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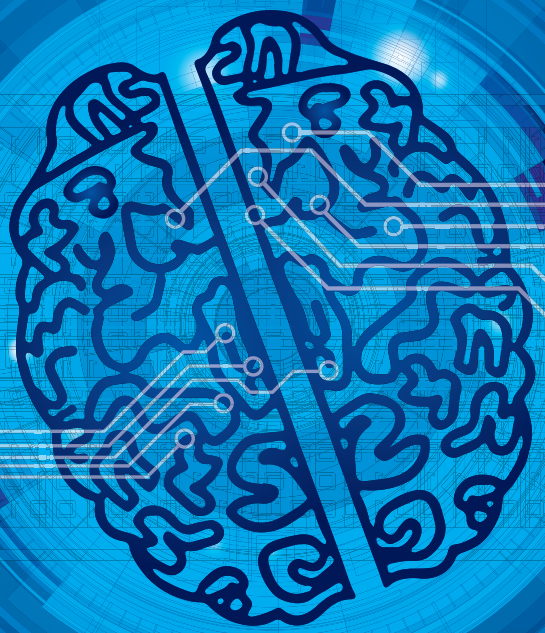
International Seminar to celebrate the 100th Anniversary of the Institution of Engineers India

DISRUPTIVE TECHNOLOGIES



Shaping Future Innovations

Le Maritim Resort & Spa,
Balaclava, Mauritius

21st August 2019

THE INSTITUTION
OF ENGINEERS INDIA


Disruptive Technologies
Shaping Future Innovations
21st August 2018


Institution of Engineers Mauritius
In collaboration with

CELEBRATING

1920 - 2020

100th ANNIVERSARY
of the Institution of Engineers India

The Journal of the
INSTITUTION OF ENGINEERS
MAURITIUS

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Contents

Papers presented:

Message of the President of the Institution of Engineers Mauritius, Mr. Raj Hemansing Prayag

Raj Hemansing Prayag is a Chartered Civil Engineer and is the President of the Institution of Engineers Mauritius. He is presently the Chairman of the Central Procurement Board, (since June 2018), an institution that is responsible of all major procurement for the Government of Mauritius and its agencies.

From 2015 to 2018, he was the Chairperson of the Mauritius Oceanographic Institute. He is also the Vice-Chairperson of the newly created Quality Assurance Authority, created under the Higher Education Act of Mauritius

His greatest challenge to date has been to build national consensus, getting all higher educational institutions and stakeholders to agree to IEM applying for the membership of the Washington Accord.

He is a member on the Court of the University of Mauritius. He has served for a term of three years from 2005 to 2008 as a Commissioner of the Public Service Commission. He has been a consultant for UNEP, UNDP and the World Bank on many occasions.

From 1998 to 2003, he worked for the Indian Ocean Commission as Regional Coordinator for national and Regional Oil Spills contingency plans. He helped create the Department of Environment of Mauritius in 1991 and was its Director until 2004.

On behalf of the Institution of Engineers Mauritius (IEM), it was my privilege and pleasure to welcome you all and a very special & warm welcome to all distinguished guests from overseas at this International Seminar hosted by IEM.

It was the Secretary and Director General of Institution of Engineers India (IEI) who initiated the request for IEM to organise an International Seminar in the occasion of the IEI's 100th anniversary. This is testimony to the great relationship and trust between our two esteemed Institutions. IEI, which is celebrating its 100th anniversary next year with over 900,000 members and IEM which celebrated its 70th anniversary last year with its 250 members.

Similar to Institution of Engineers of India (IEI), IEM is also part of the international landscape. IEM joined the World Federation of Engineering Organisations, (WFEO) in 1981, and became a member of the Commonwealth Engineers Council, CEC, in 1985. It is also a member of the Federation of African Engineering Organisations.

The subject of this seminar "Disruptive Technologies: Shaping future innovations" was also jointly discussed and agreed between IEI and IEM as it addressed a subject which will have an impact on the way we work, live, think and behave, no matter who you are or where you live.

The challenges to businesses are enormous. Market needs are changing too, and we need to continually innovate. Large and previously successful corporations have closed down due to new innovations on the market and their inability to cope with these changes. It is therefore essential that all businesses have to take serious note on what have happened in the recent past and are happening and plan with a different vision to avoid being taken down by these new innovative technologies.

This decade is undergoing major changes in our model of development and the role of Engineers, as agents of changes through technological innovations, is crucial. We need a new breed of engineers who can rise to tomorrow's challenges and hence must be equipped with new attributes.

For this reason, IEM is fully committed to the education and enhancement of the level of engineering education to take it up to a higher level, at par with the best in the world.

In this context, IEM is implementing several projects which will bring about a paradigm change to the engineering profession in Mauritius.

Firstly, we are presently mentoring over 270 Engineering Graduates who are undergoing their trainings at various workplaces both in the public and private sectors. This is in support of a very laudable project of the Government of Mauritius, to provide the graduates with the opportunity to acquire the minimum of two years of working experience, needed to register with the Council of Registered Professional Engineers of Mauritius. This is a statutory requisite for practicing engineers.

Secondly, we are regularly organizing conferences to create awareness in our profession. Last year, we organized an International Conference to celebrate IEM's 70th anniversary and to honour those great men of vision who had created the Institution in 1948. The theme of our conference was 'Contribution of Engineers to the Development: Past, Present and Future'.

Current seminar is on 'Disruptive Technologies: Shaping Future Innovations"

We are pleased that overseas and local engineering fraternity are with us on this day. The objectives of this International Seminar are to provide a platform for Engineers, ICT Experts, Innovators and the Business Community Captains to present their papers on Disruptive Technologies, to share their experiences as well as their vision of the future.

Another objective of this Seminar is to also look at the opportunities for engineers with regard to the immense infrastructural development taking place in Africa. The outcome and the conclusion arising from the special session provides insights for developing future policies and strategies as well as providing some guides for professional orientation for future engineers.

Thirdly and by far the most important project that IEM has ever undertaken since our creation in 1948 is our decision to apply for membership of the Washington Accord. This has become the flagship project of IEM for many reasons.

It is in the National Interest that our Universities produce Accredited Engineers of the highest calibre, benchmarked by the Washington Accord, an international reference of excellence.

This project is also in line with the GOM's vision to make Mauritius a Regional Educational Hub of the highest level.

Other reasons include providing mobility to our locally educated & trained Engineers at Regional and Global levels as well as to attract overseas Students to study for an internationally recognized Accreditated Engineering degree in Mauritius.

IEM is fully engaged in the building of its capacity to undertake engineering programme accreditation as an eventual Signatory of Washington Accord in about four years' time.

IEM is well on its way to complying with the conditions required under Washington Accord regarding the Criteria for admission to Provisional Signatory Status in an Accord as well as the Criteria for Admission to and Maintenance of Signatory Status in an Accord. IEM has already satisfied many of these conditions e.g. IEM is a non-governmental Organisation, legally incorporated and its revised constitution provides for the setting of the Engineering Accreditation Board. This board is fully operational and will apply for Provisional Membership of WA next year.

I would like to thank Hon Minister of Technology Communication and Innovation for having been present to deliver his keynote speech and to open the Seminar.

I thank the University of Mauritius specially to the Dean of the Faculty of Engineering, Associate Professor, Dr. Dinesh Hurreeram and his colleagues for their very valuable contribution.

I thank the Chairman of the Organising Committee, Mr. Shyam Roy and his team for the great achievement.

A big thank you to all the authors for their inspiring and excellent papers and for taking us into the new technological world. Thank you also to the MC and our eminent chairpersons of the various sessions.

I have a very special thank you for our fantastic and generous sponsors for their support.

Thank you

Message of the President of the Institution of Engineers India
Dr T M Gunaraja

Dr T M Gunaraja is a Mechanical Engineer and has a Masters degree in Production Engineering and Business Administration and is a PhD in the domain of organizational dynamics.

Dr Gunaraja, displaying strong entrepreneurial skills and foresight has founded three renowned educational ventures - Madras Institute of Engineering Technology, TMG College of Arts and Science & TMG College of Hotel Management Located in Tarnitnadu. He has widened the scope of his ventures in Europe Et Canada. He is an international level trainer. Dr Gunaraja has been a Council Member of the Institution of Engineers (India) for nearly two decades and has been Chairman of the Tamil Nadu State Centre. He has served as Chair of all-important Committees of the Institution. In recognition of exceptional services rendered, the Council of the Institution of Engineers (India) elected him as President of the Institution with a significant majority. Dr Gunaraja was also the Founder Chairman of institution of Mechanical Engineers and Member of Institution of Automobile Engineering (India), Institution of Civil Engineering (India) and the Council of Engineering Et Technology (India). Besides his keen business acumen and engineering background, Dr Gunaraja is deeply committed to social causes and actively supports initiatives in health and education. In recognition of his valued contribution to social causes, the Lions Club, of which he is a long-standing Member, had elected Dr Gunaraja to the coveted position of District Governor Lions Clubs International District Chennai. He is a recipient of many international District level awards.

His unwavering passion for professional excellence has earned him many laurels, like Technology Excellence Award presented by the former Prime Minister of India, H D Deve Gowda at Indian Technology Awards - 2014 and Bharat Vidya Shiromani Award by the International Institute of Education and Management in February 2015.

Dr Gunaraja has always believed in the philosophy of continued professional development of engineers and envisions the inclusion of contemporary learning techniques in this paradigm. As President of the largest engineering professional body in the country, The Institution of Engineers, his vision has manifested in a digital transformation of the services being offered by the Institution which would lay a strong foundation for future growth and development of the engineering community at Large

I convey my greetings to all of you on behalf of the Council of the Institution of Engineers India and the engineering fraternity of India. I am happy to be here in Mauritius again and enjoy your warm hospitality and the wonderful climate. At the outset, I would like to express my sincere gratitude to the Minister of Technology, Communication and Innovation for taking time out of from his busy schedule to be present here at this event. I am also extremely grateful to Mr. Raj Prayag, President, of the Institution of Engineers Mauritius who very kindly agreed to

host this unique event in Mauritius at this splendid facility in collaboration with the University of Mauritius. I also heartily welcome. Mr. Martin. Manuhwa, the President of the African Engineering Organization and vice president of WFEO, who is an old friend of IEI and has been at the core of many large development initiatives at the global level.

Further, I would like to express my thanks to Mr. Huang Wei President, Federation of Engineering Institutions, Asia and the Pacific (FEIAP) under whose aegis this event is being conducted. However, due to the

pressing official commitments, Mr. Huang Wei could not be present here today. I would now like to briefly acquaint you with the Institution of Engineers India. IEI, since its inception in 1920, is the premier largest professional body in India, having 200,000 corporate members covering 15 engineering disciplines. IEI was bestowed with the Royal Charter in 1935 and conducts its business through 123 centers in India and also has six overseas chapters. IEI has bilateral relationship with the many engineering professional bodies across the globe and is a member of World Federation of Engineering Organization (WFEO), The Federation of Engineering Institutions of Asia and Pacific (FEIAP) and the many other engineering bodies. The focus of the Institution is to create an ecosystem of learning which will contribute to the continuous professional development during the entire spectrum of the professional career of an engineer. We plan to engage with the engineers by way of digital learning expanding the digital access through digital India programs of the Government and other similar initiatives. Our aim is also to strengthen the interface between engineers from the academic year field as well as the industry. Our focus is to enhance the image and the visibility of IEI by fostering innovation and upskilling engineers for implementing the new technologies. IEI, being a member of FEIAP, is set to explore promotional goals of the FEIAP.

The Standing Committee under FEIAP have the mandate to carry forward the specific goals laid down under the objectives of FEIAP and I being the Chairman of the Standing Committee of Information Communication Technology, am privileged to have been the initiator for the organisation of this seminar on this contemporary and innovative theme on the eve of the Centenary Celebration of the Institution of Engineers India. A similar seminar was organized in Udaipur in India during December 2018, under the aegis of FEIAP: ICT together with Indian Engineering Congress on the theme of Cyber Security and focused on data protection. Seminar of such cutting-edge technological themes builds a strong knowledge base and provides a platform for networking amongst others, such as engineering students and professionals on areas of common interest. In this context, organising this seminar with our valued partners, the Institution of Engineers Mauritius indeed is significant. This seminar is a part of our Centenary Celebration and we propose to hold many such events in India and overseas. The subject and the theme of this seminar has been very aptly chosen and the well curated event such as this provide a valuable opportunity for engineering community, industry specialists and the decision makers to share their experience on an emerging reality. In conclusion, I would like to congratulate the Organising Committee for their ceaseless efforts in organising this seminar in a befitting manner and thank all of you who are present here today. I wish the event a great success.

Thank you very much.

The Standing Committee under FEIAP have the mandate to carry forward the specific goals laid down under the objectives of FEIAP and I being the Chairman of the Standing Committee of Information Communication Technology, am privileged to have been the initiator for the organisation of this seminar on this contemporary and innovative theme on the eve of the Centenary Celebration of the Institution of Engineers India.

Message of the Vice President WFEO & President of FAEO Mr. Martin Manuhwa

Mr. Martin Manuhwa describes himself as a nature loving engineer

who believes in green, large scale energy projects. He is the Vice President of the World Federation of Engineering Organizations and he is the newly appointed President of the Federation of African Engineering Organization. Mr. Manure has extensive experience in the field of energy construction projects and work side project implementation and management. He is the Managing Director of the Zimbabwe Africa Infrastructure Development Group, a company that specializes in engineering, procurement and construction management. He also teaches MBA and engineering graduate students at the University of Zimbabwe. Mr. Manuhwais well known for the valuable contributions he has made to both local and foreign engineering bodies in the past. He has served as the president of both the Zimbabwe Institution of Engineers and the South African Federation of Engineering Organization. He has also served as the chairman of the Engineering Council of Zimbabwe and is a member of the Advisory Council of the Global Infrastructure Anti-Corruption Center.

Good morning to you all and thank you so much for inviting the Federation to be part of this historic event where we are celebrating the hundred years for the IEI.

I can see a lot of young engineers and I am delighted. That's one of my motivation in life to make sure that we pass on the heritage that Engineer Roy and others have created over the years. I am going to speak briefly about the World Federation and the Federation of African Engineering Organization. We have made a strategic effort that every engineer should know the purpose of this organization. I will also speak about the motivation of paradigm for the disruptive technologies. And then we need to link all our activities to the Sustainable Development Goals.

I can see a lot of young engineers and I am delighted. That's one of my motivation in life to make sure that we pass on the heritage that Engineer Roy and others have created over the years.

The WFEO, which is an international organization formed in 1968, has over 90 members and 70 plus million engineers with China, on its own, has close to 40 million engineers.

IEI chairs the Standing Committee and are very active in Communication & Engineering, a Committee that deals with disruptive technologies ICTs into the future. WFEO is the only international organization representing all disciplines in engineering that are recognized by the U.N. The WFEO and the International Council are the only high political forum participants at the U.N. Assembly. We have 10 Standing Committees, an Executive Council, and the Board. You just choose which committee you want to join, and you can participate at the world level. This year, in November, we will be celebrating the World Engineering Congress in Melbourne, Australia who is also celebrating its own Centenary.

The Standing Committees (STC) and their working groups address serious issues. The Energy & Engineering Education committee is led by Lebanon, Information Communication by India, Innovative Technologies by

China, Capacity building by South Africa, Risk by Peru and Anti-Corruption by Zimbabwe, (which I chair), Women in Engineering by Nigeria and Young Engineers and Future Leaders by Kuwait. We have the U.N. Relations Committee, led by the USA and then we have the Water Group by which is led by Spain.

Members can be active in the World Federation of Engineering Organisation (WFEO) through the STCs. The 17 Sustainable Development Goals are very important to us and we partner with the International Engineering Alliance. Here I congratulate Mauritius for taking the good decision to apply for membership of the Washington Accord. My friend Raj here, who has been working on this project for many years ago. I admire his passion, the zeal and the kind of achievement that you have met so far is historic.

We work with the UNESCO and the International Centers for Engineering Excellency in China and also with the one in Jakarta. WFEO's strategic initiative is to address the gap in engineering capacity and also the quality of the engineering professionals themselves.

Hence, the IEA, according to our policy, is the only pathway and reference that all our members have to follow to attain excellence in engineering education.

Many principle actions which are to do with capacity building have international links as well as impacts of engineering in infrastructure development. And I'm so happy that the engineering institution of India had chosen Africa as one of its mentoring goals to make sure that we can leapfrog and become a developing continent by 2063. They are helping us to create to be Africa we want where all citizens are prosperous with infrastructure, less diseases, etc.

I am happy to announce that the President of WFEO,

WFEO

Dr Marlene Kanga in her message, has announced that we will soon succeed to have an International Engineers Day to celebrate engineering as from 2020. The chosen date is 4th March. So, the UN calendar will be having a U.N. International Engineering Day, which is in recognition of the engineering achievements.

The Federation of African Engineering Organizations is the grouping of five regions in Africa: Centre of Africa, the Eastern Africa, Southern Africa and Northern Africa.

FAEO
FEDERATION OF AFRICAN ENGINEERING ORGANISATIONS

We have recently included Egypt leading in North Africa. And we appeal to Mauritius to join as it can be a very important member of the African Federation because it can bring an important contribution, especially for engineering education, which is one of our focus. We are having the UNESCO Africa Engineering Week on 15-25th of September and we invite in the Institution of Engineers Mauritius to come and meet the rest of Africa. The theme this year is how to achieve the sustainable development goals for the development of Africa.

Let me now address the theme of this Seminar. What's our motivation for disruptive technologies? The world has been through the industrial revolution. We are now looking at the digital futurethen globalization has forced us to work together. Hand in handand again we are now living as a global community with big data analytics, big data sources. It's now or never that we develop and harness disruptive technologies, as it will change the way we live and do business and will affect our entrepreneurship.

Africa's population is made up of about 23 percent young people below the age of 25. That is a huge asset to have a potential digital population. This has the potential to yield huge dividend in the future.

These young people can do coding, they can do things we never did in our life. They will change our lives. So, let us make sure that we are having this paradigm shift in our future development. Historically, you are all aware of these revolutions have been driven by engineering. One was for need for transportation. The other was for production and electrification. And then the other was for the ICT technologies. we are now having the digitalization revolution and that is the future. Where are we? It's hard to tell, but I think we are in between in Africa and we need to leapfrog to catch up with everybody else. I know our professional presenters this morning and afternoon will go into detail and will enlighten us with regard to the progress being made and give us a sense of direction as to where we are going in the near future. But the Internet of Things, the Big Data analytics, Cloud and Edge Computing, the Augmented Reality and Wearables challenge us all. We should challenge ourselves as to whether our degrees be four years, three years, five years, full time to equip and empower our future engineers with the required knowledge?

How do we know? The learning environment is changing very fast. There are a lot of other trends in the Disruptive Technology's arena. Artificial intelligence, intelligent apps. Where are we? Is the IEM, IEI following the WFEO? We are told that by 2025, we will have the first 3D printed motor vehicle. Already, some body parts have been studied to a very advanced stage. We are also told that some jobs will disappear.

The first robotic pharmacist in the US is there. Saudi Arabia already has a Safire, one of their robotic citizens. Where are we? What should we do about that? So, this evolution is not only for us, it's for our young people. The telephone took seventy-five years, but the Web only took seven years to reach a hundred million.

This hundred million would be reached in one second. So, we need to know how to handle this. Some of these could be either threats or alternatively could be good. The things that we are seeing e.g. these robots will be having feelings through artificial intelligence. They may commit crimes. Ethics and professional conduct as we go into disruptive technologies is very important. We want to see how to maintain the right balance between our mastery as the human race and the evolving technology. The latter should only be an enabler. But it's up to you, the engineers, the professors, the researchers, to make sure that we have a proper pathway. Some jobs will disappear. In my lifetime, we had typists, dockers, milkmen, blacksmiths. They are gone. And probably in the young people's lifetime, we will not even have analysts, the advisers, accountants or the auditors. All this would be done by block chain. Population, calendars, enumerators. all that will be done on the go. Let us be very focused as we plan in the future. In Hong Kong last June, we were pondering at the IEI about our competencies and we had done in 2018. A lot of the digital landscape has changed. We need to refocus and come up with ways so that we can deal with this situation.

Cyber security is an issue and obviously the Artificial Intelligence issues in the fourth industrial revolution will assist us in anti-corruption and will bring in many good things. The UN Sustainable Development Goals will not be achieved without engineering.

Let us thread very carefully. We know that, engineers are very, very important. All of these goals are very important, and we can contextualize and summarize our meeting today in three or four goals. Innovative infrastructure, ICT's and many other issues. I think we need to prepare to ride the wave of the revolution and for the development of creating the Africa we want. It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to disruption.

In Africa, we always say if you want to go fast, go alone. If you want to go far, let's go together. And this is what India and IEM have done. We will go together.

I thank you for this very opportunity to speak to you

Message of High Commissioner of India, H.E. Tanmaya Lal

His Excellemcy High Commissioner Tanmaya Lal, 53 years of age, has served as an Indian diplomat for 27 years. His previous assignment was as Ambassador / Deputy Permanent Representative of India to UN Permanent Mission of India, New York from 2016-2019

His work experience includes India's engagement in its extended neighbourhood (Iran, Southeast Asia and East & Southern Africa) and west Europe as also regional groupings (EU, ASEAN, AU and BIMSTEC). As the Head of the East & Southern Africa (E&SA) Division, his portfolio included work relating to the AU and 20 African countries as also the 2015 Third India-Africa Forum Summit that saw an unprecedented scale of participation.

High Commissioner Lal has also worked extensively on multilateral aspects of India's engagement as the Head of the UN Economic & Social (UNES) Division at headquarters and earlier at the Indian Missions in Vienna, Nairobi and Bangkok. His portfolio at the headquarters included the Climate Change negotiations at the UNFCCC, Agenda 2030, Human Rights Council, UN agencies, maritime issues, and the Arctic Council among others.
He is the second recipient of the S K Singh Award for Excellence in the Indian Foreign Service.

He did his schooling in New Delhi and holds a Bachelor's degree in Chemical Engineering and a Master's degree in Biological Sciences from the Birla Institute of Technology and Science (BITS), Pilani.

May I begin by thanking the Institution of Engineers Mauritius, the organizers of this International seminar for engaging with the High Commission of India and to invite me here today. I also congratulate the Institution of Engineers India on their landmark hundredth anniversary.

I understand that Institution of Engineers Mauritius itself has just celebrated its seven decades anniversary. That's a very, really longstanding tradition.

As a fellow engineer, even if no longer a practicing engineer, I am excited to be here this morning to attend a conference on disruptive technologies. As you all know, the use of tools defined the evolution of our species and made us human. Technological advancements have continued to mark civilization and progress, as well as leadership of societies which control these technologies. Over the last two centuries, the pace of change picked up with the First industrial revolution, driven by the control of steam energy that mechanized production. The Second revolution being led by the control of electricity that transformed communication, transport and manufacturing. The Third, pushed by computing machines and internet connectivity. The last century saw human beings exploring and developing the skills to manipulate the atom, the cell and the byte. And it really transformed our lives. The Fourth industrial revolution that is upon us now is fusing the physical, digital and the biological spheres. Today, Artificial Intelligence, Internet of Things, Big Data analytics, Blockchain and Robotics, 3D printing, Drones, Genomics, Nanotechnology, Cloud computing, collaborative consumption, energy storage, geospatial analytics, 5G and many other technologies are driving this change.

The intersection of technologies is creating an unprecedented multiplier effect. It is disrupting a whole lot of things the traditional services, education, entertainment, commerce, healthcare, banking, media, manufacturing, travel, law and then goes on to governance, safety and politics itself. And this is being done globally. It is rapidly transforming our lives as individuals, societies, economies and nations. The future is surely exciting and unpredictable and perhaps a bit intimidating too. Most of you are experts who actually drive these technological and entrepreneurial aspects of these changes.

I, here today represent the Government sector, whose representatives also have important responsibility to anticipate these changes, to recognize the potential of technology, to scale up interventions which can drive these social and economic progress and inclusivity and provide regulatory frameworks and ecosystems to facilitate and manage changes at a

broader level. Unlike in the past, the capacity of developing countries to adopt disruptive technologies is also increasing and has its potential to enable economies and societies to leapfrog to the next stage of development. Although we can debate about what exactly constitutes a disruptive technology, the impact of these emerging technological trends on consumers and people all around the world equally in developed and developing countries is for all to see. Disruptive technologies are not only found in smart homes with voice user interface, but also in the empowerment of the poor and the rural farmers through financial inclusion of the unbanked, affordable Agri tech, improved healthcare and delivery of e-governance services.

India represents one sixth of the world's population, and the Indian economy is today already among the fastest growing large economies, representing a huge market where the cost effective large skilled manpower, researchers, engineers keep up capabilities in a range of high technology areas such as space, nuclear, biotechnology, etc.. In fact, the second Indian mission to the moon is currently underway. As those coming from India are aware, the Government of India is placing high value on the use of digital technologies, internet connectivity, smartphone connection, unique biometric based identity cards and so on to scale up the financial inclusion and delivery of e-governance.

This is cutting corruption, improving efficiency and transparency, and reaching government interventions to hundreds of millions of poor and the vulnerable sections of society. Similar interventions in digital payment platforms are boosting e-commerce interactive agricultural apps, providing information ranging from soil to water conditions and weather and pests to farmers and linking them to markets, facilitating farm loans and helping improve productivity. Interactive technology interventions are also helping to improve the reach of healthcare services, for instance, through real time information on availability of particular vaccines in remote rural areas. Innovations are also transforming not only manufacturing, but as I have mentioned before, transport, power, water and sanitation sectors, which really affect a large cross-section of people. Recognizing these factors, the government of India is implementing various measures. Structural reforms are underway in areas such as taxation and IPR (intellectual property rights) that are fast pushing India up the global ladder in terms of the ease of doing business, innovation and competitiveness indices.

The government of India is focusing on a series of other initiatives, such as Digital India, which was mentioned to expand the digital infrastructure across the country, innovation mission to support incubation and innovation, start-up India to support entrepreneurship and skill. India to provide useful skill to the young. All of these are being put in place to provide an enabling ecosystem of public private partnership. The government has announced a national program on artificial intelligence guidelines for drone operations beyond the line of sight are being developed. Mumbai now hosts the Centre for the Fourth Industrial Revolution Network Hub of the World Economic Forum. Today, nearly 1.2 million Indians now have a digital identity. The Internet, based in India, has crossed 500 million mark.

That includes 200 million rural users. India is estimated to be the world's largest mobile data consuming country. The cost of mobile data is among the lowest in the world, and around 350 million new bank accounts have been opened in the last four years. This is just to give a snapshot of what how the government sector is responding to the oncoming changes. As we go along, we will improve our understanding of the potential areas of risks, such as the personal data, privacy, cybersecurity, ethical standards, loss of certain kinds of conventional jobs in administration and manufacturing to AI and automation and even in their impact on basic human rights in certain instances. We also need to see at the level of international community how to promote greater international collaboration and regulation where needed to better manage this change.

At the level of United Nations, High level panel set up by the UN Secretary-General came out recently with a report on digital cooperation. It is therefore good to see that a conference on this important theme affecting all of us is taking place in Mauritius here and a fellow developing country, a large ocean state and international financial services hub and a member of the African Union. Last week, Mauritius also hosted India Africa Entrepreneurship and Investment Conference, and a couple of weeks earlier, the IIT Madras and University of Mauritius hosted an international conference on Ocean Engineering. We are happy that India and Mauritius are working together on these serious technical and entrepreneurial issues. And in conclusion, I wish this conference insightful deliberations. Thank you.

Message of Minister of Technologies Innovations & Communications Hon. Yogida Sawmynaden

Hon Yogida Sawmynaden is the Minister of Technology, Communication and Innovation. He holds a B.A. honours degree in accounting and law, a Master's degree in business administration and a Diploma on Management International from France. He has been assigned the portfolio of technology, communication and innovation since January 2017. His main objective is to position the ICT sector as the main pillar of the Mauritius economy and to promote innovation for the transformation of Mauritius into a high-income digital country. His Ministry has embarked on several innovative projects such as the Info Highway which has been designed to provide a secure platform offering E services by the government.

I congratulate the Institution of Engineers of Mauritius for hosting such an interesting event at such a point in time when there is so much of global technological development. I'm particularly impressed by the very good blends of topics to be addressed today by various speakers. I also wish to extend my sincere congratulations to the Institution of Engineers, India on its hundredth anniversary. Hundred years is a very long time in lifetime of an organization, but I am sure that members have not seen time pass as in the life of engineers, it is a day to day battle with new challenges in the history of a country which has rapidly moved from a third world country level into one of the major global players of this century.

Engineers all over the world, irrespective of their fields, have been instrumental in shaping our society and have been at the forefront of development. And now, more than ever before, the global challenges on various fronts such as ecological, environmental, health, aging population, among many others. The importance of engineers to come up with innovative ideas is more than welcome. As always, we are all eagerly waiting for the new and exciting prospects that engineers will bring to solve persisting problems. And one way of bringing solutions is through disruptive technologies. There is no doubt that disruptive technologies are here to shape future innovation.

According to World Bank, in both developed and developing countries, disruptive technologies are quickly unlocking innovative solutions to complex challenges across a broad range of sectors, from health and education to transport, disaster risk management or agriculture. My Ministry, which is responsible for technology, communication and innovation, is well engaged and committed in the use of digital technology, which is revolutionising the way government works and connects to the citizens to produce better services and opportunities and in building a better future. And now while being at the same time more innovative, we are embarking on digital innovation, which is the process of transforming almost every sector of the economy by introducing new business models, new products, new services, and ultimately new ways of creating values and jobs. My Ministry is conscious of the challenges that lie ahead in the mastery of best technologies to come, just to name a few, which no doubt will create a shift or disruption in the digital ecosystem are the emergence of the Web 3.0. Web 3.0 is being referred to as the next iteration of

> ***Engineers all over the world, irrespective of their fields, have been instrumental in shaping our society and have been at the forefront of development.***

the internet. Interactivity will be at the centre of Web 3.0 and will redefine the search in a smarter way.

By extrapolation, we may also visualize what lies ahead with the Web 3.0 and the 5G and improve data storage solutions combined with block chain and more prominent open data, It can also mean more trust in the future system. With simulation and digital twins, the market of Edge Computing, the voice economy, strategic automation, spatial and quantum computing are regarded as the next big development to bring disruption in the world of digital technology.

I would like to reflect a bit on another technology, which will no doubt if not already creating disruption. This is the ubiquitous Artificial Intelligence (AI). AI is said to be the presence of intel artificial intelligence in all our machines, applications and processes. For one thing, it is now much easier for program developers to integrate A.I. capabilities into their application without having to create or manipulate the A.I. themselves. Government is conscious of the fact that A.I. in government system shall be the next phase in the digital transformation and government process. My Ministry has recently set up the Mauritius Artificial Intelligence Council. The Council will not only leverage on local talent, and I am told that there are many of our youngsters who already have solid background in the field, but also fully engage with overseas specialists in AI. AI is, in my opinion, one of the most prominent disruptive technologies on which I will request our professionals, engineers included, to consider using in a responsible way. I'm sure you are aware of the numerous questions being asked on A.I. generally as this technology is more than ever finding its way into more and more areas of our lives, and we need to address these questions in a responsible manner.

And now, a few words on the main action areas on which my ministry is focusing. Robotic, which is no more a science fiction feature for our kids. Around 1200 students aged between 11 and 25 years and 40 trainers had been initiated to robotics. The future of Mauritius is going to be a digital one and ` coding is intrinsically linked to it. Through the National Computer Board, which operates under the aegis of my Ministry, Primary and Secondary school students are being exposed to coding. This will surely kindle interest in ICT and STEM, (the science, technology, engineering and math subjects). The first Mauritian nanosatellite has been designed and built by the Mauritius Research and Innovation Council to be launched by the Japanese Aerospace Exploration Agency by mid 2020. This is going to be a landmark development for the country and associated activities with this initiative are already in the pipeline. Engineers, will no doubt be required to reinforce the base in this new endeavour, besides having online access to government services, Citizens are more than ever connected to government through government mobile apps which are already available. Artificial intelligence and blockchain technologies are already on the agenda of my ministry and soon initiatives related to these technologies will permeate many government processes.

The digital divide has not only been addressed in Mauritius, but in Rodrigues Island also as both countries are now linked since February 2019, by the MARS cable. Following measures announced in the budget 2019- 2020, my Ministry is already looking into other services such as applying and obtaining securely extracts of birth certificates and marriage certificates online and at no cost. Online application for seats in primary and secondary schools, online facilities for citizens to carry out searches on the 'Titres de Proprietes' at the Registrar General department, online registration of vehicles, online registration or payment for private candidates wishing to sit for SC and HSC examinations. With changes in the Electronic Transaction Act, my Ministry will put in place the info highway platform to share information electronically between public and private sector agencies for better results in government process. Setting up of a Fab Lab for the S.M.E's. My Ministry has always believed in the power of innovative ICT to push the nation as a major player on the regional and international fronts. International indexes speak for themselves in the ICT landscape.

The Global Competitive Report ranks Mauritius 45th in the world. On the ICT Development Index, Mauritius is at the 72nd position, while under e-Government Development Index, Mauritius is on the 66th position and the country is 49th on the Network Readiness Index and 14th on the Cybersecurity Index, Mauritius holds the 1st position in Africa in the indices I just referred to. Having 100% Fibre to the Home in Mauritius has taken the country to the 8th position worldwide in FTTH in the world. In this respect, the engineering profession has a remarkable input by putting the right infrastructure in place. Just like in the engineering world, where there are constant challenges to address the digital world, also experience the same interrogations. In this respect, my Ministry is guided by the 3 strategy documents, which are the Digital Mauritius 2030, The Digital Government Transformation Strategy 2018-2022 and the Mauritius Artificial Intelligence Strategy. I must say that we are all set to meet these challenges. Maybe together we will do so faster and easier. Before I end, I would like to congratulate the organisers of today's event for assembling this very high-level audience, and I am sure that the deliberations of the seminar will pave the way for the future for Mauritius and globally. I now have the pleasure to declare this seminar open. Thank you.

Disruptive Technologies - What are they and their implications on our day to day living? Dr. Krishna Oolun

Dr Krishna OOLUN holds an Electronic Engineering degree from the University of Mauritius, Masters and PhD degrees in specialised areas of Communication Engineering from the University of Manchester (UMIST-UK), and an MBA in Information Technology Management from the University of Leicester (UK). He is a Chartered Engineer of the UK Council of Engineers, Registered Professional Engineer of Mauritius and member of the IET.

He served as Chief Executive of the ICT Authority of Mauritius, the National Regulatory Authority between 2004 and 2015; prior to that he was a Senior Lecturer at the University of Mauritius. He has contributed to the elaboration of the National IT Strategic Plan for Mauritius in 1998, the National Spectrum Management Policy for Mauritius in 2002, the National Numbering Policy in 2003, the National Telecom Policy in 2004, the National ICT Strategic Plan in 2007 and was the team leader for the National Broadband Policy elaboration in 2012.

His current research interest is in regulatory reform modelling, IOT and Digital transformation; he has extensive experience in Telecoms sector planning with over 50 international publications in the fields of Communication Engineering and ICT policy and reform, amongst others. He was the inspiration for the 4th Generation regulation at the International Telecommunication Union (ITU) in 2012 and is currently a consultant for the World Bank on Telecom sector reform and Digital Economy.

Executive Summary

The term "Disruptive Technology" was first coined by Professor Christensen of the MIT in 1997 in his book entitled: "The Innovator's Dilemma". Taking Christensen's theory as a starting point, a disruptive technology is one that initially has lower performance and qualities when compared with the original product. However, as the technology develops, it will begin to occupy a place in the market of the mainstream technology and may, indeed, surpass the original product in terms of performance. A critical aspect to note is that the concept of disruptive technologies is not limited to physical consumer products but can equally apply to a service-based industry. Generally, a disruptive technology is now perceived as one that introduces superior technological qualities to the mainstream product and thus causes a disruption to the market of the mainstream product.

The purpose of this paper is to present what Disruption is all about, its origin, how it affects our lives. We also consider the disruption model that professionals should be aware of to better assess risks of the business environment today with a view to be better equipped to take informed decisions in their respective organizations.

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Keywords:
disruption, innovation, sustaining technologies

1. Introduction

The theory of disruptive technologies has been widely studied as part of innovation theory. Incorporating research in product and process innovation as well as in techno-economic analysis of technology markets, disruptive technologies have gained a considerable amount of interest in technology organizations.

Generally, a disruptive technology has been perceived as one that introduces superior technological qualities to the mainstream product and thus causes a disruption to the market of the mainstream product. Christensen disagrees with this, according to the theory presented in the book "The Innovator's Dilemma" (Christensen, 1997). Taking Christensen's (1997) theory as a starting point, a disruptive technology is one that initially has lower performance and qualities when compared with the original product. However, as the technology develops, it will begin to occupy a place in the market of the mainstream technology and may, indeed, surpass the original product in terms of performance. A disruptive technology change is always classified as one that has had a lower initial performance (Christensen, 1997; Christensen and Raynor, 2003). It also addresses a different market segment compared to the original product and thus competes on a different set of issues and priorities. A critical aspect to note here is that the concept of disruptive technologies is not limited to physical consumer products but can equally apply to a service-based industry.

2. Christensen's Theory of Disruptive Technology

Christensen's book, written in 1997, gives an insight into the theory of disruptive technology that can be applied to most technology-related industries. In order to prove the practicality of his proposed theory, Christensen wrote another book titled 'The Innovator's Solution' in 2003. In this book, he gave practical examples of how to make use of the theories put forward in his earlier book. Technological disruptions have occurred throughout history and may come in any form. Disruptive technological changes and disruptive innovations, as Christensen and Raynor (2003) refer to them in 'The Innovator's Solution', drive industries to the next phase of development and can significantly protect organizations from destruction.

Christensen (1997) makes a distinction between a disruptive technology and a sustaining technology. A disruptive technology is one that will eventually take over the mainstream market and become the dominant technology. It is both radically different from the present mainstream technology and has a poorer performance record. Sustaining technologies are those that introduce incremental improvements to the performance of the existing technology. Sustaining technologies address the same market as the original product; they improve the performance of the established product along the dimensions of performance that the mainstream customers have historically valued (Christensen, 1997; Christensen and Raynor, 2003; Christensen and Overdorf, 2000). Sustaining technological changes are usually introduced by the incumbents or leading firms in the existing market and they rarely fail in such ventures, as noted by Christensen and his colleagues (Christensen, 1997, Christensen and Raynor, 2003). New entrants into the fields being addressed by sustaining technologies are very likely to fail as the incumbents would always have the upper hand. On the other hand, the new market for disruptive technologies has growth potential. The substandard technology can be developed by new entrants by sustaining improvements in their own value networks to a level sufficient to satisfy mainstream customers (Christensen, 2004). Although the performance of disruptive technology is inferior, at some point it starts to attract the mainstream consumers. Christensen's notion of sustaining and disruptive technologies is explained in the following section.

3. Modeling disruption

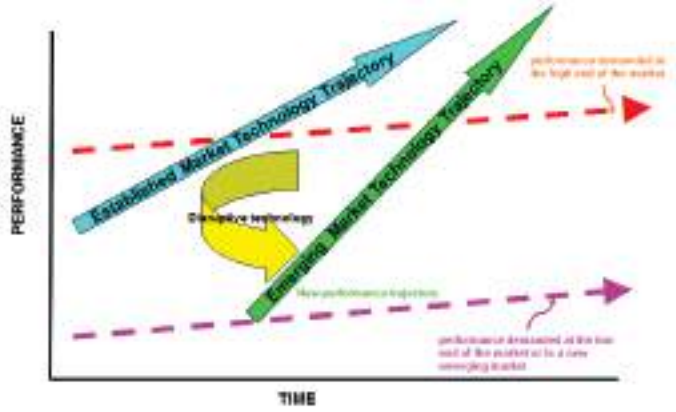

Figure 1: The Impact of Sustaining and Disruptive Technological Change; Source: Adapted from Christensen (1997); Christensen and Raynor (2003)

Figure 1 which shows the impact of sustaining and disruptive technologies, as depicted by Christensen (1997,

Christensen and Raynor, 2003), is widely accepted as the most powerful analytical tool provided by Christensen's theory (Danneel, 2004; Acee, 2001; Walsh, Kirchhoff and Newbert 2002). The technology curves show that after a point in time, the user's requirement for performance becomes lower than that provided by the original product. A disruptive technological innovation results in a new curve being added. As its performance is lower than that offered by the mainstream technology, it cannot be represented by the same curve. Christensen characterizes disruptions as being either 'low end' or 'new market'.

3.1 Low-end vs high-end market disruption

'Low end' disruptive technology initially targets the requirements of the low end of the market but as the technology improves, it can begin to address the needs of the high end of the market as well and is able to compete with the mainstream technology. This cycle, as envisioned by Christensen (1997), continues and is repeated when a new disruptive technology enters the market. Customers at the low end of the market have lower performance criteria, which are exceeded with the further development of the mainstream technology. The needs of the low-end market are not as rigorous as those of the high-end market; its requirements can be fulfilled by the early developmental stages of disruptive technology. At the same time, the evolving disruptive technology is improved further by sustaining innovations. At a certain point, it is able to meet the performance requirements of the high-end market segment, competing with the mainstream technology in this segment of the market. Because of its lower profit margins, it will eventually out-compete and displace the mainstream technology and take over this segment as the performance of the mainstream technology becomes too high, even for the high-end market.

3.2 Mew market disruption

Another technology analytical tool is that of 'new market' disruption. Because new market disruptions address a market that has not existed and are based on performance characteristics that are different from the original technology market, they cannot be represented by the same market graph. The new market disruption addresses the needs of non-consumers or consumers who were not served by the original technology. The challenge in a new market is not to compete with the incumbent but to compete against non-consumption (Christenson and Raynor, 2003). It therefore does not invade the incumbent's market but pulls customers away from that market into a new one.

3.3 Incumbents' Behaviour to disruption

Besides characterizing disruptive technologies, it is also important to understand firms' behaviour in relation to disruptive change, especially that of the incumbents. Disruptive technologies are those that show worse product performance in the near-term and bring to a market a very different value proposition from that which had been previously available. It is complex to forecast market requirements for a market that does not exist. The failure of incumbent firms, according to Christensen and his colleagues (Christensen, 1997; Christensen and Raynor, 2003; Christensen and Overdorf, 2000) is not their inability to gear their strategy towards new emerging markets when the impulsion from customers is lacking. The explanation for the incumbents' behaviour can predominantly be understood in terms of the power of the established customers in the mainstream market (Christensen and Bower, 1996). According to Christensen, the inability of firms to change strategy at the right time and to allocate sufficient resources to the new technology for the emerging market results in the interaction between distinct circumstances in the internal resource allocation process of the firm. This effect is also suggested by resource dependence theory as developed by Pfeffer and Salancik (1978).

New entrants often cause the fall of incumbents as their business models are the result of a disruptive technological change. On the other hand, the early entry advantage of the entrant firms can be found in their different capabilities to commit strategically to developing emerging markets created by disruptive technologies, and to identify them earlier (Christensen and Rosenbloom, 1995).Hence, due to an early move into the new market, a competitive advantage may be developed by new entrants; small firms that do not have the extra baggage of having to keep satisfying current clients. According to this theory, the strategies that incumbent firms can choose are restricted by the interests of their existing customers and investors, who supply the resources necessary to survive. Therefore, established firms allocate their resources towards sustaining technologies that address the interests of their existing customers rather than towards disruptive technologies for which the customers and markets are highly uncertain and initially structurally unattractive (Christensen and Bower, 1996). In contrast, after introducing the new disruptive product to the new market segment, gradually the new entrant grows and soon gains a position in the mainstream market occupied by

the older incumbents. As the new entrant grows, it becomes even more difficult for incumbents to enter the even smaller emerging market that will eventually become a large market. The divergent capabilities of incumbent and entrant firms in the adoption of disruptive technologies are based upon different sets of organizational procedures and values embedded in the firm's mores that are shaped by its business model (Christensen, 1997; Christensen and Overdorf, 2000).

4. Conclusion

Although Christensen's theory has raised a massive amount of interest in the modelling of disruptions, it has reached a stage of maturity where it can help practitioners in their struggle with emerging technologies and markets. There is no comprehensive and easily applicable method to analyse the disruptions caused by new technologies. Recent research suggests that more research is required for a mature understanding of the theoretical foundation of this phenomenon, in order to develop. In this paper we have shown that disruptive technologies are sometimes described as being simultaneously destructive and creative because they make old products - and sometimes even entire industries - obsolete, creating new ones in their place. Disruptive technologies have the power to change the way we work, live, think and behave.

In this regard, recent studies have shown that some 82% of directors of companies have reported that disruptive risks are becoming more important than they were just five years ago. In addition, the impact of disruptive technologies and innovation was named the number one issue that directors of companies would wish to see being devoted more time and attention at their future board meetings. Monitoring strategy execution and understanding the associated risks and opportunities are at the top of every board member's to-do list. Directors must truly understand how new technologies are reshaping business models in every industry across the world, so they can make better decisions and stay relevant on the boards they serve.

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The Emerging Innovative Technologies - A Myth or Reality

Prof.(Dr.) Mohd Rizal Bin Arshad

Professor (Dr) Mohd Rizal Arshad graduated from the University of Liverpool, in 1994 with a B.Eng. in the field of Medical Electronics and Instrumentation. He then pursued his MSc. in Electronic Control Engineering at the University of Salford, graduating in Dec. 1995. Following from this, in early 1996, he continued his study with a PhD degree in Electronic Engineering, with specialization in robotic vision system. After completing his PhD training, i.e. January 1999, he started working at the UniversitiSains Malaysia (USM), Malaysia as a full-time academic. He has supervised many post-graduate students at the MSc. and PhD. levels. He has also published actively in local and international publications. He is currently a Full Professor at the School of Electrical and Electronic Engineering, USM. He was also an Adjunct Professor at Universiti Malaysia Terengganu (UMT) for a period of two years (2016/2018). He is currently the President of the Malaysian Society for Automatic Control Engineers (MACE) – an IFAC NMO for Malaysia, and Past-Chair for the Oceanic Engineering Society (OES) Malaysia Chapter. In early 2017, he was awarded with the Professional Engineer (P.Eng) status by the Board of Engineer, Malaysia (BEM). Prof Rizal is well known as the pioneer of underwater system technology and robotics research efforts in Malaysia. Prof Rizal is very interested in investigating the fusion of the natural world with the modern engineering pool of knowledge.

We are seeing so many emerging technologies in the few decades. These innovations are changing how we interact with one another, how countries may prosper or collapse and how human civilisations are evolving, inadvertently, affecting the world; due to the introductions and ubiquitous nature of the inventions. They are certainly disruptive and no longer linger in the realm of imaginations. Emerging technologies are coming at an exponential rate and fast changing the realities we are dealing on daily basis.

The "democratization" of knowledge and access to information at an instant were enabled with the invention of the world wide web (WWW). Now, information is on our fingertips. Accessibility to facts and information have really affected the way human gained new knowledge and understanding about the world. On the downside, we are facing the "Google Effect" or as some termed it as "Digital Amnesia". This is a condition where one will not remember or care to remember anything which can be searched in the WWW or via "googling". The new generation is certainly very dependent on the easy accessibility to facts and information that we wonder whether they do acquire the actual knowledge on the subject matter. Certainly knowing a number of facts do not make us fully knowledgeable about something. Only until one grasps the total meaning, including the contexts, of certain topic, will one ever truly acquire the intended appreciation of the subject.

The other barrier in terms of exposure to innovative technologies is the generation gap. We are seeing various acceptance levels of people to new innovative technologies. For the Gen Z and Gen Alpha, new technologies are expected in their daily experiences. But, not so for the "Baby Boomers" and those in the 60s and above. New technologies may be too disruptive for their own comforts. These acceptance variances between generations are something which must be addressed by inventors and technology trend-setters. The whole idea is to provide ease of use and adaptation for the normal users. In policy making for technology implementations, there must be serious considerations on possible emerging issues coming out from these realities. For the educational sector, for example, the curriculum designers and developers must embrace the new emerging innovative technologies and the changing

nature of the students. The mismatch between what are assumed and expected by the policy makers or educators, and the acceptance levels of the students must be taken into account. A mismatch will mean wasted resources and loss opportunities to all stakeholders; policy makers, students, employers and the country as a whole. We must aim to produce knowledgeable and context-aware students and not throngs of "meta-ignorant" human beings. "Meta-ignorant" means people who think that they know things because they can find it online or via "googling". The "Dunning-Krueger" effect highlights clearly the repercussion of being a meta-ignorant person.

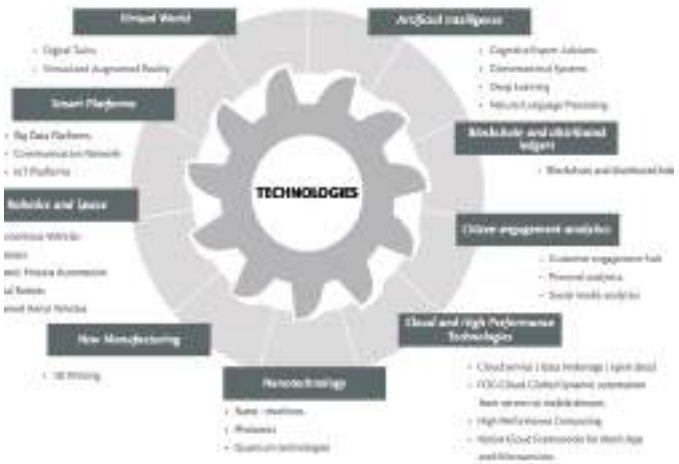
One of the most important traits of a learner is to be able to differentiate the meaning of certain terms. If you are asked to differentiate between "Science, Technology andEngineering", what would be your answers? Well, science is the study of natural world and its phenomena. Technology is a study of man-made systems. Whereas, engineering is the knowledge related to problem solving, using the concepts of science and technology. Engineers are designers of the solutions to real-world problems. So, how do engineers solve real-world problems? What are their typical approaches? Engineers have three traits that differentiate the way they think and approach a problem, compared to non-engineers. What are the three traits? The Engineer thinks in a structured manner, will always consider the constraints of the problems and solutions, and will accept that some trade-offs will always be needed to provide a feasible solution. So, there you are; structured, constraints and trade-offs.

Many of the emerging innovative technologies are in line with the drive for the Industry 4.0 (IR4.0) agenda. In Malaysia, the country has launched the national policy on IR4.0 called IR.FWD.The policies set the direction of the country for IR4.0. IR4.0 refers to the connectivity and automation, smart cyber-manufacturing approaches which will affect the overall manufacturing sector capacity and capability. One important aspect of IR4.0 which must not be left out is the humanistic aspect. In Japan, this is termed as Society 5.0, which is a framework of thinking and acting, that talks about the humanization of technology. This is to consider humans as one of the critical elements in the manufacturing process and putting the well-being of human as the apex. Another angle for looking at this is that technology may not always be the answer to everything. There is a human side of technology. The solutions to our problems consist of human and technology issues. So, when we talk about innovations, we have to use the proper thinking framework, be it IR4.0 or Society 5.0.

Every innovation is very logical when we consider them retrospectively; whether one termed them disruptive or non-disruptive. So it is a challenge for us to be able to appreciate the logic going forward instead of retrospectively. How can we improve or push our thinking so that it becomes logical now? Another aspect on innovation is what was coined by Peter Drucker; "High Tech and High Touch". This is a holistic concept of developing technology by taking into account the human factor or perspective. Humans can no longer just be treated as pawns in a manufacturing line. It must be part and parcel to the future system of survival and sustainability of the human civilization itself.

The current emerging innovative technologies which have the potential to affect our lives are topics such as big data analytics, artificial intelligence, machine learning and robotics. The fusion of these technologies will be seen in various sectors such as agriculture, finance and services. The nature of jobs will also be affected. The ratio of human and non-human roles in the manufacturing sector, for example, will shift towards more non-human modules. These will directly affect things such as employment rates and creations of new type of jobs. Human beings need to evolve accordingly, skill-wise. New skills/knowledge need to be acquired as the conventional job market is being restructured by the advent of new innovations.

In summary, the emerging innovative technologies are not a myth. They are the realities of today and must be embraced, whether we like it or not. The landscape of societies everywhere will be affected and one needs to appreciate the urgency to adapt and adopt anything that can ensure our survival.



The hype from the truly disruptive technologies- A user perspective

Mr. Shamindra Basu

Mr Shamindra Basu is Associate Partner in the business advisory practice of IBM, with experience across business consulting and industry.

As delivery executive at IBM India South Asia, he has been associated with some of the first of a kind digital and business transformation engagements for consumer product and industrial clients in India

His strengths are in working with CXOs in shaping their business strategies and assisting them in implementing strategies for transformation. Proficiency in analysing, interpreting qualitative & quantitative information and deriving strategies, operational improvement, operating models and recommending forward looking digital environment to support client's business strategies.

Digital is a journey – "It is a means to an end, not an end in itself"

The last decade has witnessed profound impact of digital technologies across business, society and individuals. This period of evolution has also seen a rapid churn of these evolving technologies; while some had significant impact while others had short lived claim to glory. In that context, this paper intends to declutter this whole hype around digital transformation and disruptive technologies and what it really means from a user perspective. In my role as business advisor to CEOs, I have been able to have a ringside view of many organizations who have embarked upon this journey in the last ten years. This paper presents a distilled view that has been formulated based on those successful and not so successful experiences I've seen across corporates.

The confluence of market forces and digital disruption has led to the evolution of key successful business patterns that can be articulated in four distinct areas.

It is critical to note that these businesses or individuals or societies were trying to either solve a problem or find new opportunities to do things. These successful business patterns and use cases have been enabled by a set of underlying digital technology like IoT, Blockchain, AI, RPA, etc. These technologies present a set of capabilities to make these business use cases real and are rapidly evolving with the advent of edge computing and quantum technologies. However global surveys (## McKinsey& Company - Unlocking success in digital Transformations) indicate that across all organizations globally, large and small, only 30% of these initiatives have been successful. This brings up the key question - what is preventing organizations from leveraging these successful business patterns and deriving the envisaged business benefits from them.

Strategies to mitigate the risks of failure

Based on past experiences and other empirical evidences highlight six strategies to navigate the risks of failure with disruptive technologies that are transforming and redefining organizations and how they can engage in their digital journey.

Clarity of purpose

The following aspects need to be considered before organizations embark on a "Digital Journey"

The Need -

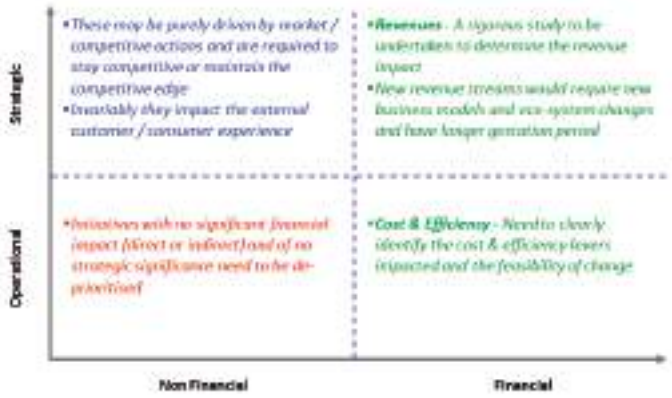
It is very important for an organization to determine the reason for undertaking a digital transformation. The reasons may be several

- Changes in the competitive landscape
- Customer / consumer expectations
- An available technology which simplifies a business process compared to its predecessor technology

The overarching need for any organization is to improve revenues, optimize costs and drive efficiencies and productivity. However, having identified the compelling reasons, organizations need to carefully evaluate the impact.

The Solution and Impact -

Most organizations are keen on a digital program given the success stories of the new age companies and their asset light business models. But as they delve further into their business context, they grapple with uncertainty of the economic value case. Some of the transitions like shifting to a cloud platform to reduce costs may be a no-brainer while others like a consumer facing app may have an intangible impact and harder to quantify the benefit. It is important to note that not all the digital projects may translate into a direct financial benefit.



While the allure of cutting-edge technologies like artificial intelligence or augmented reality cannot be denied, organizations need to carefully evaluate those technologies in their business context. For example, advanced analytics projects can succeed only if business and technology teams work in tandem with a definitive purpose. Companies also need to evaluate the scope of a project. A shop floor digital system designed to capture inputs from operators to improve visibility and drive efficiency should not become so complex that adoption and maintenance become a challenge.

For any long-term vision of a solution, the organization needs to lay out the roadmap which needs to be re-visited whenever the business or market or technology changes

2. Not all platforms are born equal

The evolution of digital platforms has been a key highlight in the disruptive technology arena. The likes of Amazon, Uber, Facebook and Netflix have become synonymous to the paradigm of digital disruption. This has also led to a flurry of

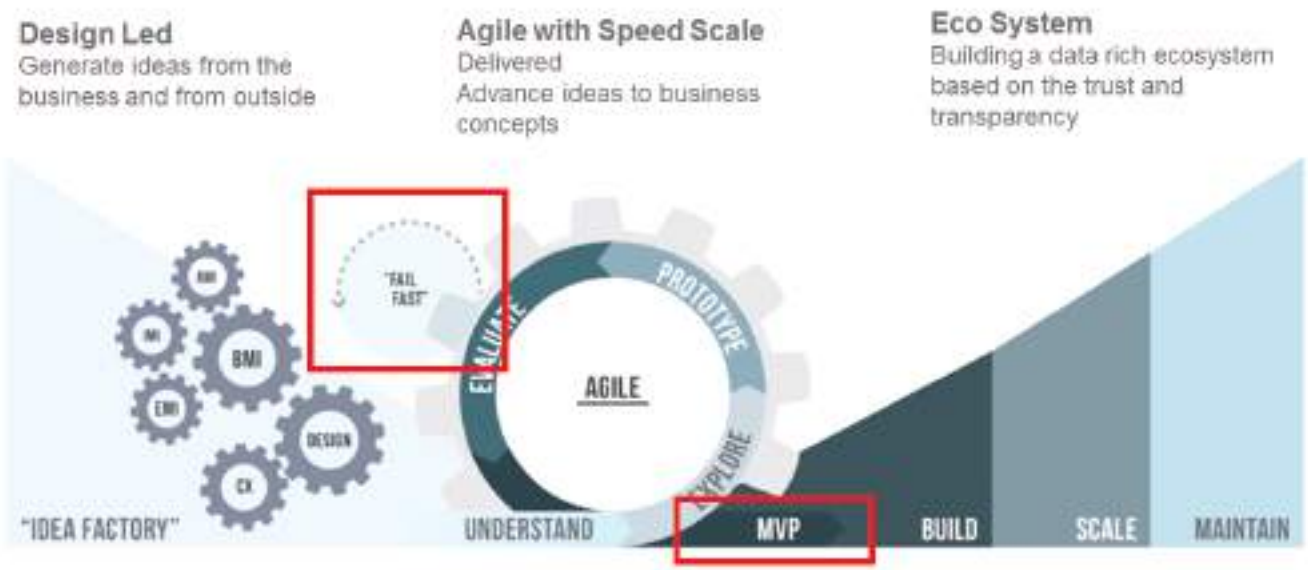
"me too" platforms that have attempted to mimic the success of the early movers. However, empirical evidences highlight, not all platforms are born equal. Incumbency has a clear advantage in the B2C marketplace. We identify three roles that lend themselves to unique differentiation on platforms and organization need to critically evaluate if their platform strategies address these differentiators.

3. The Conflict – Engineering excellence vs Digital impatience

often first of a kind in the marketplace or for the organization in question. The pursuit of innovation with digital often entails working with a large set of ideas and it is not necessary that all ideas would be successful. It is critical to appreciate that in the world of disruptive technologies; the end outcomes are not always known. Hence it becomes crucial that if one fails – you need to fail fast and cheap. The manifestation of this new way of working is Minimum Viable Product (MVP). Organizations are often unable to definite

Digital demands a new way of working that is often at odds with our desire to achieve engineering excellence in everything we do. The solutions in the digital world are

a true MVP for their Proof of Concept (POC) and saddle the MVP with too many functionalities, thereby escalating the cost and time of development before it is tested for feed-



back from its true users. In the Digital era, success is about leading with experience, being agile and blending within the ecosystem. Adopting this execution strategy in its true spirit is critical to success in the digital journey.

Most organizations grapple with digital solutions because these are quite unlike a traditional product or custom application implementation. Any large organization has layers of processes, technologies and systems. This hierarchy of systems and processes comes with its own inertia. To succeed, organizations need to consider the following key tenets:

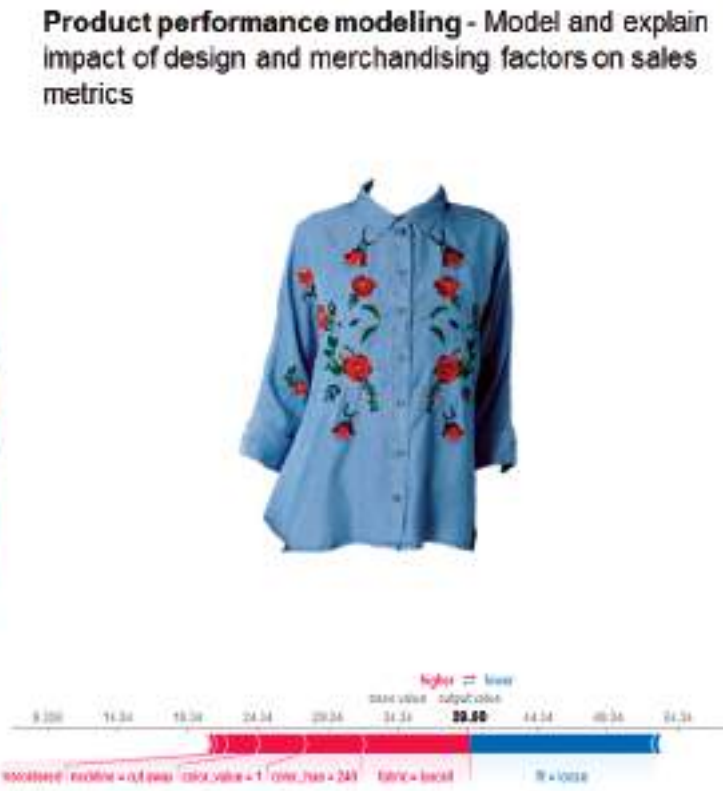
- The Customer is the focal point. The Customer may be external customers, eco-system partners or employees. Engage the customer continuously during the development process.
- Continuous engagement would call for a shift from traditional delivery models. "Try Quick, Fail Fast?"
- Create a testing lab/garage and then take it to scale.
- Continuously upgrade or evolve.

4. Curate data that "thinks" and "acts"

Data and the use of data play a pivotal role in digital disruption. Digital disruption has led to an explosion of both structured and unstructured data with sources within and outside the organization. While there has been considerable focus in unravelling the world of unstructured data, experience highlights that organization have lot of structured "dark" data unutilized within their organization. These data sets with the help of advances in analytics and artificial intelligence can profoundly impact the overall operating model of an organization and result in rich dividends from digital investments.

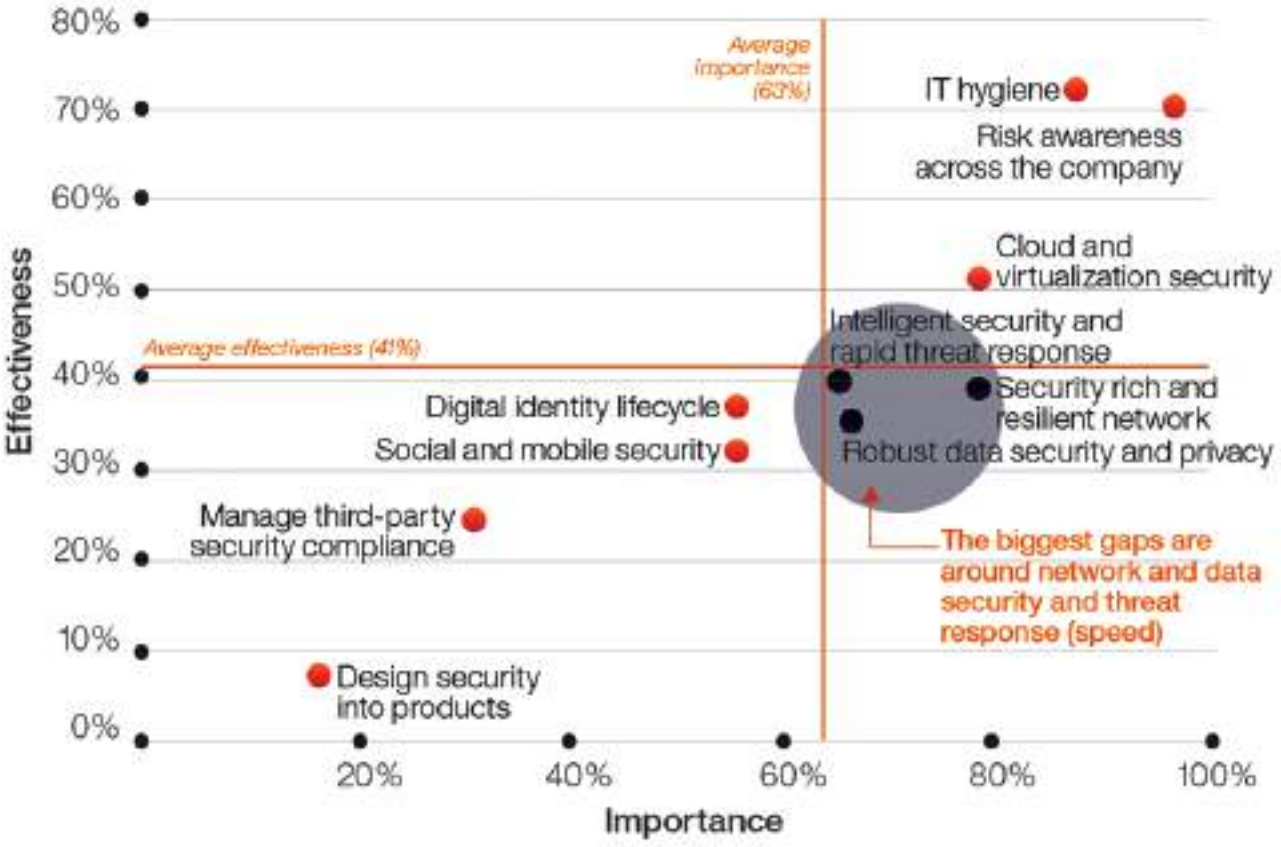
As an illustration, one of the most complex supply chain planning is for the fashion retail. Demand planning is the Achilles heel for the merchandiser as past sales data has limited salience of future sales patterns with evolving units and fashion trends. Product performance modelling has evolved as a powerful tool to do planning at an attribute level using structured data sets that have always been available with retailers.

The ability to cultivate and curate interconnected data, synchronize it dynamically, learn from data in the moment, and automate operations will become ever more prized.



5. Priming your digital immune system

While data is a key lever for success in the digital journey, the importance of data security and privacy is also become very critical. Successful digital solutions need to mitigate the risks of security breaches that can today happen from multiple sources - be it the unmanned IoT device in the field of operation or the unassuming customer experience mobile app. Companies are increasingly concerned about a loss of reputation in the future - surpassing operational disruption. Recent surveys conducted by IBM highlights that almost everything is important, but network and data protection coupled with speed are the weakest areas for most organizations.



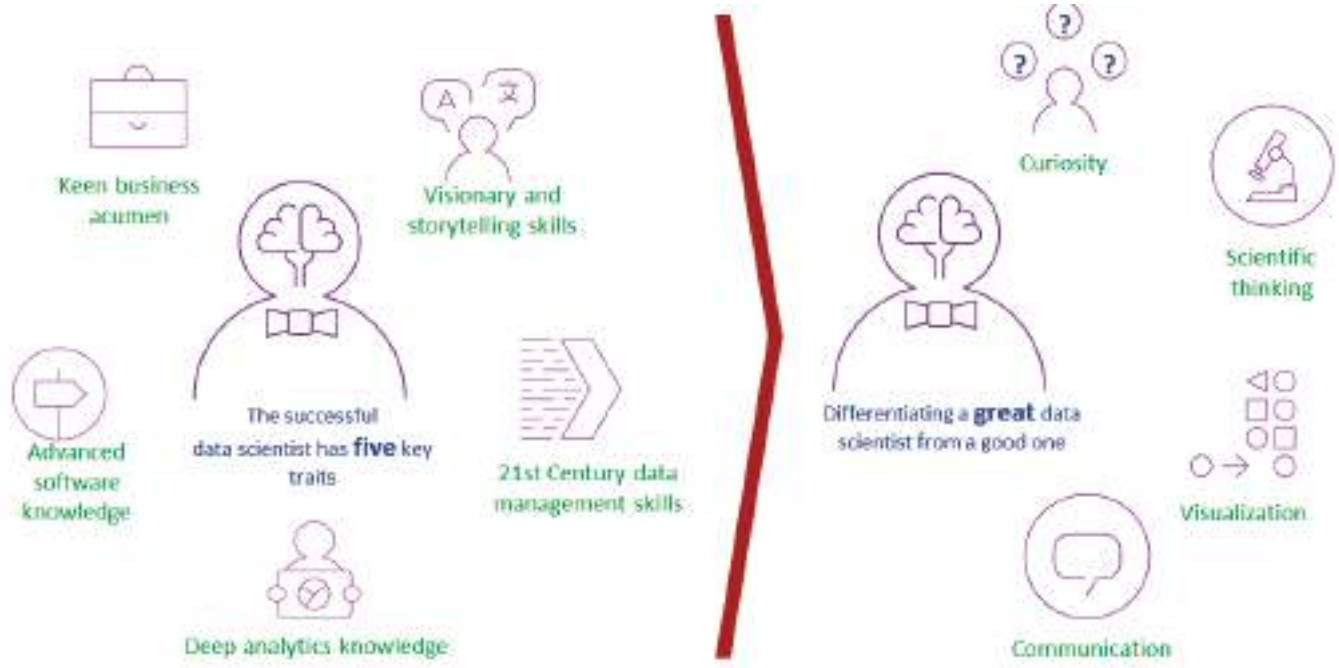
6. Future ready organization – Confluence of man and machine

This disruption is impacting global skills in three ways:

- Demand for and types of skills required by industry are changing,
- availability of skills in labour markets is uncertain azzznd
- quality of skills is being challenged.

The war on talent is today very real in every market globally. Organizations need to recognise that sustenance and scaling of digital initiatives requires a maniacal focus on talent and re-skilling. Disruptive technologies have faded the line between the functional experts and technology/data professionals. The confluence of man and machine requires a new set of skills that is nuanced with both businesses understanding and technology appreciation.

The ability to cultivate and curate interconnected data, synchronize it dynamically, learn from data in the moment, and automate operations will become ever more prized.



As an illustration, a data science expert is envisaged as someone with core proficiency in statistics and mathematics. However, great data scientists are those who can appreciate the big picture in business, and are proficient in selling the idea to all stakeholders through story telling. Organizations try to mitigate such skill gaps through two-in-a-box models, that are not very effective in end outcomes. The constant churn of technology also requires constant re-skilling of resources or augmenting the skill base from external sources.

Organizational culture is crucial for the success of digital projects. Following are some key points to note:

- Strong leadership commitment and alignment to the digital transformation agenda
- The technology teams need to be agile and have a greater business understanding. Similarly, business teams need to have a good appreciation of technology and its limitations to help with the change. E.g.: An AI system will not automatically provide insights based on a large data input. They need to be developed, trained and continuously refined.
- While the stated objective of some of the digital interventions is transparency and speed, not all levels of an organization are open to such a change and requires targeted change interventions.

It is important to note that for any digital project to succeed, an organization requires tremendous persistence, diligence and change.

Ride the digital wave

In conclusion, we have all seen those frightening videos of weaponized drones killing people. But it is the same drone which provides unique capabilities to monitor bridges and large infrastructures which can save lives of millions of people. Hence irrespective of the evolving capabilities in disruptive technologies, as organizations, executives and individuals, the onus and the responsibility are with all of us to make the right choices and adopt the right strategies to mitigate the risks of failure.

This entails a) new focus

b) new ways of work

c) new enterprise

Stake your claim in the dynamic digital space and surf the digital wave!

The future of work and the work of the future. Mr. Andy Godwin

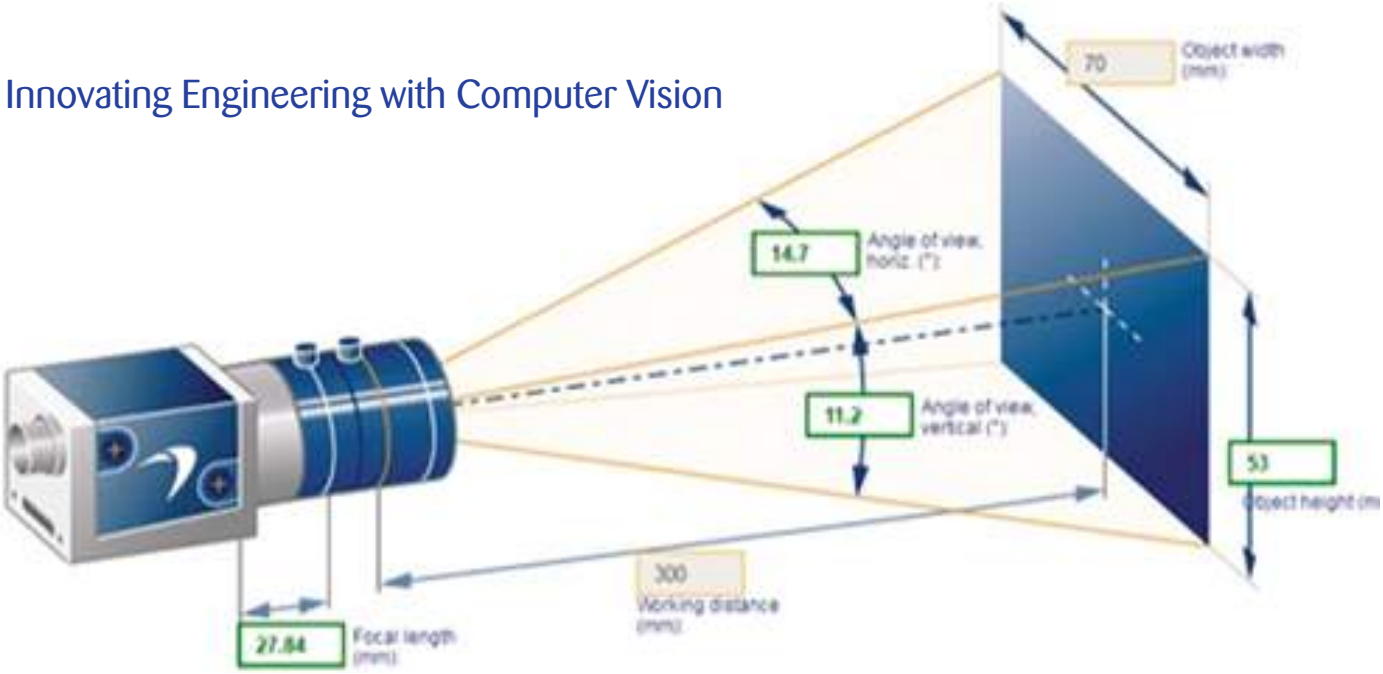
Capt. Andy Godwin ERP & Global Digital Solutions Architect, Business Transformation Architect, keynote speaker, futurist, and a strategic business & technology advisor to governments and organisations around the world.

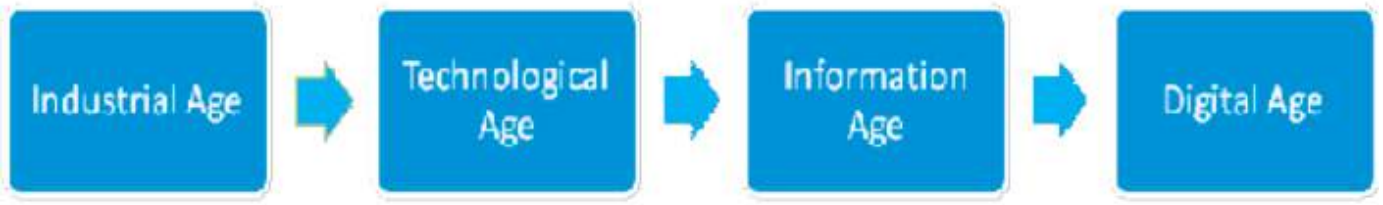
CEO of GeniusCrest Ltd Mauritius - Nextgen innovative technology Solutions

CEO of VAWaterhouseglobal UK - Enterprise Resource Planning Solutions

Founder of the Peak Performance Movement (PPM)

Innovating Engineering with Computer Vision





The times they are a changin'

The above was a title of one of Bob Dylan's popular song in the 60's. The song did very well and was popular culture back then and still remains the same today amongst music aficionados. Whilst this might have been a simple lyric, the truth of the matter is that a deep reality lies within this simple sentence. "The time they are a changing" is a reminder that 'time'

is often in a state flux therefore change is inevitable; change to the way we do things, change to the way we exist, change in our mindset over points that we may have thought were absolutes and many facets of our existence where our view position, opinions, attitude, approach, believe systems etc. are subject to new understanding/information thereby enhancing us. Indeed, of a truth, changing times gives birth to innovative transformations.

Right from our early ancestors' times during the antediluvian era, times have constantly been subjected to change which, of necessity, directly or indirectly, impacted our experience. Early human history can be divided into three ages: stone, bronze, and iron and with the transition from each age, we find the need for innovation as the main core driver or catalyst propelling the world into a new age. With such transition and transformation comes a change in the way early man worked, interfaced with his environment and how he would, of necessity, continue work and be productive in the new era. From the use of stones as the main tool for most aspects of life, including engineering to shelter construction and weapons of war, and then progressing to the use of bronze and eventually iron, we find innovation or the need for a better way of doing things was the key driver for each transitional change in our history. More importantly, these needs were often the result of paying close attention to our environment and observing the challenges we face with an inquisitive mind. Quite often the result of which is usually the birth of an idea. In order to execute the idea and convert it into something tangible, the idea is then transmitted or documented via several mediums either as drawing in the sand, etching on the surface of a stone or trunk of a tree or any other form of communication that known at the time. This are the basic elements required for innovative changes. And to put it simply, man has always been designing, building and using adapted tools around him artfully to make his world more efficient, comfortable and secure amongst other desires. Basically, he is always engineering his world.

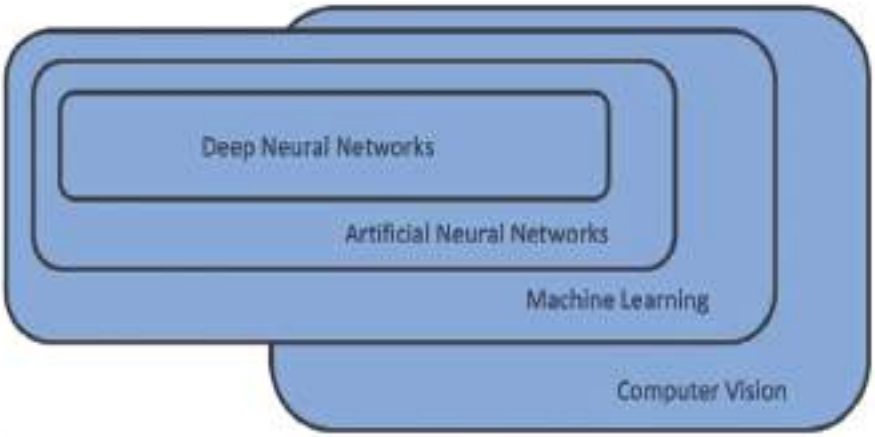
Today, we are also undergoing an extraordinary period of large-scale change driven by technology innovation and changing business models in the world. The advent and emergence of disruptive technologies that are rapidly reshaping the way we work today begs the question as to whether we are up to the challenge of a transition to a digital economy and more importantly, what will be the future of work. Giving that most societal benefits are delivered through full-time jobs, how are people outside the workforce for a lengthy period of time going to get income, health care, and retirement pensions? In this situation, is it important to rethink work and move toward lifetime learning so that people are trained for a world of dislocation? Whilst there is a possibility of reforms being put in place by governments, labour unions and other entities in the current social construct that would ease the anticipated transition difficulties. However, what is not clear to most is whether the landscape or systems we find ourselves in today, is up to the task of adopting these changes and ensuring relevant action plans are in place to redefine work, develop a new social construct, and help people gain the skills they will need. Figuring out ways to facilitate productive discussions and address the resulting economic and geopolitical tensions could be a major challenge in coming decades. Therefore, it is imperative that we make the right choices and as a result be adequately prepared to adapt. For a start, we will need to acquire additional skills in order to remain competitive in the twenty-first-century economy since emerging economy necessitates education and training programs throughout adulthood.

The sooner we realize that these technologies are no longer a mere futuristic vision, the better. Rather, it is a current reality that performs quite well with significant room for enhancement and further innovations. AI, Blockchains, Big Data, IoT, virtual reality, autonomous vehicles, facial recognition, drones, and mobile sensors are altering numerous sectors and are at the cutting edge of technology which is leading us to an automated society. These devices are increasing in sophistication and dropping in price. In the process, they are transforming commerce and ushering in new business models. The reality of a large workforce with full-time jobs and benefits is giving way to an economy based on temporary employees, partial or no benefits, and widespread automation. AI, machine learning, facial recognition, driverless cars, drones, and virtual reality. Rather than requiring human intervention, improvements in software design make it possible to perform complex tasks using sophisticated algorithms. The result is an increase in economic activity but limited full-time employment opportunities for the way we currently work today. These innovations are changing the way companies operate and altering the relationship between managers and employees. Having read thus far, you might be wondering "what does it mean for engineering; is it doom and gloom for the industry?" On the contrary. 'Change' presents opportunity always, and opportunities are the gateway or key drivers of innovation. In this paper, we will explore opportunities or rather possible innovations that these unfolding paradigm shift to digital age is presenting and how we can become early adopters of the transition within engineering.

The advent and coming of age of these emerging technologies (all aspects of AI, Big Data, IoT, Cloud, Hyper Computing, Quantum Computing, decentralized ledger techs etc.) and their effect or impact on life as we know it certainly presents significant benefits and immense transformation advantage to humans and engineering and engineers will be at the forefront. Therefore, we are the ultimate and innovator and disruptors. Some are calling this shift Industry 4.0, a term coined by Professor Klaus Schwab and introduced in Davos, Switzerland at the World Economic Forum in 2016, brings digital, physical, and biological systems together. This Fourth Revolution is going to bring all sorts of change at a speed, scale, and force unlike anything we have seen before. One aspect of such change to the way work and the work of the future will be incorporating Computer Vision (a very hot topic today within the Artificial Intelligence domain) into engineered devices and equipment particularly in the bio-medical industry amongst other industries where engineering designs and products are vital to efficient operations.

What is Computer Vision

Well, basically, Computer vision is a fast advancing technology, that plays a crucial part in Artificial Intelligence. It is an interdisciplinary field that deals with how computers can be made to gain a high-level understanding from digital images or videos. By leveraging these capabilities, we can design and build ultra-modern devices equipped with sensors that can direct take visual images in whatever form and provide outputs that are more efficient, cost effective and more importantly transform our society for good. For most people when we talk about computer vision, the first thing that comes to mind is either facial recognition or object detection properties. Whilst these two are the basic foundational element of computer vision, this technology goes far beyond the basic recognition of faces or detection of objects in isolation or merely relying on video and image feeds from cameras that most of us are now well acquainted with. Computer vision technology can be adapted into new devices as complete component of these new devices. For example, if you think traffic flow management or airport security with computer vision, generally, there are several components that work together to serve the purpose or desired objective: a camera device, a graphic processor capable of performing and executing complex algorithms, a storage where the both the input and output data are stored depending on use case.



These integrated hardware and software are becoming clunky, with significant overhead costs and scalability is often a challenge. Interdependency and compatibility issues are also not uncommon. What would be a more optimal solution are singular devices engineered as one unit that would serve the same purpose more efficiently leveraging these emerging technologies. If we consider the healthcare industry alone, we are presented with quite a significant opportunity to radically transform the way we work and the future of work as engineers by coming up with devices integrated in a singular way infused these technologies. If we consider cancer research and Mammography, MRI and X-ray devices; diagnosis and treatment have largely not improved significantly for several years giving that the equipment and method of diagnosis along with treatment have largely remained the same; scans are conducted, results are printed for review or reviewed on the computer by experts. Upon review and analysis, the experts will statement their opinion and arrive at a diagnosis along with a proposed course of treatment. Whilst this is to applauded given the sensitivity of the situation and the risk involved, such opinions are indeed the result of the collaborative experts vast experience and consultation with others. However, what is clear is that this entire process does require time to unfold, the collaborative effort of each expert who needs to review the output of the scan and other processes associated with treatment. In some cases, misdiagnosis have also occurred due to experts misreading the scan resulting in unnecessary treatments which may sometimes be quite intrusive in nature.

Well, how can computer vision help transform healthcare particularly in relation to these three examples; what if we design new devices and equipment that have computer vision capabilities built in already, giving that computer vision consists basically of taking images or videos from an input source, classifying the data based on algorithms driven by deep learning artificial intelligence that has the capability to take input data and learn how to classify that from a pool of what is known and unknown. Thereby, detect either an anomaly in an input dataset or a normal condition. The algorithm is then able to infer an output result with a level of expected certainty. The algorithm can also go as far as recommending a course of treatment by drawing from a past dataset of previously successful courses of treatments. All of this can happen within a very short time period. As a fail-safe or final checkpoint, such a system could run supervised or unsupervised and stage checks for expert validation can be built into the process. Computer vision will help introduce a more consistent approach to the diagnosis and treatment of this health conditions, help eliminate mishaps with diagnosis and more importantly the algorithm is constantly learning therefore new anomalies detected can be classified and studied with more efficient treatment. It will reduce the need for costly exploratory surgery amongst other concerns. Lastly, it will radically transform the way we work with medical devices and engineering once again will be at the forefront of this transformation.

Whilst the future of work may be changing, the process of arriving at the work of the future remains the true time; we pay attention to current challenges, we ask questions with the intention of finding a better and more efficient way of working and in time our minds are impregnated with ideas for a transformation. Giving that the future is changing and subject to even more changes, it is vital to understand how we, as engineers, can ensure that we will not be relics of the past but rather assets for the future. Ultra-modern healthcare + innovative machines + better process will be more superior, indeed more remarkably superior to a modern healthcare + latent machines + inferior/antiquated process … engineering strategic guidance combined with the tactical acuity of a computer vision will increasingly become more and more overwhelmingly efficient with long lasting durability.

Below are some other areas where computer vision integrated engineering devices/equipment will provide greater transformation to the work of the future thereby improving Human Experience with Innovative Engineering.

Engineering in business

- Engineering for faster idea sharing - re-engineering the Internet 3.0
- Internet 2.0 blockchain already has potential challenges
- Environmental Engineering to protect the planet

Biomedical engineering employment is expected to grow by 35% by 2022

- New artificial organs or prostheses, devices to help with diagnosis (such as MRI scans)
- Safety devices for the police, military or firefighters
- Refined bionic implants that are more accessible to all who need them

Aeronautical engineering

- New propulsion systems that make flying cheaper and safer
- Streamlined vertical take-off and landing
- Faster planes that run on new types of fuel

Agricultural Engineering

- Autonomous machines to harvest crops with precision at ideal times
- Energy efficient device and new ways of recycling waste

How do we as engineers make a Difference?

"the ability to leverage new technologies to transform the human/customer value equation and drive competitive advantage is within us, we just need to pay attention and be more optimistic about the work of the future". Andy Godwin

Rethinking Disruption – User Empowerment. Mr. Sudeendra Koushik

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Koushik has served in;

• Philips Global Development Centre, Singapore • Philips Advanced Systems Laboratory & Philips Innovation Centre, Eindhoven, The Netherlands • Philips Innovation Centre, India
• HCL as Practice Director Innovation, and
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Koushik has been an active volunteer for many international organisations as PMI and IEEE. He served as the chairman for the IEEE Bangalore section, Chair of IEEE Consumer Electronics Society Bangalore and is on the board of governors of TEMS and Chairman of IEEE TEMS India & Bangalore chapter. Koushik also has volunteered for PMI and was on the jury of and review committees at PMI(USA) standards and awards.
He is also a cartoonist, sportsman, actor, among other things.

Let me go to a quick recap of disruption, what disruption is and how it works. But basically, if you look at it, there is a current set of products and markets. There is a current set of users, so to say, the consumers. And then suddenly there is a new set of markets created or a new set of users created. Newbies will create that market. So, there is a kind of complacency. In case of cars, if we had the wrong question, you would get faster horses. Not cars. So we got light, we got electricity and so on. In recent times, we got the smartphones probably going ahead. We'll get driverless vehicles. But the question for me is not this. The question is who did this? And it is not always the big biggies or incumbents who are already part of the story. There's somebody who did not exist in the market as the maker. Officially, Tessla has overtaken BMW in about ten 10 years. And BMW has been at the top for around more than 100 years. So there is no guarantee that because you are successful in the past, you will be successful in the future as well, not even present. Nokia, BlackBerry and many other companies disappeared right in front of us because they did not do anything wrong but they did not do something right. It is just that they missed the point which others saw as an opportunity.

And this is a danger of how disruption can damage any company. Disruption can happen in two ways. It can disrupt the top line in the form of new products, new services, new revenue models, etc. This is what the customer can see. You can see an airbag in a car. I am very happy that my airbag is a big disruption in how accidents could save lives. It is a very big disruption. It can also disturb the bottom line. What is bottom line in disruption? It will change the way we procure things. So you get it cheaper, faster, better etc. You don't need to know how a company does it. But you will get the benefit of the bottom line disruption. Dell did the same by taking out the middleman in the whole supply chain and giving computers cheaper, wherein the computer, itself, was not their disruption.

> ***It can disrupt the top line in the form of new products, new services, new revenue models, etc***

Now we can look at it as a user perspective. A typical user expects three things from any innovative disruption:

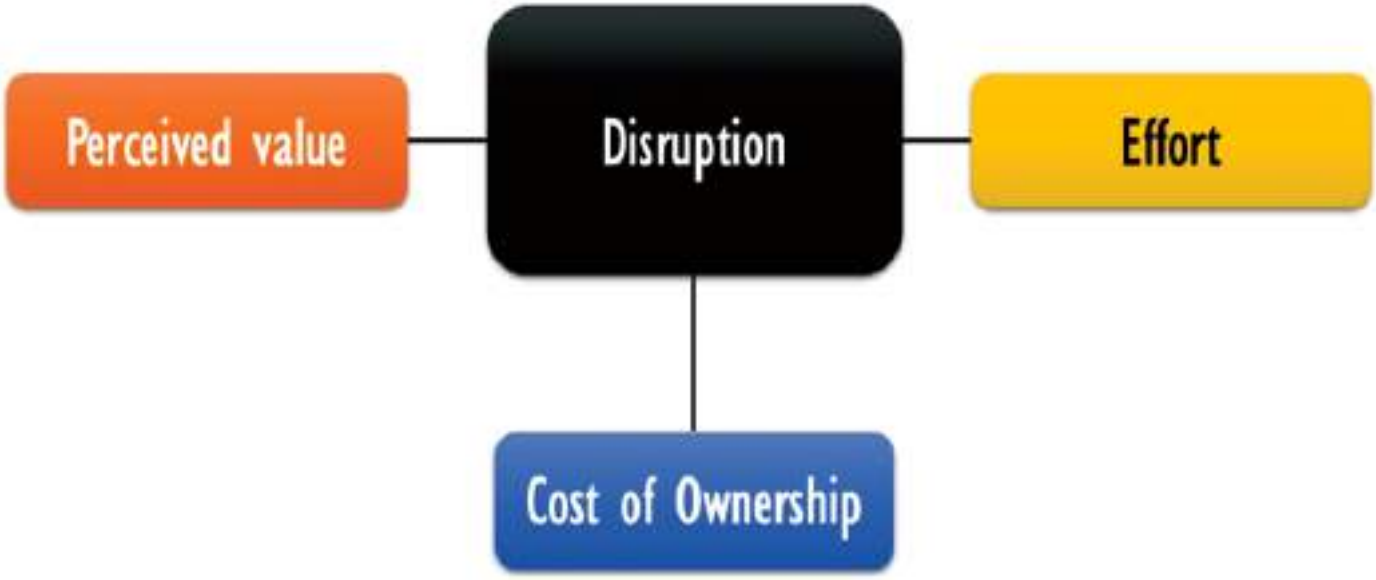
* what is my perceived value of a new product or service which is going to be disrupting me?

* how easy is it to use? Will it reduce my effort to use it or

* can it make my cost of ownership low?

It is not just the cost of buying. It is a cost of ownership through the life cycle of the product. We all know the story of printers where after three cartridges you spent the money equivalent to the printer, and you better buy a new printer.

With this concept of disruption, how do you manage it?



Complacency is the biggest trap. When I have 98 percent market share, who can even come in close to me? No way . I am the king. And those are the ones who are probably going to be disrupted as well. So one of the best ways to disrupt is to being a disruptor yourself.

One way to disrupt is to defend. The other ways, to engage. Of course the risk and the reward are different in both these approaches. If there is no risk, probably that is not what everybody would do it. So you need to find your strategy. You need to find your way to get things done. You cannot sit back and say, I will not play the game. Then, any way you are out of the game.

So the key then is innovation. Innovation is, Sustainable Development Goal (SDG 9). That means, it is linked to prosperity and is linked to society in a sustainable way. It's linked to economic growth, and hence linked directly to everything. The beauty is it does not depend on any particular technology itself. Let's see some examples today. The Global Innovation Index G.I.I. You can see it. It's a live report available free on the Web shows that I just picked up that Mauritius was ranked 75th last year and this year to 82. So this gives a view of where the countries are heading, especially in the Asia-Pacific region. We are all trying to move towards a kind of innovation economy, as we call it. And it's not a choice. Somebody else will decide what happens to you if you do not do it. Two out of the three companies will just disappear without innovation. We just discussed about Nokia, BlackBerry, etc. There'll be more such names coming up. The definition is simple for innovation. It's something new and something useful. Doing something New is easy. I can make a new trousers, which is one side is half and the other side is full. It is very new. Probably nobody will buy it. Probably there'll be fewer people who want to buy it. But making something new and useful is not that easy. It takes a little bit of craft and a little bit of resilience. So what is Research and what is innovation then? According to Dr. Nicholson of 3M, research converts money to knowledge. Innovation converts that knowledge back into money. And as you can see from the picture, it's typically more money you make than you put in makes it sustainable. Ideally, then you have a sustainable business. And then it can help to invest more money for more research. So this is essentially what separates research and innovation. And businesses usually look at both how they want to and how much they want to invest in either of this.

Now, how is the user involved and what is it to do with the user then? A user sees an opportunity. Or it could be a solution for that opportunity. There are different types of solutions for mosquito repellents in India. It could be something new and which is something useful. Now I am asking what can be an innovation in a mosquito repellent? A mosquito repellent in India - the latest innovation is, it will increase the intensity of the liquid disposition based on the time of the day and why it's based on time of the day, because that is a time of when even more mosquitoes come into your house. So apparently that's an innovation, for which users are willing to pay. So when you have all these elements, you can create value. Actually, the user pays for value, not for innovation. In India, we have peanut vendors outside big bus stops and parks and we give 10 rupees for a long peanut cone. He charges 10 bucks. We don't pay 10 bucks if we don't want peanuts. Now, even though we have 10 bucks, we do not give him 10 bucks because we do not want peanuts. What if we give him ten bucks and say we do not want your peanuts? It is a very weird proposition. Why do you want to give him Rs 10, people ask, when we do not get anything in return? Yeah, but you give tips when you go to a hotel. Maybe under 200 bucks. The idea is when you get something back which is important to you, you will give something from your pocket, which is money. OK, in that context, delivering value becomes key for a company. A company usually hunts for customers. What does the customer pay? Usually It is always money, right? Business exists to make money. What did the company give? Not a product, not a service, but delivers value to the customer, whatever. The value for the user is his choice, if it is a small car or a big car, just a Ferrari or a Lamborghini. What connects the company and the user is what is in it for me. Everybody in this room and everybody in this world have a what-is-in-it for me. What-is-in-it for me could be different for each one of us. The only option a company has is whether they know the what-is-in-it for me or not. People ask what do saints want in life? Because they do not want anything in life. That is what they want. They do not want anything in life. That is exactly what-is-in-it for them. They want solitude, etc. But the question is, if we understand what-is-in-it for me, they are already half successful. Then we can make what is valuable for people. If this is so, you can think now two big questions to ask, irrespective of which branch of engineering we come from. Why? And so what?

Let me give my own example as a head of innovation of our home appliances company and as an engineer. I was asked to make a technology based IOT product for the kitchen. I felt, isn't it overdone? IoT for kitchen. We should pursue technology and IOT is a hot topic I was told. So, I made a induction stove. Everybody knows an induction stove. So, my mother is my test-case, OK. So I went to her. I still remember she was on my right side. I put the induction stove on the dining table. What is the speciality of this induction stove? It's an app-controlled induction stove. I said, wow you know, I can control this induction stove by an app on my mobile phone. So I connected and I launched the app and did everything and using the app switched on the induction stove. She asked SO? When you're standing next to it, why do you need a mobile phone and an app. So as an engineer and vice president, "How can I accept defeat?". I was going to China the next day. I said, Mom: "I can switch on from China." Then she said: "WHY? What is the point?" There was no point. There was absolutely no point. This is what we call the anti-Nike theory. Don't just do it because it's very easy to just do it. Especially for engineers.

Technology is not necessary for innovation and disruption. Let's come to no technology then. Those who know this story, this is just a simple dhoti which exists, I know, since many centuries. We also have an Advanced Dhoti.What is the Advanced Dhoti? There is a Velcro which can you do not have to tie if you do not know how to tie. And there is a pocket. The pocket is also not new technology. So what is the innovation here? Why did my father and your parents not need Dhoti with pocket? They didn't have a mobile. It's simple. They were much happy. They did not need a pocket. So we need a solution for every problem, which may not need high technology.

So what about patents? A typical iPhone 3 according to a BBC report has close to 20000 patents, and they are not all from Apple. They are from people like you and me, I have 21 patents which have to do with all kinds of technology, from airport terminal management to radio signal processing to data redundancy. Innovation is actually that technology and domain agnostic. This survey shows that only 5 % of all the patents are actually break through. The rest 95 % are just significant improvements, or major improvements, which creates significant value for people. So the business value is not only necessarily that you have to come with breakthrough innovation itself.

It is not the technology that is disruption, it is the application of technology that can lead to disruption. The benefit technology gives can disrupt the lives of people. Technology, It is not the goal. It is the means to a goal. A summary of innovation is that it is a creative problem-solving method where we all look at the same thing but think something different.

Today, information is no advantage. If you Google or if I Google and get the same page. But what do you see is or how do you interpret what you see is very different?

What are the barriers then? The first one is wrong assumptions. We make wrong assumptions. The second barrier is missing the context.

Engineers are always hunting how to solve the problem. We always tried to solve the problem sometimes without knowing the context. We always end up solving the wrong problems. Generally, we have only about 4 % of people in organization that show successful innovation and 95 % of the startups fail because they saw the wrong problem. They are very smart people, very qualified very people, but they have picked the wrong problem. It is not that you cannot find the solution but you cannot find the problem. We cannot find the right problem because engineering education is about finding solutions and business education is all about finding problem. If you can be doing both, I think it is a good situation to be in.

As Einstein said, we cannot solve a problem with the same level of thinking that we created. It is very important that we change it. What do we change? The World Economic Forum says of the top 10 skills, critical thinking, creativity and innovation are in the top three. These we must have, irrespective of which domain we are from. This will change how we question. If you start asking what is a 8 +8, we will keep getting 16. If you just ask, say what all can add up to 16, we get different answers. Maybe we don't like some of the answers, maybe we like some answers and maybe they become the disruption. The whole point then is having the end in mind, like a new knowledge should be used to have a business application which should in the end be a benefit to humanity. A carbon composite material is of no use if it cannot apply as a weight reduction technique, which on a plane will save fuel and save carbon footprint. Then we are talking about disruption, then we are talking about innovation, which is useful. Just a carbon composite by itself, which is lighter than steel, but stronger than steel, has no value, if we cannot find the benefits.

So it is very important that we encourage our students and our people to look at the end in mind. And when we look at the end in mind, you need a different kind of skill set. Today, we are developing people with skills in a range of topics but anchored around a certain topic and we call this profile as a generalist. This model of generalist is becoming obsolete, very fast. You want engineers to be a sliding generalist who have varying depths of knowledge in different topics. I may not be an expert in everything, but I have a different level of expertise and that itself, can become a sliding point depending on which is the current concept that I want to work on. This is a skill and skill set we need to build with that.

To be innovative is a psychological skill. We all have to be ourselves, to be very unique. And I think the only way to do that is by asking these two questions WHY and SO WHAT.

The Artificial Intelligence of Things: From smart connected devices to artificially intelligent things and service. By Assoc. Prof. Dr. Kavi Khedo

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Abstract

The Internet of Things (IoT) is an emerging multi-faceted area with significant technical, social, and economic importance. Everyday objects, goods, vehicles and utility components are being combined with Internet connectivity and artificial intelligence capabilities which promise to transform the way we work, live, and play. Recently, the term Artificial Intelligence of Things (AIoT) has been tossed which engages a broad set of ideas that are complex and intertwined from different perspectives. The Artificial Intelligence of Things (AIoT) is the blending of AI technologies with the IoT infrastructure to achieve more efficient IoT operations, improve human-machine interactions and enhance data management and analytics. In this paper emerging AIoT application areas including smart cities, precision medicine, precision machining and precision agriculture will be discussed. The recent evolution from smart connected devices to artificially intelligent things and services will also be discussed. Some research projects currently being undertaken at the University of Mauritius in this area will also be presented.

1. Introduction

Internet of Things (IoT) is about connecting a huge number of common device/machines and making use of the data generated from those machines for monitoring and control purposes. Artificial Intelligence (AI) is about simulating intelligent behaviour in different types of machines. AI and IoT are both unique technologies on their own, but what makes them even more interesting is where they intersect. As the applications of IoT and AI are independently attractive, their combined use cases hold even more appealing potential. The intersection between the Internet of Things (IoT) and Artificial Intelligence (AI) has recently been termed as Artificial Intelligence of Things (AIoT) or Internet of Intelligent Things (IoIT) (Poniszewska-Maranda and Kaczmarek, 2015).

As IoT devices are generating huge amounts of data in different application scenarios, AI will be functionally necessary to deal with these huge volumes in order to make sense of the data. IoT data is useful only if it leads to a beneficial action for the scenario it is being implemented. In order to make data actionable, it needs to be supplemented with context and understanding of the application scenario. Integration of the AI in IoT systems has the potential to provide the context to create a 'connected intelligence' and not just connected devices. The objective of AIoT is to exploit IoT data to get deep insights and make it actionable, and making it possible to facilitate building intelligent systems and applications (Dey 2018).

The integration of IoT technologies with artificial intelligence is giving rise to interesting applications in various areas to improve the quality of human life. The main areas that have

seen some initial adoption of AIoT technologies are precision agriculture, environment monitoring, transportation and the healthcare sectors amongst others. The current revolution in sensor technologies, machine learning algorithms, and machine-to-machine (M2M) technologies can be seen as the first phase of the AIoT. In the coming years, the AIoT is expected to bridge diverse technologies to enable new applications by connecting physical objects together in support of intelligent decision making.

2. Artificial Intelligence of Things (AIoT)

The basic concept of IoT refers to giving internet connection to all kinds of devices including speakers, refrigerators, watches, television and automobiles which allows the collection and transmission of all sort of data. The IoT is positioned as the technology that will allow people to improve and simplify their lives through more intelligent ecosystems. The AI, on the other hand, is the engine that will allow the analysis and decision-making based on the data collected by the IoT. In other words, the IoT collects the data and the AI processes the data to give them meaning. Indeed, the AIoT is using artificial intelligence to bring more value to the IoT domain by better interpreting data obtained from connected devices (Zhou et al., 2019). Integration of these two technologies have emerged particularly on a personal level in sports tracking devices and in various popular virtual assistant devices such as Google Home, Amazon's Alexa or Apple's Siri.

Moreover, businesses are increasingly feeding data collected by IoT sensors into machine-learning models and using the resulting information to change how they operate and the products and services they offer. As growing numbers of internet-connected sensors are built into smartphones, cars, trains and buildings, businesses are gathering vast amounts of data. Tapping into that data to extract useful information is a challenging task which is starting to be met using the pattern-matching abilities of machine learning (ML) algorithms. The philosophy behind machine learning algorithms is to automate the creation of analytical models in order to enable algorithms to learn continuously with the help of available data (Mahdavinejad et al., 2018). Continuously evolving models produce increasingly positive results, reducing the need for human interaction. These evolved models can be used to automatically produce reliable and repeatable decisions.

There are some variations of how to define the types of machine learning algorithms, but commonly, they can be divided into categories according to their purpose and the main categories are the following:

- **Supervised Learning**: All data is labeled and the algorithms learn to predict the output from the input data. Supervised learning algorithms try to model relationships and dependencies between the target prediction output and the input features such that we can predict the output values for new data based on those relationships which it learned from the previous data sets. Supervised machine learning includes two major processes: classification and regression. The most widely used supervised algorithms are linear regression, logistical regression, random forest, support vector machines (SVM), neural networks, decision trees, Naive Bayes and nearest neighbor. The most common fields of use for supervised learning are price prediction and trend forecasting in sales, retail commerce, and stock trading. In both cases, an algorithm uses incoming data to assess the possibility and calculate possible outcomes.

- **Unsupervised Learning**: All data is unlabeled and the algorithms learn to inherent structure from the input data. The model learns through observation and finds structures in the data. Once the model is given a dataset, it automatically finds patterns and relationships in the dataset by creating clusters in it. Unsupervised learning problems can be grouped into clustering and association problems. Clustering is used to group samples such that objects within the same cluster are more similar to each other than to the objects from another cluster. A clustering problem is where you want to discover the inherent groupings in the data, such as grouping customers by purchasing behavior. Association is used to discover the probability of the co-occurrence of items in a collection. It is extensively used in market-basket analysis. For example, an association model might be used to discover that if a customer purchases books, he is 75% likely to also purchase electronic readers. Some popular examples of unsupervised learning algorithms are k-means clustering, PCA (Principal Component Analysis) and association rules. Unsupervised learning algorithms are often applied to explore customer information and adjust the service accordingly. They can be used to develop more efficient targeting of ad-content and also for identifying patterns in the campaign performance.

- **Semi-supervised Learning**: Semi-supervised learning algorithms represent a middle ground between supervised and unsupervised algorithms. In essence, the semi-

supervised model combines some aspects of both into a thing of its own. Semi-supervised machine learning algorithm uses a limited set of labeled sample data to shape the requirements of the operation (i.e., train itself). This results in a partially trained model that later gets the task to label the unlabeled data. Due to the limitations of the sample data set, the results are considered pseudo-labeled data. Finally, labeled and pseudo-labeled data sets are combined, which creates a distinct algorithm that combines descriptive and predictive aspects of supervised and unsupervised learning. Semi-supervised learning uses the classification process to identify data assets and clustering process to group it into distinct parts. A good example is a photo archive where only some of the images are labeled, (e.g. dog, cat, person) and the majority are unlabeled. Many real world machine learning problems fall into this area. This is because it can be expensive or time-consuming to label data as it may require access to domain experts. Whereas unlabeled data is cheap and easy to collect and store. Legal and Healthcare industries, among others, manage web content classification, image and speech analysis with the help of semi-supervised learning.

- **Reinforcement Learning**: Using this algorithm, the machine is trained to make specific decisions. The algorithm is exposed to an environment where it trains itself continually using trial and error. This machine learns from past experience and tries to capture the best possible knowledge to make accurate business decisions. In essence, reinforcement learning is all about developing a self-sustained system that, throughout contiguous sequences of tries and fails, improves itself based on the combination labeled data and interactions with the incoming data. Reinforcement algorithms usually learn optimal actions through trial and error. The algorithm uses the following learning mechanics: the action takes place, the consequences are observed, and the next action considers the results of the first action. In the center of reinforcement learning algorithms are reward signals that occur upon performing specific tasks. In a way, reward signals are serving as a navigation tool for the reinforcement algorithms. They give it an understanding of right and wrong course of action. Imagine, for example, a video game in which the player needs to move to certain places at certain times to earn points. A reinforcement algorithm playing that game would start by moving randomly but, over time through trial and error, it would learn where and when it needed to move the in-game character to maximize its point total. The most famous example of this variation of reinforcement learning is AlphaGo that went head to head with the second-best Go player in the world and outplayed him by calculating the sequences of actions out of current board position.

The data generated from IoT devices turns out to be of value only if it gets subjected to analysis, which brings data analytics into the picture. Data Analytics (DA) is defined as a process, which is used to examine big and small data sets with varying data properties to extract meaningful conclusions and actionable insights. These conclusions are usually in the form of trends, patterns, and statistics that aid business organizations in proactively engaging with data to implement effective decision-making processes. Data Analytics has a significant role to play in the growth and success of IoT applications and investments. IoT analytics is the application of data analysis tools and procedures to realize value from the huge volumes of data generated by connected Internet of Things devices (Patel et al., 2017). There are different types of data analytics that can be used and applied in IoT systems. Four types of data analytics used in IoT systems are described below:

- **Descriptive analytics**: Descriptive analytics looks at data and analyze past events for insight as how to approach future events. It looks at the past performance and understands the performance by mining historical data to understand the cause of success or failure in the past. They can describe in detail an event that has occurred in the past. This type of analytics is helpful in deriving any pattern, if any, from past events or drawing interpretations from them so that better strategies for the future can be framed Descriptive analysis answers the "what happened" by summarizing past data usually in the form of dashboards. This is the most frequently used type of analytics across organizations. It is crucial in revealing the key metrics and measures within any business. The biggest use of descriptive analysis in business is to track Key Performance Indicators (KPI's).

- **Diagnostic analytics**:Diagnostic analytics are used for discovery or to determine why something happened. For example, for a social media marketing campaign, you can use descriptive analytics to assess the number of posts, mentions, followers, fans, page views, reviews, pins, etc. There can be thousands of online mentions that can be distilled into a single view to see what worked in your past campaigns and what did not. It is used to find dependencies, identify patterns, and solve problems and is built from descriptive data. Diagnostic analy-

sis takes the insight found from descriptive analytics and drills down to find the cause of that outcome. Organizations make use of this type of analytics as it creates more connections between data and identifies patterns of behavior. Examples of diagnostic analytics include churn reason analysis and customer health score analysis.

- **Predictive analytics**: Predictive analytics help you identify trends in relationships between variables, determine the strength of their correlation, and hypothesis causality. Predictive analysis attempts to answer the question "what is likely to happen". This type of analytics utilizes previous data to make predictions about future outcomes. Predictive analysis uses the data we have summarized to make logical predictions of the outcomes of events. This analysis relies on statistical modeling, which requires added technology and manpower to forecast. It is also important to understand that forecasting is only an estimate; the accuracy of predictions relies on quality and detailed data. Some companies are using predictive analytics for sales lead scoring. Some companies have gone one step further in using predictive analytics for the entire sales process, analyzing lead source, number of communications, types of communications, social media, documents, CRM data, etc. Properly tuned predictive analytics can be used to support sales, marketing, or for other types of complex forecasts.

- **Prescriptive analytics**: Prescriptive Analytics automatically synthesize big data, mathematical science, business rule, and machine learning to make predictions and then suggests decision options to take advantage of the prediction. Prescriptive analytics goes beyond predicting future outcomes by also suggesting action benefits from the predictions and showing the decision maker the implication of each decision option. Prescriptive Analytics not only anticipates what will happen and when, but also why it will happen. Further, Prescriptive Analytics can suggest decision options on how to take advantage of a future opportunity or mitigate a future risk and illustrate the implication of each decision option. For example, Prescriptive Analytics can benefit healthcare strategic planning by using analytics to leverage operational and usage data combined with data of external factors such as economic data, population demography etc.

Since AIoT will be among the most significant sources of new data, data science will provide a considerable contribution to making IoT applications more intelligent. The process of applying data analytics methods to particular areas involves defining data types such as volume, variety, and velocity; data models such as neural networks, classification, and clustering methods, and applying efficient algorithms that match with the data characteristics. According to the characteristic of smart data, analytic algorithms should be able to handle big data. That is, AIoT requires algorithms that can analyze data that comes from a variety of sources in real-time. Many attempts have been made to address this issue. For example, deep learning algorithms, which are a form of neural networks incorporating evolution, can reach a high accuracy rate if they have enough data and time

3. AoIT Application Areas

The integration of IoT with artificial intelligence brings along numerous interesting application scenarios for agricultural, environmental, logistics, transportation and smart homes domains amongst many others. In this section four application areas of AIoT are described.

Precision Agriculture

Precision agriculture (precision farming or smart farming) is a management approach based on the collection and usage of data that is obtained from an agricultural field via sensors (Khanna and Kaur, 2019). The data collected allows agricultural farmers to make informed decisions regarding the management of their fields. Additionally, it allows them to tune their inputs - fertilizers, pesticides, and insecticides - accordingly to discrete regions of their field. These controlled inputs lead to better crop yield, efficiency, sustainability and at the same time reducing pollution.

Traditional farming meant that farmers had to manually inspect their fields and decide from experience and tacit knowledge about subsequent actions. These actions included planting, watering and adding fertilizers. Today with the rapid progress in the field on Information Technology (IT), Internet of Things (IoT), Global Positioning System (GPS), data analytics, moisture and temperature sensing are being used in the agricultural sector through precision farming. The advent of these new technologies has simplified and automated part of the farmer's tasks. It consists of adjusting the different parameters in agricultural machinery such as water irrigation, fertilization doses, and pesticides. Sensors are placed throughout the field to capture data on important environmental factors. The data captured is processed which can then be used to improve decisions. The adoption of precision agriculture is likely to increase after having obtained some positive feed-

back from farmers in India and other developing countries (Mondal and Basu, 2009).

Rajalakshmi et al. (2016) proposed an automated irrigation system which uses the concept of IoT enabled devices to maximise productivity on a large scale while controlling the water usage in India. The automated system makes use of the Arduino technology and consists of sensors which collect data such as soil moisture, humidity, temperature and light intensity. Zigbee is used for the Wireless transmission between sensor data and the web server. A web application and a mobile application can be used to analyse data and control the motor. This project has proved to be beneficial since it gives feasible results for automated irrigation. The paper provides an idea about how IoT can be used to reduce the problems being faced in the agricultural sector. Important criteria which affect crop yield have been taken into account and sensors such as the DHT11 sensor has been used to measure air temperature and humidity simultaneously. However to improve the Decision-making process, artificial intelligence such as Azure Machine Learning could have been used to predict whether irrigation should be done based on the weather condition and on the data collected. Furthermore, to have a better view of all the sensor values, graphs could have been used. The overall system could have been further improved by making it supply the right amount of water to different crops according to their water needs

Precision dairy-monitoring technologies (PDMT) are becoming more and more popular. These systems allow monitoring cow health, the time for insemination, and the birthing process, thereby leading to an increase in milk yield while at the same time reducing labour and overhead costs. Vannieuwenborg et al. (2017) identified the following important aspects of the PDMT: early detection of signs of disease, detecting the moment to inseminate, predicting the calving moment and indoor and outdoor localization and identification of cows. They proposed the use of a smart collar and smart ear tags to collect sensor data, such as temperature, location, movement and behaviour, in a non-intrusive manner. The data collected shall be mined with prior information, analysed and interpreted using dedicated algorithms. The farmer shall use an online platform that will present the relevant information and also generate alerts in case of any issues. Their proposed system, MoniCow, as shown in Figure 1, is expected to include: a smart collar, smart ear tags, GPS localization systems, charging points for powering the collars, a base station, an online management platform and mobile application, and a cloud server. The authors concluded that such a system can bring a reduction of 250 euros per cow for dairy management costs. While the proposal of Vannieuwenborg et al. is very promising, they did not document a practical implementation of their system making it very theoretical. Moreover, details about the algorithms to be used for raising specific alerts (e.g. in the event of the calving moment or for the identification of a specific disease or heat) have not been discussed, and consequently their accuracy have not been analysed.

Air Quality Monitoring

Air quality monitoring systems worldwide, mostly stationary, are very useful and constantly providing air quality information mostly to the authorities and the population. These systems are very important to monitor environments and keep people aware of the quality of the air surrounding them, eventually helping them to cater for their health and take necessary precautions when needed. However, as they are fixed in specific locations, the spatial coverage of such systems for proper monitoring of air quality in urban environment is still a challenge. One possible solution to overcome this problem is to use vehicular sensor networks for the air quality monitoring system.

IoT systems have great potential to be used to develop an effective solution for air quality monitoring on a real time basis (Xiaojun et al., 2015). Use of appropriate gaseous sensors with wireless communication capabilities can provide real time ambient air quality information to the users. Air Quality Monitoring Systems (AQMS) are deployed and used to assess the extent of pollution, ensure compliance with air quality legislation, evaluate control options, and provide data for air quality modeling. There are different methods to assess any type of pollutant in the air. These range from simple passive sampling techniques to highly sophisticated remote sensing techniques.

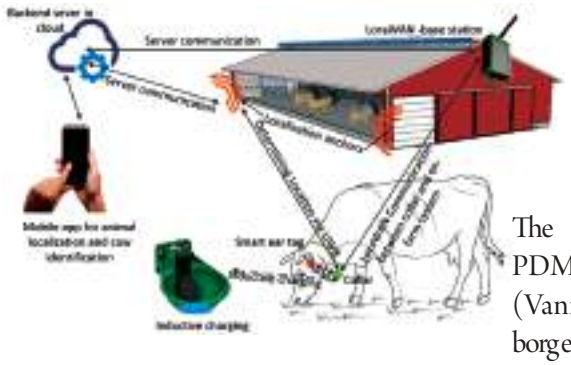


Figure 1: The Monicow PDMT-system (Vannieuwenborg et al., 2017)

A team at the Sastra University in India proposed An IoT Air Quality Monitoring System (AQMS) using Raspberry Pi (Balasubramaniyan and Manivannan, 2016) to integrate IoT for both indoor and outdoor air quality monitoring in real time. The Raspberry Pi is used as a processing unit to design sensor web nodes consisting of gas sensors with Wi-Fi. When nodes are deployed, the obtained data from each node are archived firstly in the local database and then on the ThingSpeak cloud database as shown in Figure 2. Particularly the real-time data streams can be monitored by the client, generates alert messages, and performs automating decision making methods.

In order to overcome the limitations of using expensive sensing stations for air quality monitoring, researchers from the University of Pisa (UOP) came up with uSense, a sensing system for cooperative air quality monitoring in urban areas (Brienza et al., 2015). The main advantage of uSense is that it makes use of cheap and small-size sensors that are driven by long-lasting batteries. Moreover the Wi-Fi technology used in uSense allows for fast data transfer such that the air quality information is obtained in real-time. The system has been tested in different areas of interest monitoring different places with promising results. This system allows its users to know which part of the city has less or no pollution so that they can decide on which routes to take to reach their destination. Figure 3 below illustrates the overall system architecture of uSense.

Figure 2: AQMS System Architecture

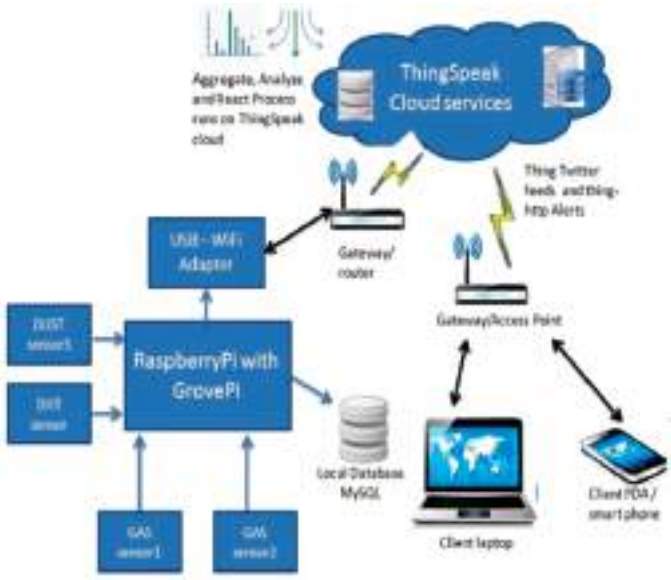
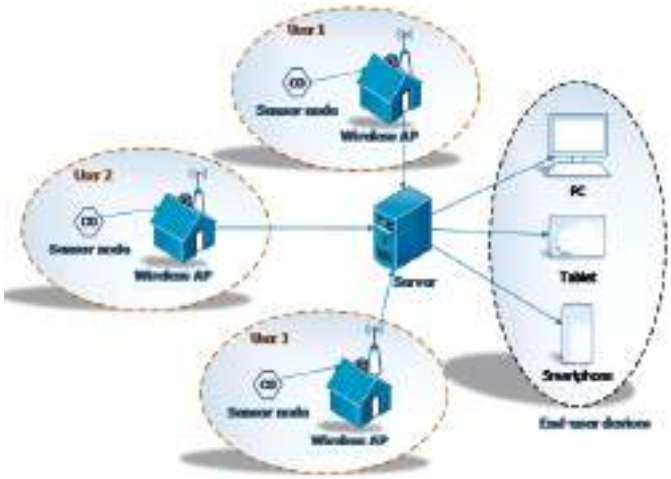


Figure 3: uSense System Architecture



Water and Flood Monitoring

IoT is the panacea to the monitoring of remote and not easily accessible places. It involves the use of sensors controlled by a microcontroller, which generates alerts in case of hazards. In the context of an urban drainage environment, sensor nodes could be used to detect anomalous level or flow rate of water in real-time within the channel to predict the possibility of overflow or existence of obstruction respectively.

In Brazil, namely the city of São Paulo, a wireless sensor network has been implemented along the riverbeds to monitor water level. A first prototype was built, but was then declared unviable since it did not provide a wide enough range of wireless communication. Therefore, a hardware platform using the XBee nodes was developed. It provided better energy consumption, physical size and range of communication between nodes (Degrossi, et al., 2013). Moreover, a solar panel was implemented to restore the backup battery. Using the mesh networks, information is transmitted to and stored in the base stations before being processed in real-time by the server.

The system was built on an open source code distributed under the GNU license (General public license), making it easily adaptable. For data server, PostgreSQL data management system and PostGIS geographical database were used. The aggregated data from the database are accessed via web service. The Application is built using the GeoExt API (Application Program Interface) (Degrossi et al., 2013). The database stores information retrieved from the wireless sensor network such as water gauge level, level of pollution and turbidity and information about the sensors. Moreover the data-

base also contains data about the limitations of watersheds and the source and trajectory of the river. When the data is required, it is accessed from the web service and populated on the API. Figure 4 shows the web application displaying the water level of the river and the changes in water level for a period of time.

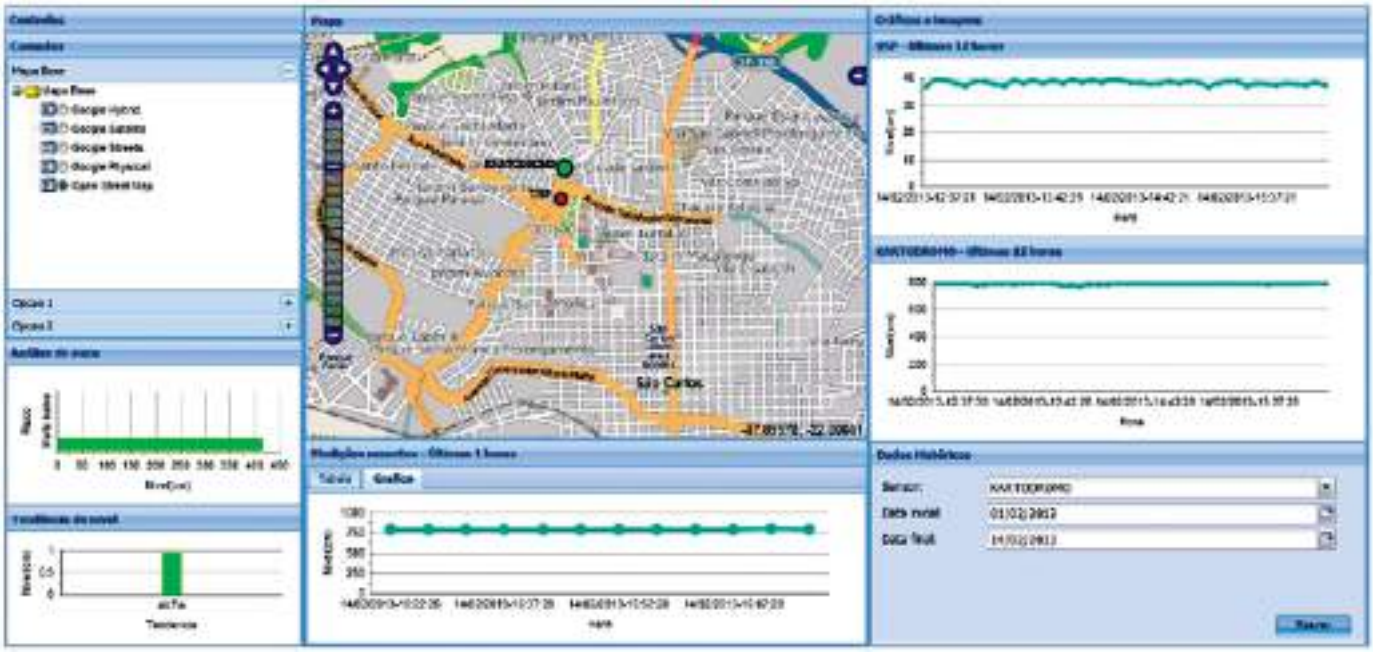


Figure 4: Prototype interface (Degrossi et al., 2013)

Precision Medicine and Health Monitoring

Precision medicine is an approach to patient care that allows doctors to select treatments or products that are most likely to help patients based on a genetic understanding of their disease (Mesko, 2017). The idea of precision medicine is not new, but recent advances in artificial intelligence and IoT have helped speed up the pace of research in this area. Tools employed in precision medicine can include molecular diagnostics, imaging, and analytics. Integration of artificial intelligence (AI) approaches such as machine learning, deep learning, and natural language processing (NLP) to tackle the challenges of scalability and high dimensionality of data and to transform big data into clinically actionable knowledge is expanding and becoming the foundation of precision medicine. For example, artificial intelligence developed at the Cleveland Clinic uses machine learning to combine medical scans and electronic health records (EHR) generating personalized radiation therapy doses for cancer patients.

AIoT for health monitoring encompasses extensive health information capture, processing, communication and, most importantly, the integration of the concept of 'wearable computing' to assist patients. The aim of AIoT health system has always been proactive detection of patient's vitals to ensure treatment and continuous monitoring for a particular disease (Liang et al., 2011). Pervasive health systems have long been used for chronic diseases such as diabetes. While issues such as dependability on sensors, heterogeneous network connectivity, security from DOS Attacks and resource management tend to curb the adoption, the advantages of such systems far outweighs shortcomings. The benefits would include treatment compliance, aggregated data and improved information access.

Pervasive health system promotes medically wearable sensors as they displace the interface of computational surroundings from the home onto the body (implantable), clothes (smart clothing) and portable accessories in patch form. Khan and Yuce (2010) explain that sensor nodes are implanted into a human body to sense biological information and wirelessly transmit data to a control device for analysis in real-time and pervasively.

Liu et al. (2011) developed a novel family-based long-term healthcare monitoring system, called "HealthKiosk" that provides rich contextual information and alerting mechanisms for chronic conditions of the elderly, children and young fitness trainers. The patients can use their installed biomedical sensors (e.g. glucose-meter, blood pressure etc.) to take measurements. Then, the sensed data are sent to a small

server or smartphone via existing communication networks like 3G, Wi-Fi and Bluetooth. Afterwards, the integrated data are sent to a backend support system where the clinical decision supporting system processes the medical data and detect any deterioration to generate alert and invoke intervention of health professionals if needed.

The WellPhone presented by Moser and Melliar-Smith (2015) is used as a personal health monitoring device which interfaces various health monitoring devices such as blood pressure monitor, body weight scale, pulse oximeter, blood glucose meter and accelerometer, and collects physiological data from those devices. The WellPhone provides feedback to the user by means of visualization and speech interaction, and alerts a health profession as needed.

Predictive maintenance

The aim of predictive maintenance (PdM) is first to predict when equipment failure might occur, and secondly, to prevent the occurrence of the failure by performing maintenance. Monitoring for future failure allows maintenance to be planned before the failure occurs. Ideally, predictive maintenance allows the maintenance frequency to be as low as possible to prevent unplanned reactive maintenance, without incurring costs associated with doing too much preventive maintenance. Predictive maintenance uses condition-monitoring equipment to evaluate an asset's performance in real-time. A key element in this process is the AIoT. AIoT allows for different assets and systems to connect, work together, and share, analyze and action data. AIoT relies on predictive maintenance sensors to capture information, make sense of it and identify any areas that need attention. Some examples of using predictive maintenance and predictive maintenance sensors include vibration analysis, oil analysis, thermal imaging, and equipment observation.

Applying the Internet of Things (IoT) to elevator maintenance, experts from Thyssenkrupp and Microsoft spent two years developing MAX, the industry's first real-time, cloud-based predictive maintenance solution (Wang et al. 2016). MAX leverages the power of Microsoft Azure, a cloud platform developed to advance IoT, in order to create a predictive maintenance service with the power to maximize elevator uptime. The system continuously collects machine data and wirelessly sends it to a highly-developed cloud, where it is combined with various other data and analyzed by advanced algorithms. Connected to this system, elevator malfunctions and their causes are visible at a glance. MAX's connectivity enables operators to monitor all elevator functions, including operating speed and capacity as well as individual components. This actionable intelligence provides service technicians and building managers with data-driven solutions that help support smarter management of their building transportation systems.

4. AoIT Platforms

An AIoT platform is a multi-layer technology that enables straightforward provisioning, management, and automation of connected devices within the Internet of Things universe (Bröring et al., 2017). It basically connects your hardware, however diverse, to the cloud by using flexible connectivity options, enterprise-grade security mechanisms, and broad data processing powers. For developers, an AIoT platform provides a set of ready-to-use features that greatly speed up development of applications for connected devices as well as take care of scalability and cross-device compatibility.

Developing for the AIoT especially at an enterprise level can be a complex endeavor, and it is very tedious and cumbersome to do it from scratch. AIoT data platforms offer a jumping-off point by combining many of the tools needed to manage a deployment from device management to data prediction and insights into one service.

Microsoft Azure

Microsoft Azure provides a fully managed IoT solution (Microsoft Azure IoT, 2018). It offers both pre-configured solutions and the capability to customize them and also to ability make custom ones to match customer's needs. A variety of IoT components are provided including: Azure IoT Central (Saas solution to easily connect and manage devices), IoT solution accelerators (creates customizable solution to increase business efficiency), IoT Hub (connecting and monitoring devices), IoT Edge (intelligence at the edge), Stream Analytics (real-time data analytics), Azure Time Series Insights (Data Analytics), Logic Apps (automates data access usage across clouds code), Azure Maps. It provides the main protocols: MQTT, AMQP, and HTTPS protocols. It also allows the possibility to create a custom gateway in case the application does not support the protocols.

It uses a Security Development Lifecycle (SDL) for security management with infrastructure-level security services such as Operational Security Assurance (OSA) and the Microsoft Digital Crimes Unit, Microsoft Security Response Center, and Microsoft Malware Protection Center. Intrusion detection and prevention, service attack prevention, regular penetration testing, multi-factor authentication, forensic tools

are other security measures taken that help identify and mitigate threats. Identity and security keys of IoT devices are provided by Azure IoT Hub identity registry. X.509 CA is used as certificate. An SDK is provided and the platform supports many languages: C, Node.js, Java, .NET, and Python. IoT Hub offers a high uptime guarantee. The cloud caters for Intra-region and cross-region high availability together with cross region Data Recovery.

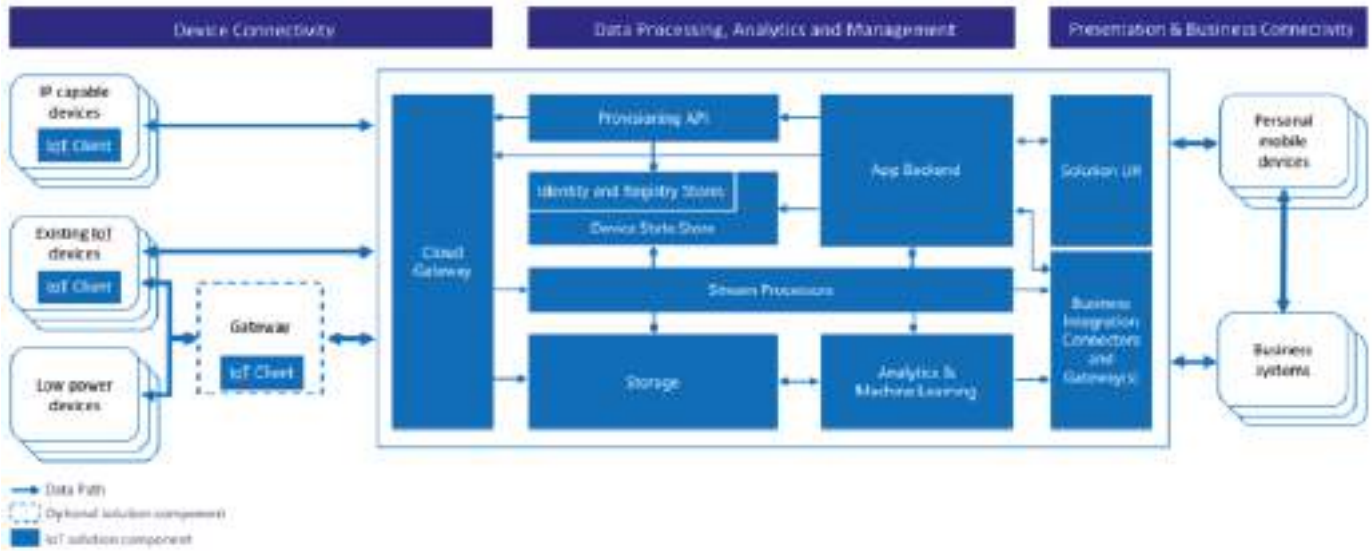


Figure 5: Microsoft Azure IoT Architecture (Microsoft Azure IoT, 2018)

Amazon Web Services (AWS) IoT

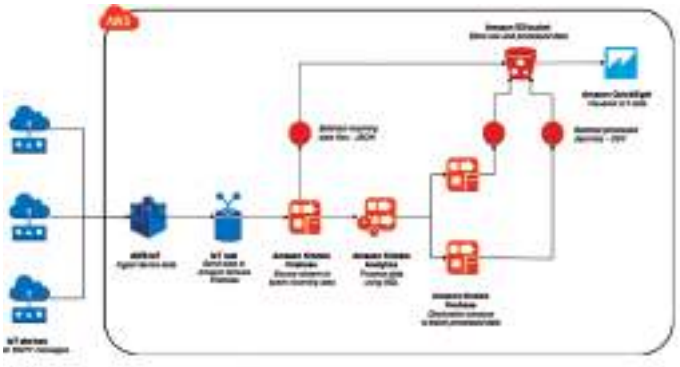
AWS IoT is a managed cloud platform that allows connected devices to, easily and securely, interact with cloud applications and other devices (Amazon Web Services IoT, 2018). AWS IoT can support billions of devices and can process and route trillion of messages to AWS endpoints and to other devices reliably and securely.

Amazon provides a variety of services: Amazon FreeRTOS (an OS for microcontrollers that makes small, low-power edge devices easy to program, deploy), AWS Greengrass (software to securely synchronize and send messages to connected devices), AWS IoT 1-Click (to trigger AWS Lambda functions and track and support assets), AWS IoT Analytics (perform analytics on large datasets and obtain insights), AWS IoT Core (connects billions of devices and securely connect with each one), AWS IoT Device Defender (monitors device behaviour and ensuring their security), AWS IoT Device Management (securely, remotely organise devices on a large scale). Device Shadow can be used to store and retrieve the state of each device.

AWS IoT provides three types of protocols: MQTT (for constrained devices), HTTP (with open SSL), MQTT + WebSocket. These protocols are authenticated with either Client Certificate or SigV4 authentication. All traffic to and from AWS IoT are encrypted over Transport Layer Security (TLS). Each device is secured with an X.509 certificate and AWS credentials. Amazon Cognito Identity Pools (Federated Identities) are used to create unique identities for users and federate them with identity providers. AWS IoT offers built-in and custom authentication. AWS IoT provides SDKs for several platforms including: Python, Embedded C, JavaScript, C++ and Mobile specific SDK for iOS and Android.

Figure 6: AWS IoT Architecture (Amazon Web Services IoT, 2018

Google Cloud IoT Core



Cloud IoT Core is a fully managed service that allows you to, easily and securely, connect, manage, and ingest data from millions of globally dispersed devices (Google Cloud IoT, 2018). Cloud IoT Core, in combination with other serv-

ices on Cloud IoT platform, provides a complete solution for collecting, processing, analyzing, and visualizing IoT data in real time to support improved operational efficiency. The platform consists of scalable and integrated software stack for edge/on-premises computing with machine learning capabilities; and managed Android Things OS for all IoT needs.

Figure 7: Google Cloud IoT Core Architecture (Google Cloud IoT, 2018)

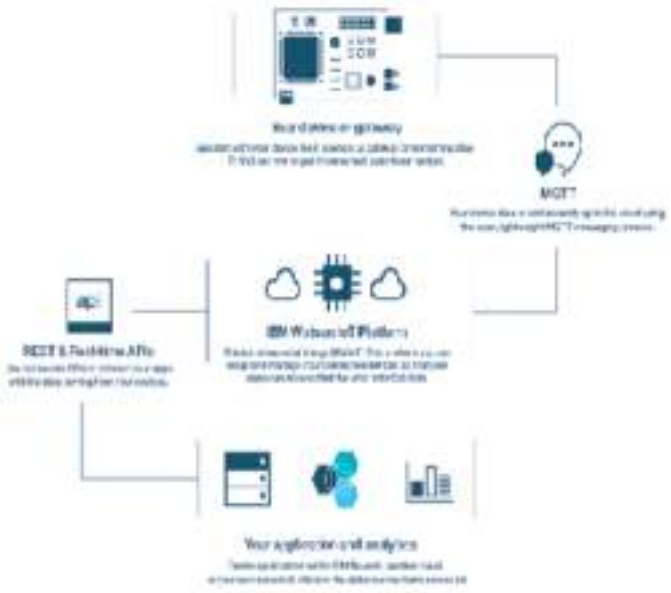
Cloud IoT Core is split into two main components: device manager (identifies, controls and manages devices) and protocol bridge (connects endpoints for protocols with automatic load balancing for all device connections). It also provides Device registry (manages shared properties) and supports Android Things OS. Cloud IoT Core supports two protocols for device connection and communication namely MQTT and HTTP. The platform is secured using per-device public/private key authentication using JSON Web Token. Signatures are verified using RSA or Elliptic Curve algorithms. The MQTT protocol is secured using TLS 1.2 connection. Credentials are provided for authentication. It supports GCP Console, node.JS and its own Google Cloud SDK.

IBM Watson IoT Platform

IBM Watson IoT Platform provides powerful application access to IoT devices and data to help rapidly compose analytics applications and mobile IoT apps (IBM Watson IoT, 2018). The Watson IoT Platform communicates with applications and devices by using the Watson IoT Platform API and the Watson IoT Platform messaging protocol. The Watson IoT Platform dashboard connects as a front-end user interface to simplify operations within the platform. Device data can be stored or used with analytics solutions.

IBM's IoT platform also provides a number of services: Cognitive services for IoT, IBM Cloud services for IoT (navigate through an IoT Dashboard), IoT Real-Time Insights API (get insights in real time using an API), Real-time IoT Data Analytics, IoT data visualization, Device management, Information Management, Risk Management. MQTT and HTTP are the main protocols used by the platform. It uses and HTTP REST API for connecting client devices.

Figure 8: IBM Watson IoT Platform (IBM Watson IoT, 2018)



	MS Azur	Amazon IoT	Google IoT Core	IBM Watson IoT
Core Services	Azure IoT Central, IoT solution accelerators, IoT Hub, IoT Edge, Stream Analytics, Azure Time Series Insights, Logic Apps, Azure Maps	Device gateway, Message broker, Security and Identity service, Device shadow, Job service	Device manager, Protocol bridge, End-to-end security, Data insights, Edge\on premises ML	Cognitive services, IoT Real-Time Insights APL, Real-time IoT Data Analytics, IoT data visualization
Communications Protocols	The Azure IoT protocol gateway includes an MQTT protocol adapter that enables the MQTT v3.1.1 protocol behavior to be custimized	Uses MQTT version 3.1.1, HTTP protocol using REST API such that client can publish data the POST method	MQTT messaging protocol and HTTPS are supported in order to send and retrieve data from application into the cloud	Has native support for secure connection using protocols such as MQTT and HTTP. These protocols are mainly used to publish device telemetry to Cloud sub/pub.
Security	Intrusion detection & prevention, service attack prevention, penetration testing, multi-factor authentification, SDL, OSA, X.509 CA	TLS encryption, X.509 certificate, AWS credentials	Per-device public/private key authentification, RSA/Elliptic Curve signature verification, TLS 1.2 connection	ISO certification, HTTPS over TLS, Digicert certificate
Supported Technologies	C, Node.js, Java Net, Python	Embedded C, Java Script, Python Mobile specific SDK: iOS and Android	GCP Console, node.JS, Google Cloud SDK	C++, C#, Embedded C, Java, mBed C++, node.js, Python

Table 1: Comparison of IoT Platforms

The platform is ISO certified for security and provides 4 areas of security: Compliance, Authentication, Authorization, Encryption. Security data goes through Transport Layer Security (TLS) with HTTPS, and a certificate signed by DigiCert. Devices are authenticated individually. The following languages are supported by the platform: C++, C#, Embedded C, Java, mBed C++, node.js, Python

5. Conclusion

This paper introduces the Artificial Intelligence of Things (AIoT), the future Internet of Things (IoT) with significant intelligence added to things. The Artificial Intelligence of Things (AIoT) uses artificial intelligence to bring more value to the IoT domain by better interpreting data obtained from connected devices. This paper is focused on the discussion of current approaches for the Internet of intelligent things connected and communicating. There are existing solutions that can analyse and interpret IoT data, but artificial intelligence and machine learning can draw more advanced insights from data and draw these insights more rapidly. AI can identify unusual trends with greater accuracy and removes the need for human data review by using computer vision and speech recognition. Instead of focusing on connecting and managing smart objects, future directions in IoT emphasize on bringing awareness and enhancing intelligence to the IoT system by analyzing the interactions between humans and smart objects.

AI has created a wide range of applications in a variety of domains, including agriculture, environment monitoring healthcare, finance, and other day-to-day lives with personal assistants like Alexa and Google Assistant. Combining AI with IoT brings the promise of a new future with a myriad of innovative applications. Data obtained from connected devices can be leveraged further with the help of AI, and smarter insights can be obtained from it. It may soon become rare to find an IoT implementation that does not make some use of AI. Internet of Things will be infused with intelligence that gets to know users and responds to them in very personalized ways. Investments in AI and IoT are leading to a future of decentralized or ambient computing, that departs from our smartphone-centric present.

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Future of Engineering Education: The Indian Experience

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Member 'Sneham Care'
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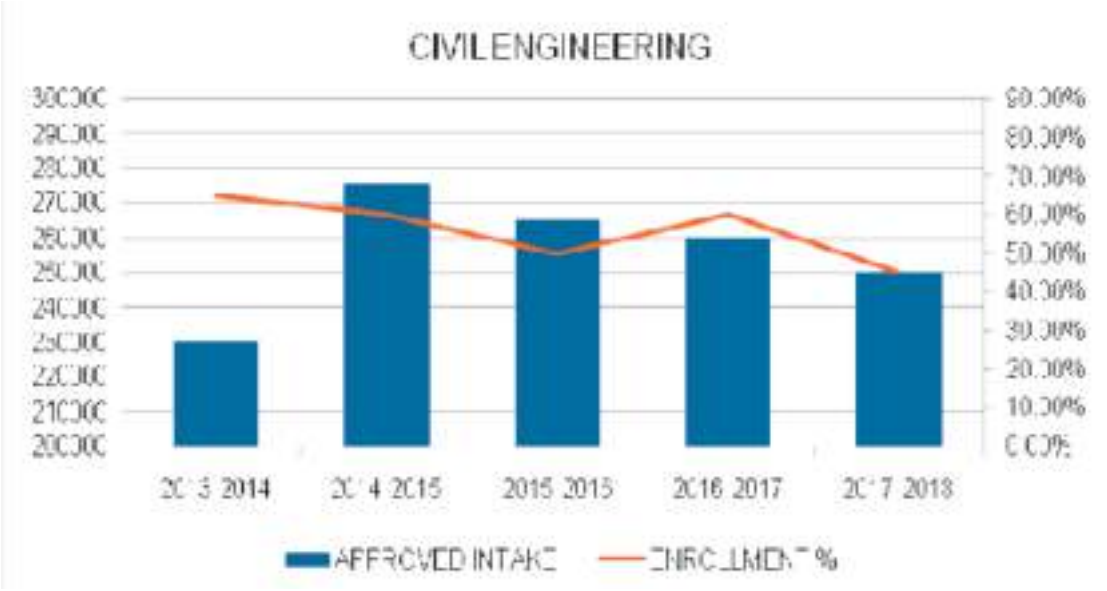
Industry 4.0 has drastically altered industry, and business as disruptive technology with its superior attributes. has completely swept away the established practices that once influenced the consumers. Now, if disruptive technology is here to stay for a while, then radical changes need to be made in the education system to prepare for the required societal expectations. Higher education forms the basis for knowledge creation and innovation in the country and thereby contributes to a growing national economy. Any national economy today is knowledge driven owing to the impact of technology and globalization and it is engineering education that provides a chance to take the country on the next high growth trajectory by creating the right manpower for expanding infrastructure.

We, in India, are at a total crossroads because of the influence of Industry 4.0. This paper basically analyzes the impact of Industry 4.0 on the education system. In our country, we have two bodies, the All India Council for Technical Education (AICTE) and the University Grants Commission (UGC). The All India Council for Technical Education is a statutory body and a National Level Council, which takes care of planning and coordination of all the engineering colleges all over India. The University Grants Commission is again for the approval of universities and disbursing the funds to all the universities which are approved by the UGC. The AICTE under its purview has 6,209 colleges, which includes management as well as the diploma and the postgraduate Institutions. If only the undergraduate level institutions are taken into account, the total up to some 3,500..

So, how has disruptive technology influenced the trend of engineering? We see that there is a total shift with data analytics and computer taking over. People don't want to be associated with the core branches of Engineering like mechanical and civil engineering anymore. We see there is a big shift which was specifically reflected in the admissions of the academic years 2018 and 2019. It was seen that civil engineering found the lowest takers. The survey shows, starting from 2012-13, when civil, mechanical and electronics were highest rapidly varied year after year until gradually the utilization did not justify the capacity. The number of sanctioned seats were close to 2 Lakhs and 80,000. But then the filling capacity came down and we find that civil engineering in 2019, especially Tamil Nadu, had the lowest, about almost 20 percent only. And in contrast, computer science, which had less seats in 2013 then, now today takes top priority in the filling of seats pattern. So this was a trend analysis which was done by the All India Council of Technical Education to show how over the years branches like electronics, electrical, civil and mechanical are showing a gradual downtrend in the number of takers for these disciplines, whereas computers and biomedical, (by computer engineering, we mean computer science, data analytics, big data, any kind of discipline related to data has been classified as computer science engineering). So all these are the choices of the new generation.


CIVIL ENGINEERING
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APPROVED INTAKE
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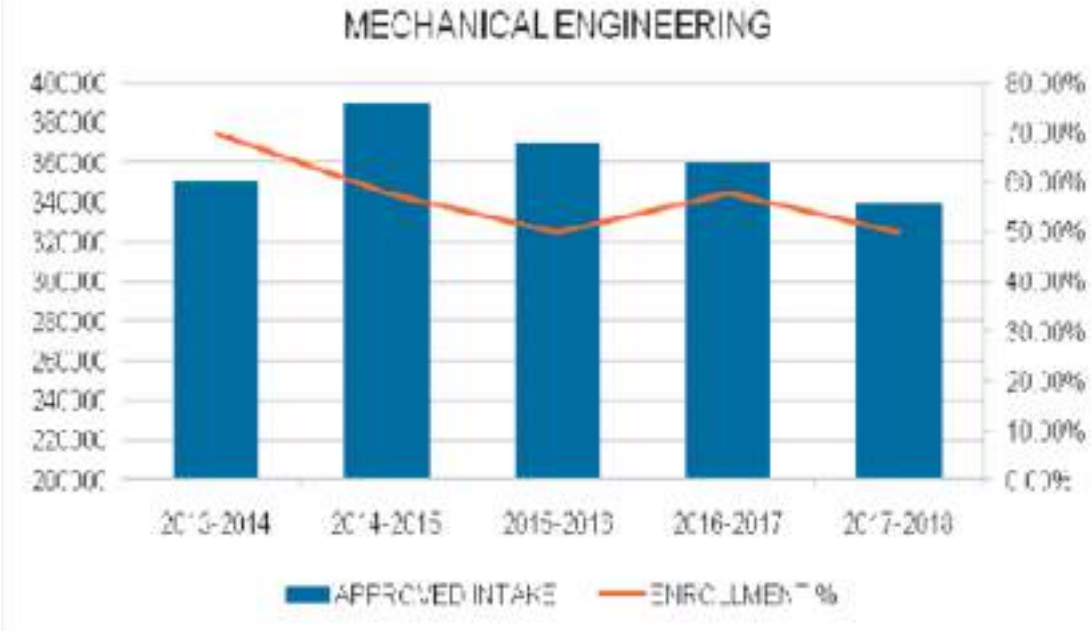
MECHANICAL ENGINEERING
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2015-2016
2016-2017
2017-2018
APPROVED INTAKE
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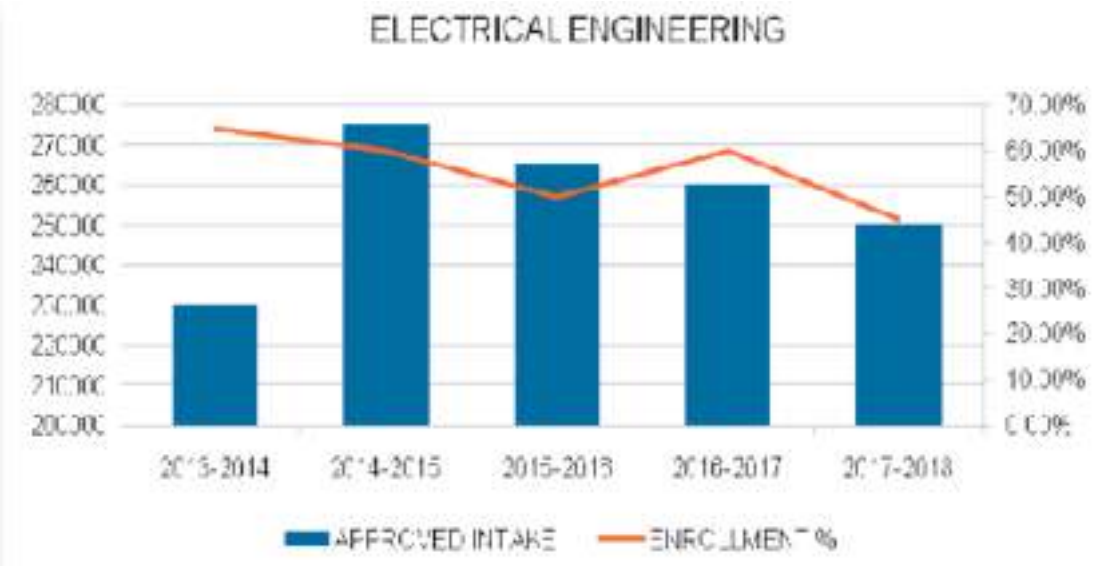

ELECTRICAL ENGINEERING
2013-2014
2014-2015
2015-2016
2016-2017
2017-2018
APPROVED INTAKE
ENROLMENT %

So what are the technologies that have influenced the engineering discipline? You have AI, IOT Robotics, cybersecurity, block chain, quantum engineering, data science and big data analytics, 3D printing, augmented reality and virtual reality. So, looking at these nine key points, we find that these are the emerging engineering disciplines in India now. Water, environmental engineering and agriculture engineering are becoming very popular. Thanks to IOT, many inventions in agriculture are being done as student projects in the country. Disruptive technology has paved way for disruptive engineering education which has highly influenced engineering education in India. Disruptive Engineering Education has led to a paradigm shift where existing methodologies of teachings are slowly dispensed with and we are going towards a more cognitive approach of discovering problems, and discarding any fundamental thinking with innovative practices.

So what are the shifts which we are gradually seeing and what is going to be the case maybe five to seven years down the line? This is based on a survey which was done by M.I.T., one of the premier institutions in India. First shift, we will see, is the centre of gravity. Right now, there is a lot of takers for UK and the American education systems. Slowly, you will see that the shift will be towards Europe and Asia. This is predominantly because of the innovation which has been coming into engineering education, because of encouraging entrepreneurs and any kind of innovation hubs in most institutions which has opened new avenues. Next is the shift in curriculum. The entire curriculum is being revamped and progressively shifting towards socially relevant multidisciplinary streams. Thus, no longer, does each discipline exist independently, but everything is becoming a joint Process. The third shift is towards quality education. There is a lot of emphasis on how things are being delivered in colleges right now. The fourth shift is towards students centricity. Ours was predominantly a professor centered system of teaching. But now we deal with millennials and as well as a different generation where you find that the concentration span is extremely, very, very low. So if you will have to talk to them or connect with them, it has to be totally different. And so, you have to ensure that there is a lot of virtual caption. These shifts are already being experienced in our country. The result is that our teaching learning process is turning towards problem based learning activity based, lab based, community based across disciplines, transdiscipline technology and enhanced assistive virtual and online courses.

So as we move towards a different system of learning, where does the check points come? That is where the quality screen is being made mandatory. By 2022, it is important that all the institutions in India have to be accredited either by NBA or by the NAAC. So, we have two bodies. The National Board of Accreditation (NBA), which was under the purview of AICTE. But right now, independent. And we have the National Assessment and Accreditation Council - NAAC by UGC. Now, NAAC is basically more for the universities and optional for Institutions affiliated to the state University. The Washington Accord is under the NBA and a mandate for top tier Institutions. NBA accreditation totally looks for outcome based education, which is very similar to what you see in the Washington Accord as well as the ABET. NBA is towards endorsing the quality of a program offered, while NAAC is institution oriented. The accreditation given by NAAC for the institution on a grading, whereas by NBA it is given for a single program based on a 10 point criteria, where eight will pertain to the particular program and two will be from the institution as a whole.

India with its diverse cultures also has different types of education systems. We have state universities, Institutions affiliated under the State University, autonomous affiliated institutions, private institutions, government universities and the private universities. So, each has their own curriculum and their own style of giving out the degrees. Ultimately education should lead to better employability. If that is the outcome of quality education, then, what are the attributes one needs to increase employability? If engineers decided our economy. then one needs to examine if the kind of education which we are delivering is able to produce engineers who are up to the expectations of the industry and able to accommodate the shift . This has come once again based on a lot of data analytics. Data is the one which is driving the changes in engineering education in India right about now. There was a survey which was done by CII and AICTE employing Aspiring Minds, a private firm, by testing students from engineering colleges from all over the country. Based on the results of AMCAT - (Aspiring Minds Computer Adaptability Test), it was decided that the analysis points to the need of bridging the gap between the industry and the education system.

Hence, there is a lot of focus on bridging that gap so that the deliverable is very good from every institution. We now have a change in curriculam once in two years, which would be the ideal pattern considering the phenomenal rate at which the technology and industry is changing. Twelve (12) attributes have been given by NBA, which have to be followed by every institution and every course which has been suggested by the university. Social awareness and cognitive thinking is becoming very, very important in education now. So has industry/academia partnership. Industry/academia partnership has been made mandatory now and students have to go through internships starting right from the first year as well as apprenticeship. InternShala, an initiatice of our Government, provides a platform irrespective of whichever institution you belong to. One will be given an opportunity to hobnob with some industry. And similarly, the government of India has set up a target of 15 lakhs (1 lakh = 100,000) apprentices from the year 2018-19. It has to go up to 20 lakhs in the year 2019-20. So how was all this done? Every institution now is being driven to take steps to improve the industry institution partnership. How do we do it? We have to make sure analytical latest analytical tools are being used in the teaching pedagogy. All Institutions are advised to have two industry experts on the board of the college. So Institutions have a department advisory council, as well as a college governing council where we have these specialized industry experts from each discipline addressing the department on how to bridge the gap. Gaps are bridged through online certification through Swayam, another initiative of the government of India and skill development program's offered through the state and central governments. All these are done at very nominal and affordable costs, so that the cost is a win-win situation for both the government as well as the individual. The Ministry of Micro, Small and Medium Enterprise (MSME) and National Small Industries Corporation Ltd (NSIC) actually gives out a large number of courses, on embedded systems, IOT, Android Mobile Development and Energy Management. All these new technology are being given out as certification courses for students, and it is so flexible that you can do it over the weekend. You can do it at your pace and it is all on an interactive basis on the labs which are provided in different places. These certifications have resulted in a number of incubation units being established in institutions all over the country.

The National Education Policy of India 2019 has come out with a lot of solutions for disruptive technology adaptation. National Research Foundation will be formed shortly so that we can accommodate more number of people towards innovative solutions and promotion of entrepreneurs. The light but tight regulation system is in progress and the Indian government proposes to bring out three different types of universities. One will be a research university, primarily concentrating on research. The second will be a teaching university which will concentrate only on teaching. These are basic institutions. And the third will be autonomous institutions, which will be concentrating with a flexible teaching methodology as well as its own syllabus to adapt to changes very quickly. Autonomous institutions can do it must much faster than the government affiliated universities. And the focus is that of one, two and three types at least one of each institution should be there in every district. So this is what the Indian government is working at.

So, now the question of so many technology changes, so many adaptations. How are we going to thrive? Are we going to have schools and colleges? Or soon, will we all become just faceless people going online? My personal answer to this will be yes, you are never going to run out of schools and colleges because schools and colleges are not a place just to enhance your knowledge, mould or bring about engineers. It is a place where you learn values, team building, human love, affection, appreciation and leadership abilities. If you talk to many of the CEOs who are sitting here, the best appreciation, which they probably received was from their schoolmates or college mates who run and come and tell them, remember, we got thrown out of class because we didn't know to solve a single problem and today see where you are. They laugh over it and things sound so light. That is the sense of humanness which you get out of universities when you come out very successful. But, then there is the challenge for the universities and the schools. Only those who can adapt to a pedagogy which will kindle both the creative as well as the analytical aspects of the brain and adapt to all the changes, will survive and come out as the most successful of schools. And, this is what the Indian government is basically looking at, putting so many check points. So, only the best will survive in India and India will soon have an unmatched talent pool.

How to optimize Engineering Opportunities for Development in Africa by Mr. Raj Makoond

Mr Raj Makoond is currently the Programs Director at Eclosia Group in Mauritius.
He has been Chief Executive Officer of Business Mauritius until 2015.
Executive Director. Joint Economic Council (JEC) since 1993
The JEC was the coordinating body of the Mauritius private sector till December 2015 when it merged with the Mauritius Employers Federation to form Business Mauritius.
Deputy Secretary General Mauritius Chamber of Commerce & Industry between 1990-1993
Economist and Senior Economist at the Ministry of Economic Planning & Development from 1976 -1990
Mr Makoond studied Economics at the University of Mumbai, India.

I will share with you a perspective, which I first presented, at the Institution of Engineers of Mauritius (IEM) conference in November 2018. It was an idea, which we thought, was worth it. Since then, I'm aware that there has been some follow up by the IEM and the University of Mauritius to join the Washington Accord[i].

Today I've been invited to share again that perspective. How do we optimize engineering opportunities for development in Africa?

I would start from the premise that the international economic architecture is changing, that there are major changes taking place within the Indian Ocean and Africa is emerging as a continent of economic expansion. But more importantly, also, there are some very major changes taking place in the Mauritian Economic architecture. Mauritius is also focusing its economic strategy within the region, namely the Indian Ocean countries, Asia Pacific and Africa. What would be the role engineers in the strategy?

I'm going to first talk about Mauritius as an integrated business platform, and subsequently explain the rapprochement between Asia Pacific, Indian Ocean and Africa. Europe, through the Lomé Convention already has been in our economic landscape.

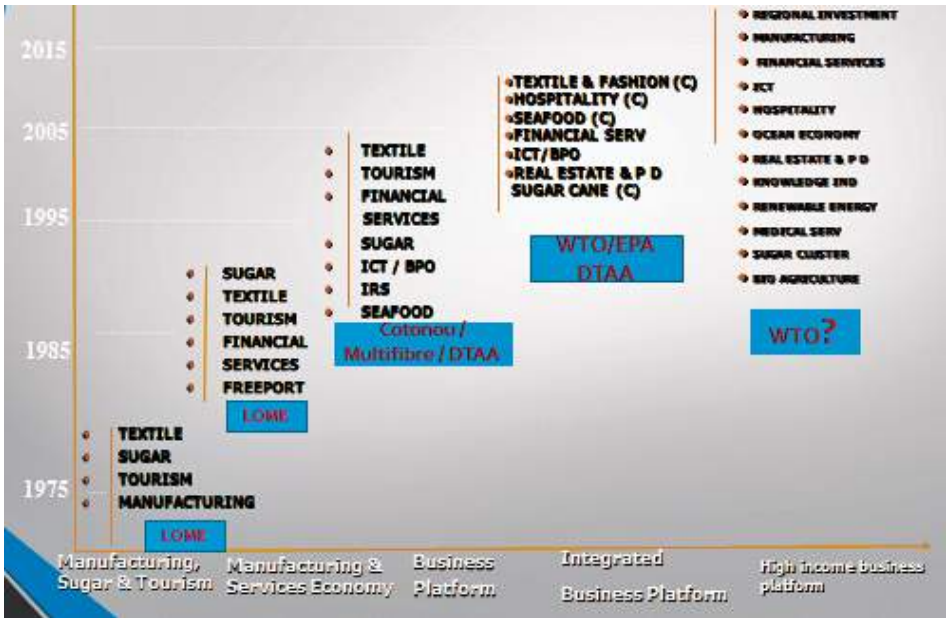
We will see what is happening in the new international economic landscape and growing interest in Africa. Given the need for major infrastructure within Africa, we will establish beyond doubt that they are in fact, major opportunities for engineers

- **Mauritius – An integrated business platform**

Mauritius moved from what was essentially a mono crop economy by the time of its independence (1968) with some diversification in textile, tourism and manufacturing. Very Europe-centric because of the Lomé Convention[ii], Mauritius was one of the very few successful members of the **ACP**[iii] (African, Caribbean and Pacific Group of States) to have market access and to be able to use them in an optimal manner. We continued the diversification of the economy and new sectors were added such as Global Business Financial services and Freeport activities

The premise that the international economic architecture is changing, that there are major changes taking place within the Indian Ocean and Africa is emerging as a continent of economic expansion

Mauritius: Evolution to High Income Integrated Business Platform



Though Mauritius signed the Double Taxation Avoidance Agreement (DTAA) only in 1983, we were able to start using the DTAA in 1991 when major financial flows started to move towards India as to open its economy in 1991 under Prime Minister Narasimha Rao and his Minister of Finance Manmohan Singh. The 1992 Euromoney conference in Mauritius was real trigger for the global business.

Around 2005, because of the dismantling of the multi fiber agreement, as a result of the WTO agreement, we were losing our textile base because new competitors were coming in the EU market. The multi fiber agreement, which gave us two levels of protection (one which prevented China, India and non-ACP to enter the EU market and the second was our duty free access to the EU market).

In 1998, we changed the laws of ICT in Mauritius in order to have a more independent ICT environment. In 2001 there was a new law which was passed, and we started to develop the ICT BPO sector in Mauritius. We tied up with a major agency in India the STPI (Software Technology Parks of India). We visited the different parks in India: namely in Chennai and in Hyderabad. And this was how the Ebene Cyber City was constructed.

The IRS, an integrated development of high quality of residential real estate for non-Mauritian was introduced in late 1990's.

Now, by 2007, we had the pressure on the sugar sector and a major adjustment program (MAAS) was introduced. We had to really revisit the way we were structured in oursugar cane sector.

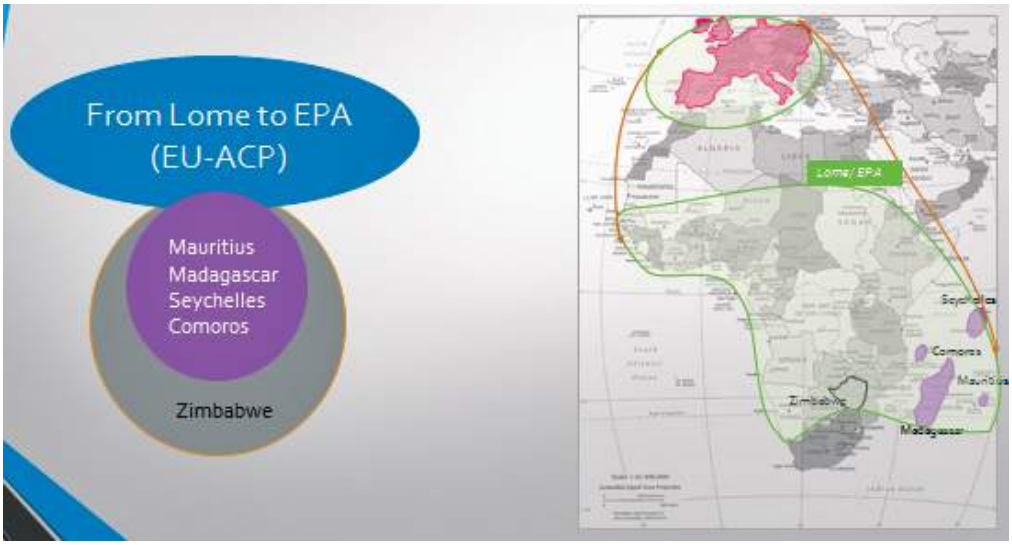
All those changes were happening in the context of the new international trade arrangements and local reforms to become a diversified business platform. By 2007, there was a major work done on the 'ease of doing business in Mauritius' because we wanted Mauritius to be a jurisdiction where we could do business quite easily. And in spite of constraints, today, Mauritius ranks 20th in the World Bank Ease of Doing Business Report. And we are First in Africa.

Over and above improving on the 'ease of doing business', it was pertinent for Mauritius, to have a strong and independent judiciary. Given that the ultimate Court of Appeal in Mauritius is the Privy Council, Mauritius is recognized as an international integrated business platform, with transparent and robust regulatory environment.

Between 2006 to 2010, Mauritius carried out a wide range of economic reforms, (15% uniform corporate tax, 15% uniform income tax, labour reforms) And today, we can say we have a very diversified economy. Global Business is about 6 % of GDP. ICT is about 6.5% of GDP. Tourism is about 8.5% of GDP. And therefore, when critics say that Mauritius is a country which is a tax haven, this is far from the truth because we are an extremely diversified economy, well-structured and with good macroeconomic fundamentals to transform the economy in the integrated business platform.

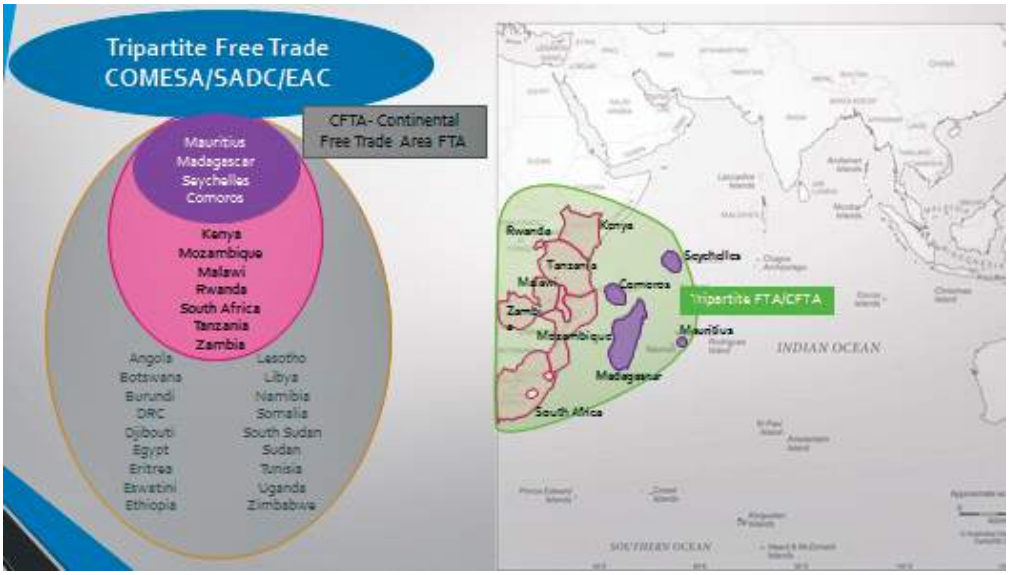
Now, having stated where we are in terms of our economic vision, let's look also at Mauritius in the region.

Defining the contours of the Indian Ocean Region & connecting Asia and Africa- Lomé/EPA



I mention earlier that because we were a member of Lomé Convention, and we work very closely with Africa. Most of the sub-Saharan countries in Africa were members of Lomé. They have now joined the Economic Partnership Agreement[iv] (EPA) with EU. And the core group within the Indian Ocean are Mauritius, Madagascar, Seychelles and the Comoros. And therefore, within the Indian Ocean, we have very good connection with EU for the Lomé Convention.

Defining the contours of the Indian Ocean Region & connecting Asia and Africa- COMESA/SADC/EAC

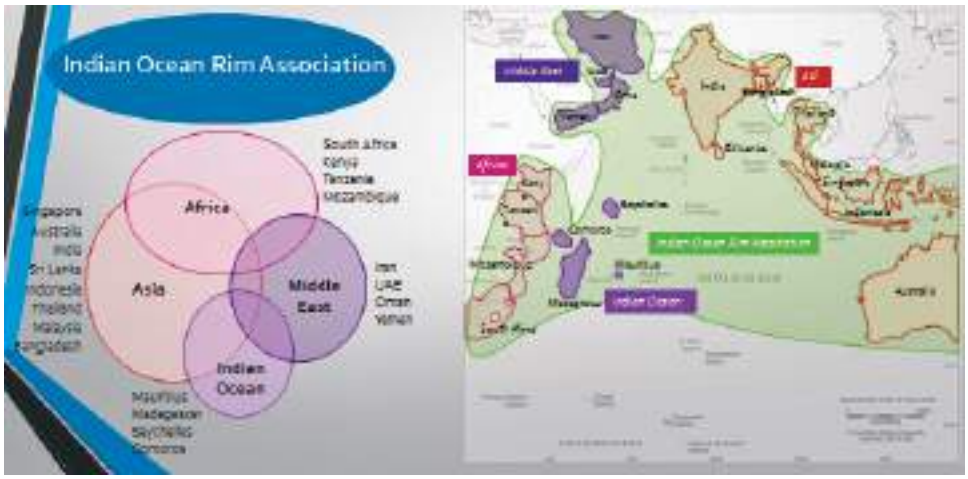


Our engagement with Africa dates back to 1968 when Mauritius became independent. By August 1968, we were already a member of the OAU, the Organization of African Union.

By 1981 we had become a member of the then PTA[v] , which eventually became the COMESA[vi] . And in 1995, as SADC[vii] became open to non-South Africa frontier countries and, we became a member of SADC. We have been very active at the level of SADC, COMESA. We've also partner of the Continental Free Trade Area[viii] , which was signed last year in 2018. We are also active at the level of the tripartite FTA with East Africa also on board. So, we are very active in the Africa region and regretfully there have been a number of criticisms saying that Mauritius is using Africa only as a platform for tax purposes.

For the last say 15 to 20 years, our imports from Africa have increased from about Rs3.3 Billion to today, about Rs27Billion. Our exports to Africa, which was about Rs9Billion, today is about Rs18 Billion. We have about 27% of our exports going to Africa and 14% of our imports coming from Africa. We have a very strong connection with Africa in terms of depth and width. This is what I wanted to share with you because it's important to understand our connection with Africa.

Defining the contours of the Indian Ocean Region & connecting Asia and Africa- IORA



Mauritius is a member of the Indian Ocean Rim Association[ix] . South Africa, Kenya, Mozambique and Tanzania are also members of the Indian Ocean Rim Association and also, of course, India and Australia, are within the platform. We therefore have some very good connection within the Asian context. The Indian Ocean Rim offers a platform also to connect with Asia, Asia & Africa and Asia & Middle East. And we shouldn't forget that there are some countries of the Middle East which are also members of the Indian Ocean Rim Association.

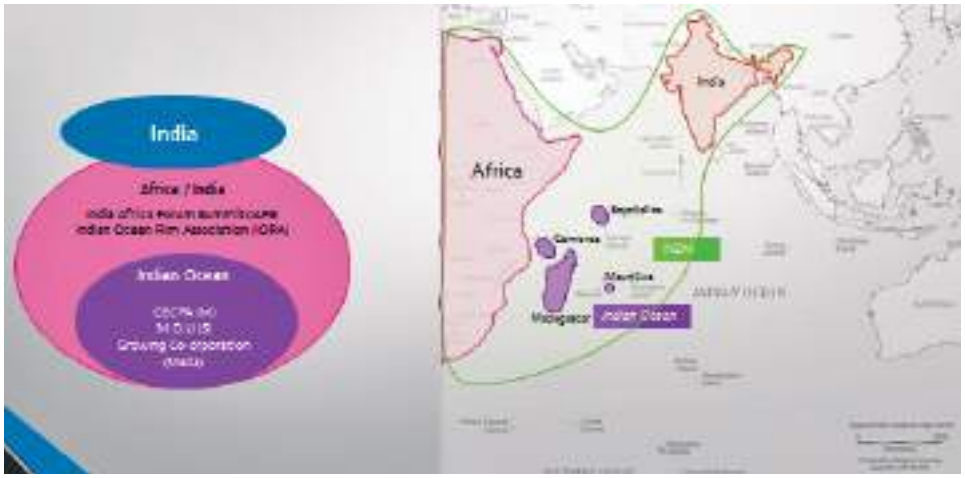
Defining the contours of the Indian Ocean Region & connecting Asia and Africa- BRICS

Also within BRICS[x], we see South Africa, China, India, within that region.

Now, on a bilateral level, if we look at what is happening with the three major players in Asia, China, India and Japan, we see the relationship is deepening.

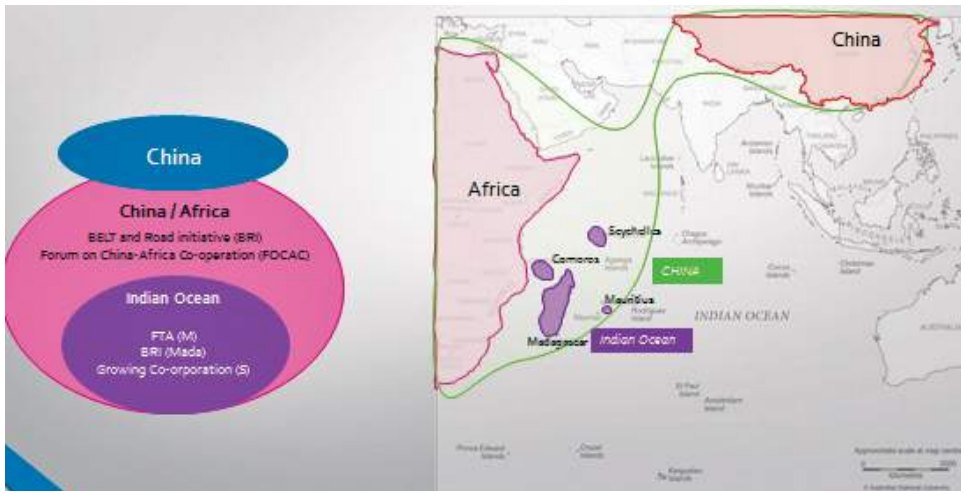
We have a very strong connection with Africa in terms of depth and width.

Defining thecontours of the Indian Ocean Region & connecting Asia and Africa- India



India has an Africa Agenda clearly. The India Africa Forum summit is organised on a regular basis. Indian Ocean Rim Association, we mentioned. But bilaterally with Mauritius sector, with Seychelles there are a number of MOUs and also there's a growing cooperation between India and Madagascar. So. there is also a strong presence of some of the major players of Asia within the Indian Ocean.

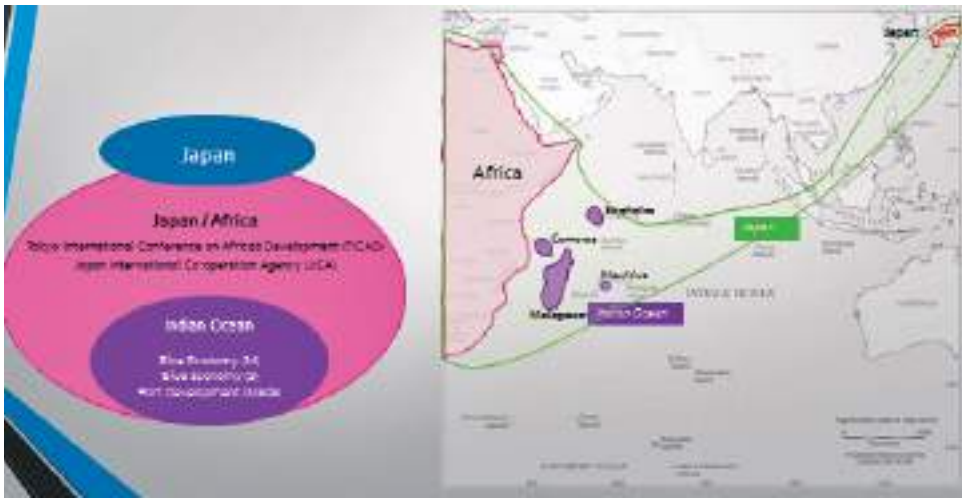
Defining the contours of the Indian Ocean Region & connecting Asia and Africa- China



China is very active in the region through the Belt and Road Initiative[xi] , especially with Madagascar, and Seychelles. And also it has its own forum on China. The Forum for China Africa Cooperation (FOCAC)[xii] being held regularly. Within the Indian Ocean there is an FTA between Mauritius and China. There is the connection on the BRI with Madagascar and there is a growing cooperation with Seychelles. So very present within that region.

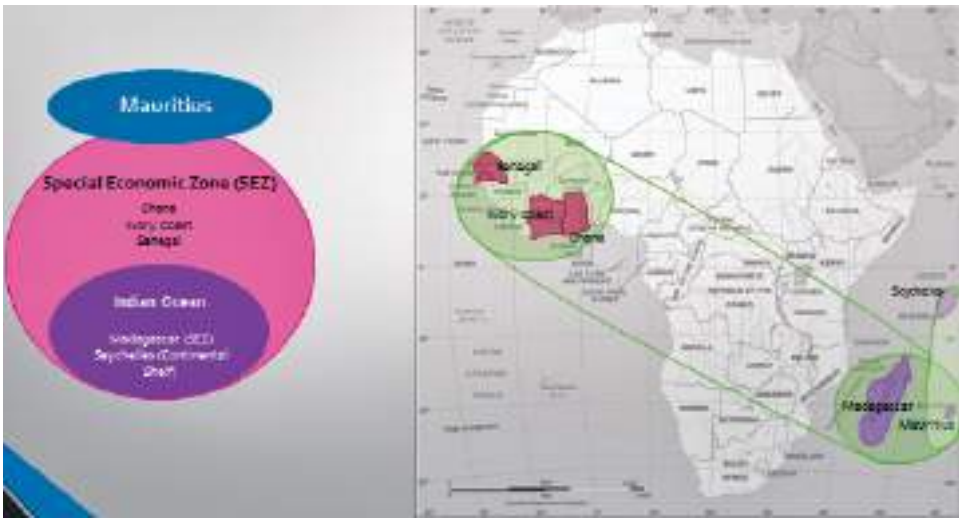
We had the right business platform (appropriate policy and right legal and regulatory in the country.

Defining the contours of the Indian Ocean Region & connecting Asia and Africa- Japan



Japan also is increasing its presence in the Indian Ocean. Of course, in about two weeks, there will be another TICAD[xiii] meeting in Japan and also very active in the blue economy. Now, why I'm saying that to show that within the region there is appetite for the big players to be present.

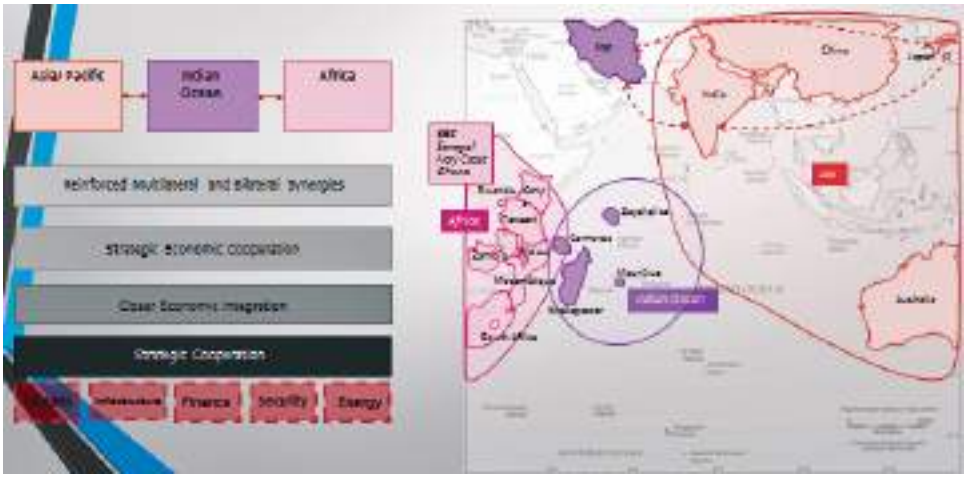
Defining the contours of the Indian Ocean Region & connecting Asia and Africa- SEZ



Mauritius is having more clarity in terms of its cooperation with Africa. But also we have some special economic zones be it in Ivory Coast be it in Senegal, be it also in Madagascar. And we said Seychelles on the continental shelf sharing that large chunk of the ocean.

Now what this means. This rapprochement between the different components players there are clearly some areas on which there will be work together, be it on energy, be it on security be it on finance be it on infrastructure. And this is the bit left on which I propose to focus because of the infrastructure component going to be quite important.

Rapprochement between Asia/Pacific, Indian Ocean Region and Africa



Now, I've mentioned in my remarks that there is a **Changing landscape in the financial services sector**.Today we are looking clearly at a model in Mauritius where we can offer a whole range of integrated services. You would see that in the business models, a number of important European players connecting with our Management Companies (MCs). We have very good examples such as IQEQ, Octorian and IFS. New business models are emerging, and we are building a quality ecosystem to provide a wide range of services. There is the wrong perception that everything happens because of DTAA's. That's not correct as about 40 percent of the Capital movement was done to Africa going through Mauritius went to countries with DTAA's.

What I also want to share with you is the massive appetite for infrastructure in Africa. Figures vary, that's why I wouldn't put a figure. AFD (Agence Francaise de Development) will mention the figure of 135billion USD. African Development Bank mentioned 140billion USD.

The needs for infrastructure within Africa would require major the financial engineering which could well be done from Mauritius. However, there will also be massive needs for project design, project management, and project implementation.

And it was very interesting when I was listening to the debate during the Q&A, there were questions about accreditation, questions about Washington Accord etc. And I know that work has started with the University of Mauritius with collaboration with IEM and a budget approved to move towards Washington Accord to finance this program.

Why in financial Services Mauritius was successful? There were three reasons:

1. We had quality people, all of them being Chartered Accountants or ACCA.

2. We had the right business platform (appropriate policy and right legal and regulatory in the country.

3. The same time India offered major opportunities for movement of Capital and investors preferred to choose a jurisdiction, which had the proper ecosystem.

Today for infrastructure in Africa, we have the same opportunities. The need would be huge. But I haven't seen much of the presence or appetite of engineers to connect with the finance people and to say, we can offer the services in the supply chain around project design, project management, project monitoring. All these are essentially the strength of engineers and therefore they must work together with other partners to make Mauritius known as a supplier of these services.I have not seen it happening yet.

It would take some time. I remember very well in 1992 when we had the first Euromoney Conference, when accountants were sitting together with legal people trying to explore opportunities.

Now, how will it happen? This is probably the difficult question, and we have to move out of our silos. How do we do that?

Strategic Alliances. It is difficult to get engineers talking to finance people. Operating in silos is a major constraint. I suggest that engineer and MCs develop a joint strategy to unlock these opportunities. I think these are challenges, which are within our reach.

At the same time, we have to do our homework. We must set a timetable to join the Washington Accord for our

engineering institutions to be recognized. When we have the right accreditation that will help us to move forward.

The Indian Ocean Countries and Africa are becoming important today for Mauritian Companies. All the top hundred companies in Mauritius are exploring opportunities in Africa. Be it in banking, be it in tourism, be it in sugar, be it in insurance, be it in leasing, they are very much present. And our growth will be to a large extent dependent on how we are structured.

Recently, some of you must have read that Moodys raised the rating of the MCB because of its strength in the region. It will change the way we will raise finance. It will change the way we do business. And we are convinced that in infrastructure, clearly there is a major scope to connect the financial engineering with the engineering work. And that's the challenge that probably all of you will have to take.

End Notes

[i] *The **Washington Accord** is an international accreditation agreement for undergraduate professional engineering academic degrees between the bodies responsible for accreditation in its signatory countries and regions. Established in 1989, the full signatories as of 2018 are Australia, Canada, China, Hong Kong, India, Ireland, Japan, Korea, Malaysia, New Zealand, Pakistan, Peru, Philippines, Russia, Singapore, South Africa, Sri Lanka, Taiwan, Turkey, the United Kingdom and the United States [i]z*

[ii] *The **Lomé Convention** is a commercial cooperation agreement signed on 28 February 1975 between the EEC and 46 African , Caribbean and Pacific countries (so - called ACP countries), and renewed in 1979 (Lomé II, 57 countries), 1984 (Lomé III, 66 countries), 1990 (Lomé IV, 70 countries) and in 1995 (Lomé IVbis, 70 countries). In 2000 , the Lomé Convention is replaced by the Cotonou Agreement .*

Although it originally had only 18 Member States, it now has 79, which is proof of its attractiveness. This cooperation was intended to promote the adaptation of ACP countries to the market economy.

[iii] ***The African, Caribbean and Pacific Group of States (ACP)** is a group of countries in Africa, the Caribbean, and the Pacific that was created by the Georgetown Agreement in 1975. The group's main objectives are sustainable development and poverty reduction within its member states, as well as their greater integration into the world's economy. All of the member states, except Cuba, are signatories to the Cotonou Agreement with the European Union.*

The Cotonou Agreement (signed in Cotonou, Benin in June 2000) is the successor to the Lomé Conventions. One of the major differences from the Lomé Convention is that the partnership is extended to new actors such as civil society, private sector, trade unions and local authorities. These will be involved in consultations and planning of national development strategies, provided with access to financial resources and involved in the implementation of programmes.

Many small island developing states are ACP states; the fourth Lomé Convention was revised in 1995 in Mauritius and gives special attention to island countries in this agreement.

[iv] *Economic Partnership Agreements (EPAs) are trade and development agreements negotiated between the EU and African, Caribbean and Pacific (ACP) partners engaged in regional economic integration processes.*

[v] *The Treaty establishing the Preferential Trade Area for Eastern and Southern Africa was signed in December 1981, as a first step towards higher forms of regional economic cooperation and integration to bring about sustainable growth and development of Member States.*

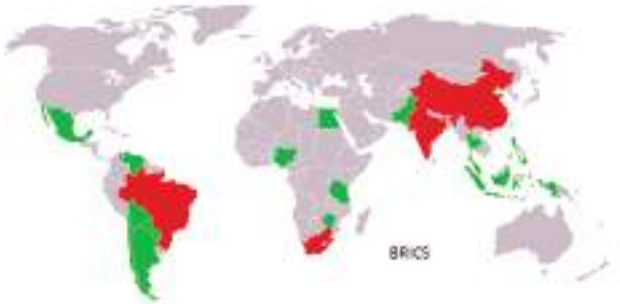
[vi] *The Common Market for Eastern and Southern Africa (**COMESA**) is a free trade area with twenty-one member states stretching from Tunisia to Eswatini. **COMESA** was formed in December 1994, replacing a Preferential Trade Area which had existed since 1981.*

[vii] ***The Southern African Development Community (SADC)** is an inter-governmental organization headquartered in Gaborone, Botswana. Its goal is to further socio-economic cooperation and integration as well as political and security cooperation among 16 southern African countries [1]*

[viii] ***The African Continental Free Trade Area (AfCFTA)****[1] is a free trade area, outlined in the African Continental Free Trade Agreement among 54 of the 55 African Union nations.[2] The free-trade area is the largest in the world in terms of participating countries since the formation of the World Trade Organization*

[ix] ***The Indian Ocean Rim Association (IORA)*** *is a dynamic inter-governmental organisation aimed at strengthening regional cooperation and sustainable development within the Indian Ocean region through its 22 Member States and 9 Dialogue Partners.*

[x] ***BRICS*** *is an acronym for a group of five countries that have been meeting since 2011 in annual summits: Brazil , Russia , India , China and South Africa (in English : B razil, R ussia, I ndia, C hina, S outh Africa)*



[xi] *The* ***Belt and Road Initiative (BRI)*** *is a global development strategy adopted by the Chinese government involving infrastructure development and investments in 152 countries and international organizations in Asia, Europe, Africa, the Middle East, and the Americas.*

The leader of the People's Republic of China, Xi Jinping, originally announced the strategy during official visits to Indonesia and Kazakhstan in 2013. "Belt" refers to the overland routes for road and rail transportation, called "the Silk Road Economic Belt"; whereas "road" refers to the sea routes, or the 21st Century Maritime Silk Road.

It was known as the ***One Belt One Road (OBOR)*** *and the* ***Silk Road Economic Belt and the 21st-century Maritime Silk Road*** *until 2016 when the Chinese government considered the emphasis on the word "one" was prone to misinterpretation.*

The Indian Ocean Countries and Africa are becoming important today for Mauritian Companies. All the top hundred companies in Mauritius are exploring opportunities in Africa. Be it in banking, be it in tourism, be it in sugar, be it in insurance, be it in leasing, they are very much present. And our growth will be to a large extent dependent on how we are structured.

The Chinese government calls the initiative "a bid to enhance regional connectivity and embrace a brighter future".Some observers see it as a push for Chinese dominance in global affairs with a China-centered trading network. The project has a targeted completion date of 2049, which coincides with the 100th anniversary of the People's Republic of China.

[xii] ***The Forum on China–Africa Cooperation (FOCAC*** *French: Forum sur la coopération sino-africaine) is an official forum between the People's Republic of China and all states in Africa (with the exception of Eswatini, the last African state with which the PRC currently does not have diplomatic relations, since it recognizes Taiwan). There have been three summits held to date, with the most recent having occurred from September 3–4, 2018 in Beijing, China. The first summit was held November 2006, also in Beijing.*

[xiii] *TICAD is the acronym for the Tokyo International Conference on African Development (Tokyo International Conference on African Development). Ella was inaugurated in 1993 to promote a high-level political dialogue between African leaders and their partners in the field of development. The meetings are organized under the leadership of Japan and co-organized by the United Nations, the United Nations Development Program (UNDP), the World Bank and the African Union Commission (AUC).*

Rapporteur's Report Maj Gen (Dr) S Bhattacharya, VSM (Retd), Secretary & Director General

Maj Gen Souresh Bhattacharya has a distinguished Army career spanning 37 years. He did his ICSE from Sherwood College, Nainital and is an alumni of the National Defence Academy. He is a B.Tech in Electronics, has a Masters of Technology degree in Computer Engineering from IIT Kharagpur and is an MBA in Operations Management. He has been awarded a PhD degree for his thesis titled "Automotive Supply Chains in India: A Study of Manufacturer-Supplier Interface".

During his Army career, Maj Gen Bhattacharya who was a paratrooper, has held many prestigious Staff and Command assignments He has travelled widely in India and abroad. He is a recipient of the Vishisht Seva Medal for distinguished service during Command of a Battalion in the Kashmir Valley and Chief of Army Staff Commendation during his tenure as Defence Attaché. He has also been awarded Army Training Command and Eastern Command Commendations as also the prestigious IETE Award for outstanding contribution in the development of military simulators.

Maj Gen Bhattacharya is a Fellow of IEI and IETE, Life Member of CSI and Member AIMA.

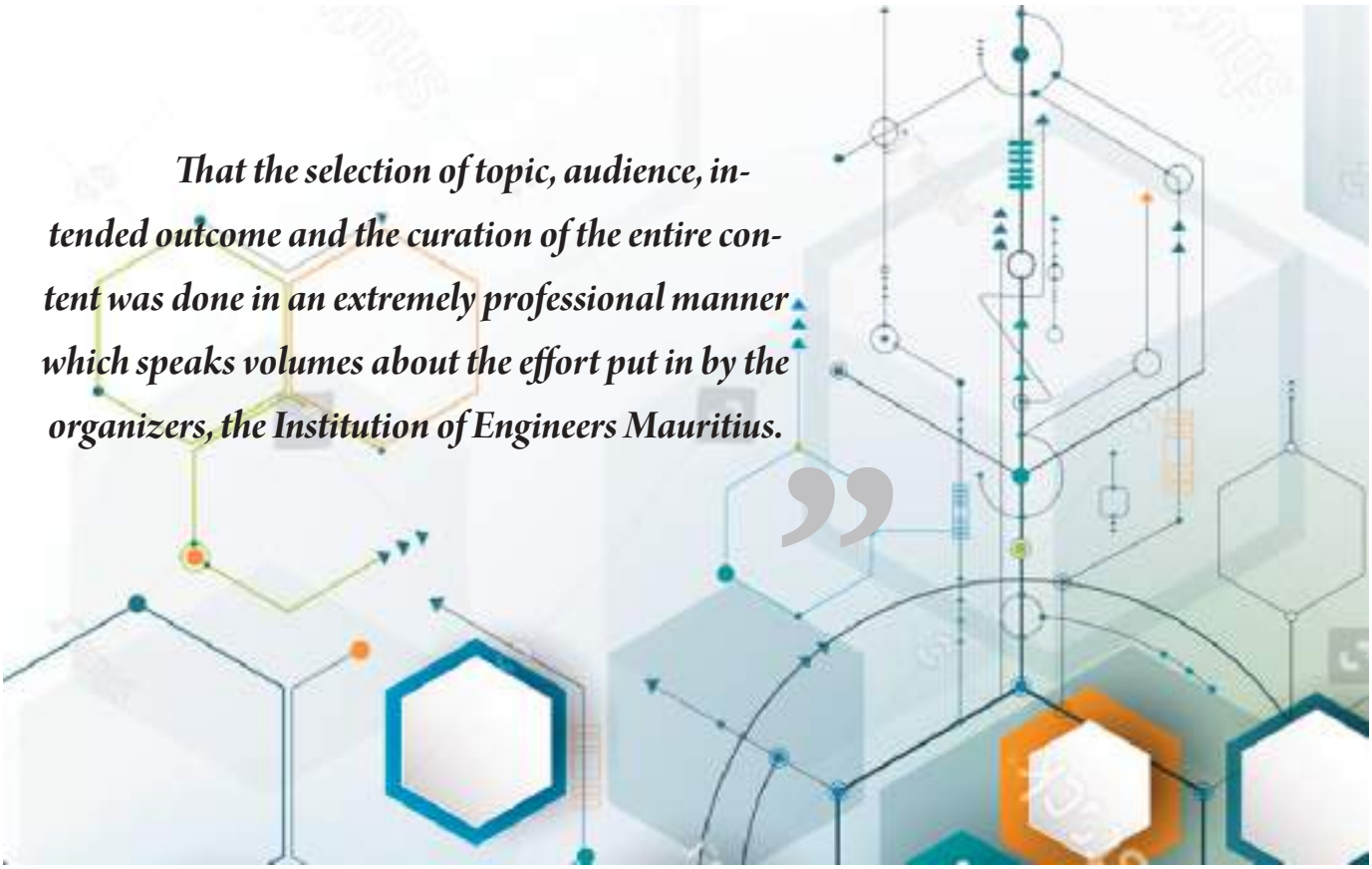
Maj Gen (Dr) S Bhattacharya, VSM (Retd), Secretary & Director General, The Institution of Engineers (India), who was the rapporteur on the occasion, provided a comprehensive coverage of all the sessions including the inaugural session. Maj Gen Bhattacharya pointed out that the deliberations during the inaugural session set the tone of the entire proceedings with Mr Yogida Sawmynaden, Hon'ble Minister of Technology and Communication & Innovation, Republic of Mauritius, speaking on the policy initiatives taken by the Mauritius Government in encouraging startups and creating an ecosystem of technological excellence. Mr Martin Manuwah, President, Federation of African Engineering Organisations, presented a perspective of the African Engineering Community and their intent to absorb the technology revolution vis-à-vis the role of WFEO towards promotion of engineering and technology in Africa. He also mentioned that Dr T M Gunaraja, President, IEI and Mr Prayag Raj, President, Institution of Engineers, Mauritius, both spoke on the need for professional bodies to impart continued professional development by leveraging contemporary technologies and also the need for synergy among the global professional societies. President IEM spoke about the support being lent by the Institution of Engineers, Mauritius to the Government in framing policy initiatives.

He expressed gratitude on the presence of His Excellency, Shri Tanmaya Lal, High Commissioner of India to the Republic of Mauritius, who spoke on the Indian government initiatives, in digital technology and other e-governance initiatives in India.

The technical sessions started with knowledgeable speakers which set the tone for the event. It unfolded with the presentation by Dr Krishna Oolun, who went on to explain the jargon 'disruptive technology' and its implications on our day to day life. He laid a very good foundation for understanding disruptive technologies and for the others to follow and most importantly, he explained the difference between sustaining and disruptive technologies. He also spoke about the new market disruption and the requirement of an organization for thriving in this age of technology revolution. Dr Oolun was succeeded by Professor Arshad who spoke on the role of disruptive technologies in the strategic space and the way forward. He spoke about 'Digital Amnesia', 'Meta Ignorance' and 'Society 5.0' which added a philosophical tone to the discourse. In this context, Maj Gen S Bhattacharya, VSM (Retd.), mentioned that The Institution of Engineers (India) believes in engineering for society as a philosophy and the 34th Indian Engineering Congress, to be held in December 2019, will be organized on a similar theme.

The insights provided by the initial four speakers on disruptive technology paved the way for the next genre of speakers, in particular, Mr Shameendra Basu, Associate partner of IBM, who gave a very practical presentation on fielding disruptive technologies, the user perspective and how strategic it is towards reorganizing a company's goals. Mr Basu's view on adoption of disruptive technologies based on user perspective was well complemented by Dr Anand who spoke on responsible usage of data and by Captain Goodwin with his categorizing of stages of advent of technology in a phased manner namely stone, bronze, iron and then digital. He also emphasized on the fact that in order to absorb the benefits, the entire process needs to be reworked and the disruptive technologies can only then be vectored in. Many speakers spoke on similar lines emphasizing the fact that the world is in flux and the people, innovation and technology are the cornerstone of any technology revolution. There was another interesting presentation from Mr Sudeendra Koushik, who runs a start-up and believes that company size doesn't matter and feels that innovation is not optional anymore. He talked about the research, innovation, ideas and money conundrum, the continuum of research into innovation and then ideas into money. Healso mentioned that utility of adopting new technology is to be assessed based on its usefulness, solution, newness and opportunity and not attempting to fix the wrong problem.

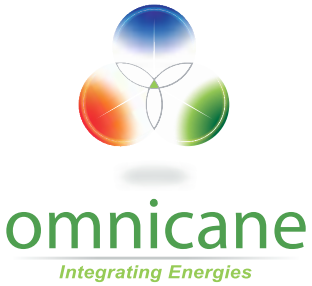
Professor Kavi Khedoo talked about artificial intelligence and what it offers in so many different dimensions. To substantiate, he mentioned the advent of IoT and things like Alexa, Netflix, Health, Amazon etc. Prof Khedoo's presentation was an excellent rendition of future of engineering education in the backdrop of disruptive technologies.



The growth of the trade agreements and how it affects infrastructure development was very well explained by the next speaker, Mr Raj Makoond whose presentation also included optimizing engineering opportunities in Africa, Asia, and Africa-Business Connect initiative.

Before concluding, Maj Gen S Bhattacharya, VSM (Retd.), highlighted that the selection of topic, audience, intended outcome and the curation of the entire content was done in an extremely professional manner which speaks volumes about the effort put in by the organizers, the Institution of Engineers Mauritius.

IEM is most grateful to the Sponsors

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