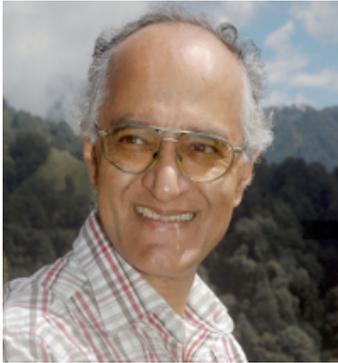# Looking Back to the Future

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Prof. Gonsalves did his B. Tech. in Electrical Engineering at IIT-Madras, M.S. at Rice University, Houston and Ph.D. at Stanford University, California. He Joined the Department of Computer Science & Engineering, I.I.T., Madras as an Assistant Professor in 1989 and rose to Professor and Head of the Department.

Prof. Gonsalves is the Cofounder of the TeNeT Group of IIT-Madras and founding Director of NMSWorks Software Ltd, n-Logue Communications Ltd and the IIT-Madras Rural Technology Business Incubator (RTBI).

In January 2010, Prof. Gonsalves was appointed as the first full-time Director of the Indian Institute of Technology, Mandi.

His Research interests include design and performance of computer and telecom networks with emphasis on innovative and low-cost product and technology development for Indian and international industry and fostering software development in small towns and rural areas.

The Nature of Social Change

Societies change from past to present to future. Change in societies is inextricably linked with science and technology. Technology solves problems of society and in its wake brings about changes in society. The change may be slight: a more efficient light bulb reduces the monthly electricity bill which leaves more money for the family to spend on, say, eating out occasionally. Or, the change may be profound: the effect of affordable near universal mobile telephony, the impact of the web on nearly every aspect of our lives.

Conversely, change drives the development of new technologies. During the last Ice Age which lasted from about 1,20,000 BC – 20,000 BC when food was scarce people lived in tiny bands of nomadic hunter-gatherers. As the earth warmed between 20,000 BC to 10,000 BC, people started to settle in villages. In China pottery was developed in 16,000 BC, while in highland Peru buildings with walls were constructed in 11,000 BC.

Change drives science also. Scientists in their quest for knowledge develop new theories or refine old theories to explain change. Even when nature does not change, science changes. Over the past few millennia, astronomy moved from a geocentric flat Earth view, to a recognition of the spherical shape of the Earth, to the realisation that our Earth is a mere speck of cosmic dust on the periphery of the vast universe with over 100 billion galaxies.

Change: Past to Present to Future

Given the centrality of change, it is but natural that we should attempt to understand it, to predict its future course, and to measure the rate of change. Visionaries are often tempted to predict the future of science and technology. Some of these predictions have come true. In 1945 the famous science-fiction writer Arthur C. Clarke foresaw a global communication network using a few geostationary satellites. This became a reality in 1964 with the launch of the satellite Syn-Com3. It is increasingly common for predictions to turn out to be wildly inaccurate. In 1943, T.J. Watson, President of IBM, famously said "I think there is a world market for maybe five computers". Today, billions of people use more than 5 computers each in their mobile phone, laptop, games and appliances.

It appears that the rate of change in our lives is increasing. From the invention of telephony in 1876 to near universal coverage in the US took 60 years. Mobile telephony went from scratch to near universal coverage in India in a mere 20 years. In some other areas, however, change is much slower. For example, the basic design of personal transportation has evolved very little in 108 years since the Ford Model-T was introduced as the world's first mass-produced car. A car still consists of 4 wheels, a chassis, an engine and a body. The driver controls it with a steering wheel, a gear lever and 3 pedals.

Since predicting the future is fraught with risk, can we more reliably quantify the rate of change? If we can measure the rate of change, we would at least be able to predict the magnitude of changes in the future, if not the actual change itself. This is precisely what Ian Morris, who is a Professor of Classics, History and Archaeology at Stanford University, did recently. In his compelling 750-page tour de force *Why the West Rules – For Now*, Morris quantitatively examines social development from the dawn of human existence when ape-men moved out of Africa into Europe and Asia about 1.5 million years ago, up to 2000 AD. He then extrapolates to 2100 AD. In the rest of this article, I shall be largely summarising arguments from Morris' book.

Morris measures social development using four orthogonal traits of a society:

1. Energy capture Only by extracting energy from plants and animals, from wind and water currents, from fossil fuel can a society advance beyond the hunter-gatherer lifestyle. With energy capture, society can solve problems beyond the capacity of human muscle power, and thus its people can have the leisure for intellectually advanced pursuits.

2. Urbanism The size of the largest city in a society is a measure of its ability to organise large, complex teams. A bigger city also gives each individual easy access to a wider range of goods and artifacts, services and intellectual ideas. This results in greater opportunities and generates more ideas.

3. Information processing Writing, language and communications enable knowledge and ideas to bridge vast gaps in time and space. Rulers, sitting in their capital, can issue laws that apply to vast kingdoms and they can get information

from remote corners of their empires.

4. Capacity to wage war Development requires resources including food, minerals, land and energy. Sadly, societies that have advanced have almost invariably done so through wars against other societies. The greater the capacity to wage war, the more the victor develops.

Morris has developed a system for quantifying each of these four traits. Drawing on data from history, archaeology, anthropology, economics etc., he estimates values for these traits from prehistoric times to the present.

By Morris's estimation, societies in about 14,000 BC had an index of development of about 7. By 2000 AD, this index had risen to about 910. Extrapolating to the future, the index is likely to increase to about 5,000 by 2100 AD. We see that the change in development over the next fifty years is three times more than the change over the past 16,000 years. Over the next hundred years, change is five times greater. In the lifetimes of today's youth, the world will experience change several times greater than that over the past 16,000 years.

Put into perspective, in 14,000 BC people lived in small tribes and the pinnacle of their achievement was crude paintings of animals and people on the walls of caves. By 2,000 AD, we had advanced to the Age of the Internet with the World-Wide Web, digital photography, supersonic air travel, the miracles of modern medicine, etc. Would any cave-dwelling prophet 16 centuries ago have foreseen any of these miracles? Definitely not! Yet, we are faced with imagining five times greater change within a mere one century.

Speculations

What will life be like with such dramatic change? While any prediction will almost certainly be way off the mark, it is illustrative to speculate on a few possibilities.

1. Today we have always-connected devices that can take a photo and instantly share it on social media with 100s of millions of others. In the future, it is likely that the brains of all 10 billion humans are directly "wired" together. This could be done through devices that detect and generate brainwaves. The implication is that the moment any person has a thought, it is almost instantly known to everyone on Earth. Today, intimate physical union between husband and

wife is the norm of society. Tomorrow we may have to become used to intimate mental union of all of humanity. Social relationships as we know them may be relics of the past.[1]

2. Ego and self-esteem play a big role in our lives. Wars are often fought over trivial insults to the ego. As a species, we are firmly convinced of our mental superiority over all other beings, living and non-living. We worry a lot about the possible existence of extra-terrestrial life that is more intelligent, more advance than us. So far, we as a species have not yet had our intellectual superiority challenged.

This is set to change decisively in the near future. Due to the inexorable, exponential growth in computing power following Moore's Law and advances in software design such as artificial intelligence, machine learning and big data analytics, machines are rapidly catching up with humans. Sometime in the next 15-30 years (depending on whether you believe the optimists or pessimists), machine intelligence will surpass human intelligence.

Many professions are already being taken over by software and Internet servers. Human travel agents, photographers, shop assistants and others are no longer essential. As a consequence of the galloping growth of machine intelligence, more intellectual jobs of today will soon become non-essential. These will include artists, investment advisors, lawyers, physicians, surgeons and even professors at IIT Mandi.[2]

Vast number of humans will be faced with the quandary of how to live their lives with no gainful employment. Even if a benevolent state provides a guaranteed income, will we get satisfaction from a life of leisure? This is the antithesis of the work ethos of most cultures.

The human race will have to come to terms with a breed of machines that are intellectually superior to us. Will they be our slaves, will we be their slaves, or will we cooperate for mutual benefit?

3. The capacity for waging war will increase in manifold ways. Weapons of enormous destructive power will be affordable by and available to small groups of people. Besides more powerful bombs, guns and missiles, we can expect to see the development of novel weapons. With the wired brains about which we speculated earlier, an adversary could instantly control the behaviour of an entire nation by infecting their brains. More conventionally, the adversary could bring a networked society to its knees by a cyber-attack on its key servers.

With such weapons, nations and non-state groups would have the capability to destroy human civilisation as we know it. If we do not figure out how to control such destructive power in the next few decades, the challenges posed by highly intelligent machines and unimaginable change will become irrelevant.

Conclusions

Our experiences over the past few decades clearly indicate that the rate of change of society is increasing. The very convincing study by Ian Morris confirms this and quantifies the likely change in social development over the next hundred years. The clear message is that today's young students will spend their careers in a world of unimaginable change.

Until the present social change has been very slow. Many people seek comfort and stability in their lives, for them it will be frightening and disturbing to face rapid social change. In the past the response of societies to rapid change has often been regression. Individuals and groups seek stability and to maintain their status by rejecting change and clinging to the system they know.[3]

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1. This development and others that we discuss subsequently are technical singularities. Due to compounding of growth year by year, after the occurrence of a singularity, growth is so rapid that society is changed dramatically and irreversibly. https://en.wikipedia.org/wiki/Technological_singularity

2. Jaron Lanier, a computer scientist, explores in his book Who Owns the Future? (Simon & Schuster, 2013) the increasing tendency of jobs to be done by software downloaded from a few global webservers. He looks at the impact on jobs, the economy and human happiness.

3. The Luddites were 19th century textile workers in England who feared that mechanisation of mills would affect their jobs. They attacked mills in order to halt the advance of technology and had to be stopped by a massive deployment of military force. https://en.wikipedia.org/wiki/Luddite

Those who can anticipate and adapt will find the future to be very exciting, extremely challenging, and full of boundless opportunities for engineers and scientists. I hope this includes all IIT Mandi students. However, it will be essential for scientists and engineers to consider the impact of their technological improvements if human society is to progress rather than disintegrate.

Acknowledgement

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4. Morris has updated his book recently: *The Measure of Civilization, How Social Development Decides the Fate of Nations* (Princeton University Press, 2014).