corporate group. On several occasions, I had revealing glimpses of his incisive insight and keen sense for detail. In the course of appraisal of RIL projects, I would personally face his searching scrutiny. Preparing for a final project meeting with him was more challenging than all the examinations I have had at Stanford. It was a pleasure to break down for him a project or an investment proposal into its various components. He would closely look, not only at the financial and market aspects, but also their technology dimension. He was not satisfied with what is the best today. He was always looking ahead at what will be relevant tomorrow. He had an obsession for next generation technology. He did not pose problems for blocking things. He endeavoured to find solutions for the most difficult problems. At all times and in all sectors, he had a deep understanding of technological trends. He skillfully played various instruments of the orchestra of development to ensure profit for the project and growth for the country. I dedicate this talk to this remarkable genius, who had the rare ability to blend finance, marketing, management and technology into a fascinating mosaic.

We, at Reliance, have a very special place for Shri Nadkarni – close to our heart. With my father, Shri Dhirubhai Ambani, he had a very warm and productive relationship. He appreciated and encouraged my father's drive and determination. My father is full of admiration for the depth of his comprehension, his masterly perspectives of future trends and stimulating impetus to initiative and excellence.

Shri Nadkarni was intimately involved in all our projects – right from the time Reliance was incorporated till recently when our refinery project was conceptualised. He goaded us to be at the leading edge of technology. He would closely monitor our progress by visiting our sites. He would look at both the macro and the micro issues with incredible thoroughness. He would not be weighed down by constraints. Most importantly, he would motivate us by saying "You can make it. I fully trust your abilities."

The story of Reliance would be incomplete without an acknowledgement to his unstinted support.

Shri Yashwant Sinha and Dr D.R. Mehta, who were the first two speakers in this Lecture Series, had focussed on the economy and the capital markets. These areas are dear to the financial community, which is substantially represented in this august audience today.

I have chosen to speak on 'Technology in a Changing World'. This is with deference to Shri Nadkarni's passion for technology, a quality that distinguished him from others in the financial community. It is my way of paying a tribute to Shri Nadkarni's memorable legacy.

Technology – A perspective

Let me begin with the very basics of what technology is. In essence, it means the application of science to the solution of problems. It enables human beings to regulate their environment. It encompasses ways and means by which men and women harness nature. In short, technology is the application of human knowledge for management of the Universe.

It is thus clear that technology is not merely a matter of machines and microchips. It is not a matter of interest only for scientists and laboratories. Technology today is embedded intractably into the fabric of our existence. It decides how long a person will live. It regulates how we work and how we communicate with each other. Technology has a bearing on how we relax and entertain. How we travel and talk.

How we learn and store knowledge. How we anticipate and solve our problems. Technology is fast becoming a key ingredient of leadership. In politics, business, society or military combat, technology makes all the difference - between success and failure, between progress and stagnation, and freedom and subjugation.

We have entered an era in which technology is power, technology is wealth and control over technology is a source of influence and power.

If you go back 2,000 years into history, for about 1,800 years we had virtually no major technological developments, save for the printing press invented in the year 1455. Things have changed, since the invention of the steam engine in 1769. It is only in the last 200 odd years that the world has seen the rapid proliferation of technologies - electricity, automobile, aircraft, phonograph, photograph, telephone, transistor, radio, refrigerator, colour television, computer and now the Internet. Technology has impacted life in every conceivable way.

Even within this two hundred year phase, the last fifty years have witnessed the induction of technology in our lives at a furious pace. For the radio to go up to 200 million users, it took forty years. TV achieved the same figure in 20 years. For Internet to reach this figure, it took only five years. In fact, in the last fifty years science and technology have transformed our lives in a manner that surpasses the wildest of science fiction. We now sit in our living rooms and watch events taking place on the other side of the planet – wars, sporting events, famine and revolution – as they actually occur. Students around the world do their homework on personal computers, each a fraction of the size and hundreds of times more powerful than the models of the fifties. Doctors routinely perform delicate surgery with lasers. Fibre optic cables connected to video cameras permit them to see the inside of the body and operate through tiny holes in the skin, often without cutting the skin at all. Military pilots and soldiers use infrared technology to see in the dark. Electronic guidance enables them to attack distant targets with unbelievable precision. In medicine, communication, education, defense, transportation – everywhere we live – science and technology have changed our way of life.

This exponential growth will continue to snowball at an unprecedented pace. In the next twenty years, more will be achieved than the previous one hundred years. Air traffic control by satellite is no longer a hypothesis. Worldwide, free trade will become a reality in our lifetime. Real-time universal language translation for both voice and text is already on the agenda. Thus language differences will cease to be a barrier in

communication. Eradication of most diseases in the world appears to be within humankind's technological reach. It will soon be possible to make accurate global and local weather forecasts upto one month in advance. People will be able to experience vacations and cultural events while sitting at home. Each person may have a unique personal communication number accessible anywhere in the world. It will become a tool of multiple usage. Projects on intelligent vehicles are already underway.

Drivers will have access to systems in cars that help them navigate select routes and retrieve information about the locality, including hotels, restaurants and events.

I would like to underline one important additional point. We are in an age where a single macro discovery can lead to scores of innovative micro applications. Who would have guessed a few years ago that the fibre optic cable created for long-distance communication would be equally efficient as a tool in microsurgery? Microprocessors have spawned hundreds of applications once they were understood. Shri Nadkarni was always fascinated by technology – he was one of the first to take the PC on his desk. He would always tell me, " Mukesh, we have to keep in step with the unnerving pace of the technological revolution. We have to adjust our minds to the fact that the world in the next twenty-five years would bear as little resemblance to what it is today; in the same way as today's world is so different from what it was fifty years ago."

This is because more technological upheavals are taking place in one year than they have in several decades. I will illustrate this point by taking you only twelve years back – and take only one year – 1988 as a case study. Achievements during this one year include the following.

US surgeons implanted the world's first plutonium powered pacemaker. World's largest tunnel under the sea was opened. It connected Hokkaido and Honshu in Japan. Australia invented the most powerful radio telescope in the Southern hemisphere.

The first transatlantic optical fibre telephone cable entered the service linking France, the UK and the USA. It could process 40,000 simultaneous conversations. Discovery, the first US manned space mission, was successfully launched. A new mirror system was devised that concentrates sunlight to 60,000 times its normal intensity. Surgeons performed the first brain-cell transplantation in UK. Nobel Prize for chemistry was awarded for discovering the structure of proteins involved in photosynthesis. On the other side of the balance sheet, an Internet computer virus by a US student jammed over six thousand military computers across the United
States.

Incidentally, but significantly, it was also the year in which the 'Race against Time' charity event in support of the fight against children's diseases was organized with fifty million participants worldwide.

What lies ahead promises to be dramatic. They would make today's world look primitive. Computing power will grow astonishingly by a factor of about a million. Gene therapies would exist for virtually every disorder. Men and women would have ventured far beyond the biosphere into the extraterrestrial domain. These are just curtain raisers to an opening of the technology theatre.

These technological changes will create a new world and usher in a new age. The greatest challenge in the twenty first century will be how do we assimilate and deal with radical technology-led changes.

Often we wonder how people lived in the Stone Age. For that matter, the fact that it took a student twelve weeks by ship to go from Mumbai to London appears

unbelievable when the journey is now completed by the student in as many hours. The next generation will wonder how their forefathers wasted hours shopping. Why government offices were stacked with mountains of files and thousands of documents. Why it took months to obtain application forms or why people carried bundles of cash or thick cheque books for making payments. All these transactions will be done electronically sitting at home.

Most people dealing with science and technology have a natural tendency to make simple things look very complicated. But technology pervades all facets of life so intensely that we need to demystify it and make it a natural component of our thought processes.

In today's address, I would not like to take a technically complex approach. Instead, I would prefer to think simply and look at technology in terms of its impact on life. I would like to deal with technology at a very basic level and see how it impacts us as individuals, as a society and as a nation.

Therefore, in this lecture, in the memory of an outstanding proponent of technology, I would like to see how technology would bear upon three facets of human existence:

1. life,
2. living and
3. living systems.

I would then like to see the imperatives for India in the context of a technology-laden society, where we seem to have arrived without preparing for the event.

Technology and Life

First, let me deal with technology and life.

Biotechnology

To my mind, biotechnology will singularly determine the impact of technology on life. It will impact every single form of life – from 6 billion people on earth to the multitude of plants, animals and microorganisms.

I can visualise the impact of biotechnology in three ways:

1. Substantially improving the quality of life,

2. Substantially controlling the form of life, and

3. Substantially controlling the duration of life.

It is predicted that by the year 2025, gene therapies will become available for every major conceivable disease. Artificial assist devices will take over diseased liver and pancreatic functions. Individualised medicine will be developed on the basis of each person's genetic make-up. Genetic manipulation will alter human traits. Animal cloning will be used to produce new drugs. Humanised transgenic animals will be reared to produce organs for transplantation. New vaccine technologies will be successful in treating drug addiction. Therapies for reducing the effects of aging will be in vogue. Tissue engineered organs will be available for replacement of diseased ones. Finally, a completely artificial form of life will be produced.

The discovery of the code of life, or genome, written in the sequence of four nucleotides that form the DNA, has enabled man to discover life and design life. A process that took nature three billion years to develop has been re-created by human technology in an incredibly short span of time. This decoding of the book of life heralds an exciting phase of human development, where life can be engineered. This is analogous to the discovery of natural elements by chemistry and physics that led to the development of a whole range of new synthetic materials, which are equal to, or better than, available natural materials. Biotechnology is also moving towards decoding the library of proteins in the body. This will enable mankind to alter the very metabolism of life processes.

Advances in medical biotechnology promise to increase life expectancy. By regulating telomeres, which are genes at the end of chromosomes and responsible for cell mortality, molecular biologists will have the ability to infuse longevity to life. By engineering tissues, molecular biologists will be able to grow artificial organs. It is entirely conceivable that in ten to twenty years from now most organs in the human body would either be derived from animals or tissue engineered.

In a lighter vein, we could have a situation where a man would go to have a knee replacement surgery and end up changing his heart and liver as well, for they come as part of a package deal.

The moot point is that biotechnology's impact on life will be so profound that one wonders if mankind would be on the path to immortality.

What does all this mean to society? To my mind, it would lead to

1. aging of societies,

2. designing of life by societies, and

3. opening up new opportunities for creation of wealth.

Aging

First, let us look at aging of societies.

Recent advances in health care have significantly contributed to human longevity. Today, 45 million people in the USA are above the age of 60. This represents 17% of the American population of 276 million. In 25 years time this number will be 83 million, or a quarter of a population of 338 million. Germany is worse off. Roughly, a quarter of Germans are now old and in 25 years a third of them will be old. The case with Japan is very similar to that of Germany. China is better off with a tenth of its population now and a fifth of its population in 25 years being old. In contrast, India has a young population. Just 7% of Indians are above the age of 60. In 25 years time only 12% will be above sixty.

The population pyramids indicate a shift to an older society in the USA. The shift in Germany and Japan will be more pronounced. China will also see a shift to more elderly society. In contrast, India will be young and will see a swelling work force. Biotechnology will have the effect of further changing the demographic profile of the world.

Designing Life

Now let me look at designing of life by societies.

Today, human cloning and germ line gene technology are banned. But, in my view barriers to technology cannot be erected forever. If animal cloning is a reality, can human cloning be far away? If gene therapy for correcting genetic diseases is a reality can germ line gene therapy be far away?

On a lighter vein, think of human cloning as a means to have an identical twin, perhaps a generation or two younger than you. Your clone could do all the things that you do not want to do – like paying your bills and visiting your in-laws.

As I see it, designing life is not science fiction any more. It is a question of when. Cytogenetics based technologies are already in a position to diagnose chromosomal abnormalities. In the near future, medical biotechnology will help us screen diseases that would set in after several years. It would also enable us to choose enhancement genes to select the height, hair colour and muscular ability of children.

Talking of longevity and designing life, a Miss Universe beauty pageant finalist in the year 2050, who was herself created by a high fashion designer of life, was asked a question "If you could live forever, would you, and why?" The lady said, "I would not live forever, because we should not live life forever, because if we will aspire to live forever then we would live forever, but we cannot live forever, which is why I would not live forever. " No prizes for guessing, the contestant won the title. Life may change, but beauty pageant contest answers remain as confounding as ever!

Creation of Wealth

The rapid growth of biotechnology will also open up several avenues for creation of wealth. One indication of this is the estimate that the global biotechnology market will grow by about 100 billion US dollars in the next five years.

Although this is small in comparison to the global GDP of 30 trillion US dollars, it signals that the race has started. I for one, would envisage that biotechnology would grow to a trillion dollar industry in ten to fifteen years.

Biotechnology would help open up a completely new segment of the geriatric market, comprising of people who are above the age of 60. Today, this market is very small, but in the future it would be substantial. People beyond the age of 60 would be productive income earners. The old mindset of retirement at the age of 58, as we have in India, would no longer be relevant.

Biotechnology would also see the emergence of such domains as nutraceuticals, individualised medicine, regenerative medicine, pre-natal genetic screening and new classes of drugs. Each of these domains will represent large market opportunities, as they would touch the life of every person who inhabits the world.

Industrial and agricultural biotechnology would also throw up new wealth creation opportunities - from providing a new class of raw materials from biological sources to creating new species of plants.

The global financial community will also stand to gain – from funding a large number of new biotechnology ventures, launching large pension funds to designing innovative life insurance policies.

To sum up, biotechnology will substantially alter the quality of life, the form of life and the duration of life. It would promote new opportunities for creation of wealth.

Technology and Living

Now, let me turn to the second facet of technology and living.

Digital Overlay

While life *per se* will be dramatically impacted by biotechnology, living will be drastically impacted by information and communications technologies.

These technologies will impact:

1. the way we live,
2. the way we transact, and
3. the way we relate to the world around us in space, time and size.

Satellite, Internet, broadband and wireless based information and communications technologies - are ushering in fundamental changes in social and economic life. Digital networks and miniaturised devices are changing our perception of time, distance and space. They help us connect and communicate with our work, home and interests, while on the move. They hold promise for disseminating knowledge at low cost.

We now have the ability to work, shop, educate and entertain ourselves round the clock, both in the virtual world and in the physical world. Very soon we will be able to feel and smell, as well, through the virtual world. We no longer need audio tapes and CDs to listen to music. Video tapes and DVDs are not necessary to see movies. Books and CD ROMs are not needed to get educated. Newspapers and magazines are not required to keep abreast of events. Vehicles and wallets soon will become unnecessary for shopping. We will not necessarily need physical space in shops, banks, movie theatres, classrooms and libraries.

Mobile phones are changing our notion of space by enabling us to call a person and not a location. Emails are changing our notion of time by enabling us to write a conversation. Virtual chat groups are redefining social organisation. In fact, email is not just for business anymore. Email is increasingly being used as a social and, yes, even a romantic tool as well as an academic one. Young people argue that if used properly, email can actually help rather than destroy a relationship of any kind.

But that is not all. New simulated virtual worlds with exhilarating experiences will emerge behind the screens of our computers and televisions, thanks to convergence of media and wide band networks.

What would be the fallout of these radical developments?

Human Ability

To my mind, the first fallout would be in substantially enhancing human ability.

Just as the age of the machines amplified the reach of the human muscle, the age of the microchip amplifies the reach of the human brain. Being connected to an ‘every time, every place, every device’ network dramatically amplifies human ability – from simple tasks like driving to an unknown destination using GPS systems to complicated routines like remote telesurgery. Networking of devices with smart software can also

relieve human effort by helping devices report problems and call for repairs on their own.

Today there are about 100 million machines interconnected. This is just under 2% of the world population. Imagine the power of this network if 6,000 million or more machines are interconnected on the globe.

On the negative side, living in privacy will be virtually impossible. Miniaturised Web cameras and microphones can observe people clandestinely and data mining can reveal habits and tendencies. Technology will make it easy for government and companies to track down and monitor every detail of our personal and financial lives. It is much like being under watch all the time.

Redesign

This digital overlay will also lead to redesign of places where we live and work. The advent of the television led to individual objects at home – chairs, sofas, dining table and beds – being physically oriented to the television. With miniaturised devices and wireless networks, devices in the room will be electronically oriented to one another with the ability to coordinate and talk to each other.

Public places would also be subject to redesign. This is not new. Consider the emergence of the automobile. In automobile intensive societies, you will see designs adapted to the use of cars – from freeways to ferries and drive-in banks to drive-in fast food outlets. Likewise, the digital outlay will call for new landscapes – from simple sensors on roads to regulate traffic to networks that track the movement of every person.

Information and communication technologies will thus change our concept of time, space and size. They will lead to enhanced human ability, redesigned private and public places and shrunken devices.

Technology and Living Systems

This brings me to the impact of technology on living systems. This can be seen by looking at the impact of technology on three forms of living systems:

1. Society
2. Nation State
3. Mankind

Society

I must emphasise that future technologies are not only all about biotechnology, information technology and communication technology. It would encompass improvements in and innovations of existing technologies. In agriculture, we will see precision farming techniques. In industry we will see micro-mechanical devices. In transportation, we will see hybrid vehicles, running on electricity and gas. In energy, we will see alternative hydrogen fuel cells. In homes, we will see robots.

Society will not only witness the emergence of new technologies but will also see existing technologies being continuously improved, based on new technologies, in a virtuous cycle. Life sciences, information and communication technologies will make existing systems efficient and productive.

Future civil societies will also see new relationships between man and machine brought about by technology. The digital overlay that I talked about will make us so much part of an electronically networked world. It would be unimaginable for us to live away from networked gadgets, appliances and machines, either at home or at the work place.

The Internet by itself will be akin to a living system. With the Internet, everyone on the planet has the potential to be virtually closer than ever before.

The Internet would penetrate every aspect of daily life around the globe, affecting everything from national security to personal privacy, from economic competitiveness to democratic participation in governance. Already millions of technologically empowered individuals are now able to participate freely in international transactions and enterprises, social and economic. The Internet has become a self-governing community controlled by no one and needing no supervision. It is remarkably decentralized and uninstitutionalised. As it grows in scope, bandwidth, and functionality, the Internet will acquire greater power and presence. Today the Internet handles 50 billion dollars of transactions. In about thirty years, this flow will amount to 4 trillion dollars, or a seventh of the world economy.

Increasing dependence on gadgets, appliances and machines will force the pace for a new relationship between man and machine. The concepts of wearable computers and humanised robots would be translated into applications in households and work places.

Nation State

I strongly feel that we are still too far from appreciating the tumultuous impact of technology on the nation state.

Traditionally, people have had sworn by sovereign alliance to his or her territorial nation state. This was understandable as resources, such as agriculture, land and minerals, were territory based.

However, information and communication technologies are re-defining the concept of nation states. Knowledge, instant communication and mobility in the twenty first century could give rise to new political models. The European Union is an example of such a political model in its embryonic form.

Mankind

Technology is changing the nature of human concerns. New controversies and conflicts are beginning to surface. For example, a big battle is already being waged in the United States about genetically engineered foods.

A furious debate is raging if such foods could be toxic, could cause allergic responses, could have lower nutrition value and could compromise immune responses in consumers.

Technology is also taking mankind to a completely new ecosystem – beyond the biosphere into space. We are beginning to see the emergence of an era of cosmic commerce. Very soon mankind will see the widespread use of satellites and space stations for communications, Internet services, remote telemedicine, observation, physical mapping, science research, meteorology, navigation, space exploration and adventure travel to space. Seven day civilian space flights could be a reality very soon.

Information and communication technologies permit the accumulation, analysis, and manipulation of data on an unprecedented scale. The potential for mass surveillance, tracking, and profiling is enormous. So too is the potential for filtering material for quality, suitability, and utility. Tools for managing content are being developed and will be widely deployed. These tools must balance freedom of speech and privacy against a desire for protection against hate speech and other objectionable material. All these issues will set a new agenda for individuals, society and the nation, states.

It will be necessary to examine what barriers must be overcome to achieve the promise of electronic commerce. How can transactional and systemic failures be avoided? How can public confidence in doing business on the Net be strengthened? What overseeing is needed to assure the security and privacy of electronic transactions? Can industry self-regulation suffice or must laws be adopted?

In essence, technology will change the very face of mankind.

Imperatives for India

Having looked at technology in the context of life, living and living systems, now, let me look at the imperatives for India in the context of technology and a changing world.

Talking of India and technology, I am reminded of the encounter between communication specialists from America, Europe and India. The American boasted that 100 years ago if you had dug 100 metres into the ground in America, you would have found optic fibre cables, because Americans pioneered them. The European countered that 1000 years ago, if you dug 1,000 metres into the earth in Europe, you would have found copper cables, because Europeans pioneered copper cables. The Indian thought hard. He told the others that 10,000 years ago, if you dug 10,000 metres into the earth in India, you would not have found anything. Why? The others asked. We were already using wireless systems those days, he said.

There is probably an element of truth in this joke. For thousands of years, India was in a commanding position in technology and innovation.

1. *Ayurveda* was practised 2,500 years ago and is today gaining a rightful place in civilisation as an alternative school of medicine.

2. Sushruta conducted surgeries 2,600 years ago for cataract, fractures and urinary stones.

3. The art of navigation was born in the river Sindh 6,000 years ago. The very word 'navigation' is derived from the Sanskrit word '*Navgatih*'.

4. Bhaskaracharya calculated the time taken by earth to orbit the sun in the 5th century, hundreds of years before the astronomer Smart. Interestingly, he calculated this to 9 decimal places.

5. Budhayana first calculated the value of pi in the 6th century.

6. Algebra, trigonometry and calculus came from India. Sridharacharya formulated quadratic equations in the 11th century.

7. The world's first university was established in Takshashila in 700 BC. More than 10,500 students from all over the world studied about 60 subjects.

8. The University of Nalanda built in the 4th century was one of the greatest achievements of ancient India in the field of education.

I can go on with more such evidence of the glory of science, technology and education in ancient Indian civilisation.

What strikes me about life in ancient India is its omniscience. Knowledge was an overriding theme and a way of life in ancient India. It was like an ecosystem driven by the thirst for knowledge. Unfortunately, we do not see the same zeal for technology in modern India.

Somewhere along the historical journey, we slipped up. Consequently, we missed the industrial revolution. It is now time to catch up with the more advanced nations in the world and take advantage of the huge technical changes sweeping our planet. Our generation can ensure this by building and nurturing a technology centric mindset.

In my view, India has the opportunity to create a whole new ecosystem driven by the quest for knowledge and technology.

What does it take to create such an ecosystem?

First, gaining knowledge.

Unlocking the human mind through education is the first step on the path to progress. The competitiveness of Indian enterprise in the twenty first century will be significantly affected by the number of scientists and engineers graduating from universities and their retention in India. The 70,000 odd engineers that we produce today is not enough. A strong science and technology education infrastructure is like a cradle for growth in the new age. If education is not addressed, deficiencies in the supply side, in the form of an inadequately educated resource base, can throttle growth.

Unfortunately, rigid state control on higher education is imposing serious limitations on India's ability to turn out high quality professionals. If this situation does not change we may miss the opportunity to leverage information technology trends in the developed world with people power.

We must recognise the ruthless 'winner takes all' environment of the 'online age'. In my view we are already getting late in bringing about sweeping reforms in education. It is time that India's education policy planners liberalise higher education and concentrate on providing free and compulsory primary education.

Second, creating knowledge.

We must also invigorate research in order to leverage technology. Progressive nations are spending significantly on research. Sweden spends about 8 billion US dollars, which is 3.8 % of its GDP, on research and tops the list. America is next at 208 billion US dollars, which is about 2.6 % of its GDP. In contrast, India spends a very poor 3 billion US dollars at 0.73 % of GDP. Science has to be placed at the vanguard of our society if we have to let knowledge and technology lead our growth.

Third, applying knowledge.

India needs to pursue the application of technology in every sphere. For example, we may apply biotechnology in a significant way to enhance yields and break the root cause of poverty, which prevails in our towns and villages. We must liberate our

farmers from the trap of low investment, low yield, low income model of agriculture production. The western world is caught in an emotive bind on genetically modified foods. India must see the issue dispassionately and give transgenic crops a chance.

Also, given her skill sets in information technology, India has the unique opportunity to apply information technology solutions to agriculture. To my mind, after e-governance, it is agriculture that will present a challenge to the information technology industry from a social contract perspective.

We are among a select few countries that have the ability to place satellites into orbit. Our need for delivery of satellite services to remote regions is significant – from telephone, telemedicine, weather information, crop prediction, land use conditions to locating rich fishing grounds. India must invest in commercial applications of aerospace technologies and capture a significant share of the emerging cosmic commerce.

Applying knowledge in creating the new technology-led ecosystem will call for inspiring and committed leadership in all sections of governance, institutions, enterprises and society. Leadership with an innovative mindset. To my mind, it is the quality of leadership that, at the end of the day, makes all the difference.

Fourth, leveraging knowledge.

India has the unique opportunity to leverage her demographic advantage of a younger population and large work force with information technology skills. This can achieve significant economic benefits. India can be the fountainhead of the new pattern of migration and mobility of information technology professionals to the developed world. This can help India capture the information technology spend in the developed world to drive the Indian economy on an export led path.

Let me explain this. In India, our current work force comprises about 400 million people. This will expand to 700 million people in about twenty five years. Let us take just 10% of our current work force and outsource work for them from the information technology sector overseas at 10 dollars per hour. This is well below the average wage in USA. For 40 million Indians we can generate trillions of dollars. These educated young men and women will demand better housing, superior education for their children, advanced transport facilities and look for vastly improved quality of life, leisure and environment. Imagine the effect that savings and consumption derived from this income can do to accelerate the growth of the Indian economy. We are talking of an opportunity that is worth trillions of US dollars. This is many times our current GDP. This huge opportunity will necessitate the creation of an overarching communications infrastructure in India, or what I call the virtual wiring up of India.

We must not be defensive in the battle for free trade worldwide. The developed world is aggressively pushing for free flow of financial capital and free access to markets. I feel that India must actively push for free flow of intellectual capital across borders.

Our policy makers and thinkers must realise that India’s prosperity in a technology laden society depends on education, research, technology development and application. At this point, I will like to enter an important caveat. Technology is an important component of India’s march towards greatness. But we should be careful not to make it the sole factor.

Conclusion

In conclusion, I would like to list some take-home points. These pertain to dealing with and assimilating technology, which I had earlier referred to as the greatest challenge in the twenty first century.

1. First, individuals must imbibe technology as a way of life.

2. Second, families must invest in higher education in technology for their children.

3. Third, societies must encourage the quest for discovery.

4. Fourth, corporates must invest in and create conducive environments for research.

5. Finally, our nation must measure and demand technology productivity from institutions.

Scientific research has been characterised by a search for the fundamental laws and principles that govern our natural world. Scientific discoveries during the last century have been profound. But the benefits of knowledge are only being tapped now. Complex problems of this century will be solved by scientific simulation that will synthesise the knowledge we have gained.

I must emphasise that technology, in itself, is not the sole panacea for all our problems. For scientific and technological development there are several other important ingredients - (1) competition, (2) private investment, (3) open access and free trade, (4) flexible government regulation, (5) universal consumer focused services and (6) cultural factors.

Free and open competition is the new religion of our times. We need to embrace it enthusiastically and wholeheartedly, and not reluctantly and unwillingly.

Why? Very simply because competition lowers prices, increases choices, improves quality and creates jobs. Creative competition will unleash innovations as well as stimulate consumer demand for new products and services. It will generate new and higher paying jobs. It will usher in an economy better prepared for the challenges of the 21st Century.

In essence, while we need not overlook civilisational, educational, psychological, economic and administrative factors in successful harnessing of human resources for growth, technology will remain the driving force of quantum change in the new age.

I would also like to stress that technology is a continuum. Convergence of technologies is creating several new opportunities. In this continuum, we will see biotechnology and information technology creating opportunities at their crossroads with other sectors.

Friends,

The twentieth century belonged to civics and economics. It will be remembered for two world wars, the rise of democracy, capitalism, globalisation and management. The twenty first century will belong to technology. Two great technologies – biotechnology and infocom – will spectacularly change the life, living and living systems.

Technology is transforming individuals. It is reshaping personal relations. It is replacing the form of governance. It is substituting official secrets by public transparency. It is reinventing commerce and restructuring industry. It is redefining education. It is giving a new meaning to national sovereignty. Technology is

revolutionising attitudes, anxieties and concerns. The technology divide may become the gravest source of concern. Unless we are vigilant, every society – in fact the whole world – may develop into two camps; those who can cope with and use new technologies and those who cannot. That may have a very serious implication for societal tensions.

Ladies and gentlemen,

Technology is giving rise to new challenges. At the same time, it is presenting unprecedented opportunities for creating a great India, an economic and knowledge superpower, in a new world. Let us seize this opportunity.

Thank you.