THE ADMINISTRATOR

Journal of LBSNAA

Special Edition on

Aarambh 1

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Lal Bahadur Shastri
National Academy of Administration

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सत्यमेव जयते

प्रधान मंत्री
Prime Minister

MESSAGE

I am pleased to learn that Lal Bahadur Shastri National Academy of Administration is bringing out a special issue of its journal-'The Administrator' on *Aarambh* 2019, a nation-entric and future-oriented endeavour to administration and governance.

As a significant measure in the training process of the new generation of civil servants, *Aarambh* strived to broaden their thinking and approach through an extensive exposure to the vision of global leaders and experts from the social and economic world.

The initiative is part of our comprehensive efforts towards preparing civil servants for the future by making them more constructive and creative through technology and transparency. Our emphasis is to ensure a paradigm shift in governance from silos to integrated approach to further a meaningful change in the lives of the needy and disadvantaged.

Sense and sentiment of service are the touchstones of governance. Our focus is on governance that ensures effective delivery unto the last. We are firmly committed to build a New India that is self-reliant and self-sufficient. Our vision is mirrored in our resolve to enrich our capabilities, enhance our capacity, with a sharp focus on skilling, re-skilling and upskilling.

Civil servants have a pivotal role as a facilitator for effective implementation of the policy and efficient service delivery so that growth is all-inclusive and equitable.

May the inspirational ideas and the valuable learning from the best national and international practices always remain firmly etched in the young administrators and guide them with the spirit of '*Seva Paramodharma*'.

I am sure that this special issue of 'The Administrator' will continue to inspire everyone in the years ahead. Best wishes for its successful publication.

May the special edition be liked and read widely.

(Narendra Modi)

New Delhi
आश्विन 28, शक संवत् 1942
20th October, 2020

Dr. Sanjeev Chopra
Director
Lal Bahadur Shastri National Academy of Administration
Mussoorie
Uttarakhand - 248 179

Lal Bahadur Shastri
National Academy of Administration

From the Desk of the Director

Aarambh 2019 marked the beginning of a churning that will propel the civil services to achieve their fullest potential. In the calm environs of the Sardar Sarovar Dam at Kevadia, sheltered by the towering Statue of Unity that commemorates the life and contribution of a stalwart leader and patriot, Sardar Patel, something quite like an idea revolution took place. This was the beginning of the common foundation course with the Officer Trainees of the 2019 batch being exposed to ideas of development in a strong and sustained manner. Speakers from across the globe joined the programme that was organized jointly by the Department of Personnel and Training and the Lal Bahadur Shastri National Academy of Administration. Our partner institutions included Singularity University and the Institute for the Future. We had insightful input on world economics from the World Bank President, David Malpass and a firm laying out of the foundations of development by the Chief Minister of Gujarat, Vijay Rupani. As a week-long endeavour brimmed with informed discussion, the Officer Trainees saw and heard the miracles that technology can usher into the lives of people and also grappled with the dangers, the gaping ethical loopholes that technology is often riddled with. I hope that through this exercise we compelled the young officers to think about the policy and implementation pathways that will enable technology to make its way into the everyday existence of people and of systems of governance.

The fact that Hon'ble Prime Minister, Sh. Narendra Modi graced the programme and spent time addressing the Officer Trainees and answering the questions that a new recruit into the system of government would have, enthused them to put forth their best as they move towards implementation and execution. The need to have over-arching and enabling frameworks of thought to guide and indicate action was created through this interaction and the process that it was a part of.

The discussions on the historical evolution of the civil services through the vision of Sardar Patel and the change in the structure of the civil services in the United Kingdom and in South Africa created dialectical space for looking at our own system of governance and at the work of civil servants in our country.

Thus, this special edition of The Administrator on the ideas revolution that was initiated through Aarambh at Kevadia and that we hope to take forward into the years ahead. We also envision its translation into practical steps on the ground that will help propel India on the path towards advanced and holistic socio-economic growth.

(Dr. Sanjeev Chopra)

Editor's Note

The beauty of curating an event that dismantled the artificial barriers between technology, human resource and the environment emerged effectively through *Aarambh* 2019. While the early morning sun glinted off the ripples in the reservoir of the Sardar Sarovar Dam, spinning the entire green ecosystem into activity; just nearby, young minds huddled to deconstruct theories, to break into problems and to perceive the ray of a solution that shone through. The Department of Personnel and Training and the Lal Bahadur Shastri National Academy of Administration brought together a myriad strands of expertise to enliven the atmosphere at Kevadia with thought-stimulating questions and proposals that sought to spur change. The very acceptance of the rate at which we are able to channel technology into the creation of projects of public benefit was questioned and turned upside down. It would not do to let such an opportunity, that encapsulated within it infinite opportunities of development, to pass by and be remembered through a record of notes and videos, merely.

Therefore, in the series of special editions of The *Administrator* initiated by the Director of the Academy, Dr. Sanjeev Chopra, *Aarambh* 2019 seeks to begin an idea stream with the aim of collating the thoughts of speakers from our country and abroad during the week-long programme at Kevadia. The subjects span the spectrum of civil services reform, artificial intelligence and how effectively technology can be translated into improving the quality of life on the ground. Each contribution to this edition was received in the form of a transcript and I have retained the tone – sometimes colloquial, sometimes formal – that defined the speaker's style of presenting.

I hope that this edition forms a point of reference for the one on *Aarambh* 2020 and the ones that will follow and that it becomes the fount of new journeys towards higher standards of development.

(Gauri Parasher Joshi)

The Parable of the Stone Cutter
- Being an Effective Civil Servant

Dr. P. K. Mishra

At the outset, I would like to congratulate all of you, Officer Trainees, on joining the Foundation Course - a memorable beginning of a long and eventful journey in civil service. Further, you have the good fortune of being a part of a momentous new initiative of this one-week program at the Statue of Unity in the picturesque environment of Kevadia. In fact, after decades, this is a new initiative inspired by our present Prime Minister, having a one-week program as a part of the Foundation Course. I was here since the afternoon and had the opportunity to observe some of your activities, particularly, those in the five thematic breakout sessions. I was amazed how far we have reached in our approach to training. When I look back at my days more than four decades ago, there is so much of change. In fact, I feel a sense of envy because you are exposed to so much knowledge; so many ideas and so many new techniques and this venue itself is extremely relevant. It's a great tribute to the memory of Sardar Vallabhbhai Patel whose relentless work and vision has enabled the civil services to contribute to the creation of a strong, independent and united India.

Needless to say, it was Sardar Patel's conviction and astounding ability to realize this idea of a united India that made it possible for all of us to be a part of this great nation. The Statue of Unity has been conceptualized, composed and built as an embodiment of Sardar Patel's leadership in laying the foundation of a new and united India. You have had in-depth discussion as I was told and have been extensively exposed to issues about the economy, technology and society. You spent Diwali with the people of the nearby villages. Of course, before that you had also your village visit and study.

You have had so many experts and practitioners speak to you on subjects ranging from agriculture, rural transformation, education, health, sustainable resource management, to the frontiers of new technology including, artificial intelligence and so on. All these, keeping in view the central theme of how to make India a $5 trillion economy by 2024-25, a vision inspired by our Prime Minister. I would not like to impose another lecture giving ideas and

techniques with which you may be already overwhelmed. While I shall speak briefly about the central theme that has brought together this gathering, I shall spend more time in telling you about my personal experience in the civil service. This will certainly include my successes. It will, however, also dwell on failures.

As all of you know, India's huge economic potential comes from its young and educated population, its abundant natural resources, its inherent democratic values and its attempt to peaceful international co-existence. Further, we talk about our young population, our natural resources and of course, our democratic institutions and our approach to international peace and harmony. All of these provide an enabling environment for sustainable and inclusive development. Far reaching reform measures have been taken in recent years. Many structural reforms apart from short- term economic measures have been initiated. Whether we talk about the GST or the Insolvency and Bankruptcy Code, which have changed the whole scenario or the measures for inclusive development, efficient delivery, *mudras*, Startup India, Standup India and so on along with schemes like *Ayushman Bharat* and the commitment to ensure piped water supply to every household within the next two or three years, the pace of positive change has been steady. Many of these measures will certainly improve and accelerate our growth and in all these things, as civil servants, you have to play an important role. Ultimately, it is the civil servants who provide the framework for actual delivery in the field.

However much civil servants are criticized, however frequently they are called bureaucrats disparagingly, one cannot but depend on civil servants like you for the future growth of this country and how to achieve a $5 trillion economy. In addition to some of these measures in the field of the economy and other areas, we have also taken up some changes or reforms in the way that governance or the government missionary works, the human resource aspects. In the last four or five years we have changed the way that our appointment process works, our placement, the human resource management. In selection and appointment, in giving an assurance to civil servants that they will not be victimized for acts done in good faith and for public benefit, there have been sturdy and incremental moves towards bringing transparency into the system of governance.

We recognize that we must innovate, we must change, we must adapt to new things and we should be prepared to commit mistakes. So this government has tried that if somebody has committed a genuine mistake he or she should not

be penalized and that was a change brought about a year ago by the Parliament and a lot of efforts were made to achieve this.

Earlier, there was a feeling that particularly at the level of the Government of India for senior-rung assignments, it was important to lobby or approach intermediaries. In the last five or six years, however, this practice has been totally eliminated. But for the last five-six years that has been totally claimed, has been totally eliminated. Now, when an officer's name is sent for an appointment, he or she gets their appointment letter even before they know that their name is in consideration by the government. This is a major administrative reform and has the potential to contribute to the strengthening of the country, the economy and towards making it more inclusive.

Many ideas came up when presentations were made about agriculture, about water, about health and technology. There is no dearth of ideas, each one of us knows what should be done and what can be done. But the basic question arises as to why it actually does not happen on the ground.

Whichever service you belong to, or whichever field you are working in, it is worthwhile to ponder over why an individual or an organization is not able to achieve what they are capable of, to question as to why they are not able to perform to their full potential. This is a very basic question. And as civil servants, I think this is the question that we must try to address.

Many of you have worked at organizations before joining the civil service. You can say from your practical experience that very often it is difficult to implement the ideas, the techniques or the suggestions which we are aware of already. I would like to give two or three very practical examples which I have experienced. We'll talk about agriculture. I will give my personal experience on something relating to crop insurance. Agriculture is an area which is prone to risk, much more risk than the manufacturing and service sector. Crop insurance is one of the measures that have been suggested to cover the risk that farmers are exposed to. Towards this end, a comprehensive crop insurance scheme was introduced in the year 1985. Today, India has 30 million farmers, back then the number was naturally smaller. I had the opportunity to do some analytical work that was for my doctoral research between the years 1991 to 1994. In the year 1995, I brought out a research paper and also later on we listed out what are the problems and why it did not work. There were many problems. Sometimes, the area insured was not accurately reflected. Sometimes, the area insured shown was more than the geographical area and so there were many problems. Later on, I was posted in the Ministry of Agriculture and I came across a report by a committee formed in 2003-04. They

had listed out the problems that the scheme was afflicted with and I found that there was a lot of commonality between their suggestions and mine. Then, in the year 2012-13, the time that I was in Gujarat in the Electricity Regulatory Commission. The Government of India constituted a committee because there were a lot of problems in operating the crop insurance scheme, to examine the operational problems and recommend measures to improve it. We discussed with the ministries, visited may states, discussed with stakeholders for six months. Then, based on all of this analytical work, we listed out the problems. At least 80 percent of the issues were the same. So the point is that from 1995 to 2004-05 and on to 2013, decade after decade, the same problems persisted. When the report was being prepared, at some point I was chairing the committee, I felt very helpless and dejected. I could make an impressive report with grand layouts and some expert opinion thrown in for good measure. We began to look at what should be recommended and why things had not work for such a long time. There were many inherent problems like other insurance, the problem of moral hazard, work selection and so on. We realized that something had changed in the two decades since 1995. The people were the same, the land holdings had become smaller and technology had certainly developed. Today, as I attended one of your breakout sessions, they used a term called 'signal' and I felt it was a concept new to me. Technology makes the difference, all other things being the same. In 2012-13, space technology had developed. It was possible to view satellite imagery. Hand-held machines, android phones were expanding their reach. So, we felt when the crop cutting experiments are conducted, then the village-level workers must record videos and upload them live. Some of the states adopted this practice. The point that I'm trying to make is that technology is something that you must keep yourselves abreast of. The other realization, which from experience I can share with you is that attitude matters a lot when you interact with the public, with other stakeholders, and this is true regardless of the Service to which you belong.

About two years ago, two and a half years ago when I was already in the Prime Minister's Office, a friend and colleague asked me to record my experiences of three decades and publish a book. Initially, I thought that I would not have the time. He persisted and when I finally got down to writing, I felt it would not do to simply record my memories. Many bureaucrats pen down their experiences and record their successes. Hardly anyone says, "This is where I failed."

I thought I would form a hypothesis on how Gujarat is one of the more developed states of the country. It moved forward very fast in the seventies,

eighties in the sphere of industrial development compared to many other states. What distinguished Gujarat and how could it move faster than the other states? In order to address this, I wrote an article about people, politicians and bureaucrats and the dynamics of development administration in Gujarat. The idea was to examine how there is an interplay between these different stakeholders and with how they orient their actions with respect to growth and development towards the people.

One aspect through which Gujarat is different from other states is the people's awareness and proactive participation. Second, the role of voluntary organizations and the third of course, the relationship between people, political leadership and the bureaucrats. I listed out an example from when I joined the Subdivision in Gujarat. It was a place called Tharad, close to the Pakistan border and a desert area. At the time, there would not be electricity for as long as a week and the water was saline. It was a drought year and there used to be a committee to sanction drought relief. The local political people used to be members and I was the chairman of that committee and I was just two years old in the Service. The *Tehsildar* was a middle-aged man in his 50s and in the meetings he would lose his temper quickly and then people would start shouting and I would find it very, very difficult how to control such officers and such situations. Over the years, however, one learns. So, in this book, I've described my failures and also an incident from when Ii was the District Development Officer in Kutch. Very often, bureaucrats talk about political pressure and interference and on the other hand politicians say that bureaucrats are very rigid, very lethargic, rule-bound and resistant to change, but in practice it is possible to harmonize this relationship and if it can be harmonized then development can be much faster. It is important to learn how to handle divergent views and perceptions in practice.

There can be three types of relationships between bureaucrats and politicians. In some cases, there is a clash and the conflict will result in no output despite the best technological aids being available. There can be collusion or a politician-bureaucrat nexus which is open to public criticism. The third kind of relationship is one of harmony, that of a constructive approach. In my book, I have cited empirical evidence to show that in Gujarat it was the third harmonious aspect in bureaucrat-politician interaction that was predominant and this could be a reason for Gujarat faring better than the other states in terms of development. It is not only the relationship between bureaucrat and politicians. It is also the relationship among bureaucrats themselves and also the relationships among politicians. Similarly, individually each one of us may

be very competent but that personal relationship, personal ego often matters; departments work in silos, so there again your own attitude is extremely important. With the right approach and attitude it is possible to harmonize divergent views and resolve various conflicting situations. In the ultimate analysis it is the larger objective of economic development of the country and also welfare of the people which matters. So far I have said that we need to know technology, we need to know processes but ultimately two issues which are important are how you approach matters and with what kind of attitude.

Whether you are amenable to change, whether you look to the future as you should and also the inter-relationship between yourself and other stakeholders are the things that matter. A responsive government is possible only with all of you who are at the cutting edge, work with transparency and empathy. Government should be seen as an entity someone can go to rather than something that inspires fear. The distance between government and citizens need to be bridged and only then the goal of minimum government and maximum governance can be realized. It is very important to bridge the gap between government and the citizens. Of course, we talk about effective delivery of government and public services. It is possible when we keep pace with technology. As you must have heard the direct benefit transfer is extremely important and in India we have introduced the *Jan Dhan* Scheme which means that every person should have an account, *Aadhar* card and of course a mobile phone and this can be the single most major for common man. We should work on identifying all the services that can be delivered through faceless means. Some of you are in the revenue service and all of us know that income tax issues are very complicated sometimes, very difficult and much criticized. Should we not have a faceless system of working? Human intervention should be an exception rather than the norm as of now. Whichever service you belong to, it is important to continually hone your skills as the effectiveness of government functioning is completely dependent on the quality of human resource. The quality of human resource means the type of people, appropriate person for appropriate place and also their attitude, their skill both in terms of mindset and technological orientation. Each problem confronting us today needs integrated solutions. You can add value only if you keep yourself abreast with the latest happenings in your sphere of work.

Be intellectually alive, be like an sponge that continuously absorbs new learning, irrespective of the source that it comes from. Looking at the larger picture and overall perspective is extremely important and of course as I mentioned you have to look at all stakeholders whether people, citizens and

other departments, other ministries and also the political leadership, particularly in a democratic scenario, so many people are to be involved. Finally, I would like to give an example that was given by Peter Drucker. If I remember correctly, he said that a church or temple was being constructed and there were stone cutters. Of these, there were three stone cutters who were cutting stones to build the structure and they were very good in their own work. The same question was asked of the three of them. The question was, "what are you doing?" The first stone cutter said "I'm doing my job very sincerely because I have been paid for this. I'm very punctual; I come and do my work. Don't do any other work." The second one replied, "I'm trying to do the best possible work of stone cutting which will be the best among all others." The third stone cutter said, "I'm building the temple or church." So this was the attitude. The first one is working sincerely, working well but he feels because he's doing a job, he is a paid for it, he is doing his work. His concern is with his own work. The second one, of course, is an expert in that, he's also very competent, very maybe technologically savvy and skilled but he is looking at himself. He is not worried what happens to the whole structure. The third one understand the overall system, the larger perspective and he is building an organization in the form of a structure. So any organization we have, we can have these three types of people and I feel confident that all of you will be like the third stone cutter and try to see the overall perspective and build not only your own organization but build a new India. An India which is not an only $5 trillion but $ 10 trillion economy which is inclusive, which is harmonious and which will be a global model for other countries to follow.

Preparing the Civil Services for a New India

Rajiv Gauba

Today I wish to speak to you about the Civil Services and a New India that this great country dreams of.

Four months before India attained Independence, Sardar Vallabhbhai Patel, the first Home Minister of the country and the great architect of political integration of the nation, spoke to the Civil Service officers at Metcalfe House, Delhi, encapsulating the vision of a civil service for independent India and laying the foundation for '*Surajya'* or good governance.

Sardar Patel said: "Your predecessors were brought up in the traditions in which they … kept themselves aloof from the common run of the people. It will be your bounden duty to treat the common men in India as your own." This statement is relevant even today, as we embark on the path of realizing the vision of a new India. Today we have the collective responsibility of realizing the dream of a NEW INDIA.

The country is going through momentous changes. The expectations of the people are very high. There is impatience and cynicism about governments or government servants' ability or even some times their intent. Hence the ability and the desire to deliver is absolutely essential. If you just maintain the status quo, the country will get left behind. You must, therefore, not waste this opportunity and do your best proactively to be agents of positive change.

The challenges are many. In agriculture, which is still the backbone of our economy, we have to deal with the vagaries of nature, and empower the farmers and the agricultural community. Similarly, we must provide decent homes to every person in the country. Also, in today's age of globalization and technological change, appropriate high quality skilling is a must to increase the efficiency and quality of our manpower, to improve productivity, to generate employment and for overall economic growth. There are several states in our country, for example, Jharkhand, the cadre to which I belong and Chhattisgarh etc., that are blessed with enormous mineral wealth. The

richness and the range of mineral wealth is stupendous. They are however, yet to realize their full potential. The North Eastern states of our country likewise have immense hydroelectric potential. There are many areas of the country which have amazing tourism potential. Yet the number of tourists that we get as the entire country is about the same as the city of Barcelona alone does. So you can imagine how much distance we have to travel!

India is seen as a major economic powerhouse of the world. The picture is both fascinating and complex. Our economic reforms have provided the country with a base for a more robust growth in the long-term. However, how we capitalize on the opportunities is up to us. Each one of you will have a tremendous opportunity of shaping the future of our society and our country. Individually and collectively you can make a huge difference. There is no system of Government anywhere in the world other than in India, which provides such an opportunity and career for civil servants such as you, to start serving the nation at such a young age and with a very rapid and almost automatic career progression. As I said earlier, initially you are going to be at the cutting edge. The working of each of your departments and organizations impacts the everyday lives of ordinary citizens, of businessmen, of entrepreneurs, of tourists, of foreigners, of people who can bring investments, of people who can create wealth and create jobs. One of the central themes of this module at Kevadia is the $5 trillion dollar economy which India is aspiring to be. This is not just a national-level objective requiring policy level changes or interventions at the Central government level. Even at the cutting edge, officers have a role to play in this. Every state, every district, every sector will need to contribute to this endeavor.

So then it makes one wonder - How do we make all of this happen?

The pace of change witnessed in this century has perhaps been the highest that mankind has ever seen. New technologies have emerged. Coupled with this, the rising expectations of an aware and vocal citizenry have made the delivery of public services more challenging. However, the problem which we all face today is the disconnect between the public expectations and the capacity of the government systems to deliver. Inherent is also the issue of capacity constraints within the government to manage the demographic and technological changes which are taking place. We need to learn to adapt to these changes much faster. In fact, we need to anticipate future trends and changes and gear ourselves to respond to these changes, rather than reacting to them in an ad hoc fashion. You must be aware, that no worthwhile initiative

can show an impact in the short term. This needs to be done on a constant, continuous and consistent basis.

Why do some countries prosper and some others don't. I will refer you to a book which I read some years ago 'Why Nations Fail - The Origins of Power, Prosperity and Poverty' written by two authors: one Turkish American economist Daron Acemoglu of MIT and a British political scientist James A. Robinson. They have very painstakingly established that what matters is institutions, policies and governance. These are the factors that make the difference between nations that fail and nations that prosper. They have debunked all other notions that it is geography which is important or history that is important or race that is important, etc. The most telling example cited in the book is the difference between South Korea and North Korea; the same people, the same race, the same culture and history and the same geography but divided by the 38th parallel and absolutely different trajectories that they have undertaken.

We are perhaps the youngest amongst the major countries in the world with a median age of around 29. It's a demographic dividend much talked about but it can also turn out to be a potential time bomb if we do not provide enough job opportunities to our youth. We will also soon be the most populous country in the world over taking China. Added to that is our very rapid urbanization. For this, we need our economy to grow at 8 to 10 percent for many years to come now. This means creating the right sets of conditions for investment and making our cities more livable because it's a borderless world today. We must all remember that capital can today flow in and out at the click of a mouse and people who make investment decisions, the ones who run the knowledge economy, the innovators, have hundreds of destinations to choose from. We want to make India an attractive place to do business, to come and work and live, of course. For this to happen, we need the right set of physical policies and monetary policies. We also need ease of doing business and ease of living. We have to provide safe cities for people to live and work in.

As heads of offices and organisations, what's important for you is that you have to bring about a change in the attitude and approach and orientation of our officers at the cutting edge. Because when people come to our country to live, for business or for tourism, the first and most impactful experience that they have is with the cutting edge of the administration that is with the beat constable or with the traffic constable or an income tax officer who is doing the assessment or a *Tehsildar*. How quickly these people respond and how pleasant is the interaction or how helpful or unhelpful they were - these

experiences often leave a lasting impression on people. So, as leaders in your departments, you can make a huge difference by setting an example and by motivating your team and by making your colleagues aware that they have an important role to play in building India's success story. You have to make them aware of their importance in the scheme of things.

Our laws give very vast powers to officers at the cutting edge. The Criminal Procedure Code (CrPC) for example, which was framed by the British, gives more powers to the policemen in India than what the policemen have in the United Kingdom. Similarly, tax men have the power to issue notices at random. These are the things that create a huge backlash and disincentivise people. They also create huge potential for harassment and rent seeking. So, powers in the field must be used with discretion, with care and with thoughtfulness. This is where you all have a very important role to play. Till the end of August, I was working in the Home Ministry and when we used to interact with officers of the Indian Police Service, they would express their concern about the image of the police, that the image is not something to write home about. But this is not something which is unique to police. It is a problem which applies to the entire administrative apparatus in the country. You must first acknowledge this and you must also admit that this perception has at least something to do with the reality. Many of us commit the mistake of going into a denial mode.

How do we address this problem? The problem is not that we are not hard working. The problem is not that we are not putting in long hours, we in fact, forego holidays. The problem is the mismatch between rising public expectations and the capacity of our system to deliver according to expectations.

Again, I will mention in this regard a book by Gurcharan Das which I came across; the title of which captures the whole problem: 'India Grows at Night' (or when the government sleeps). What does the title convey? The book is about sectors of the Indian economy which have registered very robust growth areas where government regulation was absent. So in other words, government machinery is seen not as a facilitator of growth but as an impediment. But we have to change that perception. If as a system, we fail to meet the expectations, then however hardworking we may be, it does not matter to the people because for them what matters is the delivery. So what do we need to do? One is the change in attitude which I just talked about - the approach of the administration. The second is using technology. Technology can be a big factor. And we should fully leverage it. It is being leveraged in

many sectors that have seen outstanding successes in the recent years but is still not fully leveraged. The way we can today apply for and get a passport and an E-visa is a commendable case in point. We are one of those countries in the world which provides E-visas to people travelling from more than 160 countries. It's one of the easiest and simplest visa systems in the world. Filing Tax returns and getting refunds is becoming extremely easy. Those of you who are in the police, will come across the CCTNS system which is fully implemented and taken to its logical conclusion by connecting the jail administration, the police and the courts. This can be a game changer for the criminal justice system with interconnected databases. The system can get the investigating officer an instantaneous 360 degree view about crime and criminals.

I will reiterate that for your generation, it is important to not remain content with doing your work on time and achieving targets. That is the bare minimum. You must endeavor to identify what needs to be improved, in terms of systems, in terms of processes, policies and in terms of simplifying things. You must identify where there is a scope for the application of technology. And you must challenge the basic assumptions. You must question: Why does so much information need to be supplied? Why should a licence have to be renewed every year? Why won't self-certification do? Why shouldn't there be deemed approval for things beyond a certain period of time? How we can reduce the burden on citizens and learn to trust them more?

Let us all realize that there has been a fundamental shift in the way governance is understood and undertaken now. The success of governance is today increasingly determined by desired outcomes and the speed with which these outcomes are realized. The success we realized in enhancing India's ranking in the 'Ease of doing Business' parameter globally is a shining example of how rapidly we can transform our laws, our policies, our systems, if we have the will. India has jumped in a matter of a few years from the 142nd position among countries to the 63rd position globally. This is the highest improvement by any large country in recent years and has been made possible by meticulously studying the problems in each of the parameters ranging from insolvency and bankruptcy laws, to customs clearances, to building permits. It required detailed planning and very meticulous execution across several ministries and across States. The Government e-marketing platform, GeM, which the Commerce Ministry runs, has been another big success story of huge savings in government procurement and transparent procurement.

In recent years, a number of other seemingly simple interventions have brought about far reaching changes and made life easier and simpler for

people and have reduced the scope for corruption. A few examples of simplification include the discontinuation of interview for Group 'B' and 'C' posts in Government / PSUs, self-attestation of documents and doing away with affidavits and the repeal of about 1824 redundant and obsolete laws, to name but a few.

I would like to make two more points before I conclude. One, government cannot do everything and perhaps should not do everything. There is a need to involve the citizenry even more-involve the community and the private sector and use their strength in the process of growth and development. We also need to be more open to working with and getting experts from outside to come and work with us. There is no need to feel threatened by them.

Secondly, teamwork is very important. We are often excellent as individual officers but unable to work effectively in teams. You cannot really achieve the objectives of the Government or the objectives of public policy by being individually brilliant and not working as a team. We have seen the success of the *Swachh Bharat* mission for example and I, as Urban Development Secretary, had travelled to many states, many cities, and it was absolutely fantastic to see the transformation brought about by young officers by motivating their entire team and by involving the citizens.

In conclusion, to reiterate, in less than three years from now, we will be celebrating 75 years of India's Independence. The Government has set many ambitious goals. Every person is to be provided with a house of his or her own; piped water supply has to be provided to all; the *Ayushman Bharat* scheme is providing healthcare insurance to over ten crore poor and vulnerable families. Insurance ceiling has been raised to Rs.5 lakhs per family for secondary and tertiary care hospitalization. There is an Aspirational Districts Programme under which 115 districts in the country which are lagging behind the national average have to be brought up to the level of the national average in health, education and other important parameters. These are, just a few of the flagship programmes of the Government that we, as civil servants, are expected to deliver in right earnest. Many of you, right in the beginning, will have an important role to play in implementing these programs in your sub-divisions and districts. I am sure that armed with the right perspective and equipped with the right approach and spirit, you all will be the architects in ushering in the dawn of a New India.

I wish all of you great success in your careers, in your future endeavours.

Strengthening Indian Civil Service towards Efficient Service Delivery

David Malpass

I know that many of you have recently started your career in the civil service. I want to begin by congratulating you on this important milestone in your lives. I know you put in many hours of hard work and study to reach this point. The future of the Indian government's policymaking depends on the talent and ingenuity of women and men like you.

It's a great pleasure to be here today in the State of Gujarat. As I was thinking of what to say today, you will not be surprised that I wanted to start with Mahatma Gandhi.

Early in Gandhi's life, few would have imagined that he would go on to become the Mahatma. He was a shy boy who wasn't especially good in school. As a law student, he struggled to adjust to life in London. Yet he would go on to become the leader of India's push for independence and much more. In your career, you'll likely face many twists and turns, but if you stay true to your principles and goals, you won't lose your way.

Gandhi's vision of peace, tolerance and modesty remains an inspiration to the world. It's a fitting vision to keep in mind as India aims even higher. It's one of the most diverse countries on Earth, and the biggest democracy by far. Indian creativity has pushed forward human understanding in too many fields to list.

India has been a development success story. This country cut extreme poverty in half within a generation, and is transforming itself into one of the world's fast-growing standouts. The goal of becoming a $5 trillion economy by 2025 is both worthy, and achievable with strong economic reforms.

Achieving fast growth won't be easy. India's growth slowed last year for the second consecutive year. Data suggest the slowdown deepened in the first quarter, amid weak consumption and slowing investment. And while India's poverty-reduction record has been remarkable, poverty remains a challenge. Roughly half the population lives on less than $3.20 per day, and India remains home to more than 176 million people living in extreme poverty.

Making India's economic hopes a reality will require patience, persistence, and lots of energy from you and your colleagues. To lead the country into the

ranks of upper middle-income nations, you will need to seek new engines of growth that are sustainable, with opportunity and prosperity shared across the diversity of Indian society.

The World Bank Group is committed to working with India to put in place well-designed reforms that help India in its development journey and enable broad-based growth. I'd like to lay out a few of the reforms that we think would be helpful.

Reforming the Civil Service

I'll start with you: the civil service! The World Bank has many years of experience advising countries on how to make civil services as effective as possible. The Indian Civil Service employs some of the most talented people in this country. It played a leading role in the nation's poverty-reduction efforts, by implementing policies that improved the livelihoods of millions of people. Over a million people take the Civil Services Exam every year, and only about 0.2 percent are selected. So those of you who recently joined the civil service have reason to be proud.

Yet to stay in the forefront, India's civil service needs to shift from a focus on enforcing compliance and meeting minimum requirements of service delivery to finding ways to ensure high-quality services and regulation. You need to build the institutional capacity to deliver broad-based growth and a thriving private sector. You will need skills in communications and negotiations, and to work across units and ministerial boundaries to address the complex challenges that you will face in your careers. Partnerships with the private sector and community organizations will be important for effective service delivery.

Last week we released our annual Doing Business report, which measures ease of doing business. For the third year in a row, India was one of the top 10 reformers, in part due to regulatory changes to improve civil service delivery. Red tape was eliminated in many areas, including in starting a business, getting permits, and simplifying some trade and customs procedures.

India also took important steps to improve bankruptcy and insolvency laws and proceedings. You have a role to play by working to make resolution of disputes faster and more efficient. Establishing specialized commercial courts at the district court level to fast-track commercial dispute resolution would also facilitate the Ease of Doing Business in your highly entrepreneurial country.

The government has also proposed many bold, innovative measures. One of them is *Aadhar*, the nation's system for assigning unique ID numbers to individuals based on biometric data. The system has enabled government benefits to be transferred directly to individuals, which has especially

benefitted the poor and vulnerable. The system has reduced corruption, creating substantial savings for the government.

Still, social protection initiatives are fragmented across roughly 500 schemes separately administered at the federal, state and local levels. Attaining India's economic ambitions will require a more responsive, efficient and effective public sector. Prime Minister Modi has stressed the importance of people working cooperatively across cadres, for "One India." It's a goal we at the World Bank Group support.

To strengthen the public sector, the civil service will need the proper resources and training to provide sound regulation and improve service delivery. There needs to be a stronger compact among tiers of government on issues such as quality assurance, especially given that most public services are managed at the sub-national level. And the civil service needs to embrace the idea that the private sector is an essential partner in boosting economic growth.

Along the way, it's important that India invest in the capability of its states to lead and deliver development. The share of government spending by states has increased from 45 percent to more than 60 percent in the last eight years.

Municipal governance is also taking on greater importance as India urbanizes. India's growth will depend on the productivity and livability of its cities. Still, cities can't be governed from the top down. Municipal governments need the capability to raise their own financing, tap into capital markets, respond to the needs of their diverse citizens, and be accountable to them. As federalism continues to take root, it's important to further strengthen cities and communities.

How can we do that? By enabling grassroot participation in the government process: engage youth, women, civil society and all beneficiaries in governance.

I discussed with both PM Modi and Finance Minister Sitharaman the importance of data and good statistics. How can good decisions be made if the data isn't right or isn't there? In India, there is a need to strengthen the quality of statistics and do more to link data sources. You play a key role: it's the data that you provide about your respective units that's the first step in the data collection process.

At the World Bank Group, we're ready to work with you on these important issues. I'm confident that India's civil service can rise to the challenge.

Fostering Broad-based Growth

In addition to reforming the civil service, India needs to address a number of challenges that are key to its economic prosperity.

One of them is agriculture and rural development. True, the nation's farm sector has done remarkably well over the past six decades, helping the country transition from highly food insecure to a net food exporter. India now produces food for nearly twenty percent of the world's population-on less than eight percent of the world's arable land.

Relative to the rest of the economy, however, agriculture needs a boost. The government's strategy depends on a dramatic increase in farmers' incomes. That will require a reset of policies and institutions established in the 1960s and 1970s. Their aim was to ensure food security, but policies need to be realigned to allow agriculture to become more productive, resilient, and sustainable. For example, in states like Punjab and Rajasthan, free electricity and other subsidies for wheat and rice lead to inefficient cropping patterns and depletion of groundwater.

More needs to be done to strengthen property registration, such as by digitizing land titling so that data is accessible throughout the country, and buying and selling of land becomes easier.

The private sector has a crucial place in development. India needs to build an environment where private companies of all sizes can grow and be part of global supply chains. Many Indian firms start small but don't scale up as hoped.

To unleash the productivity of small and medium-sized enterprises, India needs to rethink its regulatory, land, and labor policies. It's important to build a policy and regulatory framework that supports the growth of private companies.

Access to finance is an additional challenge. I spoke about financial sector reform in the *NITI Aayog* lecture Saturday. Reform is vital in driving a dynamic economy. I won't repeat the points here, but suffice to say that improvements in the functioning of the real economy need to be matched by reforms in the financial sector.

I've mentioned the phrase "broad-based growth." It's important that, as India sets its sights on becoming a $5 trillion economy, the gains from its rise are widely shared throughout the economy. I congratulate Prime Minister Modi's efforts to ensure nutrition programs, health coverage, housing for all, sanitation, and financial inclusion for households.

Fully including girls and women in the economy and a safe society is essential to boosting broad-based growth and achieving strong country outcomes.

The revolution of women's self-help groups in India is part of South Asia's story of women's empowerment. In India, 80 million women, organized into

self-help groups, have leveraged nearly $40 billion from microfinance institutions and commercial banks in the past decade.

The *JEEVIKA* programme in Bihar has mobilized more than 7 million rural women into self-help groups, which provide access to finance and markets to start and expand their businesses.

At the same time, India faces a dramatic decline in women's labor force participation. Part of the challenge is the availability of suitable jobs-ones that are flexible, linked to childcare, closer to home, and where transport services offer safety and security.

One solution is to broaden the revolution of self-help groups, so they expand the ranks of women entrepreneurs. Some other solutions include providing women with the skills that match available jobs and facilitating access to credit.

There are many other innovations to explore. I'm pleased to say the World Bank Group is looking into the floating of Women's Livelihood Bonds, linking capital markets to women entrepreneurs through financial intermediaries.

At the same time, India will need to significantly upgrade the reach, quality, timeliness and efficiency of its investments in human capital. India has been successful in increasing access to school education and is focusing more on the quality of education.

Under Prime Minister Modi's leadership, India is developing an architecture to support the training of India's workforce. This is important, because school education isn't always geared to preparing young people for a dynamic labor market.

India is linking schooling and markets, and the innovation is garnering global attention. Many African countries want to partner with India's "skilling" framework. As civil servants, your engagement in skilling innovation will be essential for India's economic transformation.

Technology is another key to development. With 1 billion mobile-phone users, fast-growing digital platforms and a tech-savvy population, digital innovation has the potential to accelerate India's rise. The World Bank Group will continue to support smart applications of technology throughout the Indian economy, including in systems to modernize farm production.

The IFC, the private-sector arm of the World Bank Group, has invested in companies including Power 2 SME, a digital platform for small manufacturers to access raw materials; and Blackbuck, an online marketplace that helps small fleet owners find and bid for shipping jobs from large users of transport. We will continue to leverage our investments to help create a vibrant technology ecosystem in India.

You can also play a leading role in making India's public-sector footprint more effective. As you know, state-owned enterprises play a central role in the delivery of electricity, water, and transport, which will be key to India's faster growth. There's considerable scope for improvements in many enterprises, and your innovations in this area will be important in India's economic and social progress. Creation of viable utilities and municipal structures will enable the magnitude of financing from capital markets needed to achieve services at scale.

Other countries that have been successful in realizing the potential of effective state-owned enterprises have found the right balance between the public and private sectors. This means being a good regulator while finding the right role for government.

Reaching Higher

In closing, as you embark on this exciting journey to serve this great country, I want to leave you with a few thoughts:

As civil servants, you have a dual responsibility of both compliance and service delivery.

In your day to day work, you have the power to facilitate efficient, fair and high-quality services to all Indians. While paying due attention to oversight, you should keep in mind the ultimate goal of delivering impactful services for all.

As you grow in your careers, be proactive in thinking about how to build a system for incentivising performance, a system with clear accountability, a system that rewards success.

Mahatma Gandhi likened public service to being a trustee of public resources. As civil servants, you are uniquely positioned to play a role in lifting more than 170 million out of poverty into prosperity. The people of India have high expectations of you. It's important to live up to that responsibility.

India is a vibrant democracy, a gifted technological power and an emerging global player. The competency of its civil service systems and the robustness of its institutions will be important factors in determining India's future.

As you build an even stronger India, we at the World Bank Group stand ready to help.

I wish you all the success in your careers.

Of Changing Contexts and a Threshold

Santosh Matthew

I'm going to talk to you about today and tomorrow. It was exactly 34 years ago in the month of August that I was, like you, joining the Foundation Course at Mussoorie. I also had the privilege in 1996, 23 years ago, to be the Course Coordinator of the sixty-second Foundation Course, but I have never seen anything like this before, I have never seen a Foundation Course organized with such rigor and with such shock and awe. I think you are privileged, you are privileged to go through this experience. Just look at it, at one of the largest iconic statues in the world. Built by the civil service, you heard the history of Sardar Patel and his contribution and how he was the maker of India's civil services. You are going to be exposed to the best experts in the world-President of the World Bank, the European Bank for Reconstruction and Development, the very best of global experts.

But today and tomorrow is different. We are going to change tack, while it has been a little formal, you will really enjoy today and tomorrow if you relax a bit, be a little more active and be aggressive in your questioning. What we are going to do today and tomorrow is about technologies and it's about the future. We have speakers, two experts in the form of Professor Vivek Wadhva and a lawyer Nishit Desai, who will be speaking to you today. And you have Singularity University, one of the foremost institutions in analyzing the future. They have been articulating a vision about technology, abundance and particularly exponential technologies.

And then tomorrow you will have the experience of using toolkits that have been developed by the Institute for the Future which will help you pick up signals and use those signals to be able to prepare for what's forthcoming. So, you'll really enjoy the sessions when you become aggressive in your questioning and in your listening and let me tell you why? They are going to try and dazzle you with the excitement of new technologies, they are going to try and tell you that quantum computing is going to change the world completely. They will tell you the mobile phone in your hand is more powerful

than the supercomputer of 1980s. They are going to tell you that the marginal cost of clean energy is going to go down to zero, they are going to tell you the consequences of robotics, the consequences of autonomous cars and it's going to be exciting but what do you have to do as a civil servant listening to this? A. don't get carried away by the excitement of what they are going to tell you but question yourself, ask the question to yourself, what is there in this for India, our country, in these technologies and these frame works. And B. what is the role of the sovereign? What is the role of the civil service in advising the sovereign so that the benefits of this are actually available to us and to our society. And in this I will urge you to actually think of this in a framework which looks at both government failure and market failure. You all just finished your civil services exams and therefore you will understand when I tell you about the two fundamental theorems of welfare economics.

Basically the point is that markets work well with the most efficient resource allocation and then get you closest to competitive equilibrium when they work well and what are those conditions-when there is perfect information, when there is no monopoly, when transaction costs are close to zero. Why do I say this? What are these new technologies actually going to do for you? They will reduce transaction costs. They are going to remove information asymmetry; they are going to make entry and exit easy. Therefore, the role of the market, as the president of the world bank told you yesterday, is something that we have to be very conscious of but also recognize that the rational for the existence of government is A. because market fails and B. the optimality that markets may be able to give you is perhaps not always socially desirable. That's the burden that you need to carry, that's the perspective, that's the lens with which you need to view today and tomorrow and I urge you to do that. Anything that comes on to the world whether it's nuclear energy or quantum computing, can be a force for good or it can be a force for evil. On behalf of society you therefore have to look at the regulatory frame works. That actually makes this harvestable for society's good.

The second perspective that I will urge you to think of and to keep in mind is that how can you harness the power of these frame works, toolkits and technologies for improved service delivery. Over sixty percent of you are engineers, some of you are economists, many of you are experts in artificial intelligence. I'm told over fifty of are you from IITs and look at the kind of people recruited by the top corporations of the world. Google, Microsoft, Infosys. you are no less smart than them. Perhaps you are even smarter. Some of you may have actually come back from some of these jobs. So if you are as

smart and smarter than them you need to ask the question why is the citizen experience that we deliver not as good as what some of these corporations are able to deliver. Can you harness the power of these technologies? Put in place institutional structures that make the state of tomorrow. Meet the aspirations like the Cabinet Secretary had told us, meet the increasing aspirations of India's people. I believe you are in a momentous place in India's history. We can dramatically reduce poverty, being a dramatically young country. We have integration like we had never before. You particularly are entering the civil service at a time which is almost like a new epoch in the history of India. Seize it, grab these challenges.

I wish you all the best.

Civil Service Reforms

A Panel Discussion

Dr. Sanjeev Chopra. Good morning friends. We come to a subject that is very close to our hearts, or at least should be close to our hearts, because that's about civil service reform. We'll talk about whether the civil service should reform itself, whether civil servants should believe in reform, and how reform will take place in the civil services. This would be a very interesting concept. And I have a very distinguished panel here. All three of the members have had a very distinguished career in the civil service and therefore they know about the State. They know about the expectations that the political leadership has from the state, and also the expectations that the public has from the civil service. So what we'll do is we will first be inviting all our distinguished panelists to make an opening statement, after which we will engage in a conversation with the panelists and then we'll throw the floor open for discussions. Without much ado, may I invite Sir Suma Chakrabarti to make his opening comments.

Suma Chakrabarti. Thank you very much, and Happy Diwali, everyone. It's very good to be here on stage. Very good to be here and introduced by a member of the Bengal Cadre, as a fellow Bengali. It's very nice to see that and one interesting observation at the beginning. You have three of us here, all of whom have Indian roots, and I tried to find out whether Sanjeev and his colleagues have chosen us with that criterion in mind. I'm assured it was completely accidental, but it's quite interesting in itself. Look, my story really is about the UK Civil Service and what I would call reform to remain relevant and the reforms in UK. I think there were two major changes in government in the last 40 years. In 1979, Margaret Thatcher came to power with a real manifesto of change, really moving from the state to much more private sector focused development of the country, and in 1997 after 18 years of being out of power, the Labour government of Tony Blair came to power.

And the government were under pressure, because the Tories towards the end of the mandate seemed to have failed on health and education and on public transport, and that was what they got elected on. Move on to about 1998 and Tony Blair, I remember the famous speech when he spoke of what he had

found about the civil service, and he called it scars on his back. Basically, he made the point that the civil service was preventing change, preventing real change in the country. And at that point, it was a eureka moment, if you like, for me and my colleagues, we realized we really had to come up with a reform process and engagement with the government that would help deliver what the government wanted, because otherwise, there was a threat that he could bring in the private sector and other people to do our jobs and would be happy to do so if we didn't deliver. So I give you three case studies of that change in which I was intimately involved and three case studies, which I think are quite relevant for India at the current stage.

The first was really focused on results. This was coming in because of the emphasis on the need to improve public services in the UK at the time. The mandate of the government was and it had got elected by saying that it would reverse the degradation in public services in the UK and I was asked to lead some work on this and I came up with the idea of public service agreements. These essentially had targets for each of the great public services. So you can imagine in the area of the health service in the UK, the time taken before operations, the time you had to wait after an accident in emergency war rooms, in the education sector with respect to literacy, numeracy targets and in public transport with respect to the timeliness of trains and so on. And we came up with these targets. We then made them link to budgets. This was the first time ever that budgets had been linked to outcomes in the UK and we went further than this. We wanted to really push accountability, which was difficult actually, for politicians as much as for civil servants. So first of all we looked at internal accountability-the Prime Minister, and I think it has to be the Prime Minister. He used to engage with every single department's minister and the seniors amongst civil servants to actually cross check on performance, to chase progress, to ask why were things off track, and what was required to bring them back on track. That was the internal accountability. But I also pushed the prime minister and he agreed to make external accountability, whereby parliamentary committees would then question the relevant state department and its senior management and actually scrutinize the performance of each department against these targets and that became made it much more public in a way.

It is really quite difficult stuff in terms of changing the role of ministers and the role of civil servants. But at the same time, maintaining that distinction that civil servants in the UK are neutral in serving the government of the day and yet make this something that helps the government deliver its agenda is

important. I think three really good lessons came out of this, first of all, building a unity of purpose between the civil service and the government of the day, and actually showing that we were on their side trying to actually help them deliver their agenda. Secondly, accountability improved, and without a doubt, it was painful, because sometimes failures were much more magnified in the press and the media. But it meant there was much better, healthier debate as well, about why things weren't working and why things were working as well. And I think the third thing is that it moved us to a much more holistic government approach. For many of these public services, you couldn't really do this department by department, you required actually to work across the government.

And that takes me to my second case study, which is about the need more often than not to take a system-wide view. I became Permanent Secretary of the Ministry of Justice in late 2007. Under the Ministry of Justice, it had just been created, we had the courts, the tribunals, the prisons, probation services, relationship with the judiciary, but the police were under another ministry-the Home Ministry. Prosecution Service was elsewhere too. And there was the Attorney General's office. And I'm not sure that as a system we would have come together, had it again, not been for crisis. We had a crisis that our jails were full. We had double the prison population because of a tough sentencing policy, over 10 years, and we had simply run out of jails and cells in jails. I even had a marker board outside my office. Every morning, my staff would put on it how many people were in jail that day and how many were in police cells and court cells, it was an embarrassment.

Normally, you would try and build your way out of this crisis by building more prison capacity. That was impossible. That was after the financial crisis austerity in the UK. So we didn't have money to spend on new prisons. So we had to look at how to reduce demand and how to reduce cost. This forced the various services I mentioned earlier to come together to try and design a different sentencing policy that would reduce the inflow. We would also look at how we could cut re-offending by actually bringing the not-for-profit sector into it. So they would actually be paid if they could keep people out of jail and not re-offending for two years. This is a strongly payment-by-results scheme, which has now been adopted by a number of other countries as well. We also looked at things that the British system would never have thought of looking at. We looked at the Japanese car industry and how it adopted lean measures and we took to this to simplify processes in our courts service and to reduce cost as well. It has turned out to be quite a successful reform process. But I

think there were some lessons that came out of that as well. I think, fundamentally, this would not have worked without a crisis forcing us. And we know, we need to find ways of actually doing these sort of cross-departmental service-wide changes without having to have a crisis.

Secondly, we learned the importance of joint scorecards, joint metrics that will make service delivery people centric. It will make people and policy care about the same things and be held accountable for the same things. And thirdly, we learned about the importance of focusing on the citizen's experience, the cumulative citizen experiences, you know, the policeman on the street, or the railways or the health service. So the importance of actually understanding what the citizen really values became very fundamental to this exercise.

My last case study and I'll be brief on this is about going beyond the state. In the UK, we had these big privatisations in the 80s and 90s. But I think the real mindset change was when we started allowing the non-state private sector into helping deliver part of our public services, in education, in health, in public transport and elsewhere as well. And we learned a lot, because if you remember, most civil servants, people like me, you know, we have never really engaged the private sector except when we sell our house or our car. That's about as much as we've done ever in our lives personally. Well, now we have to really engage the private sector. In my case, I was selling a social housing loan book, I was then selling the London dome, Millennium Dome. I became an estate agent for a while. And the whole question of getting in right advice, right expertise from the private sector to advise you on how to handle the private sector became very, very important as well and that has led I think, to significantly improve performance and the UK civil service.

I think there's one other question around this, which people often ask me, which is would you have the private sector come in and do more of the senior jobs. I'm quite allergic to that actually, I think the private sector tends to be very good when they come into the public sector in doing very specific, very professionalized parts. So things like procurement, finance functions, and so on, delivery of mass services, those sort of things, they are pretty good at policy work, working with ministers. Working with ambiguity is something that many private sector people find quite difficult to get used to, I think, because they expect much straighter lines of accountability, as well. But I think the key thing in the lessons on this is to get real expertise to advise you in building these partnerships with the private sector. And secondly, I think, is to have a very open mindset about how you go about this. The state is not always the right answer, or the state needs to understand what is the right answer. So

you need to do good analytics in order to take this sort of work forward. I'll stop there Sanjeev.

Dr. Sanjeev Chopra. Thank you so much. I think this has raised some very, very pertinent questions which we will carry forth in our discussion, the most important being whether the Civil Services will reform itself without a crisis, or do we need a crisis before we can reform ourselves? May I now request Peter to share his experiences and thoughts.

Peter Varghese. Well, thank you very much. Sanjeev, and can I say at the outset, how delighted I am to be back in India and to be in a part of Gujarat that I haven't been to before. Now, I was an accidental public servant. I never yearned to be one and I didn't know much about it when I joined. But I knew soon enough after I joined that this was going to be an enormously rewarding career and I learned over 38 years that there is no greater privilege really, than to serve the public good through public policy. So I hope very much that your experience can be something similar.

I'd like to just focus on a few key issues. What I see are foundational issues about the civil service and the environment in which it operates. And I want to begin with what is perhaps the single most important element in understanding the work that you do as civil servants and that is this rather complicated and shifting relationship between ministers and civil servants-between the political and the bureaucratic spaces.

It is, in my view, essential that both sides of that equation-ministers and civil servants have a very clear view about the nature of the relationship, the boundaries of that relationship and where the red lines are. There's not much you can do about whether that appreciation at the ministerial level is going to be profound or thin, but there is certainly a lot that you can do to ensure that the appreciation of that division is deeply anchored in your own work and the way that you think.

Government is infused with politics and I think it would be naive to assume otherwise. But the challenge for the civil servant is to create a non-partisan partnership between the government and the bureaucracy in pursuit of the broader national interest. It is crucial that it is not a partisan partnership, because that is a very slippery slope indeed. But it is also fundamental that it is seen as a genuine partnership. In other words, a shared contribution to solving problems. And as you progress in your career, it's more and more important that you not just understand those divisions, but that you act to enforce the fundamental principle behind them.

The second thing I wanted to discuss was how you go about defining and implementing change in the civil service and I want to introduce you to the concept of radical incrementalism, which on the face of it may sound like an oxymoron one of the difficulties of a lot of management literature on the analysis of change is that it tends to be very apocalyptic, there is a view that you need a burning platform that change is a constant that an organization needs to turn itself inside out and completely transform itself.

In the end, I don't think that approach really helps you because if change is to be effective, it has to stick it has to be accepted, it has to be understood and it has to be acted on. And in my view, the only way in which you can achieve lasting change as opposed to Big Bang, temporary change is if you work with the grain of an organization, work with the culture of the organization, in order to reshape it, and to change it.

Now that's the incrementalism part of radical incrementalism, the radical part is to ensure that the change that you are hoping to achieve is genuinely transformative over time and in its final objectives, and I would draw a very sharp distinction between radical incrementalism and what I would call its evil twin, which is ad hoc incrementalism, which is an approach to change which is purely reactive, responding to circumstances around you, and not fundamentally framed by a very clear set of genuinely transformative objectives. I think in the course of doing that, it's also important to learn the skills of falsifying the policies that you're dealing with and what do I mean by that?

I mean that it's important to get beyond the rhetoric of policy making by talking points and this might work if you're drafting a media release, but it doesn't really work if you're addressing a very substantial issue. And the best way to ensure that your policy settings are the best that can be achieved is by seeking to pull them apart, to find weaknesses in them, define gaps in them, and then to reassemble them in a way which is much more sustainable. So that falsifying of policy I think, is a skill well worth developing as you go through your career, but I will give you a little bit of advice and that is falsifying policy is something best done between consenting adults in private. You won't get many thanks if you indulge in this in public.

The third point that I wanted to make is that we live and work in an ecosystem. Everything is connected to everything else. And a change in one part of that ecosystem manifests itself in other parts, often in unexpected and inexplicable ways. And that means anyone working in the civil service needs to understand as comprehensively as possible, the nature of that ecosystem, and what works and what doesn't work. And this is much more than coordinating policy, or

bringing the right parties together, or making sure that a cabinet submission is drafted with broad consultation. It actually involves individual civil servants, starting with a sense of the common good and the national interest and starting with a sense of what a whole set of government objectives are. And that, again, is something I would encourage you all to grow and develop as you pursue your career to build a working model in your head of what a whole government framework is and what works and what doesn't work and the last point, if I may, is just to offer some gratuitous observations for you on what I think the core elements of a successful civil servant are. I used to say when I was Foreign Secretary that if you can think clearly, communicate effectively, and very importantly, work with others, you will have a successful career over time and that remains my view. But I would add a couple of other attributes – integrity. Integrity is fundamental to an effective civil servant and an effective civil service. But it is something that is very hard to train people to acquire, yet you immediately recognize its absence, and you immediately appreciate its presence. And the last attribute, which goes back to my ecosystem, is the ability to see linkages across issues. I think what frustrates governments as opposed to bureaucracies most is an inability to see linkages across issues and to anticipate and to act on them.

So if you could acquire all of those skills over the course of your career, I'm sure you will have not just the successful career in the traditional sense, but a career that makes a substantive and lasting contribution to your country and to the welfare of your community. Thank you.

Dr. Sanjeev Chopra. Thank you very much, Peter. Radical incrementalism, I think that term will strike a chord and it's going to be a very interesting debate because whereas Suma said that one needs you need a crisis, you feel that one doesn't need a crisis. So we will have this very interesting debate. May I invite you, meanwhile, Ebrahim Rasool to give his thoughts. Incidentally, Ebrahim is from Surat. In fact, his grandfather is from Surat. So, welcome home.

Ebrahim Rasool. Thank you very much. This is the first of my family who set foot in Surat almost a hundred years ago and then my grandfather with his best friend left Surat, came to Cape Town and eventually settled down. And then when Nelson Mandela became President, his best friend's son became South Africa's First Minister of Justice, and I became the Minister of Health and then later, the Premiere was the chief minister of the Western Cape. So it is Surat that produces great people with foresight, they don't become great themselves. But they make the sacrifices, which is absolutely crucial. I want to say that there's not a disjuncture between what Suma and Peter say because often a crisis is either apparent or it is hidden.

You sometimes just don't know that you're in a crisis and when you don't know you're in a crisis, you don't make the reforms proactively, because you are fooled. Sometimes the crisis is apparent and even when it is apparent it is difficult to recognize that there's a rupture. In a society like there was in South Africa, you are still having to be incremental about the way in which you reform out of that crisis. And so in a sense, South Africa in 1994, represented a clear rupture.

But the measures taken to reform the public service, were closer to the issues of radical incrementalism than one would expect this overthrow of the old and the reintroduction of the new to usher in.

I had a very interesting debate last week in Turkey, with exiles from Egypt and Serbia and the Arab Spring, generally. And they asked the question, did Nelson Mandela sell out in 1994? When he didn't grab the stick and use its power to create the radical immediate change?

And I asked the Egyptian, I asked would you want a glorious program and want to govern for a year? Or would you prefer an incremental program and be in government 25 years later to assess it?

And so, the art, I think of public service reform is to understand when you are in a crisis, whether it is apparent or not. And then to ask yourself, how would you think your way out of the crisis if you don't have such complete power to do it all in a big bang.

At that moment in 1994 Nelson Mandela's major priority should have been, “how do I deliver to my people what they need now - a people that were so fundamentally deprived by virtue of the color of their skin, that I need to give them everything I can right now.”

But that was not his immediate priority, his immediate priority was to prevent counter revolution because one, the state we inherited in South Africa, had an all-white army and all-white police service and all-white bureaucracy and all the institutions were all white. So if ever there was a case for counter revolution it was a tough case and yet what we negotiated then was a case for radical incrementalism if I can borrow your term. This said, let us provide sunset clauses for the incumbents that gave them job security of 10 years, of pensions and all of those kinds of things for at least five years, while enticing them out of the public service. A great guide to us at that moment, would be our reading, for example of Antonio Gramsci, his idea that transitions are the most difficult and dangerous periods in the life of a nation because the old has not yet died, and the new has not yet been born.

So you have this inflammable situation where the old and the new have to co-exist. And we described ourselves as a political entity and we would be undertakers of the worst of the old and the midwives of the best of the new. We understood that what we required from the old was the memory, was the experience, was the ability to comply with what the present required and the know-how in order to achieve the objectives of the new because the new without the expertise, the experience could have the most lofty ideals, but not the know-how to deliver those ideals. And then we would transform South Africa from a fragile state into a failed state. So that I think was one of the most important points and sometimes when your crisis is not apparent, you may not do those kind of things and yet, those are probably the things that you may be required to do.

We needed to lay that foundation and that allowed us to enter into a compact with our population, who for the first time were included. For the first time, 80 per cent of the population was included in health services, in education, in urbanization, and all of those kinds of matters. And so the demands were exceptionally high. The expectations were high but we understood that our resources were finite, our expertise was finite, and the transition may be quite long.

So the compact with the people was that the state will incrementally deliver to them. If people at the same time add the patience and the resilience to weather the storm and to temper their own expectations, and I think that was the unique gift of Nelson Mandela - to live very simply, to give away half of his salary and so the contract was signed. It was as simple as that and it made it easier for sacrifices at the bottom to be made. So you need that kind of cultural environment within which to drive this kid of reform.

We also had the task of bringing together a very fragmented public service. We had 14 territorial civil services, 14 homelands and four provinces that we had to unite geographically into one.

Secondly, we have three levels of government - national, provincial and local that we had to drive coherence into and we also had four racially defined departments-white, Indian, believe it or not, you had the Department of Indian Affairs, 'white', Indian, 'coloured' and 'black', and we also had to unite each with norms and standards and so that we would get at the end of this period of transition, a coherent, even if not necessarily a united, civil service, one that shares an overarching vision, one that shares certain fundamental values, one that shares certain ethical principles, and one that shares certain

defining objectives that we needed to achieve as a country. And so our civil service had to be political, with a big 'P', meaning that to have a political sense of where they were going, without necessarily being political, with a small 'p' as in parties and party. And so I think the idea of a pre-politicized civil service is good in the sense of party politics, but is bad in the sense when a country needs to think and work its way out of a crisis. You need to have a big political sense in order to understand and shape and debate, even the direction of government, its policy directions and all of those kinds of matters.

To, to conclude, I would want to say that there are probably three transitional reasons to reform a civil service. The one is a revolutionary rupture, South Africa of 1994, India of 1947-48. The second one, and the characteristics of that may not differ from the characteristics of the others, is when there is an epochal change. South Africa's transition happened with in a global transition from a bipolar to a unipolar world from two ideological competing systems to a single ideological harmonic system. And we needed to rethink all our social rhetoric, all our communist rhetoric about what we wanted to do with a state, how you would own everything in the state, we needed to make a mental transition within a political transition, because of the epochal change that had happened. I think India is having to manage each transition now within an epochal transition. The world is fundamentally changing. The fourth industrial revolution, the demands of people in a world going through climate change, all of those kinds of things are saying that you may be sitting on a crisis that you are not recognizing or acknowledging. Therefore, see what this crisis is about in order to do the third transition, which is a do it yourself reform, do the reform before you are reformed?, place your hands on the steering wheel and be not just a passenger in the reform process. Otherwise others do it for you. Rather, grasp yourself as we did in South Africa, rather get the incrementalism before your radicalism overshadows the prospect of incremental success. Thank you very much. Thank you.

Dr. Sanjeev Chopra. Thank you very much, Mr. Rasool, what a meaningful presentation. It was wonderful when you say that the civil service in South Africa was the undertaker of the old and the midwife of the new. What a remarkable opportunity! Not only that, I think the civil service in South Africa has actually delivered. One of the interesting things about civil services is that when we deliver, nobody gives us credit for that. When we fail, or when we are not up to the expectations, which, happens often because expectations are higher than our ability to do things, we get some flak but that is to be taken in one's stride. But back to you Suma. So I think one of the things that you were

mentioning and that you look at now that you are the president of the EBRD is the system's view of things? I mean, how do you link so many things together? You know, how do you make various parts come together. And it was very interesting how you use the Japanese car-making technologies to look at reforms in jails. So now that you are the president of the EBRD, now that you're looking at the civil services in terms of cooperation across Europe, how do you look at this particular aspect of a large holistic systems view? May I request you to respond to that after which I'll request my other two panelists also to take this idea forward.

Suma Chakrabarti. So I agree that you don't always need a crisis. But you have to, I think, quite often have a sense of challenge and opportunity. Otherwise, you don't move, whether it's in the multilateral development system, or in a civil service.

I would say right now if you look at the UK civil service, if you look at the UK Civil Service in '79, '97 and I bet you 2020 will be a major moment, if the UK has Brexit. This is a constitutional change of very wide-ranging ramifications for the public services, it will have to adapt. And it's a massive adaptation exercise. I think that's one of the big things. And that will lead to system-wide changes within the civil service. I think we look at the multilateral development system, and I have my world bank colleagues here, as well, I would say there are three things that are going to force us to think in a more system-wide way than the multilaterals have done up to now. One is climate change, for sure. We have different skill sets and institutions. And we ought to be really more than the sum of our parts rather than less than the sum of our parts in dealing with the next would-be technology. Ebrahim was right to mention the fourth industrial revolution, I don't think we have thought through the implications of technology for the types of work that will be, frankly, done by robots rather than us. We can do the stuff that's empathetic and analytical, things that the robots will not be able to do. But that has massive ramifications for all of our organizations. I think the third area, I would say, and I noticed it more and more, and one of the reasons for Brexit, I think, is inequality. Inequality is rising in all our societies in the West, for sure. And governments have not really thought about how to deal with it and again, you can't really deal with that sort of issue. Department by department, you've got to think in a system wide way. Those are opportunities that will also provide the real challenges in my view.

The lesson I learned from the system wide work that I did is a bit like what my colleague said, first of all, you do need within the system, a set of people who

are not frankly, earning their loyalty to the department or to the one institution, who actually feel a sense of national interest who are really not interested in just getting ahead within their own departments. But thinking across that is certainly what happened in Britain. I think that when the Blair government came in, there was a group of us-Young Turks-we might call ourselves who were much more system wide thinkers and this is the reason that the PSA is a public service agreements that came in the UK in '99 because a group of us were looking at the results-based approach taken by the Clinton administration. That time I had brought in my experience in the World Bank, IMF programs, conditionality linked to outcomes and so on. We put these ideas together and looked at what was going on in the wider world and that was very, very important, I think in terms of driving that mentality. But then comes the hard work. So you can come with all these ideas. But to make them happen, you then have to hard wire the system. And that's why I went on about the importance of shared scorecards, shared metrics, building capability across departments, to think about these issues, creating cross-cutting units quite often, to tackle these and actually quite often linking them to the Prime Minister's office to drive the change to the departmental incentives.

And that takes a lot of courage for the civil servants, it takes courage actually, for politicians too because they basically were all being asked to do one thing that none of us like doing which is pooling our sovereignty or sharing our sovereignty with others. We don't like doing this generally because we like to be in control. But actually, you've got to have this mindset that the overall good is served by giving up control and sharing it with other people. That's the challenge that comes and you need leadership both in the civil service, I think, but also political leadership to do that. And, you know, I think that's what makes for a better service over time, if you can get there.

Dr. Sanjeev Chopra. May I request Peter to join this debate and take this idea forward.

Peter Varghese. Thank You. So look, there are always opportunities in crises and you have to be smart to take them and run with them, for crises tend to run. And their responses tend to run on quite a different dynamic to any other period in history. You see, they are also huge opportunities in aspiration and when I look back at the big reforms in the Australian public service, they almost exactly coincided with a period of big structural reform at the political and economic level and why is there that congruence? Well, it flows from a very simple proposition. If you have big ideas and want to make big changes, you need the systems and the processes that are going to enable you to actually deliver on them and so a big political and economic agenda that is not

supported by a strong civil service agenda, in the end, I think will achieve much less than it could.

So in Australia to give you a couple of examples, we firstly abolished seniority completely. When I joined the civil service, it was very much a seniority-based system. Subsequently, a merit-based system took its place. Every position was advertised, everyone competed openly for promotion and while at the time it seemed a rather revolutionary thought, over time it actually worked exceptionally well.

Then, we abolished the tenure of secretaries, which I think was good and bad. I think abolishing the tenure of secretaries leeches some complacency out of the system. But I think it also actually can reduce the fortitude of those at the top of the bureaucratic system who from time to time, do need to give unvarnished and difficult advice to ministers. And if your next contract is turning on that dynamic, you could find yourself in quite a compromised position.

We also began a process of decentralization, when it came to recruitment and when it came to pay and conditions and training and again, like all changes, it had it's good and bad parts. I think on the whole the proposition that secretaries of departments should have the room and the authority to manage as they see fit is a good principle to have.

But I think it's also the case that if all of your civil service leadership were focused only on what was happening in their own portfolio or their own department you lose the sense of a one civil service or a singular approach to how you develop and implement policy-making. So you need to sort of, I think, have a more nuanced view of many of these things. You asked, Sanjeev, about what's the best way to think about global best practice. I think these days for anyone working in any area, whether it's the civil service or any other discipline, you have to benchmark yourself against global best practice. I think that's just the reality of everything that we do. But a civil service in my view cannot be detached from the culture and the history and the nuance of the country that it serves and so the idea that you could scout the world for global best practice and then just adopt that into your system, I think it's very unlikely to succeed because unless you're working with the grain of your community, whether you define that nationally or provincially, things that look good from afar may turn out not to be so easily implemented.

Dr. Sanjeev Chopra. I think it's a very relevant point about how we handle this aspect of looking at global best practices. I have a question for you, Mr. Rasool, especially because you've integrated so many Civil Services, I mean, state, national, provincial, and also when South Africa was getting on its feet, there

would have been the issues of competence at one level and the inclusion of all communities and all ethnicities at the other level. How was South Africa able to achieve this or are you still struggling to achieve this? What is the process there? And also the much larger issue that I want to ask all my panelists is that there are two aspects - There's the aspect of inclusion and there's the aspect of competence, and also both have to be balanced and how have you in South Africa done it or how are you achieving this?

Ebrahim Rasool. The ideal is when inclusion does not compromise competence. Then you find the holy grail because you're moving beyond the representative to repopulating the public service and I think that we are beginning to reach that stage now in South Africa. But it certainly was not necessarily the case in 1994. In 1994 there was an all white civil service, we needed to bring in good black people into the public service and it was a matter of choosing competencies. So we kept, as I said, the best of the old in order to create that kind of undergirding for keeping the state running. But we needed to be able to act either in incentivizing ways or punitive ways in order to safeguard the integrity of the state. Initially, what we placed at the disposal of every minister, moving into a department was what we call a strategic management team, a group of people who are guardians of the policy and also able to oversee the transition within the department itself and infuse good people into the system. At first, the people were policy gurus who could come in and give the direction and later they took up positions in the state. But very clearly, we needed to infuse a different color into our civil service, we needed to diversify the religious space of it. We needed to make sure that gender was being looked at aggressively and language as well, for all our diversity, I think the people of our country needed to see themselves in the public service, because you are at once a delivering body, but you are also a representative body of the people because if people are asked to make sacrifices, they need to see that they are represented in the structure that is asking for all of these sacrifices. I think that when competency is compromised too much, at the altar of inclusion, you are going to inherit a state that I think will not be as efficient as it should be and I think we therefore also send some of our best people for training overseas in order to lessen the gap and recreate that mentorships within our departments. So that the old transfuse the new with some of those kind of issues as well and to end, the very important lesson we learned is that if you allow new entrants to jump too many levels too much, they don't know what to supervise at the bottom. For example, part of the weakness of our state was that our chief directors were placed in the first posting as chief directors with no experience about our deputy directors, the procurement, how route

forms were being devised by assistant directors, and therefore effectively did not know what they were supervising. And so it's useful even for shorter periods of time to push people through the system so that they know what to look for, what the alarm bells are and how to manage things.

Dr. Sanjeev Chopra. I think it's a very interesting response. So, inclusion, yes, representation, yes, and a lot of training to ensure that competence grows. Peter, you've done this Woman and Leadership programme in the Australian Diplomatic Corps, so could you throw some light on this.

Peter Varghese. Well, let me make some broad comments and I'd like to talk a little bit about what we did in terms of women in leadership. So I don't think the civil service should be the vehicle for social engineering. That's my personal view and by that, I mean, I don't think you serve the best interests of your community if you work to a recruitment policy which seeks to, in effect, replicate the profile of the community in which you're in.

So, merit has to, in my view, always remain the Lodestone of recruitment policies in a civil service but I will say this, and I don't think it's as appreciated as it should be. There is enormous merit in diversity and so when we think about merit, we need to have a fairly broad view about what constitutes merit.

In countries like Australia, I think the pitfall has been that people think about diversity in terms of ticking a box, whether it's a gender box or an ethnic box or a disadvantaged community box or an indigenous box. The merit of diversity is that it strengthens your ability to analyze issues and come up with problems. When you have a group of people with a wide range of world views when addressing a policy problem or a challenge, almost certainly you're going to end up with a better outcome than if you had people with a very narrow life experience and a very narrow set of views addressing those problems. So it's important not to make too much of a stark demarcation between merit on the one hand and diversity and inclusion on the other.

When in my case, we did run a very explicit Women in Leadership initiative in the Foreign Ministry when I was Foreign Secretary, and the reason for that was simply this, we had been recruiting roughly equal numbers of men and women since the mid-1980s and here we were in the second decade of the 20th century, and the discrepancy between women at senior levels and men at senior levels was stark and not all of it could have been explained by career breaks that women may have had to have kids and raise families.

So I began this process, actually, from my participation in a private sector group called Male Champions of Change who were the Chief Executive

Officers of Australia's largest companies. It's a group of about 20 to 25 people and the thing that struck me was they approached the gender diversity issue almost exclusively in terms of productivity benefits. And they had all of the data and information that you would expect number crunchers in your big companies to have and so I found making the case for a Women in Leadership program off the back of that sort of empirical private sector experience was actually a very, very useful starting point and it meant that the debate moved away from something like “are you compromising marriage?” or “does this mean that women are going to be given you know, positive advantages in the selection process to understanding what better gender diversity meant for the functioning and the productivity of the department” As part of that, we also introduced an all-roles flexible policy, which was to say to men and women in the department, “if you wish to move from a full-time job to a variation of a part-time job or if you wish to do some of your job at home, and some in the office, your supervisor has to have a good reason as to why you can't do it. So, the assumption wasn't that anyone can just choose whatever mix they liked, the operational requirements were still paramount. But you had to make a case as to why you couldn't accommodate a greater measure of flexibility in the working day and the working life and interestingly enough, those who took to that, by no means only women-the number of men, particularly young men with young families who put in applications for more flexible working arrangements was also significant. So again, I think the end result was both a more diverse workplace and importantly a more productive workplace.

Dr. Sanjeev Chopra. Wonderful. So inclusion and productivity can go together and that's a very important point. We have almost come to the close of our session, but may I request Suma Chakrabarti to make his closing comments for three to four minutes and then maybe two minutes from both the panelists?

Suma Chakrabarti. Thanks, Sanjeev, I think I want to speak on this inclusion-competence issue. Firstly, I reject the idea of an a versus b trade off if you like. No one ever asks, what is the competence of the existing status quo? You know, no one ever asked that question and quite honestly, throughout my career, the civil service was not performing as well as it should have done. I think, you know, inclusion has been an important part of how the civil services move forward, actually. But like the other speakers, I don't think it's just about race, religion, gender, I think it's about openness of mind, openness to different ways of thinking about things as well. But that's not to say I don't think gender particularly matters a lot and now increasingly, not just gender, LGBT1. All sorts of other definitions of inclusion matter increasingly. I'll stick

with the gender issue. First of all, for me, the original motivation for being interested in gender was ethical, moral, I could never understand why actually the senior ranks of the national civil service looked so male and pale.

And the service really did not reflect me or others below it at all. But I also like Peter's side of looking at the literature, the literature is very clear on this, the performance of organizations the productivity, other indicators improve, as you have a more gender-diverse workforce and senior leadership teams, that's very clear in public and private sectors too. So is it for ethical and performance reasons. I personally really pushed this agenda in the Department of International Development and also in the Ministry of Justice and again now in the EBRD as well. We've done lots of things such as you know, putting people on leadership courses, building networks, flexible working. I'm probably the one person in the UK civil service who, when I became Permanent Secretary, made the headlines not because I was the first non-white Permanent Secretary-which you might think would be the reason-but because I was the first Permanent Secretary ever to have flexible working. I refused to work in the office on Fridays, because my young daughter now 24, so basically I like to go to her school assemblies on Fridays, and be with her as much as possible on Friday. So this made headlines, national headlines at the time. It was ridiculous in a way, simply because I made the headlines because I was a man. Many women have been doing this for years and didn't get the credit or the headlines for it. But it was good that it happened as well.

Over time, I've learned also that there are one or two truths about the gender issue. Women tend not to apply for jobs, more senior jobs, unless they're sure they've really got a chance. Look at us, for men on this panel. You know, we tend to look for chances as we say, we always think we're in with the chance and we'll go for it. So I found it as a leader. I had to encourage really good women to apply for more senior jobs and over time that worked. So I ended up leaving with 50 per cent of the senior posts being held by women and two-thirds of the management board by women, also a fair percentage of women in the senior civil service.

You shouldn't clap because I'm now coming to my failure. At the EBRD I started over 10 per cent in eight years, I've managed to move it to 30 per cent Why? And that tells you something about the markets in which the EBRD recruits 80 per cent of its staff and the private sector banking industry. This is the most misogynistic industry I've ever come across in my life. There are very few senior women in banking anywhere. So your pool from which you're

recruiting makes it really difficult to make progress. So the progress within EBRD is very much internal promotions by them being able to bring people in as women leaders, so we've got a long way to go. But this is something I think as a senior leadership team, we've got to be very, very committed to and to make inclusion beyond just gender.

I think I'll finish off with closing remarks just very quickly. I think I've got five quick things to say. One is, it's really, really important, as Peter said, to remember to keep a non-partisan civil service, but to be clear that you are trying to help the government of the day deliver its agenda, and for the people at the end, for the provision of public services to them, that's the ultimate test. Secondly, you've got to be good at partnership. And here, you're working with the government of the day and you must always have courage, courage to speak truth to power, even if it's uncomfortable. It's very important to do that as civil servants and also you must be able to be open and work with the private non-profit sector as well out there. Thirdly, evidence matters. On many issues in my lifetime as a civil servant, I have thought it looks more like policy-based evidence but evidence-based policy is important. It's really important that we go for the latter as civil servants. And I think capability fundamentally matters. You can't just be policy brains. You've got to think about the commercial, the programmatic, the crisis, the risk management, options, analysis and communications as well as diversity and finally, it is one thing you must do in your careers. Please stay open to the wider environment, learn and relearn. If ever you say to yourselves or to anyone else, "we've never tried that before. Nice idea. But not now. Not here." That's the time to look for a new job, in my view. Now I'll finish off with one minor anecdote maybe 40 years ago, I was an undergraduate at Oxford University. My father sent me forms from Calcutta for the IAS and the IFS and the reason I didn't fill them in was because I had a Japanese girlfriend who's now my wife. The only place we could agree on living in was neither Japan or India, it was actually the UK. So I ended up joining the UK civil service. But if I hadn't done that I would have been out there or probably where Sanjeev is now trying to run this session. So good luck to all of you, you're in a very noble profession.

Ebrahim Rasool. Just, just very quickly to latch on to something that Suma had said and that is, how does the civil servant find his or her voice in an era of populist extremism and while working for governments that go off the rails. South Africa had an unfortunate 10 years behind us and instead of the public

service, gently and subtly pushing back, there were large areas of it that succumbed to it and led to the erosion of our institutions. I think that civil service pride requires not brashness, not brazenness, not rudeness, but it requires sticking to the ethical precepts of what you do, finding a voice that is respectful but firm in that, and being able to keep a country by and large on track. And to almost say to themselves, this too shall pass. I always make the analogy that politicians which I have been for most of my life, we are like the memory stick that gets plugged into the computer when we come in. But the hard drive is the public service, and we can't have a corrupted hard drive and therefore you've got to guard that very generously.

Dr. Sanjeev Chopra. What an interesting analogy of pen drives and hard drives. So Peter, may I ask you to given the closing remarks.

Peter Varghese. Thank you, I'll look for very quick points because I know you're running out of time. Firstly, just remember that you are custodians of an institution. And institutions are extraordinarily fragile things. They are fundamental to the success of any society and particularly fundamental to the success of a liberal democracy. They are easy to subvert and impossibly difficult to rebuild once they've been subverted. So think long and hard about the health of the institution that you have entered.

Secondly, as a civil servant, you are in this position where you serve the national interest and the broad common good and there is no other profession, frankly, that can make a claim to doing that. Political leaders of course, aside from every other professional serve a narrower constituency. So keep that broad obligation. It's a pact really between you and your community, to keep it alive and well. Thirdly, don't fret too much about the distinction between policy and implementation because in my view, they're part of a spectrum. if you're a good policy maker, you're thinking hard about the practical difficulties of implementation. And if you're good at implementation, you will have very good ideas about what will improve policy - the two really do run in tandem. And my last piece of advice for you is to have fun. It is very important as you build your career that you enjoy it and I want to quote something from Teddy Roosevelt who said that life's greatest good fortune is to work hard at work worth doing. So you're very, very fortunate. Thank you.

Dr. Sanjeev Chopra. Let me on behalf of the organizers thank this panel for an absolutely wonderful session.

The potential in YOU

David Roberts

So, let's start. One. I want you to think about what you think about when you look at this slide. Because when I look at this slide… For me, I feel a sense of awe. And it's a sense of awe because this is probably one of the most extraordinary sets of exponential technologies that we have ever been able to pull together. There are only a couple of countries right now in the world that have been able to do this. And one had to copy the other to do it. And yet, as exponential as it is, it's actually too obsolete already to fly. This is old stuff. We actually are not able to safely fly this anymore because it's too old. And what I want to walk you through in the next hour and ten minutes is a little bit really around the spice trade. And I know that may sound like a strange thing but I think we are going to get an essence of that. I don't know a better way to explain what disruption really means. And then we will talk a little bit about leadership.

So, to spice trade. More than any country I can think of, this one would know it right. If you were the CEO of one of these companies a few hundred years ago. See, we have been talking about disruptive innovation for the last 25 years. It's because we only discovered disruption and innovation 25 years ago. It doesn't mean it didn't exist. It just means we only understood it because of one guy by the name of Clayton Christensen, a Harvard Business School Professor. And I want to thank you, by the way, for the service you are going to do. I was in your position 39 years ago. And so, what I am going to share with you now are just insights of what I have got over the last 39 years. So, remember this. Spices are grown in the Far East. Their demand was in the Far West. Does anybody remember why there was so much demand? Who remembers? Why was the demand so great? By the way, both couldn't travel that distance. It was too far technologically. And so, they would have to transfer the shipments. And every time they transferred the shipments, somebody would make a little percentage, a little profit. They take their 20 percent, 30 percent, 50 percent. And so, by the time the spices make it to Europe, they are so expensive that if you had loaded up a ship full of cumin and got it to Europe, you would make

more money than if you had loaded up the ship with gold. Why was the demand so great? Yeah. Anybody hear that? People thought that spices preserve food. And there actually are very few spices that preserve food. But for the most part, spices do not preserve food. It's a myth. But they do make rotten food taste better. And so, you could eat food that you wouldn't have otherwise eaten for a longer period of time. And so in a way, it was the essence of refrigeration. And since there wasn't any refrigeration, that was it. Now, this industry was so big that literally it moved off of the ocean to the land. And people moving it on horses and carriages. And all of these redundant intermediates making their little cuts. Complex experiences or shortage of the demand. The demand was there, the supply was here. And it really was responsible for the industrial revolution. Why? Not because of spices, but in order to do this… In order to pull off this massive industry, they had to develop better ships and communication and messaging and navigation.

The secondary and tertiary impacts of this were extraordinary. In order to do navigation, they started to understand celestial bodies in the universe to navigate. I mean, it was just a crazy development. And the stunning thing about this massive industry was that one guy who thought that he could disrupt the entire industry. Now, we have some really bright students that come to Singularity University. But one of them asked me whether this was a real photo of Columbus' ship. Now, rather than pointing out the multi-hundred-year difference between the ship and the development of the camera, I pointed out this little pinnacle in the back of the photo. I am not sure what he was trying to say, but he sent me this photo the next day. Columbus was an entrepreneur, not an explorer. He was in this for the money. And it makes him different than an explorer. Because he was in this for the money, he actually didn't understand exploring very well. And that is actually typical of most entrepreneurs. And most entrepreneurs even in the government. They actually don't understand the industry well. The people who innovate in our government are typically the people who don't understand it well. And so, they are willing to try things that have never been tried before. And Columbus is no different.

This is Columbus's map of the world in orange over the real map of the world. And so, he thinks that China is where Alaska is. He thinks Japan where he was trying to go for the spices is where Mexico is. And he mistakes the Narco mile for the Arabic mile. So, he couldn't be more wrong on the distance. He thinks that the distance from the Canary Islands to Japan is 2000 miles. And the real distance was 8000. And there wasn't any ship in the world that could go 8000

miles. And so, he takes his business plan around Europe to the venture capitalists in Europe at that time, to the kings and queens of Europe. And they take his plan and pass it to their scientists and engineers who look at the plan and say, 'This guy doesn't have a clue of how big the world is.' And so, he doesn't get funded over and over again. Just like the real entrepreneurs. And Spain had just been through a very long series of wars and was massively in debt. And it's believed now that they even knew that he didn't know the real size of the world, but they funded him anyway. Because they were desperate and were willing to take the risk. And so, Spain puts up about half the money. A group of wealthy Italians put up the other half. And they fund him anyway. Now, even an entrepreneur cannot be foolish about everything. And Columbus knew something because he had been a weatherman. He had been a weatherman and he knew that if he flew along… If he sailed along one latitude, he would have the wind behind him. And he knew of this easterly and westerly winds, that if he dropped ten degrees and went up ten degrees, he would have the wind behind him coming back. And so, he knew the way to make it back. See, people had made the journey before. They just never made it back. And it doesn't count if you don't make it back. And so, Columbus makes the journey, and he makes it back. And he thinks even till his death when he had made three of these trips, he still thinks that he made it to Japan. But he doesn't bring back a single, even a bucket of spice. He fails at his primary mission. But he brings back so much gold that it brings Spain completely out of its decade of debts. And this is actually how most entrepreneurs work.

They try something that no one else thinks is possible. They typically fail at it. But they succeed at something else. Even the Google founders. The Google founders' original intention was to sell a search engine to Yahoo. And Yahoo didn't want to buy it. So, they had to come up with plan B. And I am telling you this because you are about to pursue maybe a 10, 20 or a 30-year career. And you have the ability to change India. And if you are lucky, change the world with it. And there will be all kinds of people along the way to tell you that you can't do something or that we tried that before or that's a bad idea. I am here to tell you that all of the progress of this nation and the world depends on people willing to try something that everyone else thinks won't work. So, Columbus makes the journey. It doesn't impact the spice trade at all. In fact, the spice industry continues as it is. In fact, the spices end up heading over into the Far West. And if you were to look at the spice industry, you would see though that it was ripe for disruption. And you would know it because there would be four things about it. And even if there's just one of these four things, it means an

industry is ripe for disruption. And when I say industry, I mean an industry whether it's a business or whether it's an industry in the government, it's the same concept and the same idea. And this is them. Complex experiences which they had. Broken trust from all of the redundant intermediates, and then the limited access to the spices. If you have even just one of these, you are ripe for disruption. And what's fascinating is that the same four reasons exist today as they did a few hundred years ago. See, technology changes. But the principles and the insights of it don't. Learn from history. And project into the future to understand it, to make decisions in the present. That's what good managers do. They understand the future because they have looked at the past. And then they make good decisions in the present. Here's the amazing thing. The entire world's spice industry does get disrupted by one guy. Anybody know who he is? The reason we don't know who he is because we only understood disruption in the last 35 years. And so, we have never looked back at history with the new understanding of disruption to understand history correctly. But now, we can actually do that. And we know who he is.

One guy disrupted the world's largest industry. And no one has ever heard of him. Here's a picture of him. One of our faculty members said that everybody looked like that back then. Anybody know who he is? Here's his name, Frederick Tudor. Anybody know who he is? So, Tudor invents this. Thoughts? What do you think? Even though refrigeration related a little bit to it. Anybody knows what this might be? Yes, it's a warehouse. There's something special about it. It's insulated. He invents the double walls for an insulated warehouse. If you build two walls and put an air gap in between, or if you stuff it with stardust, you can build a giant warehouse. And he lived in Massachusetts. He had just visited the Caribbean where it was hot as heck. And he thinks to himself, 'If I can cut ice out of the lakes of Massachusetts and store it in an insulated warehouse, and ship it to the Caribbean, I can make a fortune.'. And so, he does that. He builds a giant warehouse, double-walled. And he has men cutting ice out of the lakes of Massachusetts, and loading them on horses and bringing them back and stuffing them and loading this thing all the way up to the top with ice. And because of the laws of Thermodynamics, all summer long, you lose maybe 3-6 inches of the outside of the ice. It's kind of like glaciers don't melt during the summer. And he builds a business to ship ice. And he loads up a ship and sends it to the Caribbean. And what do you think happens? It all melts. He loads up, borrows more money, loads up another ship and sends it to the Caribbean. What do you think happens? It all melts. He gets sent into debtors' prison for six months.

And he gets outs and he borrows money again from his family and his friends. But this time, he insulates the ship and sends it to the Caribbean. Only a third of the ice makes it. And he makes a fortune. He pays for all of his debts and funds the next year of operation. And he builds one of the biggest businesses in the world. Cutting ice out of the lakes of Massachusetts, loading it on horses, taking it in the warehouse, loading it back on horses, taking it to the ships and sending these ships all around the world. Because ice really does preserve food. In fact, India ends up being one of his largest costumers, where the spices came from. In fact, you can even visit the Vivekananda House in Chennai. Frederick Tudor built that as an ice warehouse to store the ice when he shipped it from Massachusetts to India. One of the biggest businesses of the world. And the entire price of spice over the next 20 years as he expands his business collapses completely and becomes completely worthless. One guy disrupted the entire world's spice industry.

And here's the question. How many or what percentage of the companies and the people that were in the spice business do you think made it into the ice business? Zero. There's not even a record of the single person that used to be in the spice trade that makes it into the ice trade. I mean, this didn't happen in a year or two. This happened over 20 years. It's like skating on a train rail and a train is coming at you, and you are watching it for 20 years and it finally hits you. Disruption is illusive. Illusive in a way that is very difficult to comprehend or understand. And you would think that the guy who just disrupted the world's largest industry would have understood disruption. But he gets his own business disrupted over the next ten years. By this. Thoughts? What's this thing? What do you think? Be a little louder. Yeah, Ice making. It's sort of… It's like a freezer. It's the artificial ice maker. But it works like a freezer by reducing pressure and producing the cold so you could create these giant ice blocks the same way. But you didn't have to ship the ice. You could just ship the machine. And then you could use local water for the machine. And the funny thing about it was that for almost ten years, probably because of Frederick Tudor, people believed that artificial ice was not as good as natural ice. So, these collaborative groups had to be created to try to educate people that artificial ice was as good as natural ice. So, this was a few hundred years ago. See, fake news existed even then.

Here's the question. How many or what percentage of the people that were in the natural ice industry do you think made it into the artificial ice industry? Zero. The natural ice industry collapses. Evaporates. See, even the ships used to ship spice weren't even the ships used to ship natural ice. The ships that

were used to ship natural ice were not the same ships that were ship artificial ice machines. No one makes the transition. And this happens over a ten-year period. So, the giant ice warehouse gets disrupted by this. What's this? Who knows? Refrigerator! Not quite yet. This is the icebox. My grandmother had one in her house in Northern Wales. And she told me the story about how the iceman would come every morning and deliver an ice cube in front of her house from the ice warehouse. And she would pick up the ice cube and stick it in the top of this and she would have her own ice warehouse. It was incredible. It was patent number 5000 and something. It was an incredible innovation, to have your own ice warehouse. I mean, it was a hugely expensive thing otherwise. The only people that were sort of eating ice creams during the summer were the kings and the queens. They were the only ones who could afford an ice warehouse. And by the late 1800s, two-thirds of the homes in England had an icebox. And this is the democratization of technology. It works the same way. You democratize technology and make it unbelievably inexpensive so that everybody can afford it. It's the same thing. Or you make it a little easier to use or a little bit more accessible. Technology only does three things. And that's it. Cheaper, more accessible, easier. So, we end up with a freezer. And can you guess what percentage of the people make it from the icebox to the freezer? Zero. And so, we all end up with a fridge. And since we gotta laugh at how do these people not know that the icebox is going to get replaced. How do they not know this stuff? And now, we are laughing. What disrupts the fridge? And that awkward silence is what makes disruption illusive. Because fridges get disrupted too. All this stuff doesn't happen so that you end up with a fridge forever. Fridges get disrupted too. It's just not obvious what does it. I will walk you through some ideas I have about it. But I am really not sure. I think I am more confident than I was ever before. This is one. So, I don't know if you drink milk or almond milk or soy milk, but it doesn't need refrigeration. I mean, you could just leave it on the shelf. Ironically, because we sort of stick the spices, we stick the preservatives back into it. Alright. This is another one. This is real milk. They radiologically kill the bacteria that eat the milk and then they hermetically seal it so that it doesn't need refrigeration. I took these in the desert. A hundred degrees.

You know you could just open one up several days later and drink real milk because it didn't need the refrigeration. Here's another one. So, now, we actually understand the gene responsible for the ripening of vegetables and fruits. And so, there is a gene that actually creates the ethylene transition that starts to make the fruit ripen. Now, we are starting to modify the gene so that a

tomato last as long on the shelf as say a kiwi fruit does. Or a banana just lasts a really long time because we modify the timing of the gene. This is a company in Silicon Valley and they make a magic marker. You take the magic marker and you wipe it on the vegetable and it puts the bacteria on the vegetable that eat the bacteria that eat the vegetable. And so, the vegetable lasts longer. Here, I think we are getting closer. So, in the USA, Amazon now delivers it to over a dozen cities within an hour. So, if you want a cold soda or something, you order the cold soda and you just get it. So, there are people in San Francisco, New York, Chicago. They actually don't use their fridge anymore. They even unplug their fridge. Because if you can get anything cold when you want it, why would you have your own warehouse? I mean, you didn't bring your warehouse with you here because you knew you could just get some cold things if you needed to. This one I think is a little closer. And it didn't exist 11 years ago. But I think the most likely thing that's going to disrupt the fridges is probably drones. Because if you put in San Francisco even a couple of drone senders, you can reach everywhere in San Francisco within 90 seconds using today's drones. So, if you can get anything in 90 seconds, why are you going to have your own warehouse? And who would have thought that drones would disrupt fridges anymore than someone would have thought that ice would disrupt spices.

So, here's the question. How come the people in the spice industry couldn't understand that they were getting disrupted by ice? What do you think? Thoughts? It was 20 years. Say it again. They were not aware about it. So, maybe they were a little distant from it because they were in their industry. They were probably inert towards the idea because they were risk-averse. If you have been doing the spice industry for a couple hundred years, what could suddenly change? You have been doing this for 200 years in this way. How could that suddenly be changed by something? I think that's a good point. Lack of imagination. How imaginative do you think the spice industry was after 200 years?

By the way, remember. We are talking about the spice industry but we are talking about any industry. Any industry. Anything that you are about to spend the next 5, 10, 15, 20 years on. These analogies are the same. These reasons and these excuses are the same. The technology is different, but the principles are the same. What about this question? Which industry are you really in? What industry did the people that were in the spice industry think

they were in? Spice. So, if you are in the spice industry and you see ice, it has nothing to do with you. If you are in the natural ice industry, and there's this artificial ice industry, it just seems different. If you are in ice warehouses, and then there's these iceboxes, it just feels like a different industry. But if you were to redefine your industry and understand what industry you are really in, you might worry. Because if you were in the food preservation business, then ice would've worried you. Natural ice, artificial ice, iceboxes, ice warehouses. As you go into your government service, think about what industry you are really in. If you go in and think you were in the satellite business, or were in the fiber business, or were in the local governance business, you want to understand the real question. What are we really doing? And it's not even so much that you make it disrupted by something else. It's even better if you could think of what disrupts yourself so that you could be in a completely new industry. Because that's how the best governments succeed. They start to disrupt themselves. Because innovation is easy.

Innovation is just doing the same things better. Cell phone companies innovated on cell phones for years and years and years. But the glass phone wasn't an innovation, it was a disruption. And when the glass phone arrived, all the people that were making cell phones disappeared within four-five years. I mean, Nokia goes from being a hundred-billion-dollar company and gets sold off to Microsoft for seven, three and a half years after Google and Apple ended the cell phone industry with a glass phone. So, now we know that this is one kind of disruption. I mean, disruptive innovation that Clay Christensen figured out was one kind of a disruption. It's a low-end disruption. When a cheap thing arrives like a cheap Japanese car. And then it slowly upgrades until you end up with a Lexus. Now, it's just one kind of disruption. In Tesla, you will get a high-end disruption. You will get a junky thing on day one. You get this really great thing on day two. And it's really expensive. And then they figure out how to make it cheaper so that more people can afford it. And what we know is that five years ago, there was only one kind of disruption. And today, there are seven. And so, we are going to get a lot more disruption than we ever thought before. And here's the point.

At Singularity University, we bring together about a hundred executives every month. And at the beginning of the course, we ask them what are the industries over the next say 25-30 years that aren't going to get disrupted. And they come up with a list. But if we ask them at the end of the course, they typically only come up with one. Which is consulting about disruption. Every

industry over the next 25 years is subjected to disruption. There is nothing safe. And what it means is that you will need to think differently about the future. Because the future isn't like the past. It is a place where things start to change very quickly. See, in the last 20 years, we got the internet and we got the phone. And it changed our whole world. But in the next 20 years, we are not going to get two things. We are going to get five, or like ten, twenty things of that magnitude. We don't even know how many. Because if you combine say artificial intelligence or say robotics with crypto currency, that means machines can have money. But we never thought machines could have money. We always thought it would be our money. What if you tell your Tesla to go off and make money? We always thought it would be our money. What if it's your Tesla's money? What if your Tesla starts making more than you? It's gonna be a lot more machines in the world than the people. So, if the machines start making a lot of money, you can bet that we are gonna figure out a way to tax them. And that means the GDP of a nation is no longer constrained by human potential. It means that everything we think about in terms of economics and the future is suddenly different. And we get all of this stuff because of only one thing that we do. Because we can think. That's it. It all comes to us the same way.

I want you to understand how significant this is because everything we get; we get because we are slightly smarter than this. I mean, the spectrum of intelligence is huge. And we know where we are on it. We are here. We are slightly smarter than this. You go one dumber than us, and you are this. And it's not that you get smart enough to use tools. A lot of animals use tools in the world. But if you get a little bit smarter than that, suddenly now you can use tools that make other tools. And then you get plasma screen TVs, iPhones and everything else. In other ways, a tiny increase in our intelligence allowed us to get all this stuff. And if you can understand that, what you are about to recognize is that because of artificial intelligence, we are going to get not just a tiny increase in our intelligence, but a really magnanimous one. And the reverberating impact of that is extraordinary. And it means something profound. It means that we are about to get extremely powerful very quickly.

These ants are brilliant. They climb out of their underground city and they find a particular kind of tree. And then they climb up the tree to a leaf. And then they cut out the leaf just the right size. And then they bounce it on the central gravity on their back. And then they travel all the way back to their

underground city to a particular room in the underground city where they plant the leaf so that it later grows into mushrooms which they can eat. And they do all of that with a pin-sized brain and without a single instruction. This ant can sense this finger. It could sense the finger but it cannot comprehend what's behind the finger. It's never going to comprehend the internet because its brain is of the size of a pin. And this is us today. And this is actually our very near future, which we are trying to comprehend with a three-pound monkey brain. But one thing is certain. We are about to become extremely powerful. And here's the challenge.

What does this picture say about the kind of people that we are? Because she is crawling to a food station that's located more than a kilometer away. And we have had enough food to feed everyone in the world, one and a half times over for at least 70 years. See, technology gets us stuff. But it doesn't make us more thoughtful people. It doesn't make us kinder. We can easily become very powerful and not very kind. In fact, it's easier to become very powerful and not very kind. And I want you, for a moment, just to think it through. Imagine that we learn all knowledge, imagine that we expand into the universe and learn everything, and we have somehow not learnt to be kind or compassionate, it will be a worthless trip. We can easily become something that we are not proud of. This photo changed my life. I had a teaching assistant in 2011 who shared the photo with me. His father was best friends with the guy who took the photo. Kevin Carter. Kevin takes the photo, and then he wins the Pulitzer Prize for that photo seven months later. He wins the prize. While he is on stage winning the prize, someone in the audience asks him what happened to the girl. And he doesn't know. Because he took the photo and he walked away. And I remember judging him for it. Who takes a photo of a little girl with a vulture behind her, about to eat her and walks away? Kevin takes his own life several weeks after that. Leaves a note. The regret of his life. And I remember judging him for it. Who takes a photo of a little girl with a vulture and walks away? And then being honest with myself and thinking… Well, how am I any different than Kevin Carter?

I know there are people starving all over the place. What am I actually doing about it? Because the answer was nothing. And so, I had a lot of excuses. One of my excuses and I am embarrassed to say it, I actually said it to the class that day. I said, well, it's mostly Africa. I said that. And one of the students in my class, she sent an email to me that night. And it was titled, 'It's not just Africa'. And in it, she sent me this photo. Another starving child in the European country that I was going to the next day. So, then I had to find some other

excuses. My next excuse was just food. It's just a food problem. And then I learnt that half of the hospitalizations in the world originate from people who drink bad water. And honestly, in my life, I never had to worry where my next glass of clean water was going to come from. I mean, even the military survival training in the USA, they give us clean water because they think it's that bad. So, here's the question. There's a big hole in front of your house. And a blind person is walking around the big hole. And eventually, they stumble down the hole. And you have been watching. Who is at fault? Because if we have been watching and we could've done something about it, we are at fault. And this isn't even just about the divide. It's not just about the poverty, the poor and the rich. We do dump things all over the planet all the time. And it negatively affects all of us regardless of the economic bracket we are in. And what it means is that we have to think differently. We have to think about the world differently. Because we live in a fish bowl. It doesn't feel like it. It feels like we explored the world in nations. So, we governed it in nations. And we thought that we could make it all work by just governing it in nations. But no one was responsible for the air or the water. And so, we just dumped into it as much as we wanted to thinking it wouldn't matter. But we were wrong. It matters. And so, now, I mean, this is all the water left in the world.

This is everything. 98 percent of it is seawater, 1 percent of it is in the icecaps, 1 percent of it is the fresh water of the whole planet. I mean a little bubble so small that it wouldn't even show up on the chart. That's all the fresh water in the world. We live inside of a fish bowl. And that's all the air. But here's the point. Even though that bubble is small, there's enough water for a hundred trillion people in the world without even impacting the environment. We don't have a shortage of water in the world. We have a shortage of moving clean water in the world. And that's a very different kind of a problem. That's not a problem of abundance and scarcity. That's a problem of leadership. And it means we have to think about the world differently. Who has seen one of these? It's a sealed glass ball. There's no opening. And there are some shrimps inside. And the shrimps produce CO_2. And the CO_2 gets taken by the algae that grow on this plant and then they produce oxygen which the shrimp live off. And then the shrimp eat the algae, and then they poop the algae, which the algae live off. It's a perfect ecosphere. I had one for like a week. I had it in the sun and everything died. And I told it to Ramon Mcolly. He is one of our faculty members. He is a Biology professor. He said, 'You just left it in the sun for too long.'. And he bought me another one. And I have had it now for four years. And there are still three shrimps alive. I didn't even know shrimp lived that long.

But here's the point. If I move it and leave it in the window where it gets too much sunlight, everything gets out of whack. It will all turn grey and then it all dies. And scientists believe that our world is actually just like that. We live in a sealed glass ball. And so, the thing to understand is that it's not about increasing CO_2 levels or the increasing temperature. It's not the issue. And even though we are sort of off the chart for the last 800 thousand years, that's not the point. The point is that there are tipping points. See, if I push this over… If I push it, it bounces back a little bit. It comes back a little bit. But at some point, I pushed it too much. And then it will just accelerate and hit the floor. And our world is just like that. And so far, the world has been a net carbon absorber. And if we stopped doing everything we were doing and let it go, because of the trees and the algae, it would slowly recover. But many scientists believe that we are no longer at this point anymore. We are at the brink right now of becoming a net carbon producer. And if it becomes a net carbon producer, it means things will start to accelerate away. And we don't have a clue how we will ever bring it back. We don't even have a plan. And there's not just one tipping point. It's like 15 of them. Just for the weather, there are 15 of them. And there's tipping points for all these other things. And most scientists I speak to, they say that global warming isn't even the biggest issue. They say ocean acidification is the biggest issue. We are going to lose one-third of the world's oceans in the next 20 years. We are going to lose one-third of the world's fish. And right now, most of the world is getting their protein from fish. And so, it's going to be a very different kind of world. Three months ago, I was in Australia. I don't know if you have been to Australia, but the Great Barrier Reef, the largest living structure on the planet is just off the coast. And if you haven't been there, it looks like this. All the coral is bleached. In 2016, 90 percent of the Great Barrier Reef got bleached. Because of the ocean acidification, the coral ejected its algae. And within two years, the coral will die. In 2016, one-third of the 800-mile Great Barrier Reef died. If you haven't seen it, go. Because it won't be there for you to see or very little of it will be. Three weeks ago, I was in Hawaii. Hawaii is the most distant piece of land from the other major piece of land. And if you have been to Hawaii recently and you go to a beach, it's not clean by a hotel, it looks like this. Covered in plastic, none of which comes from Hawaii. In fact, if you look at the results of it, it's quite fascinating. 90 percent of the plastic in our ocean comes from just ten rivers. 90 percent! In fact, if you had some salt with your food today, it almost certainly has plastic in it. There's no salt in the world that comes anymore that is plastic free. Most of our salt comes from the ocean. And there's still some stuff. You get the Himalayan salt. But all of our salt, our table salt has plastic in

it. 50 percent of it is the polyester fibers in our clothes. Every time we wash our clothes, those little polyester fibers go into the ocean, fish bowl and end up back into the salt that we eat because we live in a fish bowl. We live in a spaceship. It's a sealed glass ball. I often think we don't have to go to space; we are already in space. And the strange thing is that it's not even that big. It used to be huge. I mean, 200 years ago, if I wanted to come here from California, it would have taken me two or three years. And I probably wouldn't have made it. Today, I got here in 16 and a half hours. I mean, we could all go to the airport and fly to where the girl who was crawling in the sand lived. I mean, we could go outside maybe and see that. Somehow, in the last 200 years, our world went from being a 2-3-year big world to a one-day world. And all it means is that distance is no longer an excuse. We all live in the same place. We don't live in a big place anymore where we can just worry about our own little kingdom. So, we have to think about the world differently. I am going to show you a video and I want you to know that the video is a little bit violent. It takes place in South Africa in Kruger Park. When you watch the video, I want you to think about two things. I want you to think about the hurting instinct where we want to help each other. And I want you to think about the self-preservation instinct where we just want to look after ourselves.

That is a huge buffalo. A bunch of African buffaloe strolling one day. They don't realize that they are about to walk into a pride of lions. Five lions. The lions see well. They can see the buffalo coming. Buffaloe don't see so well. They don't even know it. The lions are thinking, 'Our lunch is just going to walk right into us today.'. As you can see, there's a big male buffalo, a mama buffalo, a baby buffalo and a hundred buffaloe behind them. Even I can see some of them. See, those buffaloe can smell the lions now. Here we go. Watch this. Survival of the fittest. They go after the baby. Now, lions aren't amazing swimmers. They hate swimming. They hate swimming because these waters are typically infested with crocodiles. And if you look very carefully just to the lower left, you will actually see a crocodile already coming up. So, they are trying to get the baby out. Hurting instinct, helping each other. They are trying to get this baby out of the water. The crocodile is right there. He is going to take a snap at that male lion. Watch this. Watch how fast the lions' reactions are. Boom! Missed. The male lion now hissing at the crocodile. The lions are realizing there's a crocodile in the water. All of them are getting out of the water. This crocodile is going steal its lunch. The crocodile has got the baby calf. The lions' hurting instinct, helping each other. Manager in the back. Keep an eye on that manager. Tug of war going on. Hurting instinct, helping each

other. And the lions win. And in the meantime, the buffaloe had a meeting. Buffaloe usually run from lions. Something different happens today. Watch this. Now, watch the manager lion. Here we go. One buffalo is going to get a crazy idea. One buffalo's crazy idea. Here it goes. He is gonna charge a lion. He charges. He turns around to run. Realizes, hey, that does work. And that buffalo now chases the lion. Now, success. He comes back and he does this. Watch this. Oh! That's going to hurt. Buffalo chasing lions, lions running away. The baby calf standing up. The baby calf walks away. And now, this is called stubbornness or stupidity. I mean, they don't even have the calf anymore. They are still trying to hold their ground. But these buffaloe don't think the same anymore. They have been changed by that one buffalo. And they chase away even the last lions even though they don't have the baby calf. I won't show it till the end because it's about eight minutes long. There's a cool moment where that male lion goes so far enough away that he is not being chased anymore. And he turns around, looks back and he just stares. Like what the heck just happened! How did we end up running from buffalo today? Two lessons we can learn from this. Not that the lions were perpetrators. But I think I am pretty sure we were all rooting for that baby buffalo, right? Perpetrators, collaborators, bystanders, victims. Perpetrators, the lions. Collaborators, maybe the crocodile. Bystanders, all those buffalo that weren't doing anything and weren't involved. Victim, that baby calf. We can be clear about three of these. The bystander, however, is the fulcrum. It's the point of change. I didn't get this for the longest time. Perpetrators, collaborators, bystanders, victims. We can be clear about three of these categories. The bystander, however, is the fulcrum. All those buffalo that weren't involved were the fulcrum, the bystanders. See, these other three, perpetrators, collaborators and victim make a triangle of stability. They will go on for not just years, but decades. For hundreds of years. And each time you see something harmful, something evil in our world, you will see these four players. And three of them create this self-supporting triangle. And only one of them, the bystanders, can make the change. I will show you what I mean. Victim. Perpetrator, slave owner. Collaborator, people buying bricks, people buying cotton, whatever it is. This triangle went on not for just decades, for hundreds of years. And it wasn't until all the bystanders, all the people that weren't involved decided to get involved, and it stopped. In other words, the bystanders, people like us that actually are not involved have all of the power to make change. It's better than that. We are the only ones that can make change. It means it's more of a responsibility than optionality. Here's the

challenge. The challenge is that perpetrators are typically surrounded by other perpetrators. And so, it's hard for them to recognize themselves. Because everyone around them is doing the same thing. And so, if you want to be a perpetrator, you have got to think different. You have got to think differently. And I know. You are looking at this and saying… Well, clearly, I would never be involved in slavery or anarchism. But I think we are involved in all kinds of things like that. We just haven't thought about it enough. They hate it when I show this. They say, we know they suffer. And what's strange is we know it's not sustainable. And what's worse is that we know it actually now contributes to our number one problem in the world. 20 percent of global warming. And we still do it. But it's crazier than that. By eating too much of it, it will become the most likely reason that we will die. I mean, atherosclerosis is the number one killer. Stroke is the number three killer. And by eating too much of that, we will die from it. And yet we still do it! See. Everybody wants to change the world, but nobody wants to change. Here's the second thing. The second thing I call the third thing. And it means this. It means you hear somebody scream down a dark alley, and there is a part of you, the hurting instinct, that wants to go down there and help. But there's another part of us too. The self-preservation instinct. The manager lion that doesn't wanna go down and help because he might get hurt. Animals share those two things. We just watched that video where they exhibit those two things. But because we are slightly smarter than an ape, we get this third thing. And the third thing is that we know that the right thing to do is to go down and help. It's not one or the other. There's a right thing to do. And we know what it is. And then the only question is whether we can do it or not. I am kind of convinced that even animals have this third thing where they know the difference between right and wrong. And I am kind of a dog guy. So, it's a little bit weird. But I am going to show a cat's video. But I am pretty sure this cat knows the difference between right and wrong. And you can tell me what you think. And that is why I am a dog guy. How do we make a difference? First, you have to realise you can make a difference. The only people who can change the world are the people who believe they can make a difference. If you don't believe you can make a difference, you won't try. So, you have to fully internalize the belief which is the truth that you can make a difference. If you looked at any world problem we have actually solved, you would see the same thing. I will show you an example. Ozone hole growing out of control. I mean, clearly, 25 years in a row, it's getting bigger. Had it reached the half way point, the tipping point, it would have never recovered. We could not have made it recover. But some

people who weren't responsible for fixing ozone holes, people like you and I just decided one day that they would get together. Then they flew around the world and talked to the governments to actually reduce the CFCs being produced in the countries they visited. And the ozone hole has either shrunk or stabilized depending on which scientist you speak to. In other words, the problem got fixed because of some bystanders. They stood up. That was it. They showed up. They weren't responsible for fixing ozone holes. I will give you another example. United Nations, 70 years in a row, responsible for one thing. Stop World War 3. That was their mission. And some people like you and I, bystanders who weren't involved decided to go to the UN, and try and convince them that it wasn't the biggest problem in the world. And it took a few years. Four years. Four years later, the UN says that that's not the biggest problem in the world. These are the 17 biggest problems in the world. In other words, the UN disrupted itself. Now, I want you to get this. The UN is probably the most bureaucratic organization in the world. And they still disrupted themselves. Which means no other organization in the world has an excuse. Here's the other thing I will say about it though. It's great that we fix problems. And I am sure you have heard about moon shots and about fixing problems. Here's the thing to get. We didn't fix a problem by going to the moon. We didn't do it to fix a problem. We did it because we could. We did it because it inspired us. It inspired the best of us. Yes, we should fix problems. But we should also do inspiring things that remind us of what we are and what we are capable of doing. And so, in July, I briefed to the UN a different set of goals. Not to replace the sustainable development goals, but to augment them. 17 goals that didn't fix a problem per say. But they were just inspirational. And so, now, we have the 17 global inspirational goals. They don't fix problems per say, but we should do it. We should have a global internet. We should have global currency. We should have universal citizenship. The UN members have the universal citizenship and the UN passport. People in the world should get the same thing. I mean, just because you are born in a certain place 50 years ago, that might not be your strongest affiliation anymore. And sure, enough modern governance. I mean, we need to think about a new governance. 300 years ago, if George Washington, the president, wanted to send a message from Washington DC to Boston, he would have to give a note to somebody on a horse. And it would take him a month or three just to get there. In fact, he typically would give it to three people. Because you know, two of them would get a job or get married on the way, and no one would even make it. Well, guess what? Things are different today. And we should start thinking about

governance, about government, about how it can be different than what it has been in the past. Because we can do extraordinary things if it is different. There is more to government than management. There's also leadership. Leadership is about doing things different. And leadership isn't about creating a bunch of followers. That's old leadership. I mean, leaders can make mistakes too. So, what it means is that really great leaders don't create a bunch of followers. They create more leaders. I mean, the best leaders in the world create more leaders. They know how to create leaders. They know how to create more leaders. You get just one of these in your organization. And it will change the world. It will change your whole organization. And so, now, how do you do that? You don't do it by trying to be a leader. You don't do it by trying to have a bunch of followers and manage a bunch of followers. That's not actually how leadership works. Leadership works because you change yourself. You become a person that's worth leading. You become somebody that people want to be like, that people want to copy or follow. And you do that by working on these things, by working on your character. You grow your integrity. You grow your humility. You grow your compassion. You grow yourself. And then the world starts to change. See. Exponential leaders don't try to change the world. They try to change themselves. And then the world starts to slowly change around them. They don't try to change the world. They try to change a few people around them. And they create some leaders who create other leaders. And that slowly unfolds to change the world. And all of the greatest leaders that we have ever had, all do it the same way. And the second thing they do is that they create a great culture. So, you can create great leaders, but if you have a bad culture, great leaders can't perform. And so, you also have to create a great culture. And the number one most important thing to create a great culture is the ability to take risks without punishment. It's like a casino. And this is the great culture. I know it seems strange. But you walk in a casino and there's the excitement of the machines making noise and everything. But which machines make noise? What sound do the losing machines make? It's just clicks, click, click. You imagine if you walked in a casino and all the losing machines made noise. You would never walk in again. This is Silicon Valley. This is the greatest companies in the world that innovate. They celebrate the winners. You hear about Airbnb, Uber and Facebook. How many of the loser companies do you know? I am telling you Silicon Valley is a valley of death and carnage. There are dying companies all over the place. For every one you have heard, there are a hundred others that had died, that you never hear about. See. If XXX gets put in charge of the next cool project in the

Indian government, and then the project fails, what do you think is going to happen to him? It may not be the best things. And then all the other buffalo in the organization see that and they don't want to take a risk. So, we have to create a culture where we get rewarded for the risks. Which means now we get another cool project, and it's like Kip gets to get on it. Kip gets to handle the next cool project. And then all the other buffalo go… Oh, I get it. That's how I get a hand. I take some risks and I fail. And I get rewarded by getting another project. And when you create this buffalo thing, it means you can allow an individual to succeed without the price of failure. If the first buffalo in charge had gotten killed by the lion, none of the other buffalo would've done anything. They would all sort of just turn their heads and walk away, like the manager lion. I am not saying you take dumb risks. I mean there are dumb risks you take too. I am saying you take calculated risk. And you are rewarded. And the kind of risks I am talking about aren't even that kind. They are not the physical courage risk. They are the moral courage. The risk to stand up to what other people are doing and do the right thing. Here's the best photo I know of it. It was actually discovered 15 years ago. Adolf Hitler just spoke. In 1936, it was illegal not to hail the Hitler. And I don't know if you can see this guy. Well, he is like… I am not doing it. I was curious. Curious to know who this guy was. How do you get the courage to say I am not doing it? I mean I didn't draw that circle by the way. The Nazis drew that circle to identify him. Because what I am going to tell you now isn't a happy ending. All risks don't go rewarded. You need to have some certainty about what you are doing and the right way to do it. Six months later, I learnt who he is. August Landmesser. This woman from Denmark told me about him. Here's the story. He joins the Nazi Party in 1931 for the hope the party provided. In 1934, he meets Irma Eckler, in the photo, gets engaged, falls in love. In 1935, the Nazis discover that she is Jewish. So, he gets expelled from the party and his marriage is denied. And that's when the photo gets taken. In other words, August Landmesser gets the courage to say 'I am not doing it' because of his love and compassion for Irma. His compassion gives him the courage to say, I am not doing it'. Well, sure enough, he flees to Denmark. But they are caught at the border. They were arrested. He is acquitted. He is warned to not do it again. But for his love for Irma, he continues anyway. He is actually warned a third time to stop and never do it again and he continues anyway. And then finally, the Nazis send him into a penal colony and hard labour in the war. It's presumed he got killed. And Irma gets sent to Benburg where she is killed along with 10,000 other Jews. Not all risks go rewarded. Few are willing to brave the disapproval of their fellows,

the censure of their colleagues, the wrath of their society. Moral courage is a rarer commodity than bravery-in-battle or great intelligence. Yet, it is the one essential vital quality for those who seek to change a world which yields most painfully to change. But if you think for a moment that one person can't make a difference, you would be wrong. And it's because of a physical law. The Butterfly Effect. Something as small as the flutter of a butterfly's wing can ultimately cause a typhoon halfway around the world. And we know that. Because we model typhoons and super computers and hurricanes, and we can trace them back. And they always trace back some little wispy wing somewhere. It builds and builds and builds until it's a level five hurricane. And if you looked at any of our great leaders in the world, you would see that same affect. Martin Luther King, an extraordinary human being. I mean I wish I could develop the character of Martin Luther King, or have the leadership or the change that Martin Luther King created. But here's the point. All of Martin Luther King's works get inspired by one woman. One woman in a single day of her life because of where she chose to sit on a bus. I mean it's worth repeating. One woman changed the world in a single moment of her life because of a single day in her life where she chose to sit differently on a bus. Each time a person stands up for an ideal, or acts to improve the lot of others, or strikes out against injustice, they sent forth a tiny ripple of hope. And crossing each other from a million different centers of energy and daring, those ripples build a current that can sweep down the mightiest walls of oppression and resistance. And so, now, you get to see the potential of a human being. What's the potential of a baby? Unlimited. Anybody doubt it? What's your potential? I mean I guarantee it's more than a baby. But most of us as we grow up, we start to create these little walls about what we think we are capable of doing. Most people in the world don't leave the town that they were born in. Not because anyone stops them, just because they never have the internal courage or the internal ambition or adventure to just step out. But your potential is unlimited. And we know it. And we know it not because technology is exponential. But you have got to get it. Even thought we spent the last two days with you talking about the potential of exponential technology, you have to recognize that we are the exponential thing. Technology is exponential because we make it so. We are the exponential beings. The technology is just the effect of the extraordinary thing that we already are. A year ago, I got to have a very moving week in Varanasi. In it, it made me think about death and what we are supposed to really do in life. And there was this amazing woman in New York city named Bronnie Ware. She was an investment banker for about eight years.

And she thought about the same question, except she did something about it. She thought… You know what if I want to find out about how I am supposed to live my life, I should go and talk to people that just live their life. So, she quits her job and becomes a palliative carer. And she starts taking care of people that had a few weeks left to live. And she starts writing a blog. Because she starts asking them what's the biggest regret of their life. And she makes an incredible discovery that everybody has the same five regrets. And those people helped her write a book called The Regrets of The Dying. These are the regrets. People who were dying had wished they would let themselves be happier, laughed and stayed silly. They wished they had stayed in touch with their friends. They wished they had the courage to express their feelings and tell people that they loved them. They wished they hadn't worked so hard on the treadmill of existence. But the number one regret… The number one regret by far is that they wished they had the courage to not live the lives others expected of them. I will take about a minute and then I will close. This is Paul Graham, Y- Combinator. The five regrets paint a portrait of a post-industrial person who shrinks into a shape that fits their circumstances, and then turn dutifully till they stop. In other words, we become a cog. This isn't just true for our life. This is true for our jobs. This is true for organizations. We do just what's expected of us, and nothing more. And that ends up being the biggest regret of our life. And if you don't want to be a cog, because cogs are not very valuable, cogism doesn't make for a fulfilling life. And I know of only one way to break out of it. And it's just this simple. You have got to do what that buffalo did. You do something courageous, and you run like heck afterwards if you have to. But courage is the only way you break out of cogism. And the only other question left is how do I get the courage. And the answer is in August Landmesser. Because now, I have been serving the government for 35 years, I have seen enough people win medals of courage to realise that they never do it to win a medal. They never do it to be courageous. They do it because they love their family, or they love their community, or they love their fellow officer, they love their country. You grow your compassion for a set of people, and the courage comes with it for free. I end with this. Courage is not the absence of fear but the judgment… Not the absence of fear. You have to have fear to have the courage. But the judgment that something else like compassion is more important than fear. The brave may not live forever, as August Landmesser showed us. But the cautious do not live at all. I hope that something I said to you today was helpful. Thank you.

Exponential Potential through Exponential Technologies

Andre Wegner

This is an exciting time for me as I said, I lived in India for a couple of years and so it's great for me to be back and to speak to a group of people who will clearly lead this country forward.

The place I lived in also inspired a lot of the talk. I lived in Mumbai and in Hyderabad and, and specifically the area I lived in Mumbai, the commute I had to do to work every day took me through a small area, area of small and lightweight manufacturing, Goregaon.

These areas brought to my attention that so much in this country is being done in relatively smaller micro manufacturers, right. Specifically, they would be doing metal work. I even found one shop in that area that was making bullets. There were companies making fabrics or leather. So all kinds of different industries will exist in these locations. So when I'm now looking at digital manufacturing, the really exciting thing that I see is that the innovations in manufacturing are mostly directed towards these kinds of small manufacturing outputs. So think about this machine. This machine is the world's first machine that combines 3D printing and subtractive manufacturing, in one machine.

This is essentially a factory in a box. You can put any powder in there and it will come out with a finished part that you can use on a plane. And that kind of machine could be set within the setting that I had to walk to work every day through so it's an exciting opportunity because not only are we changing the way manufacturing happens locally, we're also enabling completely new opportunities.

Think about it as we're moving companies from a manual manufacturing environment to a more digital one, what we're doing is that we're creating a whole lot more data. That data currently goes down to the granularity level of being able to see the spatter that comes off metal powder as we're hitting it with a laser. That's how much information we can get from one of those machines. And as a result of that data, we can have a lot more control. Those machines are faster, more accurate and better than any manual manufacturing

process precisely because they use the opportunity of data leverage within them.

And so with 3D printing we're seeing that innovation happening at a very, very fast pace. In 2015, when I came to Singularity and gave some talks, a lot of the questions that I got were, but hey, we'll never be fast enough. And in 2015, the first printer came into the market from HP. And they said, “we're 10 times faster than any competitor in the market today.” And then only three months later, a printer came into the market by Karbon, a startup in the San Francisco area funded with $600 million and they said, “Hey, we can print something 100 times faster than our nearest competitor. “ So within three months, all the questions I ever got about speed, were gone and that cycle of innovation, that trajectory is not yet complete. This is one of the latest printers come out of a research lab in California. That literally sends a fragment of light into revolving vats of material for several seconds and the finished part will come out of it.

So we're on a trajectory not only with polymers, we're also there with metal right now, the most advanced metal 3D printer can print with four lasers at the same time. This company and start-up in Boston can print with over 1000 lasers at the same time, and they're releasing a machine this year. So that level of information that we get from within a digital manufacturing process yields control, which yields in massive improvements in speed, and reliability and efficiency and so forth.

So, that innovation cycle then yields a lot more opportunity. We get more materials coming out of it. So the incumbents in these industries, they tend to think, “Oh, goodness! What are we going to do with so much innovation happening? Our current product portfolio doesn't work anymore. Let's work on a future product portfolio” The first time we were ever able to manufacture anything off the face of the earth was quite incredible. We're now able to manufacture 3D and print very big objects, as big as 7 * 14 * 10 meters. We're now able to print food or pharmaceuticals and these are based on the same process of innovation that we started at the beginning, which is that we made the manufacturing process go digital in the first place.

And that extends not only to 3D printing, every other manufacturing methodology that uses the concept of returning a manual device from a computer essentially does the same thing. Think about collaborative robotics, or digital knitting. This talk reached me in a store while I waited or a CNC machine or carbon fibre layups. This carbon fibre used to be incredibly expensive and until Boeing started innovating and that way we would

automate the layup and control the layout much better and now we have the Dreamliner, one of the world's most advanced aircraft. Their ability to control the exact process of laying metal wiring down to the design that we created on the computer is being refined every day.

Those machines, what they've brought together is that they are all communicating a very clear sense of the capability at any given moment. That is one of the most fundamental, most important aspects of digital manufacturing today, especially when you pair it with the other important aspects that are happening at the same time and that is Design because we have so much control of the design process, of the manufacturing process, we're able to now start designing parts in a completely new way.

And when you're thinking about designing a physical product, typically what you're doing is you're thinking in terms of constraints of the manufacturing process. You're thinking in terms of how do I bend this? Or how do I punch a hole through this? That's the thought behind product design. But with digital manufacturing equipment, taking your design and transferring that into a physical reality, by using computation, we don't have those. We don't have to think about those constraints anymore. We still have them, but the computer deals with them and that allows us to now start designing in a completely new way in what we call generative design and that generative design process gives us the opportunity of going through thousands of different iterations of our objective in a very small amount of time. Think about this, a motorbike. I wanted to go 200 miles an hour, I want a seat, two wheels and a handlebar, Great! Computer, GO.

Of course, this is still being used to inspire designers and is based on old technology, finite element analysis. But what is remarkable about this is that all the companies are making software for designers today, Autodesk Siemens, for instance. This is the future of manufacturing. And what's happening in design is that we're turning engineers into constraint managers, because we're no longer asking people to draw lines on a computer or onto a piece of paper. We're getting the engineer to tell us what is it you want to accomplish and with that input, we generate auto geometry, we no longer design the geometry in the first place and that's already coming to bear.

Think about the metal 3D printer right now. Metal 3D printing requires us to provide support structures for the object being printed so that we can withdraw heat and keep the object stable. Those support structures used to have to be drawn by hand. Now that will be done by an algorithm because we know exactly how much heat we have to bring out, we're saving valuable time

from highly experienced engineers. The same is also true for tools, jigs and fixtures used in the manufacturing process. Previously, it might have taken up to six weeks to get a fixture into place so that we could actually manufacture the part that we were making. This is a tool we're making, not the actual part and now these guys with the combination of generative design and 3D printing were able to bring that time down to just a day or two. Incredible innovations, incredible speed happening and it's not just in those corner cases or in those niches that we have found this generative design approach useful. It's happening right now on a very large scale. There is a company that has gone completely all the way towards constraint-driven design or generative design and it's no longer giving its users the opportunity to draw the physical shape anymore. Instead, you operate in fields and we are getting designer designers to tell us what material is being used, what is the simulation result that I want to achieve, what is the geometric space available for this part, and the algorithm will come out with a final shape. This is technology funded by Lockheed Martin, Siemens and other big players. So we know there's some reality behind it. What the opportunity is there to bring those two sides together! But on the one side, we have the idea and on the other side, a physical production of it, and this used to be very divorced, it used to be a very long value chain and process to get this idea into a pot. What we're seeing now is that timeline is contracting quite heavily.

On the one side, you have the new generative design algorithms and on the other side you have machines that are able to, at a moment's notice, tell us what they're capable of producing and you bring those two together and you create a much more agile manufacturing network and in this manufacturing network, we are able to say that we want to get an idea and get a part out, we want to be able to produce. Your algorithm tell us which nodes in the manufacturing or in the manufacturing value chain, I should actually be using or in which cases I should be using humans and in which all machines and bring all of that data together and let me communicate within my manufacturing network. So, a manufacturing network that enables us is one that brings both this new production capability of digital equipment in many different locations plus new generative design algorithms together.

So in the Indian context it is not hard to understand what might be enabling for there is this company called Intech DMLS based in Bangalore, and in just nine months, they were able to come up with and produce the first gas-powered turbine for fighter jets in the country, a challenge which has eluded us for a long time. So these are huge advances that we can get. Think about new performance parameters in pretty much every mechanical equipment

company today. We are going through a process of taking parts out of the machine, figuring out how we can save material, how we can increase performance, how we can reduce the path count of those devices, bit by bit by bit. It's a very long and arduous process so that improvement is happening, as we speak. But it's not only happening at the mechanical level that we're adding, performance is also happening at the micro level, we can now 3D print at less than one micron, less than 1 percent of the width of the human hair and that allows us to drive new micro structures in physical parts. We're basically starting to innovate based on physics, not chemistry, innovate on this principle.

So I could have a part or a piece of elastic, that if I pull it, normally would contract. But I can affect the micro structures in my new digitally manufactured elastic so that the elastic actually expands or a piece of equipment and I heat one side of it and it's so effective at transferring heat that the side that I'm heating never actually gets any hotter at all. That's innovation in a subject area called Architecture of Materials. And there are a lot of examples of how that's being used today, including lifting a lot of weight with any very, very lightweight equipment, or 3D printed shoes, like these ones, over a million shoes are being 3D printed this year and that's up from zero, just 18 months ago and this idea of architecture and materials yields yet another idea, which is that of 4D printing. That's the idea that we might be able to print two materials side by side that have different reactions to a given environment for example, water in this case. So I am designing a part, I expose it to the environment, in this case, water, and what I get is the MIT logo, but the same is true, really for any physical object. So the idea that you could, for example, print or print the joints of an IKEA bookshelf and instead of having to screw that IKEA bookshelf together, you have a bookshelf - you tear off the cover, it reacts differently to oxygen, and the bookshelf rises from the box. Right? These are all opportunities that are still ahead of us.

All of this is based on knowledge that we've generated over the last few decades. In particular, DNA origami has been one that's been around for more than 20 years. And this is the idea of using DNA as a building block rather than simply as an information carrier and heating and cooling it in specific intervals and that allows us on the other hand to think about new types of medicine. This is a DNA-built robot. It floats in your bloodstream, identifies cancer cells and only releases the chemotherapy drug when it's identified that cancer cell, completely eliminating any side effects from the process or most side effects of the process. It's a huge improvement thanks to digital manufacturing and that innovation is what is yielding yet the next breakthrough, which is an

innovation in nanomaterials. So this example here, each golden thread here is a robot that is holding down one atom at a time and allowing us to assemble atomic structures 100,000 times faster, building the new set of nano materials faster than anything that came before.

The next layer that we're enabling is new business models.

Those of you who have heard of 3D printing have probably only heard of it in your engineering courses. Maybe you've seen some in schools or libraries, but this is actually big business now. This company here makes more than $2 billion based on the 3D printed mould. So it makes these clear braces that are called Invisalign, and they print the mould and then they thermoform the brace on top of it. That business would not exist without 3D printing.

And it's now one that's driving a lot of investments in the US because the patents have just expired. GE is another example GE has not made an engine for a small plane in over 20 years and with 3D printing, they said let's give it another try. So they came up with an engine design that is 35 percent 3D printed, they've reduced the part count for those 35 percent from 850 parts to 17 parts and as a result, they're in sourcing all of the supply chain, they no longer have a very complex supply chain out there.

And there is this company called Divergent 3D. The Divergent 3D is a car company that does not build any cars, but what they do instead is that they sell the technology that enables companies to start tooling their cars in a very different way. What's amazing is not that it goes from zero to 100 in less than two seconds. It is that we are 3D printing joints and joining them together with carbon fiber tubes to allow us to reduce the tooling and set-up costs of a new car from $250 to just $16 million.

It's a huge price difference. And that enables us to create new car companies but more importantly hit different types of consumers at any given moment. That concept also extends to construction. There is this house that was built in less than 24 hours for less than $10,000. And they believe the price this year will be less than $4,000.

And lastly, as a result and obviously given what you've heard, we're also enabling new types of competitors. This is a company called Relativity that builds entire rockets, 97 per cent of which are 3D printed. So this is hundreds of millions of dollars and the whole space industry is basically unimaginable without digital manufacturing because it so massively reduces the cost of entry for these programs. Space X may be the most famous example in that industry that has two 3D printed components for every traditional

manufacturing component on their spacecraft. Huge changes are happening. And of course, that is what's enabling countries like India to engage in large-scale production processes. And I want to raise this point again, these programs are really a big driving force, but who actually is feeding these programs are the SMEs and the small and micro businesses that you will all be in touch with as you go and do your work. It's incredibly important that those guys at the ground level know about the opportunities of digital manufacturing because without them, these programs would have not actually happened at all.

So where do we go from here? I think I've made that clear on a national level. But I think the global drivers for this digital manufacturing innovation are first, obviously fickle consumers. We are so used to getting whatever we want at the drop of a hat, with just the press of a button on our phones in terms of digital information, videos, books, music, whatever you want. But physical products are still harder to build. 83 percent of kickstart projects that involved a hardware component were delayed. If a company, for example, Lego tries to reject or tries to not address this challenge of the customer demanding more and more immediate responses to their needs, then they will start to fail. Traditionally, what they will do is they will increase their product portfolio, they will double the number of parts in the case of Lego in order to give the customer whatever he or she wants, wherever he or she needs the product.

But if you're using traditional manufacturing to accomplish this aim, you will fail. Lego started making a loss the moment it started increasing its product portfolio, it started making a loss and it only recovered and made a profit as soon as it re-worked its product portfolio again. So, think about this, if we try to meet the demands of the consumers, for physical products, to be like digital products in terms of that immediacy, with traditional manufacturing, we will fail. It will only be possible with digital manufacturing. And this is going to get worse as the amount of data around us to enable better engines, increases. For instance, just flying here. The planes I flew on generated about 10 to 15 terabytes worth of data, we could use that information to design better engines for the Indian subcontinent or for the Pacific crossing or for the Atlantic crossing, but we can't because it takes a minimum of 10 years to get an idea into a flying jet engine. The same is true, as was mentioned, with self driving cars. Never before have we had more information about urban and rural landscapes. We could use that information to design better shopping experiences, better lifestyles, better engagement models for humans in those environments, but it takes 10 years to get a real estate project or regeneration project off the ground at the minimum. Even worse for DNA. It will soon be

cheap for us to get a full body DNA scan into the toilet flush. We could use that information to generate even more personalized data, medicine, medical devices or other kinds of equipment that is personalized to our body but can we now? Perhaps no, because it takes us years and years to get those products into the market.

Another aspect is our ability to react to changes in markets. Take for example, the energy prices, Over the last three days, the energy prices in the Midwest, in America because of heavy winds have been below zero. The same is true at six points in the last year in Europe. If you are a manufacturer, and have energy as one of your big cost constituents, your best big cost drivers, wouldn't it be amazing if you could produce all of your inventory during those six points when engine energy prices are below zero. But you can't, because manufacturing lines are laid out for one specific mode of production, one specific volume of production. The same is true too for the environment. Let's talk about Toyota. When the tsunami hit the east coast of Japan its four major production centers and over 60 subcontractors produced 600,000 cars less that year than in the previous year. They lost the crown, but that's the point. Toyota was not able to react in an agile manner to a major market or environmental event. Lian Fong on the other hand, is a massive intermediary between eastern factories and western consumers. About one third of all the clothes that are consumed are bought in the US. This is intermediated by Lian Fong and when SARS hit China, and there was an export ban from China, Lian Fong just said "no problem". We will switch to one or the other of 40 countries, one or the other of 15,000 factories that we work with. And as a result, they only had a 0.3 percent drop in revenue during that period. So you can see the contrast if you're not able to react if you're not able to be agile then you will not succeed in the global marketplace.

And of course, lastly, one of the main drivers for a more agile manufacturing network as the one I've been proposing, is politics. Now, we've seen protectionism as a great tool for development in some scenarios. For me, personally, this populism and protectionism hurts me, I am the product of a European exchange program. So this hits me particularly hard, but it also hits businesses, businesses are beginning to realize that they have to start producing the things that they make in the place where they are needed, because some countries won't allow us to import. And if they can't, if a company now tells India we can't make our parts locally because we don't have the experience or the tools necessary to do so, we can presume that they are simply lying. This is because it's not true anymore. With digital manufacturing, we are able to produce locally on demand. It's very exciting to hear that Apple just recently announced that they would be starting to make

their phones locally. So these trends, the opportunity for India to take advantage of its massive domestic market, with the parts made specifically in India, is increasing every day as a result of digital manufacturing.

And one of the big drivers for me personally, in this transition is supply chain failure. Everybody who is here today has some kind of experience of supply chains, failing them personally, or from a business perspective. In Nigeria, where I moved after I wrapped up in India, I lived in Nigeria for five years and a plane crashed, and 159 people died because it takes a minimum of three days to get a spare part into that country. That's an extreme example, but it happens in every country.

In America, every commercial and private plane that flies in America is expected to have a counterfeit or fake part on board, even Air Force One. Because supply chains fail us all the time. My wife ran an oil company in Nigeria, they lost $30 million in four months because the part broke and the company that made that part went out of business 17 years beforehand, so they had to tool it up, get it recertified, produce it and send it back again. Even NASA is not immune to this. They recently found out that a supplier had been cheating with their test results for over 20 years and as a result, they lost two satellites. Just one material provider failed them and they lost $700 million worth of equipment. We spend 32 percent of our GDP in the US making things and sending them to people and yet we have an environment that constantly fails us and so when you see opportunities arising out of new developments currently, like in 3D printing, which move from prototyping to functional prototyping equipment to customize parts and then to high performing parts like this fuel injection, also by GE, I see a trajectory that can solve that challenge. Over 36 percent of the parts that we consume, that we make with 3D printing, our final parts that are used by people, only 15 years ago, that percentage was zero. But it was just prototypes and one off. So you can see the next step in this trajectory is spare parts at present and after that a huge percentage of everything. We expect that by 2027 everything that we use, or 10 percent of everything that we use will be digitally manufactured locally on demand.

That's huge. That doesn't mean that we're 3D printing everything. It doesn't mean that we are making it at home but it means that we're making it within our local area A bit like the hub and spoke model of 2D printing for a few color copies, you'll go to your local shop for a million high quality posters, there's two or three places in the region that will help you and it affects absolutely everything. Think about this value chain of getting a gear to an oil rig. But we first have to go through and understand what are we even capable of

manufacturing? And does it make economic sense to manufacture them in a new way and then we have to redesign those parts for that, to address that particular need and then we have to transact those parts in a new way and get them to the manufacturing side. And then we have to think about where we're going to manufacture them. Does anybody ever think of us as a manufacturer? They have over 300 locations in the US where you can now go in and get a 3D printed component. They become manufacturers themselves and of course, then you have to qualify the parts in completely new ways.

That's all happening already, as I told you, what's exciting for me is that this new paradigm is going to change a lot for you and compel you to think about these areas and I want to take a few minutes now to just speak with the audience and get some feedback on how you think of a change in manufacturing.

And the way I've described today, and the change in supply chains in the way I described today might impact these areas that I've got listed above here. And for those of you who participate, there's a small reward of a pack of cards with 52 examples of 3D printing on them. And that's unique to us.

How would the change in manufacturing and supply chain likely to change security?

Audience. People could print guns.

Andre Wegner. Yes, exactly. When 3D printing is available, we can print guns at home. That's a great example. Thank you very much.

I encourage you, though, for every positive impact or negative impact to think of a counter as well, because they exist. Now we can 3D print guns, you're absolutely right. And that is a big fear. It was actually a 3D printed gun that was for the first time used in a terrorist attack in the US last month. It's really frightening. But what we can also do is we can inject a virus into our computer systems that will insert the IP address of every printed gun into the barrel of the gun so that the bullet now has the IP address of the person who manufactured it. So we have new opportunities in addition to new threats that arise out of this technology.

Economic development, this might be on everybody's mind, how will this transition towards distributed manufacturing impact economic development?

Audience. This 3D manufacturing can help create new micro entrepreneurs who can set up small manufacturing units in different areas at near the point of consumption. So it boosts economic activity in the villages as well as in the cities.

Andre Wegner. I'm glad you saw the positive effects straightaway. That's great. Anybody got a negative consequence that you're worried about.

Audience. I feel that there will be widespread loss of jobs due to which economic development will suffer because the virtuous cycle is that is a result of people earning and spending will be disrupted because of loss of jobs.

Andre Wegner. I was just speaking to the rest of the World Bank and they are worried because the previous cycle of economic development from low income labor towards a service economy that is under threat now, because we can produce locally, America will produce locally, and others will produce locally, but we're talking about 10 percent of everything that's manufactured, not everything, we still have a large portion of local development available. We're going to continue to move to new examples.

Audience. As far as environment is concerned, I was just thinking if we can 3D print edible cups and plates like made up of millets which are biodegradable and also edible, it would reduce pollution.

Andre Wegner. You might be able to develop the print parameters that allow that to happen. That's a great idea already a research subject that you should deploy.

Audience. Intellectual property.

Andre Wegner. Can we just speak about environment a little more?

Audience. First of all, I think by using 3D printing, we can minimize waste that is produced by manufacturing.

Andre Wegner. That's true. In aviation, usually we use 17 to one flight by ratio. That means we need 17 times the material that actually ends up flying on the plane with 3D printing, that ratio goes down to three or two to one. So there is huge environmental benefit.

Audience. One of the major drawbacks for deployment of solar energy is that manufacturing of solar panels is a lengthy process. I think that with 3D printing this time can be minimized.

Andre Wegner. Or you can come up with new solutions much faster as a result of reducing the development cycle. Another example in the environment field is that maybe a negative consequence if you 3D print all of these different materials at the same time, you might change the way we have to recycle. Think about it. Right now, when you assemble something, we put an electric wire into a plastic component, it's easy to tear that way out because it was put there by a human hand in the first place. But if I'm printing it, I can't tear it out

anymore. So we need to think about new ways of recycling as a result of this technology.

Audience. Intellectual property, I think the issue of generic medicine could be resolved by 3D printing.

Andre Wegner. That's great.

Audience. The cost issues could be resolved.

Andre Wegner. Yes, 3D printed pharmaceuticals that we've had so far have been mostly used for customized medicines. So the epilepsy pill that was 3D printed actually was printed to dissolve at a specific rate, given the saliva in the human mouth in a specific human mouth, so that we can control the exact amount of active ingredient that is happening in that environment. So that's another example of intellectual property.

Small Scale Manufacturing- We have in the company that I've started, we've actually embedded the printing of a QR code. There is an opportunity to perceive exactly what is happening in the production device during the print. And then we can use that data to guarantee that the print was printed correctly. And we only apply a QR code in the last possible instance that lies on top of the part to guarantee that the part was printed correctly. So there's some really interesting connotations of a QR code in there as well.

Audience. We have an example from the job sector. That is manufacturing is usually associated with blue collar jobs. But if we have 3D printing, then it can turn more sophisticated and also that there can be more decentralization of manufacturing because then everybody can be a designer.

Andre Wegner. The job example is a very real one. And there are a lot of concerns about the loss of jobs, not only among blue collar workers, but people that have been highly trained for their specific skills.

Audience. With the coming of homemade 3D manufacturing technology, it can also hamper the IP regime and it can discredit the original manufacturers because of the easy availability of open source manufacturing codes online.

Andre Wegner. This is the big threat that is mentioned all the time. So thank you for bringing it up. There are real concerns about intellectual property consumption.

Andre Wegner. However, think about it like the music industry. The music industry now makes more money than, than before mp3, even though only one third of music is legally purchased. Why is it doing so? Because it's learned to sell value added services, we buy t shirts, we buy ticket sales, tickets for

concerts. And that's how the industry makes more money. Now, if intellectual property is under threat, and I doubt it very much, because it's very unlikely that an airline is going to purchase parts that are not original, let's just put it like that the rate is not going to be 30 percent, it is probably more like 90 percent of the original purchases. But even so, the manufacturers can think about value added services that they might sell to consumers that are buying that equipment from other sources. For example, warranties, warranty is the final value added service. That's the name that's attached. And if you think about a company selling warranties and not producing the parts anymore, that's a massive opportunity because now you don't need to buy the equipment. You don't have all the heavy investments that you need to make. Somebody is buying the path from a third party provider and all you need to do is warrant the data and say that the part was produced correctly. So there's a big opportunity on return on investment for companies engaging with it.

Audience. So we would be reducing the occupational hazards in jobs. If the current manufacturing process has occupational hazards then 3D printing would reduce them.

Andre Wegner. Thank you. I'm going to continue because otherwise we're going to run out of time, but I'm really impressed by the level of comments that have been made. And one of the big things that I realized about jobs is that it's not actually about the threat to jobs. It's a threat to managers. This is the big thing holding jobs back in the manufacturing sector because if we look at how manufacturing is working today, automation is not a threat to jobs but a threat to tasks. Everyone that sits in this room, everybody in the world does a job, that they don't enjoy 100 percent they have tasks within those jobs that they do not enjoy that are repetitive that they think are menial and automation provides an opportunity to get rid of those jobs. Now, the problem that we have is that we never actually asked the people who do these jobs, what jobs they want to have eliminated. That's the challenge that we have. What we're doing is we are enforcing automation from the top down. We're saying you must automate in this way. But we're not actually asking the people that are doing the day-to-day job on how they think the job should be automated. That's the big challenge in automation, right? Because if we did that we would liberate everybody who's doing a job who is relatively high trained for that specific job to do the things that they really enjoy and the things they really add value to and what frightens me is that we're stopping them from automating their own processes, despite the fact that the technologies to support them are already there.

This is not the manufacturing technology innovation of today, I have spoken relatively little about what's happening in major manufacturing centers. They're deploying AR and VR and exoskeletons and collaborative robots. But this is not about deploying these relatively expensive technologies that always require an industrial engineer to deploy them. Because at the end of the day, that is not enabling that is part of the whole top down and forcing that's happening. What I'm talking about is thinking about a new paradigm, for example, this collaborative robot will be still a collaborative robot, and for those of you who don't know, collaborative robots are those that can actually work with humans instead of behind cages. And collaborative robots here are being produced in modules which means that any operator within that manufacturing environment can go to the store cupboard, pick out a few modules, assemble them together and use an app to tell us exactly what tasks they have to do, we do not need an industrial engineer to help us deploy this system anymore. The same is true for jigs and fixtures in the manufacturing setting. This usually takes four to six weeks to deliver and requires approval for many different people. However, we're coming up with tools that are drag and drop interfaces that allow us to deliver the jigs and fixtures within four to six days within an interface, a web interface that the user is always used to.

The same is true for machine learning when I hire machine learning engineers it costs me between $140,000-$180,000 a year that's in the US. But machine learning can now be done within drag and drop interfaces. That's hugely exciting. I means that anybody who knows how to use a drag and drop interface can start designing machine learning algorithms themselves.

We have the first Qualcomm chips that are sitting on a chip and can scan any given environment. The unlock feature of your iPhone is the same 3d scanning. Now we can scan environments

Create 3D models without ever knowing anything about how to design something on the computer. You can design something within Minecraft and export it to a 3D printer. There's plugins available to that. That's free. That doesn't require a lot of training. There's a lot of opportunity within the already existing tools. Everybody in this room is capable of designing a website. Ten years ago, we would have had to hire somebody to design that website. Why shouldn't we allow manufacturing operators to go and use those tools to design their own automations as they think is valuable for them rather than be told how to automate their processes. That also reduces the level of conflict that people are currently experiencing with new technology introductions. They're fearful of new technologies, because they're being forced to adopt a

certain process, rather than be able to come up with their own automations at the same time.

Now, the question for you is what are you going to do when you go to your local areas or districts? And how are you going to act in that environment to support the development of digital manufacturing? Now, I spoke about this earlier, it's incredibly important that you do so because without that the national systems that we have, to which your local area manufacturers or suppliers will never come to fruition. The country as a whole will not be agile enough to develop with a modern economy. And the way that you can help them is first through education and awareness. Clearly, the manufacturers that are operating at a very local level may not know about these new opportunities, but it's also about supporting them.

Now, within Caterpillar, they would say, I want to deploy 30 different uses of technology of 3D printing within my factories within 30 days. And they were able to accomplish 40 in just 20 days, primarily for two reasons. The first is that they had a SWOT team, they had two or three people that really knew what they were doing in 3D printing. So when somebody came up with an idea on how to automate the process, or how to come up with a new 3D printed component, they had a SWOT team available to them. And that is something that I think can be replicated at the district or local level. The government's responsibility is to provide those resources to them so that when they start engaging with the technology, they're able to actually come together and deliver something straight away to the to the user.

The second is that Caterpillar kept it small. They kept it very restricted, and they said within 30 days, and I would encourage those of you who engage with manufacturers later in your deployments, to think about that scale, this is not about industry 4.0 and big data deployments. This is about tiny little innovations and improvements to that processes. And that is something that the people that run manufacturing at the local level today need to know. And they also know what the problems are. Their strategic competitive advantage is that they know the problems better than anybody else, because they've been engaged with this production for so long. That's a huge advantage. Because right now, there's a series of startups coming into the field that have no idea what the real true problems are in our environment and so I encourage you to support them and to encourage the companies that you're working with at the local level, because without them you will fail to deploy a more agile India and also, because giving them the opportunity actually builds on something that they already have, which is this knowledge of the local environment of their

local production environment.

The area that I think that you can support, the local manufacturers in SMEs and micro manufacturers, in is in guidance. They don't know what's coming down, down the down the pipe. And your role is to help them understand what technology developments are happening now versus five years from now, 10 years from now, what is something that they should invest in right now? What is something that they might not want to invest in for a few years and this guidance is for me something that I determined through signals. I have various subscriptions to, say Google news, that tell me that the area that I think is most important for development is developing at the rate at which it will yield a result within a few years, or it's actually further away.

So these are the three areas that I would say are critical to the future - One of them is the taxonomy of intent. So if we're not designing in a geometric shape anymore, then clearly what we need is a new way of capturing what we're actually trying to achieve. That's a whole new language that we have to learn. The second, generative design, we have to take these inputs of intent and develop algorithms that can turn that intent into an actual geometry. And thirdly, machines. Today, we utilize maybe 5 percent of all the available data in the manufacturing environment. And that's because we've always seen machines as dumb executors of our wishes.

But instead, what they're becoming is important partners. These machines are telling us what they're capable of producing, how much and what tolerance they can achieve, what material and so forth. We need to use that data, we need to figure out what language they should communicate in and provide us with that data in a form that we can actually use to create a coherent system. One example of a bet that I made based on the signals was recorded on this website where I said that by 2026 there will be no commercial wind tunnels operating in the in the US anymore.

And that's because I believe simulation technology to be so advanced at that stage that we do not need physical verification, destructive or nondestructive of the parts that we're trying to get to fly at that time. Now, experts in the room that work in simulation will tell me that I'm wrong, I most likely will miss that particular date. But this is absolutely what is there a world in which simulation can determine whether the parts that we're building are going to fly properly or not. We have to adapt our systems, our regulation, our certification systems to take into account that new reality is a huge opportunity for us because without this happening, without simulation, certifying work, it would be incomplete.

When we get all these pieces working together, there's this really huge opportunity for us. Because that's the time when robots that are learning to walk will figure out for themselves that a limb needs to be longer a foot or needs to be wider a back or needs to be taller, and they will send those signals directly to a 3D printer that will print out a new limb or print out a new body and we can assemble that into place at a much faster pace of innovation and this is already happening in labs. Now transfer that to the real world and you will have shoes that will take into account the weather report for your day. Or how much food you ate that day, what your calendar looks like. What your Fitbit data says and will transfer and translate all that data and print a shoe that is perfect for your day and you come home at night and you start recycling it straight away. You think I'm dreaming but this is already happening. This is a project in California that is putting sensors on all of the cars and takes that data immediately in real time and translated to a design software that designs the next generation of that car.

Right now every manufacturer or traditional car company will release a new physical version of its car every three years. Any guesses for how long Tesla needs to release a new version of its car? Every two weeks a new Tesla is released. That means if I buy a Tesla today, the Tesla from two weeks in the future is different from the Tesla that was released two weeks ago. That's the cycle of innovation that we're going to see. So if somebody comes into a hospital and needs a custom implant today, they need to wait four to six weeks to get that custom implant. But in future you can lay somebody in the scanner CT scan or the MRI. They'll be scanned, the end rolled right into the operating theatre and the implant will already have been printed for them. That's the future of manufacturing. On a plane that is breaking apart as it lands, sensors pick up that the part is breaking, machine learning algorithms identify why the part is breaking, generative design algorithms redesign the part to address the point of failure. And before the plane has even landed, a part that is better than the part that has not yet failed is already printing. That's the future of an agile production system, without which no economy will survive. Because every country that does this well is going to have humungous advantages over any other. I encourage you to think about this not only for the industries that I mentioned, but all industries -pharmaceutical, food, construction, white goods, anything out there. It will all be impacted.

Manoj Nair. Dr. Wegner, it was an absolutely riveting presentation with the intended pun on riveting in manufacturing. I have a few questions with me and we have about four minutes left. The first question is from Amritpal Kaur -

"As an expert in this field, how do you see the spirit of digital manufacturing in India in the days to come affecting jobs specifically, given the fact that a lot of jobs in India in the manufacturing sector are labor intensive?"

Andre Wegner. There will be job loss, it is almost inevitable. But in every situation we have also seen job creation happening at the same time. So now that we have more digital manufacturing environments, for example, we can build applications on top of that, that we wouldn't have been able to build. New software companies being established as an example. But I still think that there will be job losses. Now, the important thing to remember is that those job losses will be really detrimental if we enforce them all at the same time from the top down. So if somebody comes in and says, I've automated everything here, you guys can go home. That's the point when it really starts hurting. But if we enable the operators to come up with their own automations, they will bring in those automations in a sustainable manner. They will automate 10 percent of this, 5 percent of that, may be a 2 percent here, and they will do so in a way that feels empowering rather than being confronted with a new reality. So I think it's about how we manage this technological change, rather than whether we prevent it or we allow it. This is going to happen. Let's engage with it and try and figure out how we can do it in a nondestructive manner.

Manoj Nair. I think that makes perfect sense. Here is a question from Kishore Kumar - Please speak about the need for the government to invest in material sciences to progress in manufacturing. And do you have any examples from emerging economies specifically in the South Asian region, that have foreseen futuristic technologies coming into place.

Andre Wegner. Here I have a very good example of a friend of mine in Bangalore who uses 3D printing and went independent and he sought out Singapore as a development environment for his new products. Because the government support there was fairly significant. They've invested more than $500 million in those programs. Now, Singapore does not have a lot to show for it. The companies like his company might come there, and just take the advantage and move right out again. They are ground hopping, so to speak. So we need to think about ways in which we can sustainably support the existing infrastructure that isn't going to change so quickly. And one example as I already mentioned, is to support the local companies with guidance and education, but also actual physical support. Think about having SWOT teams for digital manufacturing in every district so that the manufacturers in those environments will feel the support necessary to improve their production. And that doesn't mean that we don't need to invest in basic research projects.

You mentioned materials. But right now there's more than 26,000 different plastics available in manufacturing today. And it's very expensive to develop new materials and companies like DMLS Intech in Bangalore that I mentioned today has to do that development cycle all by themselves. So it might be possible to support them in ways that aid them at a micro level in a way that isn't going to make them hop from one place to another. But you're only going to do that if you engage on a day to day basis at the district level with those manufacturers to understand what their needs are.

Manoj Nair. I'd also like to add that when you talk about Bangalore, the Indian Institute of Science, Bangalore has a reputed material sciences department and a lot of work is being done on that. I think, I think we have time for a last question from Anviti.

How can small and medium scale industries leverage digital manufacturing to adapt to the future of manufacturing?

Andre Wegner. It's important because there are a lot of opportunities here and the thing is to remember that it's not about big programs to deploy digital manufacturing at a grand scale. This is about asking them what their current challenges are, and supporting them in identifying solutions that I've mentioned that may not have anything to do with manufacturing and automating or improving those challenges in the first place.

Manoj Nair. Do we have a good example of regulatory frameworks in digital manufacturing from emerging economies which India can possibly emulate or even take good practices out of?

Andre Wegner. I think right now the regulators worldwide are on a reactive path to this technology. Take, for example, the US, they had an environment in which a patent for Invisalign, the braces that I mentioned, was still applied in the US but not no longer in an Asian country. So a competitor to Invisalign exported the scan of the mouth, and reimported the scan to have it produced locally. Now, the regulation in the US and nowhere else captures the idea that you might be able to break patents by digitally importing a product again, so that was actually handled all the way up to the Supreme Court. And so it's those lessons that we need to pay attention to, to how other countries deal with the unintended or intended consequences of these new technologies and may be then react to them. But in any situation, my time in India and in Nigeria told me, it's always better to be light and slightly late in your reaction rather than too heavy and too upfront because these industries are just starting to develop now.

India's Potential as a World Technology Leader

Vivek Wadhwa

This is an old story, but it reminds us of the surprises we could get when even a small number like 2 is multiplied by itself many times. King Shihram of India was so pleased when his Grand Vizier, Sissa ibn Dahir, presented him with a game of chess that he asked Sissa ibn Dahir to name his own reward. The request was so modest that the happy king immediately complied. The Grand Vizier had asked for this - One grain of wheat be placed on the first square of the chess board. Two grains on the second square, four on the third, eight on the fourth, 16 on the fifth square and so on, doubling the amount of wheat on each succeeding square until all 64 squares were accounted for. When the King's storage had got into the 17th square, the table was well filled. By the 26th square, the chamber held considerable weight. And the nervous king ordered his servants to speed up the count. When 42 squares were accounted for, the palace itself was swollen. Now, King Shihram learned from the court mathematician that had the process continued, the wheat required would have covered all of India to a depth of over 50 feet. Incidentally, laying these many grains of wheat end to end also does something rather spectacular. They would stretch from the Earth beyond the Sun, pass the orbits of the planets far out across the galaxy to the star Alpha Centauri four light years away. They would then stretch back to Earth, back to Alpha Centauri and back to the Earth again.

So, this is how technology has advanced. And this is the history of technology. Yesterday you learned a lot about some of the applications of technology. Now, I'm going to take you through all of it again and tell you about the opportunities India has, to not only solve the problems of India, but those of the world. The basis for a lot of modern science is actually India. If you go back and read the writings of Aryabhata and a lot of Indian mathematicians, they have pioneered these things. I was with the Dalai Lama this Monday. He was talking about how quantum physics has a basis in the Vedas. He was talking about how he was reading it, how he was inspired by what he read. And it helped him understand a lot about the reality we live in or the lack of reality we

live in. So, a lot of these technologies that we are talking about, have a basis right here in India, and we don't seem to understand that. This is why I was joking that we are looking to foreigners to teach us things we already knew so well that we exported these to the world. So, this is the map of the technology exponential. And it's not only computing that's advancing exponentially, it is everything that computing touches. AI robotics, network sensors, etc. I'm going to take you through a couple of technologies to show you what they mean, and what the implications of these technologies are. First of all, Mirco-Electro-Mechanical Systems. What are MEM Systems? They are essentially circuits that are becoming smaller and smaller. What happens is that as usage increases, we have sensors now in our smartphones, the price keeps dropping. So, the trend is for technology to become smaller, faster and cheaper. Keep this in mind. This is what's going to enable India to rule the world in technology because everything is now becoming affordable and available to all. Look into your pockets. Your Android phones, your smartphones. They have in them sensors that would have cost hundreds and thousands of dollars and weigh hundreds of pounds just 30 or 40 years ago. Everything from barometers to touch screens to proximity sensors, all are in your pocket. You have got the most advanced MEM technology, and you are carrying it everywhere you go. So, what we can now do is to build smart cities. The Indian prime minister has been talking a lot about smart cities, but I don't think he understands the real potential of it because people don't seem to understand how sensors have become so dirt cheap that they can be applied everywhere. My guess is that you could take the entire city of Ahmedabad and turn it into a smart city for about $50 million. How are you going to do that? You don't have to build new infrastructure or build a new city. What you do is that you start putting sensors everywhere. All sorts of light sensors, heat sensors, pollution sensors, sound sensors, you name it and start monitoring it, and then you run your IT operations back and analyse these using AI. This is a trillion-dollar opportunity for India. Because imagine, if you started retrofitting cities and turn them into smart cities, the money to be made isn't in setting up those sensors or even building the sensors. The money to be made is in monitoring those cities, watching them day to day. You know, this is exactly what Indian IT does with western systems. The data centres are back here in different parts of India, and the operations are happening in the West. Imagine, now, if India built the expertise to start implementing cities, making them cleaner, safer, making traffic flow better, and it was all done back here. We are talking about, literally, a multi hundred-billion-dollar market for Indian exports-bigger than today's Indian IT industry. And this can happen today. There is no hurdle to doing any of this.

When we were young, we dreamed about robots like the one from ‘The Jetsons’. You know, 3CPO and R2D2 from 'Star Wars' and 'Star Trek'. We grew up and we got incompetent robots that keep falling down at the 2015 DARPA Challenge. I was going to take you to Carnegie Mellon University and show you the progression of robots over a 20-year period, 6-year period, 4-year period, 1-year period to show you what exponential means. This is the Carnegie Mellon Leg Lab, where they develop some of the most advanced robots. This is 20 years of progress. The founders of the Leg Lab left Carnegie Mellon University and started a company called Boston Dynamics. Watch what happened over 6 years. Alright. Now, watch what happened over 4 years. Now, these humans keep beating up the robots, but the robots will get their revenge. Now, watch what happened over 2 years. No one is going to screw with him. Alright. Now, watch what happened over 1 year. This is called exponential progression. Notice how fast technology is moving. So, what happened over here is you had advances in computing and AI because of the exponential pace of computing. And then you had advances in sensors, cameras, 3D visions. And then you had the actuators. And suddenly, it became possible to build a robot's science fiction. Today, we can build the robots we saw on TV. All the advanced robots can be built today. Also, today, we can build industrial robots, and it has become cheaper. As of last year, it became cheaper to manufacture in the United States and Europe than in China. This is going to be devastating with China. I'm going to get back to this later on. Because you no longer need cheap Chinese labour. This is a trillion-dollar opportunity for India as I'm going to explain to you at the end of this talk. But this is now all changed. AI. We keep hearing about AI. There is so much nonsense we keep hearing about AI. I want to cut through it and give you a crash course. So, you don't feel inferior when you have these techies talking about all of these things and all the buzz around AI. It's mostly complete nonsense. There is a lot there, but it's being overhyped. What is AI? First of all, we were hearing about AI since we were children. Well, most of you are children. I've been hearing about AI since I was a child. We heard about how machines will do what human beings will do. And what happened? Nothing happened. It was great hopes and dashed expectations. The Japanese had the fifth-generation project and they were supposed to take over the world. In the 1980s, we feared that Japan would own AI and will become a superpower. Just like we fear China becoming an AI superpower today, we feared Japan being an AI superpower. And then what happened? Nothing. It imploded. It was called the AI Winter. So much so that if you had an AI start-up and you went to Silicon Valley, you would be laughed out of the offices of the venture

capitalists, five or seven years ago. What changed? The method of programming AI. The old AI used to be if and else statements. So, when Deep Blue beat Garry Kasparov at chess, it was essentially a million lines of code, roughly. They coded up every contingency and with superfast computers, it seemed like magic. Scientists have been stocking for the last 30-40 years about AI's potential in being simulating neural networks. That's how the brain works. The trouble was to create massively parallel computers which is what the brain is. It would have required super computers. And super computers that could do that didn't exist. So, what happened was, our children started playing games. Remember those video games we used to play. The tech industry saw an opportunity there to create a Graphic Processing Unit (GPU). And when scientists looked at it, they said, 'Oh, my God. This is a massively parallel computer.' So, the technology that was built for computer games now was applied to Artificial Intelligence. And then, we started gathering massive amounts of data. And then the scientists got a better algorithm. And voila, the magic happened. It became possible now to create what's called Narrow AI, which is where we are today. When the system acts intelligently, it makes you think it's intelligent, it really isn't. Then next leap forward and there is no such leap in sight. We keep talking and speculating what happens when AI become smarter than humans. It requires the ability of AI to form its own judgement to really understand what's going on. And there is no path to that in sight. So, all these things we hear about singularity, about machines taking over, it's complete nonsense. That it requires leaps of faith that don't exist yet. Not to say that there isn't value in it. It's almost science fiction that you are going to get from where we are to where you have to be because once you have that, then you get the robots of science fiction and you get super intelligence because of the pace in which computing is happening. So, nowhere near that right now. All we have is the basics. And what is AI? I'm going to cut through all the hype again and tell you exactly what it is.

Supervised learning is the system that we have right now. What is supervised learning? Supervised learning. You take a system, you tell it, 'This is a duck. This is not a duck.' And basically, you create a model, you give it examples and it's able to now infer from that, that if has a beak, then there is 95 percent likelihood it's a duck. If it has a tail, there is 0 percent likelihood it's a duck. Essentially, it looks at the example you gave it and learns from that. And then when you give it an example, it tells you what it saw. It's pattern recognition. That's what AI is. AI has some amazing applications but in all the stuff you hear about the magic of AI, and again, India seems to be terrified of China

becoming a superpower in AI. Don't fear it. China is nowhere with AI as is the rest of the world. This is what AI is today. AI achieves learning through neural networks, in which you create a model, give it examples and it understands the patterns that you gave it. And then you give it lots of examples. So, there are lots of opportunities to use AI, to improve things, but AI is simply pattern recognition. We used to call it data mining before. Data Analytics is what we used to call it before. We have given it better names so that people can charge more money for consulting on it. That is what AI is today for everything you need to know.

And then, another side of technology is editing DNA. We have been able to read DNA for quite a while. Genomic sequencing. A few years ago, scientists at Berkeley and MIT also discovered that they could edit DNA. This is an opportunity for India and a dire threat to mankind at the same time. This is how the technology is. Because what we can now do, China is doing it to create Crispr animals. Dogs that are extra muscular, sheep that are the size of cows, monkeys that have completely different characteristics from what they had. These are the type of things China is doing with it. Bill Gates funded a project to edit mosquitoes so they don't carry Malaria anymore. It was a disaster when it was implemented in Brazil because they didn't understand the consequences of that. Crispr food and flowers, already in the United States... The FDA... I mean, it doesn't require regulations. So, mushrooms don't turn brown. Soon, apples that don't turn dark. This is done through gene editing. And it's possible everywhere. And do you know what it costs to do this type of gene editing? It's in hundreds of dollars. Anyone can do it. It's that straightforward. You can go on the internet; you can buy gene editing kits and start doing all sorts of examples. So, what's China doing now? Editing human beings. We've heard about edited embryos. There are probably thousands of people now who have cancer, who have had their genes edited in China. Is it good or is it bad? We don't know. It's too early to judge from that because the next step is that they start editing humans en masse to try to create super human beings. Super babies. This is the dire threat of technology because it can be abused. But the fact is, there is an opportunity here now to leapfrog everyone and to use Crispr in an ethical way. Imagine, if you could now grow apples in Rajasthan. In the desert. Imagine, now if you could create a new species of crops that are suited to India but will work in different climates. This is possible right now. India used to do a lot of work in agriculture with CSIRO and traditional methods of doing it. You can increase the pace of this technology exponentially today. The fear is that China has raced ahead,

America has raced ahead. No one has raced ahead. The playing field is completely levelled. What's happening is, it's being used for bad purposes right now. And those are being demonstrated. The good purposes are what we need India to take leadership of. To use this technology to truly solve the problems of agriculture and even diseases. It can be done in an ethical way. So, this is what you need to start learning and start making happen in this country. And then genomic sequencing, like I mentioned. The cost of this sequencing has dropped to the point that it's now... In India, you could partly do it for about a hundred dollars for a full genome sequencing. This is possible in the next year or two. Its cost $3 billion in the year 2000. So, what cost $3 billion is now at a few hundred dollars at best. What this means is that we have become data and our doctors are becoming software because there are major advances happening which will transform humanity because we have now been reduced to bits and bytes, including curing diseases. Because what is disease? They are symptoms caused by genes and proteins. And yet, what we do with drugs is that we target specific symptoms without trying to understand the disease. There was a research project done that tried to map every symptom there is. There are only so many symptoms you can have. A few hundred symptoms. What do you have? You have pain in the arms, in the legs, you have a stomach ache, you have a headache... How many ways can you complain about what's wrong with you? So, scientists looked through all of the research publications, and they found that there were roughly 1,50,000 connections between 322 symptoms and 4000 diseases, roughly. So, think about it. What do we have here? We have a problem for AI. Because this is what AI is really good at. If we can now start giving the AI all of these data, we can start finding all the coalitions between disease and our health. And we can start developing all sorts of fantastic treatments using this technology. This is another area where Indian engineers and scientists could get to work immediately and start solving the problems of cancer, start solving the problems of tuberculosis and all these diseases we have here.

I put a proposal together for the Indian government which will allow it to build a trillion-dollar industry in the next 10-15 years. And by 2025, I believe that we can cure cancer. This is something India can do very uniquely because it's an open playing field. It doesn't have a legacy industry to protect. America's healthcare system is corrupt. It's special interests... It's as bureaucratic as the British Raj was. Right? India has a chance to leapfrog all of this. This will cost, probably $150-200 million at best. And with it, we can cure one of the most lethal diseases there is. This paper has been co-authored by two

of the leading scientists at Harvard Medical, at Columbia, at Stanford and at Mayo Clinic. So, I'd love to share it with everyone and get India now to embark on this immediately because India can lead the world in fighting diseases. And then the next frontier. The same technology that was used to sequence the human genome was also used to sequence the bacteria and the gut. And all sorts of crazy revelations are being made. They are about to upend the entire Western system of Medicine. This field is called the microbiome. Here are some of the studies. The studies published in nature and all the prestigious magazines in the world in which they did different experiments. In this experiment, they took the faeces of a fat mouse and gave it to a thin mouse, and the thin mouse gained weight. They took the faeces of a thin mouse and gave it to a fat mouse, and the fat mouse lost weight. Imagine, now, losing weight by eating shit. Would you do it? It would always be worth it rather than all these horrible diets that we go through. Also... The Chinese replicated this in humans, and they found similar results. So, it might well work. Crohn's is a disease, a bilaterian disease that children have. They transplanted the faeces from a healthy child and gave it to a sick child, and the child's symptoms disappeared. They replicated this hundreds of times now with different diseases. And it seems that just by transplanting bacteria, you can treat diseases. This doesn't make sense. But the evidence is mounting. Antibiotics. Indians give antibiotics to their children like its candy. The antibiotics may be destroying the entire ecosystem in your body and creating long-term health problems. Using antibiotics in moderation, when it's an emergency, is fine. But using it the way you do in India is destructive. We better start learning about it because an entire generation of Indians is going to have major health problems because of their abusive antibiotics. This is what the evidence is showing. And then, how do genes cause cancer? How does the microbiome cause cancer? How does it cause diseases? Several studies have been published which are finding the links between the microbiome and disease. What seems to be happening is that the bacteria in our gut are turning DNA on or off. They are causing diseases simply by reprogramming our genes.

Now, go back to the ancient system of Ayurveda. What's Ayurveda based on? On managing the gut. What's Indian science based on? It's holistic health. If you now bring things full circle, where is western medicine headed? Into the ancient system of Ayurveda. I was with the Dalai Lama this week because I talked to him about the proposal, I'm making to Prime Minister Modi. He was very excited about it. What he said was he believes that Ayurveda might be a key to curing cancer as is Tibetan medicine and Chinese medicine. He said he

wants to hold a global conference to bring scholars together to look at it. What I told him was, let's get this Indian project started. Let's create a scientific test bet for this and then test these ideas on that because that's what you need to prove the basis of Ayurveda. But this is all happening. And this is something I'd love to see - India leading the path on because it is all about holistic health. It's all about fixing the microbiome. And this is a unique opportunity for India because India understands Ayurveda and natural medicines better than any other country in the world does. This is why India can build yet another trillion-dollar industry here in health by focussing on the holistics and by focussing on the gut.

Now, let's talk about solving humanity's grand challenges. You know something. This slide, when I use it in America, and when my students have to tell them about the problems of a developing world. That when children come home in villages, they don't have electricity. They can't study because there is no light. You know, I don't think I have to tell anyone in India what the problems of humanity are because you see it everyday. I have to educate the West in the problems that we face. One of the biggest problems here is energy. Look at this chart over here. This is the chart of the energy reserves of our planet. That little ball over there is petroleum, which is what we are fighting wars over, which is destroying the planet. That big ball over there is sunlight. We get something like 1400 times more sunlight every day than the entire planet consumes in a year of energy. We are bathed in energy. So far, we have not had the ability to harness it. Hence, we have global warming, pollution and all other problems we have here. But you know something. This problem is fixing itself because with solar and also with wind, what's happening is that the price keeps dropping. As the price drops, insulations double. As insulations double, the price drops. We are in a virtuous cycle over here. Even if United States ban solar energy and mandate that everyone must use coal, it would not matter. Because this on autopilot right now. What's happening is that solar is defying all predictions. International energy agency keeps putting all of these ridiculous forecasts, and they have to revise them every year. The IIA keeps getting it wrong. The OECD and the OPAC do the same thing. They publish all these reports, and they are wrong every time. I don't know why they can't see the obvious. What is obvious, that we are reaching tipping points. That in China, already now clean energy is cheaper than coal. In India also, I think we reached a tipping point about a year ago. It doesn't make sense to use coal anymore. The coal industry should be out of business soon. Because this is what's happening, where are headed into an energy era of unlimited, free and almost clean energy. Go back 10 years in India. I know when I used to

visit over here, calling America would be extremely difficult. Landlines were limited. It was painful to call the West. Now, drivers, beggars and everyone seems to have smartphones. And they are dialling everyone as if it's free because it is practically free now to communicate with each other. The same thing is going to happen with clean energy. By 2025, we are going to cross all the thresholds and it's going to be cheaper without hesitation to install solar than to have diesel or petroleum. There's going to be a switch that happens... You know, without any government intervention. I wrote this article for the Washington Post. I do a lot of writing. This article was in the Washington Post in 2014. I talked about the era. It created major controversy there. In fact, there was a complaint to the ombudsman of the Washington Post about this professor being crazy. He doesn't know what he's talking about because I predicted that the utility industry would go bankrupt. There were lots and lots of complaints about this article. The energy industry came back and summarized what their complaints were. That number one, the sun doesn't shine, it's not sunny. The wind doesn't blow, it's not windy. I know that. And then what they essentially said was, you need fossil fuel as a backup. But here also they're wrong because the cost of battery is also dropping exponentially. It's dropping at the same pace as solar. What's more is that we have the same debates about battery and technologies. They too, by 2025, you'll be able to build electric cars for about $5000-7000. These cars could go 150 mph, not kph. This is what will be easy to do and it will be possible for anyone to build these automobiles themselves. It's like you have these electric rickshaws and so on. You will be able to build electric cars and they will be cheaper than fossil fuel consuming cars are. My advice to India is to now declare that by 2025, fossil fuel cars will not be allowed on Indian roads, and to start the process because India can do it. China has already begun to do this. They are already beginning to go to an all-electric world, and we are reaching tipping points across the world. So, the fossil fuel industry, the internal combustion energy industry is practically dead now. This is happening, whether we like it or not.

The next big problem, clean water. I'm going to take you to Chile now to show you a team of 12 people that might well solve one of the biggest problems there is. It's of having contaminated water. The planet is bathed in energy. We keep talking about water shortages. If you are an extraterrestrial looking at this planet, you will think that human beings are crazy. All you see is water. Why can't we have clean water? Because the cost of energy is so high. What is the tech to get clean water? You simply boil the water; distil it and you have 100 percent clean water. Why can't we do that? Because it costs too much to boil water. What happens when the cost of energy becomes zero? We can boil all

the water we want from our rivers, oceans and put it back after it's used. So, this would fix itself. But in the meantime, we still have a problem here. So, this company in Chile has developed a technology which could immediately solve the world's problems. Because since 1960, there's been practically no new advances in clean water. Even these companies that you are hearing about in Silicon Valley, it's more or less the same. Reverse osmosis or nano-tech based filters. Forget it. It's much simpler than that. Watch this.

'The system works by compressing contaminated water and then feeding it into a chamber where quick change in pressure and exposure to an electrical field converted into a plasma, a state of matter similar to gas. In a plasma state, the water is ionised, killing 100 percent of the bacteria and microbes it carried. According to Alfredo Selazzi, a scientist at the centre, this system can purify 35 litres of water in just five minutes using the same amount of energy that it takes to run a light bulb.'

I was an advisor to the President of Chile on innovation, and I met Alfredo Selazzi about seven years ago. And I was blown away with his technology. But he had the same problem that entrepreneurs in India had a couple of years ago. No one took him seriously because he was Chilean. And Chile can't innovate, and they had an inferiority complex. India has had an inferiority complex about its entrepreneurs also. This is changing because you have so many new unicorns and suddenly entrepreneurs have become hot. But this only happened in the last year or two. Before that, it was the same problem in Santiago. Alfredo built a world-changing technology. No one would fund him. So, I invested in him. I got my friends to invest in him and we saved the company a couple of times. But the company couldn't scale. The last year or so, Airbus and Siemens discovered, 'Hey! My God! There is a technology here that could help us solve one of the biggest problems we have, which is dirty water on airplanes.' I hope you don't drink the water on airplanes because it's the filthiest water you can possibly get. It's worse than what you get in Indian villages. So, what Airbus is looking to do is to provide 100 percent clean water using this technology that Alfredo built. So, the deal that they are striking with Airbus is, for every unit that Airbus buys, they are going to donate five to villages. Five units to villages. So, this is now an innovation from Chile that's going to reach the West because of the need that the West has to provide clean water and it will be beneficial to the developing world.

Now, let's talk about healthcare. In America, we have ugly debates about healthcare. I mean, Obama Care is considered to be bad because you are providing healthcare to people in need. The reason is because they believe

healthcare costs will keep going up. But the US healthcare system is about to be disrupted by a company from New Delhi. Let me show you. This technology is called HealthCube. What does HealthCube do? It does the same tests that you do in hospitals. Everything from pulse oximetry, blood grouping, dengue, malaria, HIV, Syphilis, 12 lead ECG... That's what this test does. Do you know what the tests cost? The device costs about a $1000. About Rs 60,000-70,000. Each consumable costs Rs 50-60. I mean, Rs 20. They are dirt cheap. So, the advantage of the technology such as this is that you get the results immediately. In America, when I get sick, I have to call up a doctor. The doctor will give the appointment a day or two later. I've to drive to the doctor's office. He makes me fill out all these ridiculous forms. And then deal with the insurance issues. Then the doctor sees me. They will do a blood test. Send the blood test out to a testing company, get it back a day or two later. Then they call you back. You might as well die in the meantime. This is America's healthcare system. With HealthCube, you get the results immediately. Watch Mrs Rajashree Birla tell you about what they are doing.

'At Idea, we have evolved the social entrepreneur model embedding the HealthCube. We are able to reach out to rural areas, including labour migrants, and offer them a path to proactive wellness. Timely health screening and diagnostics on 32 related tests, including all pathological tests, blood sugar, haemoglobin, blood pressure and many more issues are diagnosed before they turn into a major illness. We have created an army of village social entrepreneurs who do the health screening at a very nominal cost. We have taken HealthCube to Haryana, Uttar Pradesh, Kerala and Andhra Pradesh, collectively spanning 20 districts and 100 locations. In all these, we have seen a palpable change, healthier people, fewer illnesses and the general sense of wellbeing.'

This is another Indian technology that no one took seriously as it was an Indian technology. I got involved in the company about four years ago. I funded it. I got my friends to fund it. I'm not talking about friends. I'm talking, you know, you should see the list of investors in the United States. Ross Perot Jr. Ray Dalio. I mean, they are some of the big names in America who funded this company. And now, we are taking... Bill Gates is taking this across Kenya. They just did a pilot project in Kenya, in which several thousand people were tested and now, they are planning to take it there. Several countries in Africa are doing it. In Mexico, we are doing a deal with the largest pharma company over there to take it all across Latin America. In India, no one is taking this seriously. Why? Because it's an Indian product. So, I told Ramanan Laxminarayan, the CEO, to get this company out of India. This is wrong. India

needs to get over its inferiority complex. It needs to realise that it can change the world. Because here's what is possible now. This is where all of the money goes in healthcare. In curing diseases, going to hospitals, in being sick. What if you can be diagnosed immediately? What if you have a device at home in which you did a blood test? You are feeling sick and it told you, 'Okay. You have got dengue.' So, you can go and get treated immediately before you have all the horrible symptoms. Or your blood pressure is too high. Now, you start doing meditation and getting natural treatments. If you can be diagnosed early enough, then natural treatments will work very, very well. You have time to go to your Ayurvedic doctors or whatever. But what happens is that we get direly sick, we got to go to the hospital, and that's where the money goes. Imagine, now, if everyone had a HealthCube at home or had it in their schools or had it in common centres. This is what we are about to do with this technology. This device has already done half a million tests. It will be a million by the end of this year. Ten million by the end of next year and billion soon afterwards. I heard the Dalai Lama talking to his devotees and I was so touched. In my private meeting with him, the first thing I said to him was, 'Your Holiness, I want to make a contribution. I want to do pre-screening for the entire Tibetan population in India.' Because these people came here from Tibet. They came from a cold climate to a warm climate. They are having all sorts of health problems. Everything from diabetes to obesity... They have all these problems and no one focuses on the Tibetan population because it's such a small population. So, what I offered to him was to screen the entire Tibetan population and give them their health records on their smartphones or will produce it on cards with QR codes. He was very positive about it. We are going to do a follow-up with them in the next week or so. But this is what's possible now. I mean, it will cost Rs 100-200 per person, which is nothing compared to the benefits. We'll save thousands of lives. This is what is possible. When this technology reaches the world, there will be copies of it. HealthCube won't be the only device. There will be Chinese no-costs. There will be other companies getting into this space, which is all good. Because my goal is to positively impact the lives of hundreds and millions of people or billions of people. And this is what is possible using technology such as this. What's happening is that the technology industry is eating medicine. The tech industry is now in the medical business. And you are going to see all sorts of amazing advances because of that. So, many industries are going to be disrupted such as medicine, healthcare... Every industry I look at, I see the same happening. You know, manufacturing, I talked about it briefly. The robots now can do what human beings can do. It's not that China isn't aware of what I said. China is acutely aware of it. So, they built their first zero-labour factory. They want to robotize all of their manufacturing. The trouble is, America doesn't need their

robots. American robots work as hard as Chinese robots do. They don't complain. They don't commit suicide. Well, at least for the moment, they don't go on strike. So, China's manufacturing industry is about to implode because you can now robotize it.

And then the next revolution is 3D printing. You will be able to 3D-print all your goods. And then the robots will go on strike saying, 'Stop the 3D printing. It's taking our jobs away.' Now, the opportunity for India over here is to start building zero-labour factories, piloting them in India and then offering them to the West. Just like I talked about smart cities requiring all the back-end monitoring. Imagine, now, if Indian IT or a new industry setup in India started going all across the world and providing robotic manufacturing plants. The Americans don't know how to do it. The Americans do not know how to program robots, how to design a new value chain. This is another $200-300 million opportunity for India to start going and doing it. And what will America do right now? America hates India because it's taking IT jobs away. Here, you are bringing jobs back to America. So, the Americans and Europeans will be very grateful if India steps into this business. So, it's literally another trillion-dollar opportunity for India to go and automate things. And then, 3D printing. I mean, we are going to be 3D printing 3D printing systems. And we are going to be 3D printing electronics in 10-15 years. So, this is another area where India can get involved with because the artisans all over the country can now start doing their designs and marketing these to the world. Probably, it's another $100-200 million opportunity for India to start exporting designs for 3D printers.

Transportation, as I said, cars and computers are becoming one. So, we are talking about now disrupting the entire automobile industry because... I mean, several car manufacturers have now announced that they are going to start going all electric. My guess is, within two to three years, every car manufacturer will discontinue the development of petrol and diesel-consuming cars. We are talking about major disruptions happening in this industry.

Agriculture. Let's look at what's happening with agriculture. Robotic farmers. Now, India doesn't need robotic farmers but this is another opportunity for India to start automating and then teaching the world how to do it because you can now start monitoring agriculture. An Israeli company has drones that fly around, analyse crops and then analyse it using AI.

Internet at Farms.'There's still a man in the driver seat but this Combine steers itself by GPS. And there are still men in the fields. But this modern farm runs

on big data. Everything on this nearly 20,000-acre Indiana farm is tracked, from the moisture of the soil to the precise productivity of every few square yards of corn. With data streaming from soil sensors, Combines and satellites, Tom Farms manages an immense amount of information through its cloud computing system. It's all geared towards increasing yield.'

So, India's $200 billion IT industry. Imagine, if they understood agriculture and robotic farming and started offering it to the mid-West, the United States. They would be so grateful. It's another multi-billion-dollar opportunity. Why aren't we doing it? Because India doesn't seem to understand the opportunity there is over the need for this in the West. Because you can revolutionise agriculture completely. And India stepped into the IT industry in the West because of Y2K. Suddenly, they got an opportunity and they started training people up. What if now India started going worldwide and offering robotic farming expertise? Again, it's a matter of managing... It's like managing data centres. You have to manage smart cities, you have to manage manufacturing operations, and you can manage agricultural operations back in Bangalore or across India. You have to program the software. This is another trillion-dollar market I'm talking about. Another $200 billion industry could be created in India to do this. And the West would be very grateful to you because you are making things more efficient for them and you are reducing costs. Drones for agricultural monitoring is costly. This is a big problem in the West. They need to be able to go and monitor and technologies for this exist.

LEDs are quite commonly used in India. They are not that used all over the world, but they are advancing exponentially. There was a Nobel Prize given out for LED advances because what LEDs are now making possible is vertical farming. Watch this. This is in the Netherlands. I don't know why India isn't looking into this much more. Looking at using LEDs to accelerate agriculture. Amazing things could be done with this technology.

And then meatless meat. I'm sure there are a lot of vegetarians in this room. But what if the meat didn't have meat in it? We can synthetically produce meat. Technology, at the rate at which is advancing, by 2025, we will now have debates in India about whether we really can eat beef or not, if it really wasn't beef. I mean, in this example, they took a sample from a cow. What if you took a sample and did genetic sequencing on it? And then you simply took the genetic sequence and produce meat from that. Are you eating a cow? Would you eat it? You know, it's not a cow. It's synthetically produced food. This is the kind of debate we are going to be having in 5-7 years from now because it is

becoming possible, and within 10 years from now, it will be cheaper than killing animals. So, we are talking about a revolution here because we don't have to kill animals anymore. And you know, again, it's going to create all this moral and ethical issues. Can Muslims eat that pork? Can Hindus eat this beef? Well, start thinking about it because we are going to have these debates.

To summarize, number one, there are trillion-dollar opportunities happening at the intersection of exponential technologies. Disruptions are happening in every single industry where technology can be applied. I didn't have much time to get into other industries or get into detail, but every single industry you are looking at is about to be disrupted in the next 5-10 years. We are talking about trillion-dollar industries being decimated. We are talking about companies that are worth billions of dollars being worth nothing. We are talking about dramatic changes happening in the next decade or so. India doesn't need to be doing basic research. I mean, Western scholars and governments keep taunting India for spending much on R&D. You don't need to do that. The United States have spent trillion dollars on academic research. Hardly, 1 percent or 2 percent of it is commercialised. All of their money necessary for this has been invested. In fact, if you look at India's contribution to the world, it probably provided $10 trillion of value in terms of scientific research in the early ages. So, the West has spent a trillion or $2 trillion on it. Don't feel guilty. Build on top of it. You don't have to design the wheel. You don't have to invent the wheel. You have to be able to design better cars. That's the economic opportunity for India. It's to focus on implementation and using technologies to solve real problems. Because India, once again, can lead the world in science and innovation. I really believe that within a decade, India could go from being a laggard to being the leading centre of science and innovation all across the world. And the example I'm going to show India’s government today basically demonstrates how exactly India can lead in medical research, particularly in cancer treatment. This is what's possible.

I'm going to skip forward to the message that technology can be used for good and evil. We have to use it in a wise way. We have to make sure it benefits everyone. We have to make sure what the rewards and the risks are. We have to make sure that it proposes autonomy versus dependence. I suggest you to read my book, 'The Driver In The Driverless Car', because it walks you through all the ethical issues and it teaches you about the core technologies.

Questions and answers - The first one is on the ethics and the dangers of the unknown. This is by Manjeet Singh, he asks, “Is AI worth the danger of the

unknown consequences that may happen to humans as humans have survived thousands of lives without AI? And now, we face the danger of extinction within 100 years of gene editing and AI going out of control.'

See, it is not the threat you think it is. It will take jobs away. It will do automation. The opportunities here to analyse the data we are gathering are much better. But let's not worry too much about something which is nowhere near being a threat yet. On gene editing, it is a threat. The Chinese have gone crazy with gene editing because they are so cheap. I am really worried about them creating all sorts of killer viruses, of the experiments they are doing with human beings. And this is why I'm saying that India needs to now wake up and look at the opportunity and use it in an ethical way because there is a lot of good that can be done with it as well. And we need to have people with strong moral values, ethical values now to use this technology wisely because technology can be good and it can be evil at the same time.

This is a related question. We keep talking about using AI in ethical way, but who decides these ethics. I think this is what India fears. Misuse of AI. Yes. My entire book is about that. I fear that every technology, you know, robots, drones, everything can be used for evil. And AI will be abused as well. I mean, right now, this problem of fake news is really AI-driven. Algorithm-driven. So, you are having elections being rigged in the United States and abroad. You are having all sorts of problems because of the bias that's injected into AI. You already have this problem today. And it's going to get much, much worse. You are going to have deep fakes, you are going to have videos of government leaders saying things which they really didn't say. You are going to have your videos being mutilated by other people. All in the next 2-3 years.

We have with us, Dr Vijay Raghavan, the principal scientific adviser, who will comment on the ethical issue.

Yes. I like to take a little broader view of what Vivek so nicely put together. Vivek covered every possible technology and pointed out how dramatic changes very recently allow for an exponential growth of the technologies and a corresponding exponential impact. And how it's time to grasp that? That I think is without questioning the fact. And that's absolutely true. I'll just add two points to that. This is very critical and very important because what's happened over the last, you know, 10,000-20,000 years, is that humans have moved from becoming creatures whose goal is to survive on this planet to those who have actually changed the planet dramatically. And because of that, this period is called the Anthropocene because we have become the stewards of the planet. So, in addition to technology, the change and the opportunity,

we have a responsibility for the environment, particularly in the context of climate change. So, that's something to be kept in mind. The second point I have is about the value of ambition, intellectual growth and development and investment in basic science. Vivek so beautifully pointed out the historical contributions from India in fundamental science, in a beautiful way. Some time ago, in 2011, the then Chinese Prime Minister, Hu Jintao, came to India. He came to Bangalore, and gave a talk to all the heads of institutions. All of them were gathered. He gave a beautiful summary of science and technology in China. No notes. He spoke for 45 minutes, every single aspect of Chinese science and technology. Either he was brilliant or he had a brilliant interpreter. Now, at the conclusion of that, he made a very a interesting statement. He said China and India should collaborate because there should be a bridge between knowledge and power. To him, and to Chinese for many years, many generations, India was a source of knowledge and China was the embodiment of power. Over the last couple of decades, that has changed dramatically. China has invested enormously in basic science. Both by having its students go all over the world, and internally. China, today, has knowledge and power. In today's world, driven by data, driven by design, you cannot grasp all these technologies unless you invest in basic science. The kinds of basic science you need investment in are in mathematics, statistics, language and understanding of our society and also technology. To imagine that one can adopt technologies without an understanding of the insides of the black box, without an understanding of the data systems, of mathematics and statistics at a deep level, would make us essentially purchasers and implementers of such technology. So, I fully agree that there are extraordinarily disruptive technologies going on. I should also add that those technologies are being imbibed and looked at by our systems all over the country, right from our agricultural scientists, our IT companies, which actually do contribute to these technologies globally, and by our students. We are not doing enough, not unshackling bureaucratic rules and regulations, but there is an enormous amount of domain depth which is there in each area, they need to go across silos and go there.

Last point. There was a trade dispute between China and the US recently on a chip made by Qualcomm. Qualcomm is a chip company which doesn't have any manufacturing at all. It sources its manufacturing from multiple players. The design for that chip, the core of the dispute between China and the US, the pattern dispute, the design was done in Hyderabad by Indian engineers. Close to 70 percent of Qualcomm's design today is done in Hyderabad. In other words, Indians. And this is true for many multinationals all over the world.

Indians are there as well as over here. In other words, it is due to the investment and foundational understanding of science and technology that one can be in the global stage. These need to be unshackled and where I would agree very enthusiastically with Vivek is that one should have a certain level of self-confidence and ambition to trust one's inventions and discoveries and take that forward, and not be mentally subservient to viewpoints which are abroad. For that to happen on scale, in addition to all this teaching and basic science, we need to also have all of this done in our languages. So, our languages, again, need to be connected and we need to have a bilingual way of learning so that we can be comfortable in English but also have deep rootedness and understanding and the power of abstraction coming from our language. So, I would give a very strong qualified support to much of what Vivek said with all those caveats which I mentioned.

Thank you. There are a couple of questions on agriculture sector. One is by Pratima. It says, 'Reduced productivity of farms can be a challenge to adopting Ayurveda wholeheartedly by the large population of India. How do you account for this in the near term?' There is one more on agriculture which says, 'How do you scale up technologies in AI, Crispr, etc. in the agriculture sector in India?'

There are lots of social issues over here with these technologies. I mean, automating it may not make sense in India because you have so much labour. You have small farms. You have individual ownership and so on. There, you may simply want to develop better crops, that's why you can use Crispr and come up with crops that grow better in the Indian climate, that are more adapted to the states that they are grown in. So, that's a better application than that. The robotics I was talking about is for the West. That you develop the pilots and prototypes over here and you take them to the West. You export them to the West and you automate where there is a shortage of labour.

Here's another question - Can we use exponential technologies to erase climate change? Do you know any specific examples of it? It's by Riyaz.

Well, the only thing I can think of is now moving to clean energy, accelerating it. This is why I want India to ban, literally ban fossil fuel cars and accelerate solar... For large scale industrial processing, have wind power, but just accelerate the process because the investment that you make in this gives you many dividends over a long period of time and it saves the planet. Right now,

China is ahead of India in implementing solar. If India steps on it, India and China together could save the world.

There is one question on biotechnology. How can biotechnology help in fighting malnutrition, which is the gravest problem India faces today? It's by Akshay.

Ratan Tata was looking into this. He was looking into analysing grains and usage and data, and trying to come up with better ways of feeding the population. I think what you need to do is to start now working backwards and figuring out where the malnutrition is, understanding the data. Find out what's efficient and then engineer the crops to add the things that are missing. Ratan believed that some specific nutrients were missing in the Indian diet and that's what's causing the problems. This is two years ago when I had a discussion with him.

Would you like to add something on this?

The issue about malnutrition or poor nutrition is a serious transgenerational one. Mothers, if they are undernourished will have children who stunted growth will cause them to have children who have stunted growth. So, it's a grandmother level problem. And therefore, this needs to be addressed in early schooling, particularly for girl children and also for girls and boys on large scale. So, it's a very serious problem. Many people, scientists included, seem to assume that if one detects what nutrients are missing, and you give that to the kids, the problem is solved. It is not that simple. It's not just providing iron, protein, carbohydrate, packaging it and giving it. It needs to be put in food in a manner which is context dependent, socially relevant, something which people like, which they take. It’s linked to environment, pollution, sanitation in multiple ways. So, it's a multicomponent problem which science can bring more value by the analysis of the problem and what interventions succeed in measuring them. There are no easy tech fixes for malnutrition yet, except for the rich.

Creating Futures with Data Suffusion

Dr. Michael Gillam

You've heard it said that the largest taxi company in the world owns no taxies. You've heard it said that the world's largest lodging company owns no hotels. You have heard that the most valuable retailer in the world, until recently, didn't even produce the products they have been selling. The most popular media company hasn't produced the videos that people were watching. All of this will lead to the question, what would the world's largest companies in other fields, what particular assets will they be missing? These are companies that build networks and connections rather than products. And they often build these network and connections based on the foundation of new data.

So, you probably heard that the economists recently said that the world's most valuable resource is no longer oil, but it is data. And they based that thought on the fact that four or five of the largest companies based on market cap are based in data. And what's interesting is if you look at those, out of the top ten companies, if you look at those top ten companies, and if you look at them in terms of revenue, none of those companies, none of those data companies appear in the top ten. It's almost as if your vision for what you are doing with your data in the future and your potential with that data means more and matters more than the revenue you are making yourself.

Well, to begin answering that question, where these large companies come from that are not based on traditional physical assets, we can begin back in 2008. I am working in Microsoft. I was running a healthcare innovation lab. And that particular day, Microsoft had decided to have a brainstorming day on the future of robotics and healthcare. On that particular day, I met a guy by the name of Eric Horvitz. And Eric is the first physician ever hired by Microsoft. He was actually hired by Bill Gates. And he started telling his story. Basically, he said that he remembers the day right after medical school. He remembers the day when he walked onto campus, and he looked around. And for some reason, it suddenly struck him that every person in the entire company was a computer scientist, and he was a doctor. He was a physician.

And he thought to himself, 'Have I just made the biggest career mistake of my life?'

But despite that trepidation, he was also excited because that day, he was planning to meet Bill Gates. So, he travelled to building 34, went to the 9th floor, where Steve Ballmer's and Bill Gates's offices were and in the centre was a conference room. And in front of each their offices, they said there were these programmers. These programmers were 6 feet tall. They were over 200 pounds of solid muscle. They probably were not programmers. Maybe security guards or something. But he walked into the middle conference room, and he looked around, and he said to his colleagues…He said, 'I wonder what would happen if I said I've got a bomb.' Immediately, the doors flew open and those programmers came pouring in, they press him up against the wall, they tied his arms behind his back. They march him out of the room, out of the building, and he did not meet Bill Gates that day. This did not reassure him that he had made the right career decision.

But fast forward 15 years later and Eric had a treasure. It turns out that every time you file a patent, you get a 2-3-inch stone cube inside Microsoft. And 15 years later, Eric had more patents, filed more patents than anyone inside of Microsoft. In fact, you go to his office, about 2-3 feet deep across one wall are all the stone patents that he had. In fact, his room, when they re-built the building in 1999, the research building, they had to add additional struts underneath his office, just to support the weight of all of his patents.

So, Eric started talking about his favourite way to brainstorm about the future. And he said, a lot of people when they think about the future, they try to forecast. They start with today, and they try to forecast in the future. But he said that's not his favourite technique. He said, 'My favourite technique is back-casting.' He says that I like to think of what are the inevitable futures. The futures that almost all of us agree are going to happen. And he says I try to go back in time and imagine what sort of technologies enable that future. And then he takes another step back. What enable those particular futures? And he keeps stepping back, he said, until he finds what he identifies as a stepping stone. Once he found that stepping stone, that's where he would focus his efforts to try to get into the future. And you might recall that other companies have taken the same sort of approach. Other organizations as well. Google, you might remember, in 2009, was trying to decide whether or not it should go into self-driving cars, into driverless cars. And at a meeting where they were trying to make the decision, Astro Teller, who is the head of the Google X Labs,

the innovation labs inside Google, spoke up. And he said, is there any future where driverless cars are not a part of it? Everyone said no. And he said, 'Alright, then let's do it.' They basically saw driverless cars as the inevitable future. And they spent the rest of the meeting essentially trying to back-cast to see what that stepping stone they could get to become part of that future.

And you might recall that this is a little bit like you may have heard of John Hagel who works for Deloitte. And he did a study of east coast companies and west coast companies. East coast linear thinking companies and west coast exponentially thinking companies. And he noticed that at least in the US that these linear thinking companies often had three to five year plans. What they plan to do in over the next 3 to 5 years, whereas he studied these exponentially thinking companies the Google, the Facebook, and the Amazon. They thought that three to five years of planning is too hard, is too complex. How can you possibly think what the future is three to five years from now? It's changing so much. Instead, they had a 15-year plan, where they wanted to be in 15 years of that inevitable future. And then they had a six-month plan, of what they would try to do over the next six months, and they constantly revisit that to look for new opportunities ahead. And it is for this reason that the companies and the organizations are now asking the questions, even countries themselves. What are the inevitable futures that we are trying to be a part of, that we are trying to build into and be part of that inevitable future? So, to begin answering those questions of what are those inevitable futures that you can aim for and how do we build towards them, you can begin by going back by again. And this time to 2011.

And a guy by the name of Steve Yegge is about to make a mistake that he'll probably remember for the rest of his life. He worked for Google, and he formerly worked for Amazon. And Steve decided to compare the strategies of the two companies. But he didn't have a lot of good to say about the company he was currently working for, Google. And as he wrote up his thoughts and after he finished them, he posted them. He thought to his friends, but he accidentally posted them publicly instead of privately. And these were meant to be private thoughts, only for his friends. Well, to make matters worse, his private post was then picked by Forbes magazine. And before all was said and done, this post criticizing his current employer Google had been viewed 14 million times. Well, much to Google's credit, they didn't fire him. He actually stayed for many years after. But it raises the question about what was so interesting about this post he had, his thoughts.

Well, it turns out that he worked at Amazon at an interesting time for about six years, from 2002 on, when Amazon transformed itself from a company that just sold books to selling all the products that we know today, but perhaps even more importantly, transformed itself into a web services company. It's the web services company that even today, Microsoft and Google are trying to catch-up to in terms of public cloud revenue. It's a web services company that transformed the finances of Amazon. It's a web services company that accounted for almost half of Amazon's, in fact more than half of Amazon's operating income. It's a web services company that even changed the finances of Jeff Bezos himself. And Steve traced this transformation of Amazon to a memo. A mandate that Jeff Bezos had sent out to everyone across the organization, everyone inside the company. And his memo began like this. He said all teams across the organization from this point forward will expose their data and their functionality through something he called 'service interfaces'. He said all teams across the organization must communicate using these 'service interfaces'. He says there will be no other form of process communication. You cannot direct link to someone's webpage, you can't directly read someone else's database. There will be no backdoors whatsoever. He says I don't care what protocol you use in your organization, you can use web protocols, you can use other protocols. He said, but most importantly these 'service interfaces' that your organization builds, they must be Externalizable. Meaning that companies, organizations, governments outside of the company must be able to use these 'service interfaces' just as easily as people inside the organization. And he said, no exceptions. And he followed this with, "anyone who doesn't do this will be fired." Thank you. Have a nice day!

Well, you can imagine how this hit like a bombshell inside the organization. Imagine you are in the organization, and maybe you're in Human Resources. And now no one can read your Human Resources database. Not until you build a 'service interface' to it. So, whoever thought you were going to hire will now probably have to hire an IT person first instead. But of course, this mandate, this memo changed every single project that Amazon engaged from that point forward. So, for example, when Amazon created Instant Video to stream movies. they made those interfaces externalizable. So, other companies started using them. Companies like Netflix. At peak Internet times in North America, almost 40 percent of internet traffic is people watching movies from Netflix. And everything up to the play button was coordinated on Amazon's servers. Basically, Amazon helps coordinate the delivery of more videos by

competitors than they actually stream themselves. And the same thing goes for images. They needed some sort of infrastructure to store the picture of various products that they sold. They opened up that infrastructure for other companies to use them. Other companies started using them, like Pinterest - 50 billion pins of pictures on 1 billion boards showing more products that could be sold, more than Amazon even carries. And yet, all of it coordinated on Amazon's infrastructure. And of course, because these service interfaces were externalized, externalizable, that meant hackers could attack and Amazon had to learn So many security lessons that even today, the United States central intelligence agency stores, our government stores, some of their data on Amazon's servers because it is safer than our government's server.

Of course, today, we call these service interfaces Application Programming Interfaces or APIs. Companies have perfected these policies, the process of taking internal tools and turning them into external business and services. For example, this is just a short tiny list of products that began inside Google. That ultimately became services and businesses outside Google. And if you think about it, just put an exclamation mark on this sort of API infrastructure, think about Uber, the Uber app. This is an app that any company in the world could have created. It probably cost $200 thousand to build. And any government could have built this, any company could have built it. It is built on two APIs, the Google maps API and the Twilio API. And that $200-thousand app has grown into a $70 billion company. And even the Twilio API, just that API Company itself has become a $17 billion market cap company. You can trace the rise of this API economy through websites like programmableweb.com. This is the graph we did on the number of APIs that are out there. There were over 20,000 different APIs that companies are now offering, including governments. And you can search for these particular websites for various areas. For example, if you type energy, you can see that there are over 100 different APIs related to energy. If you search real estate, there are over 100 different APIs on real estate. Unless you think that there are some products or services that are too small, even something like a beer has a dozen different APIs of alcohol. And you may have seen that Google acquired a company called Aberdeen for half a billion dollars and what does that company do? It helps companies build and monetize these APIs. So far, you can just imagine what this API economy is going to look like.

For decades our governments, our organizations, have built themselves to serve and work very well with people. And yet, the next wave is automation economy through APIs. What do you connect through these APIs? If you are a

government, you are an organization, you are a company, what do you go out and secure in order to make available to your citizens? What are the challenges we often find particularly in something like healthcare data, is that they are regulatory barriers, or privacy barriers. And yet, we do see that there is a Copernican shift in data ownership. That's a current, where the centre of the data universe is no longer the facility, where instead of the hospital owning your data for example and you have to go to a hospital to get your medical records, instead receiving the shift where the patient themselves or citizens own their data, whether its government data or company data or organization data and as a result a different group asks for access to the citizen for access to that data. And an interesting thing happens when patients own their data or citizens own that data. Some of the barriers to innovation like privacy go away. Because if you own your data, you can share your data with whomever you want whenever you want. And because those innovation barriers go away, what we find is that people own their data and can share it safely. We see that this flurry of different apps emerges and new value-added services get created. It is for this reason that some people believe that just like gas, water, the electrical grid, were infrastructure for innovation, "citizen control data-vaults" are next the platform for innovation that countries will be building. So that data can be liquid and can flow wherever it needs to go. Just like you can turn on your water and turn it off, you control the choice. And there is a variety of different technologies that are emerging to make these citizen data-vaults possible. For example, you may have seen Tim Berners-Lee who invented the World Wide Web, recently endorsed a technology called Solid. And what does Solid do? It creates pods, as you are browsing around these pods, you can place your data into them and then it's a secure place where you can share with other groups and decide who gets access to it and who doesn't. If you think about a Facebook and Google today, the advertiser pays Facebook and Google for private information about you. Why aren't you paid by the advertiser directly as a post to Facebook and Google? And yet these citizen data-vaults enable that potential future. And what sort of things are built inside these pods.

You may have seen in Estonia, they are attempting to use the block chain infrastructure. You have heard me talking that they are using that to place the entire health records of the population into a data-vault. So, every patient inside the country owns their data and they can share access to that healthcare data. Anyone wondered what sort of things become possible when citizens own their private health data? How many people have heard of Blue-star?

Anyone out there? Blue-star? This is the world's first US FDA approved app for managing Type 2 Diabetes. This means that this is a prescription that a doctor can write just like they write a prescription for medicine, they can write a prescription for an app. And this app will then help manage the patient's Type 2 Diabetes. This type of application becomes possible if patients share their health data with a company like this. So we are moving towards the future where every medication, every procedure, every single diagnosis can be managed by apps. Think about it, right now it's estimated that there are 2 billion people world-wide who in the course of their lives may never see a clinician. And yet, a billion of those people have a cell phone, and the next billion are expected to come online in the next five to 10 years. Which means the way to reach those patients is through mobile devices and if we give them ownership of their medical data, suddenly we can see how we can scale intelligence across in the entire country, to start to manage things through technologies that we would not otherwise be able to manage. Suddenly, we can give hope to patients who might not otherwise have hope. And this is one example of how you can build APIs to government-owned data. For this reason, the government and organizations are starting to ask a question, where can APIs to citizens own data-vaults to enable the creation of new value, new services.

Well of course, one of the remarkable things about the world today is the amount of new data that is out there, that is emerging. And once you think of that sort of inevitable future and that stepping stone that you are trying to get through, one of the ways you often get there is through emerging forms of data. And one of the ways that you can think about data is using advice from press, plus my favourite advice from Tim O'Riely, who is CEO of one of the largest technical publishers in the world. And Tim, one day said, "I see a lot of companies, I review a lot of companies. And one of the things, I see the smartest organizations doing today, is doing something I'll call enriching their base layers." And the example he gave is up Google street view. How many of you have Google street view, you can zoom in, and look around on the streets, dig something up there. So, you can look around as you're standing on the map and remember when they first came out, maybe 10 years ago, what people said? They said, "Oh! Google is going into advertising, right." They are going to put ads on people's real estate. And the answer was, well, maybe. Right, they spend 10 years they haven't done it yet. So, what are they doing? It turns out, as Google street cars drive around, they have a little bit of memory in them. And every time they see a street name, they grab the street name off and

save it. They are enriching a base layer of the street names. And every time they pass a business name, they grab that business name and they capture that as well. They are enriching a base layer of business names. And as a result, many countries you go to around the world, you can see a street name, a business name no matter almost everywhere you go. But it turns out they are using this base layer for something even more.

Recently, an engineer of the Google Self-driving Car project was being interviewed. And they ask him, "how is your driverless car so successful?" And he said, "Well, it turns out it's a lot easier to know the condition of a stop light or a stop sign if you already know where to look. And what he said was that they were using the base layer from all that street view data to pre-compute all the locations of all the stop signs and all the stop lights and so, it was like your human memory, the car remembered where all those were. If someone wanted to build a driverless car as good as Google's they would have to recreate and enrich that base layer as well. And you might wonder how much it is worth to an organization, how much should an organization actually spend just to build a data layer, just to buy and build up data and how, much is that worth to do? Well, we have an estimate to that because you might recall that Uber hired a Google Maps person and how much money they set aside to rebuild and enrich this base layer, half a billion dollars. Just to build up this database, this data layer. And of course, you think about a company like Google has been very good about enriching their base layers. Remember, they created Gmail, So, they can capture a bunch of emails. So, they can build Natural Language Processing technology. And they enrich. Remember they created Google Voice, So, they can create Interactive Voice Response Systems. Well, because they enrich both of those base layers, they were able to combine that and this is what allows them to release Google Assistant like Amazon Alexa. And of course, they are very good at enriching one of the biggest base layers of them all, the World Wide Web.

And of course what's interesting is that the base layer gets bigger. As they enrich that base layer, it's the knowledge layer that knowledge graphs grow, your Google Home gets better and better and better because it can answer more and more questions. It became an appreciating asset as opposed to most of the things you buy that depreciate in value over time. And of course, with just these three base layers, we can probably brainstorm for 20 to 30 minutes and come up with service after service, new value after new value, just based on top of those base layers. And what is particularly remarkable is new base layers, they are merging from new places all across the globe. And one of those

places is from the sky. There are almost over 5000 satellites circling the planet. Every red dot you see is a location of a satellite that's currently circulating around the earth. You may have seen the number of satellites being launched is increasing exponentially. There are dozens of companies that have announced thousands of additional satellite launches going forward. You might recall that it was Google that used vertical satellite pictures combine with 45 degree angle satellite pictures to combine them, in order to get textured maps just before they started using these on aeroplanes to get this very same three dimensional data. It is because of the exponential increase in satellites, that the cost per pixel in space has been dropping. And it's led to a rise in the new field of geo-analytics. Companies like Orbital Insights are using satellite data to track paring spot occupancy from space. They are tracking over a million different parking lot spaces all across the planet and as a result they were able to watch hundred-year old companies go out of business. They predict bankruptcy. You may have seen a group of researchers at Berkeley decided to study and see whether stock traders could be making money from this data. They found that small private hedge funds have been buying this pixel data and whenever the analysts predict that a company is going to do well, or do badly, they saw something different in the parking lot images. They were actually able to hedge their stock trades and so, they actually got a margin of almost 5 percent. They make millions of dollars essentially tracking this retail traffic from space. It turns out that we have been able to track other things as well. It turns out that you might remember that oil storage tanks have floating roofs. As the result vapour doesn't built up and they don't explode and they cast a shadow from space. You can see that shadow from space and as a result you can estimate the oil inventories of countries around the world. So, when China tried to under-declare how much oil they were storing, they actually were caught by this particular company, as China was trying to manipulate the oil price that way.

There are economic indicators that you know of. Recently, the United States got into a trade war with China. And you might recall Guangdong province accounts for almost 12 percent of China's economy. And there was an economic indicator that they were publishing, and it was going down for five months in a row until finally, China stopped publishing it. They didn't show it anymore.

Well, a startup in Silicon Valley called Space Now is now using satellite data to monitor manufacturing activity and they have recreated that index of economic development and they are now selling to hedge funds, banks and

market traders who are interested in that. They have been able to index economic activity simply from pictures from space.

We have been able to track varieties of things from space like Fifa World Cup construction. We have been able to see a luxury resort being built in Dubai. We have been able to see an illegal activity like deforestation of the Congo or pools, building projects that are built at places they shouldn't be built. We have been able to track humanitarian crises like refugee camps expanding. We have also seen migration from entire villages during various crises. We have been able to track economic indicators like different fields of manufacturing and energy such as solar energy in Dubai and the deployment of oil companies. Perhaps even more importantly, we were able to start tracking GDP in Africa simply from the lights that they are turning on at night which had been measured automatically on a satellite in space. That's called nocturnal luminosity.

And of course what's happened now is that a company like Planet.com will assemble multiple satellites and focus on the same location. This way, they can increase the resolution and now what they offer is that they take 13 satellites that they point at any place on the planet within 12 hours and give you 72 cm resolution. This is an airport that was bombed in Tripoli and three days later you can still see the smoke coming out from space.

Governments like the United States have decreased the allowed resolution and allow higher resolution now. So, for example 25 cm higher resolution is allowed publicly, about the size of a mailbox. There are spy satellites out there which now measure about 5 to 10 cm. which means that it should just be some five to 10 years before this kind of resolution is not only with governments but with companies all across the planet. This means that we are now reaching the point where from space we can essentially track individuals. At 10 cms resolution, you can even see a single person move throughout the world.

What is going on here? This is an infrared camera and this is in London. What is going on in this particular apartment building, why is it showing up on the infrared camera? This is from a helicopter. Any guesses? I hear, fire? It turns out it's not fire. They are growing marijuana. It is cannabis. They have heated their apartment to help the plants grow. But it turns out that these infrared cameras are now being placed onto satellites in space. This means that not only could you see cannabis growers, maybe that's important, maybe not but it also, means that we are now reaching a point where with a mailbox resolution from space you can see essentially fires in various apartments from entire cities, entire countries.

The first company to build fire surveillance systems of the future would not build them just for their city or just their country because these are data centric, because these can be used anywhere. You build these for the entire planet. The world's largest fire department in a future may not actually have any firemen, may not have any fire trucks, may have no firefighting ability whatsoever but it will be the largest because it will be watching the entire planet for these fires and serve the entire world. And these sensors are increasing in diversity. Now they have hyper spectral imaging. We can see minerals, vegetation, even different types of gas leaks in the air from the satellites. In a first in history, we have wireless technology. This company Hawkeye has now deployed satellites that track wireless technologies that track wireless activites. This means you can track cellular deployments. You see cell towers go up. That means that you can track wireless signals.

The Chernobyl accident was tapped by the government to hush it. We now live in a world where you can audit, you can keep track of emergency signals traversing on the emergency bands wirelessly. So, it will be harder for the government to hide this sort of activity at any time. It will be easier for us to detect what the government is doing. This means that every organization in every country will have a choice, a decision to make in the future about what are the pixels from space that might disrupt what we have done before or open new value. You can think about how you can start to imagine what those inevitable futures look like. For example, imagine the banking industry. Think about how many times people take loan for a building project and then a building has an overrun and they come back and ask for more money. Now how many banks in future might look to see if that building is actually being built and might use pixels from space to track in real-time and monitor that sort of progress? You might think that sort of inevitable future we can expect. And if that is inevitable future, then you can start to imagine what the base layers are you need to collect today, right. You going to want to collect images of lots of different buildings and their building progress and you want humans to imitate different data so that eventually, you can train AI on top of those base layers.

So, it is for these reasons, every government and every organization around the world is asking the question, what are the base layers that we could be enriching, that can be a foundation for future value?

Well, of course, one of the places that you can look for these base layers is to start by looking at your data exhaust. And perhaps a few of the examples of data exhaust is probably wearable's world. You all have seen wearable's

world, these fit-bit trackers, and whatever they track, how many steps we take, maybe our location. And yet, what is the device that virtually all of us carry and does almost the same thing? Right, Cell phone. It has a pedometer, it has a GPS device in it. And a company by the name of Moves created app to do this. It was acquired by Facebook. Now, this technology is built right inside the IOS. But importantly, the companies around the world and organizations are leveraging their data exhaust to build new value.

I'll just give you an example. It turns out that 1 out of every 3 fish that we eat has been fished illegally. Yet the challenge is that there are 200,000 boats on the ocean. And about 1 in 6 or 1 in 7 of those, i.e. 35,000 boats are fishing boats. The challenge is that if you are analyst and you try to see if they are fishing illegally you have to watch their movements and it takes hours. You have to try to see if they are moving in a way that looks like they are fishing, long glider patterns, like fishing lines or stroller patterns or circular parsing patterns, like they are throwing nets. But by the time you've spent a few hours to identify a one boat and whether it is fishing in the wrong location, it is you who now have 200,000 more ships to look at. It turns out that recently the Leonardo di Caprio Foundation donated money to this group called Global Fishing watch and they created three machine algorithms to recognize these three patterns and they turn the system on. Today if you go to GlobalFishingWatch.org you can see in real-time where all these fishing boats are fishing. But notice that there are areas of red rectangles. These are areas where there should be no fishing going on whatsoever. So, they took a look at Phoenix Islands, it's a World Heritage site, a protected area and there should be no fishing going on whatsoever. And when they zoomed in on the Phoenix Islands, this is what they saw. This is how much fishing was going on. So, they went to the President of Kiribati Republic, who was responsible for that area. They have 1 boat to patrol 157,000 sq. miles. And Kiribati's President said, "don't worry about it, I'll take care of it." Well, this was November. This was December. This was January. And this was February.

How did they do it? Well, it turns out that they can turn on the system and can track a boat. And you can see this is like a parsing pattern and this is a troller pattern. And this is the protected area. No boat should be sailing there. You can see boat passing through should not be fishing there. Also, what this? This is a parsing pattern. So, they went to the ship's captain, and they said were you fishing in the protected islands, in the Phoenix Islands. He admitted. And they fined him $2 million. Captain by captain they were able to crack down on these illegal fishing boats. What perhaps is most remarkable is to accomplish this

using data exhaust that's been coming off these boats for years. It turns out that this data exhaust has been building up in organizations and companies everywhere. You may have seen that Ford started a study. They found that 63 per cent of data inside an organization is unanalyzed. It's just building up. They called it Dark Data, like dark matter. And you may have seen companies have now started to look for value inside that data. How many of you are familiar with I-robot? That robot sweeps your home. It also creates a map of your home and this company has been sitting on more data, mapping data, than almost any company in the world. So, they decided to try to sell that data. You know, maybe someone has use for it. Well, 18 months later, a company announced that they are going to buy that house data, that two dimensional data that it's collecting. Any guesses what company offered to buy that data, to enrich their base layer? Do I hear Google? Exactly. Google, right. They have been very good about enriching there base layers. And this is another base layer they have added. Why? So that now you put a smart device into your home, it actually knows what room it's in or if you buy a smart speaker you get optimal sound inside your house for that particular speaker.

You may have seen Apple acquire an AI company focused on dark data for several hundred million dollars. We don't know what Apple is doing with their secretive acquisitions, whether they are using the data internally or maybe they have a future announcement. It just adds an exclamation mark to what this Dark Data is. Government is notorious for having dark data everywhere, unanalyzed data everywhere. And it turns out that the amount of data exhaust out there is increasing. You may have seen that Qualcomm has now put chips inside the cloud. This is a woman paying and the tablet is watching her play and you can see it capturing this 3D point cloud.

Nike made an announcement that they are putting an app with these chips inside your shoes. They scan people's feet and they can give you perfect fitting tennis shoes, perfect fitting shoes. Soon they will be sitting on more measurement of more people's feet than anyone on the planet. But of course, we can use this in medicine as well, tracking people's swelling in the lower extremities, for instance.

We often talk about the six Ds of disruption. Notice how this is the Digitize, Demonetize, Dematerialize approach. This is actually 3D data. But what is important more than anything else, is not so much the data that we are collecting but the metadata. And you heard in an AI lecture about how we reach the point now where you can take any picture and tag virtually anything

inside that picture. It turns out that we not only tag that data so that we can get the sort of information as base layers but also as AI reaching the point that now it can recognize behaviours as well. Watch the AI as it watches behaviour and you are uncovering something. The AI is noticing behaviour and labelling it. You are folding something, you are tearing something just a little bit, and you tore something in two pieces. Notice that this is behavioural data. It can watch and pick up from the video.

Some people have said that governments are concerned that they will have less revenue with emergence of driverless cars. Because they won't have any tickets, as many traffic tickets. How will they make up for that loss in revenue. Well, you may have seen that the Chinese are now using facial recognition technology to send jaywalkers instant fines by text message. Some people believe that this amounts to moving from essentially traffic-based revenue generation to behaviour-based tickets revenue generation.

The I-robot company that has robot sweepers is now putting those 3-dimential chips, because they are so inexpensive into the robot themselves. This means that as the robot sweeps people's homes, it is not only capturing 2-dimensional floor plan but capturing the 3-dimensional shape of the furniture and also the behaviour of the people in the rooms doing something, as this device is sweeping their home.

People are now starting to ask, where might these developments point to? These new base layers of behaviour as metadata create new value and services which is something that we never could do before. And companies and organizations and governments are asking, where is our dark data, what can you do with our dark data and what is our data exhaust and is the data exhaust from other parts of the world available so that we can use it to create new value. Perhaps, most importantly what are the business models or government interaction models that we can create with data exhaust that is automatically generated in order to create new base layers.

How would you go into the future? How would you ensure that you are able to handle the variety of all these new data that are coming with all these new sensors? For those of you who participated in the IT project, think about how much knowledge you gained during the course of the project, How many times have you been 6 months into a project and someone says, "I have an idea!" And everybody looks at him and says why didn't you have that idea 6 months ago now it's too late. Right! We've already made all those decisions.

In a world that's exponential, it becomes increasingly important for our decision curve to match our knowledge curve. And this means, putting off every possible decision you can put off until the last possible moment that absolutely has to be made. This is great news for any procrastinator out there. We call this late bindings.

We see this example in landscape design. In how many weeks did they decide where the sidewalks go and where do people walk? On the smartest college campuses what do they do? They lay down all aside. They let the students walk wherever they wanted to and then they came later and put a side walk where the students had walked. The result is pristine lawns. We call this late bindings. And we see this in data projects. How many times have you been in a data project and the first thing they say is that, "first, we have to decide what data standard we are going to use. Well, challenge with data standard is that there are so many standards that you could walk up a project for days, weeks, months to try to make this decision. In fact, you have probably heard the phrase that the great thing about the data standard is that there are so many to choose from.

I would argue that if you make a data lake, if your particular organization decides to make a data lake and all you can store in your data lake is numbers, texts and binary streams, then you can store anything in that Data Lake. Later, when it becomes clear what data standard that needs to be in, you can create a data pond. That's smaller and you can put that data into it. This is like some people move into a skyscraper today while we still working on other floors, while we are still building the other floors. This is applying that same principle when applying it to your data. Ultimately, how do you make sure that you are able to transform your data into value. Perhaps my favourite advice is from Vinod Khosla. He is the co-founder of Sun Microsystems and a billionaire venture capitalist. He said, "I review a lot of companies and a lot of organizations and one of the smartest things I see organizations doing today essentially replacing road maps with base camp strategy." He said that the problem with road maps is that they assume success at every single point that we are going to do this, then this, then this. He said that the future is uncertain. There is new opportunity exponentially arising ahead. The problem is that organizations assume success when there is potential failure in opportunities that are lost. If these organizations are trying to reach a summit then they have to try to get to the base camp first with whatever energy they have and there they rest to build up to make it to the next base camp. Or, you build up enough revenue to make it to the next base camp. And you assume potential failure at

every single point. There might be an avalanche, So, you have to go up the mountain a different way.

Inside Microsoft, we used to call these technologies, trees. We would create branching lists of possibilities. We can build this, this would enable these technologies. This would enable these others. You can see these sorts of trees, where you can see black boxes, these where we failed in one particular location. So, we had to go up the mountain in a different way. It's a little bit like Steven Johnson's book, "Where do good ideas come from?" We navigate adjacent possible evolution which is like walking into a mansion and every door that you open opens up opportunities into other doors and other rooms.

What does this look like in an organization today? Think about a company like IBM a hundred years ago. This was their first product and they had to reinvent themselves over and over again over the last hundred years. Then you might remember Ginni Rometty's recent announcement for IBM. She said, of the $80 billion revenue about half, i.e. $40 billion, came from new products and services that they had invented in the last three years and this is what our governments will need to do to going forward as well.

How many block chain projects would you imagine that IBM has going on inside today? It turns out that there are 500 block chain projects going on inside of that company. This is just one technology. How many of these are going to fail? Almost all of them? How many of our governments are doing 500 projects and expecting almost all of them to fail? They are most likely just trying to figure out what is going to work. We often talk about failing early, failing often, failing forward and one that everybody forgets, failing cheaply. Right? How much do these projects cost if they are doing 500 of them. All very small experiments? And yet one of those experiments paid off. Recently, IBM just inked a billion dollar deal for one of their block-chain projects as a result. And yet it's this type of experimentation that virtually all of our governments will have to be doing with data if we were to thrive into the future.

How does the company, how does the organization, how does the government keep up? We don't all have experts. You may have heard about Joyce law. No matter who you are, most of the smartest people work for someone else. How do you get those smart people working for you? How many of you have heard Kaggel.com? Anyone? Few people out there, scattered. It is the largest data science competition site in the entire world and has over 2 million data scientist and you can take your data and put it on to the site and create a contest. And you put a prize somewhere between 5,000 dollars to the biggest

prize I saw was a health care for 3 million dollars. Here's the example, State Farm insurance wanted to see of you can detect these tractor drivers. And they created a prize of 65,000 dollars. And in real time you can watch the data scientists compete and try to win the competition. At the end of the project they win the prize, the company or government keeps the IP and can use it. But often different organization looks to see who won and offer those people job. One way to find some of the best talent for work for them.

You might wonder, how much data do they need? Big data, small data to run these AI experiments and prediction projects. A thousands of competition run on kaggel. Virtually every single competition has been won using data that would fit in your laptops. Small data. Odds are, every department you are working in has enough data to begin running contest, to running these competition.

So, what does the future look like? What is next in data space? You have heard about driverless cars. There is a lidar system on a Google self-driving car. It picks up 9 million data points every single second and this is an image generated with one of those Velodyne Lidar systems. What's interesting is that driverless cars like Google's have 3 Lidar systems, 5 radars and 8 cameras. This means that a single car driving around, captures 4 tera-bytes of data every single day. And what does that mean? This is an actual event, this something that actually happened with one of Google's cars. The car was driving down the road and it stopped because there was a baby duckling that was being chased by a woman in an electric wheel chair. This was seen by the car. Basically, it was trying to save the duckling's life. But think about this. A single self-driving car, this is the type of data that it would be generating. It means that a single car may see a car accident as it is driving by, it may see disasters, and it may see crimes just simply driving by. The question becomes that once in the city, will that data, will a policy require that that data has to be shared if it sees a car accident with other cars that were not involved in it. We are essentially moving from the internet of fakeness to the internet of people. This is where people's behaviour and locations and all the data will give access to the data that we never had before. And of course, this data is out there. This means that policies can be started and regulations written today.

More intriguingly, we can start to use virtualization to build new base layers that never existed before. You heard Amin talk about digital twinning. How many people heard eXP Realty? This real estate company that's worth a billion dollars is completely virtual. They have no physical offices whatsoever. They

have grown by over 10,000 employees just in the last year. Their stock has tripled and they had 120 percent year on year revenue growth. This is essentially exponential growth with a company that has no offices. And I am just going to play an interview here, of someone who works inside this, who is a realtor inside this company. So, can you just get volume for this?

Here, I am actually showing to you on my screen. The company is virtual. You can walk around and you can meet people and you can go visit these different departments and you can sit down and have meetings. For example, I can tell everybody on my team, no matter where they are, to go meet at a specific location and we can have a meeting. This was weird, I had to go into their world, go into the Accounting department and take a number. And the next thing was like sitting on the desk with somebody like a real person but I was there like an avatar. We can hear each other. They are pulling up the screens. It was just like, I never really experienced anything like that. It was something like I had to get adjusted to because it was just like you kind of feel like a playing a game. But once you get the hang of it and you see how it all works, you realize that damn, this the most convincing thing ever. I can literally sit here in my office or sit in my living room and get what I need done. Apparently, that's our future in virtual reality. But imagine, how many offices, these are the places that are expanding and they don't actually have to build a new building. It's completely virtual. Which will be the first virtual government or virtual companies that will emerge using the same approach. And notice that companies are now able to capture base layers that they were never able to capture before. How long people are waiting? What que times are? They move from space to space in this new virtual places. Its new opportunities we never have before. Of course, this is just to re-emphasize a point Amin was making. Organizations and governments are asking where can we start to create these digital twins to create new value that we never had before.

The last thing I will mention is that we are moving towards this world, you probably heard Tim Cook announce that within the next two years he thinks that all of our phone devices will be replaced by devices we essentially wear, like glasses. Augmented reality glasses. Think about what that world looks like. Think about the day when the first person puts on the augmented reality glasses. Not only do they augment their world with data in a light wave or in a hyper saturated way like you see here. But in order for this to possible, it means that every single pair of glasses is picking up 3-dimensional data of the

world around it. It's picking up the audio, it's picking up the video. This is new data that we never ever have had before. New base layers that will enable us to unlock value that we have never been able to unlock ever before. We start to get a sense of how, we talk about the world's largest companies in the world's largest organizations. How they have been built without the traditional assets, the physical assets they formally had. And how the next biggest organizations in various years will be built on a foundation of data rather than these physical assets.

These are the 12 takeaways we talked about today. We will send these to everyone. But of the three big takeaways, my favourite is Eric Horvitz's inevitable future, Tim O'Riley's base layers and Vinod Khosla's base camp strategies into the future. Greatness is as you help your governments and organizations navigate into these futures. The great thing is that there are more adjacent futures possible that anytime in human history to make that migration possible and to make the work you are doing matter more.

Let's do a quick exercise. So, brainstorm for five minutes with people around you, how satellite data or 3 D point cloud data or the Internet of people, people's behaviours, locations and emotions, how that might change the work that your particular area of government is doing? What new value can be created? What new services?

We thought we could figure out if there is a civil servant given a specific area and he has a number of people to administer and you can then build these base layers to indicate poverty, to get quality of service and then mapping it on a performance-based parameter.

Here's another example - I think we could measure the waiting time of patients in a hospital then we can get to know which Department actually is more efficient and which is not. For example orthopaedics, people wait for a longer time than in other departments and we need to have more doctors there and more services there or may be the doctor is not that efficient and compare it across departments like Gynecology, dentistry and orthopaedics. So, this is one and we have to think of ways on how to reduce the waiting time of people there.

We can use satellite data to map the high accident risk prone zones and also the traffic congestion areas and use it in city mapping.

Those pixel data are from space. This means that you could literally do density mapping of traffic multiple times per day and the pixels are dropping in price

which means that oppose to manually going everywhere, you could just use pixel-press pixel pieces for that.

A final example- Building on the previous idea that was mentioned regarding traffic, we can actually reduce the number of rail accidents by understanding the overall operating cost, the time taken by various trains and then mapping it all together.

There is this long discussion on governance and but I think that one of the key principles in terms of data that governments are now moving towards is citizen ownership. A lot of the challenges and governance sort of go away if you create safe harbor vaults into which that data can be stored in and build APIs for it. For example, there's a Blue Button project for the veterans administration in the United States for health care where they put data into these vaults and then the veterans themselves can share that data with various organizations.

The real challenge is this loss of human contact that can occur when people become data. And so, one of those key pieces we have to look forward to is to resolve how do you maintain that human touch in this sort of world of data? How do we create ethical AI going into the future? This is also a design question. It is incredibly challenging and as far as the principles go and one of the things is this rigorous testing of these AI systems. Today we see correlation-based systems in AI, there's a whole class of causality-base AI that helps remove some of the biases that we're seeing in these ethical systems. There's a book by Judea Pearl called the “Book of Why”. He talks about how all of our current AI infrastructure has to be replaced with new causality-based AI.

The AI Crystal Ball

Amin Toufani

It's an absolute pleasure to spend some time with you today, and congratulations! It is a humbling experience to be in front of such an impressive group. I spend about 30 percent of my time in front of audiences not as impressive as you, but perhaps, you know with the same aspirations. It's about 30 percent of my time because nothing teaches like teaching. I'm very much here to learn from you, as much as I am here to share our research with you. But first, I want to address the question that came up multiple times in the men's restroom. 'Am I the world's best guitar player?' It's true. For those of you who might not know the context, if you Google, 'the world's best guitar player' and you click on the first result, it is me. Let's be very clear, I am not the world's best guitar player. I am probably not even the best guitar player in this room. Somebody posted a video, it went viral, and Google now thinks I'm the 'world's best guitar player'. But I've contacted them. I've let them know their engine is broken. They are not paying attention. I want to share a secret with you guys. Last time I checked that video, it had around 86 million views, and please don't share this outside of this room. Of the 86 million views, about 85 million is my mother. Thank you, thank you.

But ladies and gentlemen, we live in an amazing world. In the last 100 years, human life expectancy has more than doubled. Today, integrated circuits are more than 30,000 times faster than they were in the 1960s. Solar panels are more than 250 times cheaper, since 1975. DNA sequencing, as you heard, is more than a hundred thousand times cheaper since 2001. We are seeing exponential growth in bio-tech, nano-tech and information technology. And this is changing absolutely every aspect of our lives. Facing point, let's talk about Artificial Intelligence. I want you to look at these six images and ask yourself, 'Which one do you think might not be a real human being? Which one do you think might be machine-generated?'Let me put numbers on them. How many people think its number one? You've seen it before. Fantastic. All of them. Every single one. And this is exactly the world that we are headed

towards. It is an exciting world. The time that I have with you, I want to spend it on these five areas of AI. Science, trends, data, risks and strategy.

How about this video? Those of you have will see it again. This is Google demonstrating how they have created an AI to make a haircut appointment on Tuesday morning any time between 10 and 12. So, this is an AI calling a hair salon on its own and carrying a conversation. Have a listen.

"Hello, how may I help you?"

"Hi, I'm trying to book a women's haircut for a client; I'm looking for something on May 3rd."

"Sure, give me one second."

"Mm-hmm."

"What time are you looking for around?"

"At 12 pm."

"We do not have a 12 pm available, but the closest we have after that is a 1.15."

"Do you have anything between 10 am and 12 pm?"

"Depending on what service you would like. What service is she looking for?"

"Just a women's hair cut for now."

"Okay, we have one at 10 o'clock."

"10am is fine."

"Okay, what's your first name?"

"The first name is Lisa."

"Okay, perfect. So, I will see you, Lisa, at 10 o' clock on May 3rd."

"Okay, great. Thanks."

"Great. Have a great day. Bye"

Pretty impressive. And this is AI today. We are not talking about the future. This is the current state. How did we get there? One way to think about it is, this was the world of AI before 2007.This was the world of AI after 2007. What happened in 2007? Deep learning happened. Deep learning is an AI technique that basically has transformed everything we talk about in the world of artificial intelligence. There are deep learning publications, numbers of publications. You can see that China has now surpassed the United States in terms of the number of research papers that are published on a subject. We looked at the Indian picture of this type of contribution. Every year, you generate about a million engineers in computer science. Really impressive stats, but the latest analysis points to about less than four percent of these

engineers actually having competencies. Strong competencies in deep learning. So, definitely, an opportunity area, because as you can see, deep learning has taken off. Deep learning is valuable because it is leveraging biology for inspiration. There are many techniques that we have seen in artificial intelligence but deep learning is modeled after the brain. And that's really what is pretty impressive about it and why we are seeing the type of exponential growth that we have been talking about. Convolutional neural nets, recurrent neural nets and generative adversarial neural nets are the typical candidates in this category. Now, to put this in perspective, feature engineering is what we used to do with AI. Feature engineering is if you are trying to detect a human face using the machine, basically you need to define every single feature that defines a human face. For example, you have to define what an eye is, the distance between eyes, the distance between the chin and all the different components. This used to take thousands of hours to do. Instead, deep learning, that is what AI is all about today. It is about feeding the machine with many-many examples of images and then allowing the machine to come up with its own vocabulary, if you will. So, the machine notices that there are patterns that keep repeating themselves. All of these little boundaries, these dark versus bright areas next to each other. And then it also notices that sometimes those boundaries are combined to give us the next layer of abstraction. And that's how perhaps you define an eye or a nose. And then if you keep going up, it combines these elements of abstraction into more and more abstract elements. In this case, the human face. And this is automatic. The machine is doing this on its own. And to really appreciate for what it means for it do all of this on its own, we need to go to the cat moment in AI. There is very critical moment in AI history that happened not too long ago. Basically, this was when Google was training, over three days, 14,000 CPUs to detect human faces. They were leveraging about 10 million images from YouTube to train the machine on how to detect human faces. Very-very massive operation with 14,000 CPUs. By the end of this training process, the AI could look at various images and detect human faces. Great. The researchers accidentally noticed that the machine was also very good at detecting cats. Nobody asked it to detect cats. It came up with the concept of a cat automatically, and this came to be known as the cat moment in AI.

Today, in terms of computer vision, AI beats humans at object detection. Already AI is better than us in this particular domain. And that's pretty good, because if you think about it, 90 percent of all recorded data in the world was generated in the last two years. 90 percent. There is an absolute explosion in

the amount of data that we have available. This is why we are super excited about models of AI that look like deep learning. Why? Because we have seen the emergence of hypothesis-free AI. It used to be, if you have the data, if you were lucky, you would go to the computer, and say here is my data, here are my questions, give me the answers. Now, you go to the machine and you say, here is the data, tell me what questions to ask and also give me the answers. You do not need to have any hypothesis about what is going on with the data. And this departure from hypothesis-driven AI is truly revolutionary. Case in point, Google Translate used to be about a million lines of code. Today, with this hypothesis-free approach, it is only 500 lines of code. That compression is something we have never seen in the history of computer engineering. And to really drive this message home of the concept of hypothesis-free AI, which is a remarkable revolutionary concept consider this. How many people have played the game of Breakout, as you can see here? Yeah, you guys remember this was a game that basically involved moving a platform left and right and the bouncy ball goes on trying to destroy the wall. A group of researchers at Deep Mind, a company that Google has acquired, for about half a billion dollars, decided to train a machine to play this game on its own. Instead of telling it to do exactly what to do and feature engineer every aspect of playing this game, they decided to do something much simpler. They said, 'Okay, we are going to let you play according to these rules. Go left or right, that's what you control. Watch the screen and higher score is better. Good luck!'And basically, they let the machine play against itself and against this game. So, as expected, the machine gradually developed the concept of the bouncy ball and the platform and all of that. This is great. But right around the four-hour mark, something magical happens. Wait for it. Here we go. This technique is called tunneling. Tunneling, for people who used to perfect this game and really played professionally, is the thing you want to do. Because the moment you tunnel, it basically finishes the game for you automatically. Consider this, from the moment the AI understands the role of tunneling, it almost does nothing but tunnel. And again, nobody taught it. It taught itself. Why is this happening right now? This revolution that we are talking about, there are three factors driving it. New engineering technology absolutely plays a huge role. We are seeing also the exponential growth in computational power. As you heard from Peter, this is truly remarkable. An explosion in the amount and quantity of available data is the third leg of this table. Combined together that's why we are seeing this exponential growth in AI. Now, we used to use CPUs for developing artificial intelligence, then people decided to have more processors in power. They pushed to GPUs, Graphical Processing Units. As

many of you know, GPUs are also used for Bitcoin mining and cryptocurrencies and what not. But then people have now switched to ASICs, these are Application Specific Integrated Circuits, meaning a machine that can do nothing but the thing that it is designed to do. So, single-purpose machines. And this has reduced and compressed training time for these models in AI exponentially, in fact, hyper exponentially. So, this is a video by Nvidia, they are developing self-driving car technology and basically the computer vision technology that we need for self-driving cars. Looks at an image like this from the feed in front of the machine in the front of the car, and it detects objects. We used to have to train machines to do this for one year on a CPU and now we do it for one week on a GPU and one hour on an ASIC. That is the hyper exponential proof in computation power that we are talking about. From one year to one hour. That is truly remarkable. Now, here are advances in computer vision.

I want to show you these images, and I want you to ask yourself, 'How would you describe what you are seeing here?' In each case, these were images that were given to AI, and we actually asked AI to describe what it sees in the image. The first image on the left, the machine comes up with this. 'A person riding a motorcycle on a dirt road'. That's pretty impressive. What about the second one, a little trickier. It comes up with this.'A group of young people playing a game of Frisbee.' It actually detects the game as well. Now, what if we flip this? What if we started with a description, and then asked for it to generate an image? A small bird has a red head, with feathers that fade from red to grey from head to tail. Pause for a second and reflect on how you would draw that? What type of image comes to mind? Then I'll show you what the machine actually came up with. Think about that description. A small bird has a red head, with feathers that fade from red to grey from head to tail. Here is what it came up with. That is not an actual bird. That is how the machine is translating the text into an image. This is a state of artificial intelligence that we have today. It does calls for a round of applause. I wish I had done it. Now, computer vision and processing of human voice, translating human voice into actual text. These are the two frontiers of AI. And I really want to strike a balance and calibrate this conversation in terms of what AI can do today and cannot to today. There are many engineers present in the room and you are probably very well-tuned into the reality of what AI is not capable of doing. But let's continue on what it is able to do and then we will come back to that a bit later. Today, we can do style transfers. Basically, you can take a picture and then provide an image to the AI, and ask it, 'JM Turner. How would Turner

have painted this photo that I took?'And that is what you get. The machine generates this image for you. Here's Picasso. If Picasso, this is what the machine believes that Picasso would have done if Picasso was trying to paint that. Munch. And Van Gough. I think it's pretty remarkable.

Now, you guys probably remember Deep Blue in 1997, this is the machine that defeated Garry Kasparov. How many people remember that game? I remember that match. He is holding his head. This is the World Chess Master, and he was defeated by Deep Blue. You probably heard about another game that was recently defeated by an AI. Deep Mind defeated the World Go Champion. And to put this in perspective in terms of the relative complexity of the task here, in 1997, Deep Blue, at any point in time, was considering 400 possible next moves. Deep Mind, at any point in time was considering 1,30,000 possible next moves. That gives you an impression of the scale here. Now, the story gets even better. Here's how Alpha Go was trained. This AI that actually defeated the World Go Champion. They followed a two-step process. Number one, they taught Alpha Go to play like a human being. Basically, there was a massive library of about thirty million human moves. And they said, 'Okay, watch these moves, understand how humans play.' Now, you and I, after we have studied 30 million moves, we probably would take a break and say, 'Okay, I'm good. I am now proficient.' Not with this machine. They took it one step further. And then they said keep playing against yourself with the equivalent of 80 human years to perfect the human skills that it had developed. So these two steps is the engine that you saw on the last slide. But then, the Deep Mind team decided to do something else. They said, hold on a second. Why don't we get rid of the first step and never teach the machine how humans play. I like to think that the easiest way to think outside the box is to not know where the box is. That's exactly what these guys did. They removed the first step, and then the engine that came to be known as Alpha Go Zero, they only let it develop its own strategy without having ever seen any human strategy. Now, Alpha Go Zero played against Alpha Go. The engine that had never seen human behaviour versus the engine that had studied human behaviour. And in a hundred games, AlphaGo Zero defeated Alpha Go, hundred to zero. Again, the easiest way to think outside the box is to not know where the box is. And I think this needs to be our beacon of guidance to know how we plan the future of AI - future that is uncertain but there are elements about it, that we can already pick up on.

So, on that note, let's switch to talk about trends. Some of the trends that we are noticing both in the world of business, which I truly believe all of us need to

understand if we are going to be good public servants, but also in the world of governance and policy making. We've all probably seen Kayak. Kayak and any of these other engines whenever they come up with a recommendation through using some form of artificial intelligence on Kayak and also on Google Flights. Basically, the engine tells you whether the price is likely to go up or not. Whether you should book the flight right away. Now, one of my favourite tools and my team at TLabs, everybody uses this tool - Boomerang. How many people have heard of Boomerang? It's a life saver. I highly recommend it. Boomerang's main functionality is to return a message that was never answered. So, basically you don't need to worry about figuring out who never answered your message, but it also has another functionality. As you type your e-mail in real-time, Boomerang will track how likely it is that you will receive a response in real-time. Basically, it's tracking positivity, politeness, subjectivity, length, all sorts of stuff and at the very bottom, the likelihood of a response. Let me tell you this is a pretty accurate response. In terms of credit card fraud, right now, it takes about thirty seconds for financial institutions to detect credit card fraud. Let's put this in perspective. 30 milliseconds versus 60 milliseconds for an airbag to deploy, 200 milliseconds for a Google search and 300 milliseconds for a blink of an eye. So, one-tenth of a blink of an eye. That's how quickly we can detect credit card fraud. There are many other business applications in sales and marketing, for instance, rocket fuel will generate a marketing campaign for you that is AI driven. Salesforce has launched Einstein which is a completely predictive analytical type of approach to pipeline development. Basically, it can let Einstein tell you which customers to go after. Conversica will actually take those potential customers, engage with them, talk with them until they are ready to purchase, at which point they'll switch over to a human. Basically, they will pass on the account.

And in human resources, one of the most exciting developments is Textio. As you are typing a job description for the people you are trying to hire, Textio will tell you in real-time how likely it is that you are skewing your applicant pool in unintended ways. For instance, if you use the term 'rock star', statistically you are more likely to receive more male applicants as opposed to female applicants. So, they come up with recommendations that will result in a gender-balanced neutral strategy. And HireVue analyses the video interview of a candidate and predicts the likelihood of their engagement on the job. And there is an epidemic of disengagement in modern work force, in modern work places. That is why more and more we're beginning to use tools like this to predict engagement before you hire the actual individual. Customer service is

another key area. Google Cloud platform already prioritizes the most irritated customers and tells you which ones to go after sooner. And not only that, Afinity will then pair up that particular customer with the best customer rep that can help them most efficiently. And this pairing is extremely powerful. There are many companies that are using the combination here. What about policing? In China, smart glasses are already in use by the police force and basically the smart glasses detect criminals in real-time against the data base of facial recognition. And predictive policing is a tool that has been used in California and in India and many countries around the world. Basically, it allows the police force to focus on areas that historically have shown to have higher likelihood of crime happening. And what it allows you to do is to have limited resources, but concentrate those resources in the right areas. And one of the companies that we have found and really like in this space is actually from India, Staqu. It has done a remarkable, remarkable type of AI algorithm development. Both with smart glasses and predictive policing. Their technology is in use in the United Arab Emirates and as well as in parts of India.

Now, to shipping and supply chain. IBM believes that AI predictions for supply chain are more than 80 percent more accurate than human predictions. And again, this has massive implications for how we plan. Sail Router is a technology in AI that basically allows for ships to plan their routes based on all sorts of environmental and engine factors in the most optimal way. And again, it's fully automated. Health inspections - one of my favourite examples in this space is the Nevada Heath Authority, which basically trained an AI to monitor Twitter and watch for people who are complaining about food poisoning when they got sick after visiting a certain restaurant. They said, okay, normally we would do random inspections of restaurants that's one of the things that the health authority is required to do. So, instead of randomly auditing these restaurants, they decided to look for Twitter mentions of people getting sick. And by doing this, they have reduced food poisoning by 9000 cases per year - by simply choosing to go after and correlating those tweets with the likelihood of different locations that have actually created food poisoning. This is an anchor that is completely machine generated. China is beginning to use virtual anchors that are trained on the actual human face of individual anchors. Because there is such a massive library of their gestures, of how they articulate. We can now do this, and train an AI to look almost undetectably like a human. We are not quite there yet. But, pretty soon, we will get there. One of the projects that my wife and I are focused on at our company

in TLabs is that this is where we decided to put all of our life savings, into projects that we care about. We're using AI to build a hedge fund for the poor. We are using AI also in Stage zero detection of cancer. If you detect cancer that early, people tend to not die from cancer. We think this is going to explode, and the only reason we are able to do this thanks to AI in effect is that we now have digital representation of our bio-chemistry that we can track over time. This is a pretty exciting area and very timely as well because today, medical knowledge is doubling every eighty days. Every eighty days, the number of articles in this field is doubling. Is your doctor keeping up with this? Probably not. This is why we believe that pretty quickly AI is going to play a huge role in how we experience the medical system. And on that note, let's switch gears and talk about data for a little bit. Data and its ownership is giving rise to questions that we've never had to consider before. Have a look at this video.

'Today, I would like to talk about change. Because change is what we are looking for and we have changed absolutely. Mind-blowing. We are changing the way people communicate. We have been changing the way the world is connected. We changed the way people are sharing stuff. We build incredible, exciting, awesome, amazing products and incredible devices. But honestly, the biggest change of all is this - We make people give us all their data. Why? Because we told them our amazing products are for free. But in fact, all this will cost them the most important thing, their data. The journey has just started. The good news is that today we know everything about everybody. We will be using all this information, this data to make an awesome incredible lot of money and it should be shared across with the government."

I was hoping you were going to like that. How many people caught this Zuckerberg testimony in front of Congress, the United States Congress? Did you guys notice the difference in the level of technological understanding between the Congress people and Zuckerberg? It was this one Congressman who kept asking him, 'What happens when I e-mail you on WhatsApp?' Remember that? When I e-mail you on WhatsApp, what happens? After that testimony, the market cap of Facebook jumped by two billion dollars. Effectively, public market said alright this dude is collecting a lot of information, at least he is transparent about it now, and the government has no clue. Great investment, let's go along. So, the point here is that one way or another, we need to answer this question properly. The question 'Who owns our data?' The correct answer should be, we own our own data and we are able to license it out as we please. We are not quite there yet. But to demonstrate the power and the type of predictive type of analytics that you can execute with

data, consider this. Most of the products that Amazon ships today are shipped using anticipatory shipping. Meaning, people have never placed an order yet. But Amazon knows from the AI modeling that most likely people will. And that's how they ship to a location near you, and wait until you place an order. So, this is one example.

Here is another example. Let me warn you. I am about to show you a car accident. This is a pretty serious accident, but it's not fatal. Have a look. We are watching this accident from the dash cam of a Tesla. Did everybody hear the beep? The beep is the first moment that the car detects that something is wrong and it applies the breaks automatically. I'm going to play the video again, and this time, I'll pause at the beep. Does this look like an accident to you? This is 1.7 seconds before the actual accident. What's happening is the Tesla is scanning two cars ahead and saying there is no way those guys are going to stop, so I'm going to stop right here. Pretty remarkable. Notice the guy in the front in the red car is not even in an accident yet. He has not even applied the brakes yet. This type of AI will completely change our public roads. And I like to think that we are moving towards intersections like this - where nobody is stopping, because every car is nano transacting with all the other cars in real-time. And combined with AI and Blockchain technology, we can have continuous flow. I was in Milan, Italy, two weeks ago and somebody raised their hand and said we already have this. I think there is truth to that. There is definitely truth to that. Now, let's double click on self-driving cars for just a second. As I mentioned earlier, I think most of us are underestimating the impact of self-driving cars. So, let's spend a little bit of time on this. By the way, I live a couple blocks away from the world's busiest intersection for self-driving car testing. This is in Paulo Alto, California. And almost every day, I drive next to self-driving cars. By the way, when there is a self-driving car next to you, it is very tempting to do a little bit of mischief. I am contributing to the training of the AI. I am doing my part. I actually don't do that. But when self-driving cars show up; and they will show up very, very soon; we know three things that will most likely happen. Number one, we are going to dramatically reduce car accidents and fatalities. You probably heard about the tragic accident in Arizona, where the Uber self-driving car killed a woman who was crossing a street at night. The part that is not publicly reported is that, if you look at the total number of kilometers that these cars have driven in self-driving mode and you put in the average human driver, by now more than a hundred people should have been killed. Instead, one person died. And as tragic as that was, that accident mechanism is never going to be repeated,

because the entire network gets an upgrade. That's why we are talking about orders of magnitude in improvement and safety. What about this? We are also going to have a whole bunch of unemployed drivers. Bus drivers, taxi drivers, Uber drivers. And we think car ownership will also go down, because most of us are not interested in cars. Most of us are interested in rides. And when the friction to access goes down, why would you own? This shift away from ownership to access is very pronounced in life exponential technologies. Now, you might own a car because you love a car. But most of us are interested in rides.

Let's put some numbers on these. Unemployed drivers in most economies that we have looked at make up about 1 percent of the work force. Reduced car ownership in most countries is about 2 percent of GDP. And this part kills me. In most economies around the world, 3 percent of the GDP comes from the death and destruction from car accidents. 3 percent, that is ridiculous! And it will go away. It will go away. Let's add them up. That's 5 percent of GDP and one percent of the work force who is extremely angry. Good luck retraining them quickly. In the last two years, I've had the opportunity to meet with nine Presidents or Prime Ministers. Now, let me tell you, not a single one has been prepared for this picture. Because this is systemic. Too much is happening all at once. And we need to upgrade our collective imagination. We think this is probably going to be why the global conversation around technological unemployment is going to accelerate. And my team's prediction is that by 2030, every country on the planet will have had a public debate about Universal Basic Income (UBI). Where they land on that debate on UBI is unpredictable. But UBI is going to gain a lot of momentum. By the way, just as a side note, you know when we talk about UBI giving free money away to everybody in the society to cover their basic expenses, there are two concerns. How do we pay for it? It's a longer conversation. The math does check out, especially in light of technological deflation. But the second part is, how can we ensure that people don't become lazier? Thirty active studies that have looked at the impact of UBI on a local community - almost without exception, they report that entrepreneurship shoots up the moment you introduce UBI. Quite often the number that is reported is threefold increase in entrepreneurship. So, lots more to cover there.

But on this note, let's switch to talk about risks of this new type of technology, Artificial Intelligence. How many people have watched this movie? Great, to the rest of you I am not going to spoil the movie. But if you did watch this, do you remember where this guy worked at? He was a police officer but where

did he work at? What was the name of the department? I think I heard it, Pre-Crime. So, Pre-Crime was the name of the department that would look at a person today and say I think you are going to commit a crime in the future. So, we are going to arrest you today. A group of Chinese researchers watched the movie. They liked it. They said, why don't we try this? They did. They fit an AI with 1891 images of criminals and non-criminals. The top three gentlemen are examples of criminals. The bottoms three are examples of non-criminals. By the end of this training process, the AI could look at a single image of a person and predict criminality with 89.5 percent accuracy. I have the app on my phone. We are not going to try it right now. Now, the concern here is, if you train an AI on historic data, then may be the criminals belong to a racial minority that has been historically at a disadvantage and that has had a financial disadvantage. You are basically perpetuating past incidents into the future. Another theory is that this is really only looking at the collar of the individual. If you notice, the criminals in the top row are all wearing black collar shirts. And everybody in the bottom is wearing the suit plus white shirts. Nobody knows and this is one of the key major risks we have with AI today. We do not understand how the AI is doing this categorization. All we know that it is extremely accurate. But it will be helpful for the AI to try to explain how it is arriving at these conclusions. And that's why there is a massive research effort towards explaining these types of results. Another concern has to do with privacy. A photographer in Russia went around Moscow trains, and basically took random pictures of people on the train. Here are some people. He used an open source AI to look up these images that he took and leveraged the facial recognition software to find their profiles on a site which is kind of like Facebook in Russia. Here are some of the examples of the random photos he took of people on these platforms, on the train, and he found them online only using their image. So, this technology is in public hands and it is already here. Like I said, image recognition and also audio recognition are the two frontiers, where we have seen tremendous momentum in AI. That's why we are seeing the rise of anti-detection fashion. Basically, people are saying if you do this and there is an entire roster of different approaches you can take, this is how you trick artificial intelligence today. And it is a constant battle between the people who are trying to avoid being detected and people who are advancing technology to overcome this type of fashion. One of my favourite examples is this napkin that you can buy on Amazon. And it currently trolls off the vast majority of facial recognition software if you wear it around your neck. But really, the best example of this is this - This gentleman is a researcher and he 3D printed the frame that he is

wearing right there. And the vast majority of facial recognition software detects him as this actress. Pretty useful thing to have. This area is called pixel hacking. And pixel hacking is gaining a lot of momentum. This is where you are trying to trick artificial intelligence for whatever objective that you might have. People also are really concerned about the emergence of not just AI, but Artificial General Intelligence, AGI. This is an AI that can not only do small little things like specialized tasks that we see with AI today but an AI that can do every single thing that a human can do. A general artificial intelligence that we call an AGI.

Some of my favourite quotes in this area, 'Success in creating AI would be the biggest event in creating human history. Unfortunately, it might also be the last." Elon Musk, 'Our greatest existential threat.' And Bill Gates, "I am at the camp that is concerned about super intelligence." Now let's be very clear. AGI is not near. We do not have technologies that point to the possibilities of AGI in the super short term. It is only a matter of time. And there are people who believe that even robotic and computational consciousness is within reach. Nobody knows right now and if they claim they do, they are bluffing. AGI should be a concern, though. Because like any other technology, Artificial Intelligence will be weaponized. And we will have pretty tough choices to consider long before we create AGI. Consider this example - let's say you have a robot that is trying to keep the house very clean. It's a cleaning robot. It does its job very well and it basically keeps the house pretty neat and tidy. Except that it notices that every Thursday grandma visits, the house gets very dirty. So it is trying to keep the house very clean. It decides that the best solution to this consistent problem is to kill grandma. Right, then the house remains very clean. This is an example of reward hacking. The problem here is that the AI never understood what the cost of its actions mean. It is trying to optimize from one outcome. Keep the house clean. And that means it is oblivious to the true human cost. There is an entire research effort around helping AI understand the broader set. The broader scope of costs that they create for humans. We are not there yet. This is an area we all need to be concerned about. But now, most importantly let's talk about strategy. What could be our strategy when it comes to AI? There are a lot of exciting developments. There is a lot of stuff that we cannot anticipate but there are also massive opportunities for leapfrogging with this technology. So how do we approach this in the context of our country, the context of policy making and the context of roles that you are hoping to play in the service of your country? Let me share with you the obstacles of adopting AI. This is a survey done by Forester research. It

talked to business executives. But I think the results are really clear. Because the vast majority of my government conversations also roll out under these categories. These are the top categories of objections, obstacles that executives and leaders see while adopting AI. 23 percent of executives say there is no budget for an AI project. We will come back to this in a second. 29 percent believe that they need to first modernize data management. 33 percent do not have the required skills. They believe their organizations do not have the skills. And the largest category, 42 percent have no defined business case.

Let's go through them one by one. Again, very informative regardless of the context of business or government. No budget for an AI project, this is historically accurate but progressively it is harder to justify. And the truth is, AI projects do not require massive budgets. Because of technological deflation we are seeing smaller, and smaller and smaller budgets actually lead to productive results. And companies and certainly governments are beginning to notice and also act on this. This is the number of companies mentioning AI in earning calls, it does not get any more exponential than that. What about the second one? Need to first modernize data management. This is very on point. And I truly believe it should be top for all of us. Unless we have to write data that we cannot really do anything with. And what about the third category? Do not have the required skills. This used to be a concern that made a lot of sense. But today because of the stack model of AI, progressively actually you do not need a lot of coding. At TLabs we have switched to drag and drop for a lot of our AI projects. Because so many people have written the code that we can go further up in extraction and have more user-friendly experiences. And certainly, the open source model, the stack model tends to flow, which is the Google project and the most popular AI platform today has certainly liberated and liberalized the vast majority of these types of applications. And what about the fourth one? No defined business case. This plagues the vast majority of organizations that we look at. Because it is ambiguous what AI can do very well today. That's why I want to share with you some of the highlights from our research into the most productive approaches we can take today. We have looked at organizations exponentially in the last two decades. We have a framework around this called the exponential business models. We noticed and found that the common denominator across all these organizations was this - digital twins. What is a digital twin? A digital twin is a digital representation of something from the physical world. Basically, ask yourself the following question. Think of any person, any piece of property and any process in your world and in your future world. And ask yourself whether that

person, property or process has a digital representation? If not, then go invest in creating that digital representation. This has massive implications. The moment you have that digital representation, you can basically take the digital twin and apply all of these exponential technologies that you heard about from Peter, to that digital twin. And that is how you unlock exponential value. This is the highway to exponential value. And again, it does not require us understanding what the future model of AI is going to be and which AI project to invest in. A digital twin strategy will basically embrace whatever that future of AI is going to be, regardless of what the future might be and you will certainly be able to leapfrog into future versions of technology. It all begins with a digital twin. This is a common denominator and the first and the only thing that you need to have in place to be able to apply any AI technology.

Let me demonstrate exponential value with a couple of examples. Because understanding this equation is a beacon of guidance for us as to how to invest in this space. Moving forward, I think it is going to be informative for all of us in the future. Let's say we looked at bicycle accidents. What if we could look at thousands of bicycle accidents and create a nearly perfect digital representation, a nearly perfect digital twin of the final second before somebody falls from a bicycle. I'm taking a very simple example. Right, not a massive infrastructure project, but really one tiny bit of digital twinning as an exercise. What if we could look at thousands of bicycle accidents and have the perfect digital twin of the final second before somebody falls from a bicycle. This is exactly what a company out of Sweden did. Have a look. Now this device takes about one tenth of a second to inflate. Have a look. That took one tenth of a second. Let's watch it again. Pretty impressive. How many people believe that this device, this collar is safer than a bicycle helmet? Yeah, it's pretty hard to believe. Not only is it safer, in fact it is eight times safer. It turns out that if you are wearing a helmet and you are involved in a bicycle accident that involves head impact; you are more than 90 percent likely to end up with head trauma, more than 90 percent with a regular helmet. With this device, it drops from 90 to 2 percent. 2 percent. And this is only possible because of the digital twinning process. They use AI to detect exactly which motions are not falls and which ones are. Now, let's try this again. Something broader that we are noticing is that markets are moving away from demanding products for services, not only from market players but also from their governments. We are moving towards demanding performance. Now I think this will dominate the types of conversations around value, that you will have moving forward in your professional capacity. Delivering performance is also better possible than

ever before, thanks to digital twinning, which unleashes the use of artificial intelligence.

Let me show you an example of this again from the real world. Let me set it up for you. Let's say you are an owner of a theater company in Spain. In your theaters you run comedy shows. Business is great. Every night you have a comedy show and you are very popular. Now one morning you wake up, and you notice the government has increased the tax rate from 8 to 21 percent. Government has tripled the tax rate for theatrical shows. Big problem. Translation - tonight, nobody is going to show up. What would you do? How would you respond to this external shock? I want you to think about this for a few seconds. Think about it for 10 seconds and then I'll show you what these guys actually did. Ready? Here we go.

'Pay per Laugh, the first comedy shows where you only pay for what you consume. We fitted each seat with a facial recognition system that detects the smile and proposes the following deals to the spectators. Entry will be totally free. If the show produces no laughs you don't pay anything. However, if you laugh you have to pay for each smile. Each smile produces value worth 30 euro cents, something that in this day and age is quite a reasonable price. At the end of the show spectators can check their laughter account before paying and even share it on social networks. And so no one would cry for having laughs more than they can afford. The maximum amount to pay was 80 laughs for 24 Euros. The average price of a ticket increased by 6 Euros. The system was covered by the main national media outlets and this produced 35 percent more spectators. Each Pay per Laugh show produced 28,000 Euros more ticket money than that was normally taken. Currently, the system is being copied in other theaters in Spain. A mobile phone app was created as a system of payment, and the first season ticket was launched for the number of laughs, not shows.

Incredibly creative. If you are going to a comedy show, what is your biggest risk? What if it is not funny? That's exactly what these guys de-risked. How did they do it? By creating a digital twin of a smile, of laughter. And how did they do that? Using AI. So, I want you to reflect on how you might be able to use the digital twinning process? To unleash value for constituencies. We think the next decade is going to be remembered for four moments in technological history. Let's call these the four supremacies. It comes down to quantum supremacy, block chain supremacy, solar supremacy and AI supremacy. Quantum supremacy is the moment when quantum computers

become more powerful than digital computers. Block chain supremacy, when the block chain architecture for data base becomes more useful than conventional data bases. Solar supremacy is when the marginal cost of solar energy drops below all other forms of energy, without government subsidies as you already heard, this is already happening. AI supremacy is when AI becomes more powerful than the human brain in the vast majority of business applications. Now, it's the convergence of these technologies that I want to put on your radar. That is the exciting news. By all indications these are going to happen before 2030. Quantum supremacy might already have happened around two weeks ago with Google. It is the combination that will give us amazing new things including the next version of the internet, which we call the BLAIQ net. BLAIQ net stands for Block chain, AI and Quantum. On the BLAIQ net you will have accountability of the block chain, automation with AI, and optimization at levels we have never seen before using quantum computing. Ladies and gentlemen, the name is probably not going to stick. I'm not going to be heartbroken. The point is, whatever we end up calling this, the BLAIQ net will do to the internet, what the internet did to the library. That is the scale of shift and destruction that we are talking about. And now is the time to reflect on how we can upgrade our delivery of value to our constituents using BLAIQ net. This world is approaching faster than most people realize. Let me demonstrate what type of value delivery your markets, your constituents are going to expect from the BLAIQ net. And we think this is going to happen before 2030.

To demonstrate, I want to show this project. This is project YOLO. YOLO stands for You Only Look Once. It is an AI project that has trained a machine to watch a video for the first time and detect objects in real-time. So, in this case, it's detecting a person and detecting a motorbike. But as I play the video, this is from a short segment of a James Bond movie. Notice that this rate of object detection is faster than the human brain can handle. So already we are seeing AI supremacy in this one particular domain. But as you watch this video, ask yourself when you combine block chain technology with this level of AI, with sensor technology, with IOT, what types of nano transactions could be happening in real-time? That is one of the biggest, exciting developments of areas that should be on your radar - nano transactions, in this hypothetical world. Think about this for a second. She just fired her gun. And this is in Turkey and the gun was a smart gun, has a sensor, has a digital twin. Immediately after firing the gun, her gun license fee jumps by about 7 percent automatically, without any human intervention. This guy who is running

away and he is jumping over the bridge before he hits the ground, an ambulance is already called. An insurance claim is already settled. They took the money from his account. All these people in the line of fire, their lives have been endangered. So naturally they have sued her agency. The law suit is settled automatically. The money is already in their accounts. They are all enrolled in therapy. Its starts next Thursday. The insurance premium in that yellow card just jumped by 10 percent. Real estate in this whole neighborhood just dropped by about 20 percent. And all this happened without any human intervention. This is the world we think we are headed towards. And we think we are going to see the beginnings of this before 2030. Are we prepared for this? Now, how do we prepare for this? In order to understand what types of value you can expect from AI. we've found that it is helpful when we talk to governments and when we talk to the private sector to structure the value of AI in terms of three key areas. Value delivery, practical applications of AI in my assessments comes down to prediction, assistance, and automation. Prediction is when you are trying to say something about the future. You are trying to look for co-relations and you are trying to anticipate the future. Assistance is when AI is able to help the human do her job better. And automation is when you are bypassing the human and doing whatever they are focusing on. Now, the time line for these really matters. I find that the vast majority of prediction scenarios can be accomplished within one to three years. This is in the context of government applications and also corporate. Now, assistance is a bit tougher. In the next one to five years we think many assistance scenarios will see fruition. And automation is the toughest; we're projecting one to ten years. This is a very aggressive time line. But it seems to be corroborated by the exponential growth in computational power but also growth in data. Now, you combine all of this and the question is, how much money can you save for a government? Someone has done an analysis, where they are saying that using current AI automation technology and considering two scenarios – either high investment in AI or moderate low investment in AI. The government of the United States is expected to basically save anywhere between 97 million hours to 1.2 billion hours per year by leveraging current AI technology. Again, not future technology and in the United States this translates to somewhere between $ 3 billion to 41 billion. Very, very exciting. If you compare your national budget to the American national budget, this means that pretty readily we can divide these numbers by about five to ten. Somewhere in that range is the projected value to the Indian economy. How much can the Indian government can potentially save? Is IQ what we are

trying to match with artificial intelligence? Is human intelligence what we are trying to match, or are we trying to do better? We know in light of exponential technologies, the type of technologies that you heard from Peter and myself, we know that the human brain gravitates towards IQ in light of uncertainty and volatility. We try to surround ourselves with very intelligent people. We build very smart teams. But here is a problem. Recent research has shown that beyond the first two years on the job the IQ does not predict success. Let me say that again the IQ does not seem to be predicting success. So what are we missing in this exponential world? With the group of researchers at TLabs, I have invented the concept of AQ - adaptability quotient. If the world is changing exponentially faster and faster, then your ability to respond to that change is the strongest predictor of your success. And we believe in a stack model of intelligence. At the base of the pyramid is IQ. It still matters. Top of that we have EQ, for emotional quotient. And on top of the pyramid we are introducing AQ, for adaptability. And why does this matter? This matters because AI can actually help boost our adaptability. And we have quantified adaptability today. At TLabs, it took us 5 years, but we have used AI to be able to do that. In order to demonstrate why AQ matters and why AI should not be trying to match human intelligence, but do better.

Consider this, I want to give you this example. The question is which medicine do you choose? I'll let you read the question on your own and then we will compare the answer. Alright, I think everybody has had a chance to read. So, medicine A given to three people and all of them survive. Medicine B given to eight people and seven of them survive. How many people would prefer to choose medicine A? Amazing! How many people would choose medicine B? Great! In many countries in the world, people would choose A? But of course, B is four times safer using this available information. And without specialized training most humans cannot answer this question very well. This is an example of an area where we hit the cognitive limits of IQ. And the answer is here, but you all got it. This brings us to the next critical point that we are noticing that is changing the work environment, the work place. In the modern work place we are noticing that companies are progressively hiring what we call trilinguals. People who speak three languages. Number one is decision science, what you saw on the last slide that's an example of decision science. It's not about data science, its broader than data science. It's about decision making under uncertainty. How do you embrace new information? The second language is AI and coding. And let me be very clear I'm not saying that

everybody needs to code, I'm saying everybody needs to understand coding and understand the language of AI and what type of problems it can tackle. Number three is the job. Notice, the job is in position number three. Because if you have one and two, and those are hardest to give to a person then number three becomes very-very easy. Hiring trilinguals means that either you are trilingual or you need to train yourself to become a trilingual.

By the way, if you would like to go deeper into coding and AI, two resources that I would highly recommend - Deeplearning.ai and fast.ai. These are great resources and great courses that are available online. And you can do this without getting into a lot of technical details but you can very quickly get into pragmatic applications, which I think is critical for all of us in our future roles. Now, here is another area where we think AI is going to affect the modern work place, much sooner than most people realize. Collectively, we are going to be able to make better decisions that today we are not able to make. Here's a question. What was the best invention of the 20th century? What if I wanted everybody in this room to participate in coming up with an answer to this question? And let's say I gave you these 6 choices, radio, personal computer, antibiotics, airplanes, television and duct tape. And I gave you one minute. All of us to come up with a single unanimous answer. This is pretty impossible to do. If we decided to do this right now, we won't have time. But what would happen if we would break into small groups. A loud voice will emerge, we will try to manage the group and then have a process of consensus, and then voting and some people will start Googling. And it's messy. Now let me show you an application that was developed using AI that reduces the process to a very efficient 37 seconds. So, this is from a company called Swarm AI. Unanimous AI is a product or the other way around, Swarm is a product. Basically, there are the six answers and each of us would have a platform in front of us. It's basically a website that you can access using your phone or your computer. And you would drag that bubble in the middle to the answer that you like. Let me show you what a group of people actually are doing as they are answering this question. You would drag the bubble towards the direction of your answer, but in real-time, other people are trying to drag it in other directions. This is truly magical because this creates a feedback. You will see what I mean in a second. Here they are, it's about to start. Three, two, one. There we go. People are pulling it in different directions. And at any point in time, you can see how much more confidently some people are pulling it towards antibiotics and then it's moving towards television. And then it's going back towards antibiotics and people are getting convinced and it is done. It only took about

30 seconds. Not only that, you now have a level of conviction for the entire group. It turns out if you use this tool which leverages AI and tried to make predictions, those predictions tend to be on average 30 percent more accurate than if a group of people tried to do this without this tool. 30 percent boost in accuracy is remarkable, which brings us to this point - what should be your AI moon shot? How do we define these massive ambitious AI projects that are overspending on the wrong things and without underestimating what could be accomplished. So, I think there are three elements. Most people believe that you need good engineering, computational power and data. These are the three required elements. In reality all three are required but the relative balance of how to create magic using AI based on these three factors looks more like this. That is the role of AI. That is the role of data in AI. And that's why when we talk about data we really focus on digital twinning. Digital twinning begins with connecting, collecting and analyzing. That sequence is going to be critical. In fact I think the vast majority of your near future careers will be the process of observing or perhaps enabling this flow - connecting, collecting and analyzing. And most data in our organizations lives in silos. That's why your cloud strategy is very much a part of your AI strategy. If you do this right, I want to share with you our playbook, how we approach AI projects in terms of the data strategy. That's my personal checklist. Every time I work with a government agency or a corporation these are the seven questions that we try to ask. Do we have the right data? Does that data live in silos? What are our future data needs? Can we anticipate them? Can we move in that direction? Can we collect an update in real-time? Most data is stale and is not getting updated very frequently. Do we have capable data scientists? Notice, I didn't say engineers. Engineers are great to have but not absolutely necessary. Progressively, we are switching to higher levels of abstraction with AI. Do we have the right legal rights to the data? Can we handle 10 times growth in data than is in the world to anticipate? And what about implementation? These are the three typical questions we get. Do we buy or build our AI? Do we automate or assist a human or bypass their job? And do we have an open architecture or closed architecture? This is little more technical for your reference. But I believe you should start by building, especially if it is going to be a core part of your business or core part of your value proposition. And I think it will be core to the vast majority to what you guys will be focusing on. Automate or assist? Begin with assist and graduate to automate. Try to understand how you can help a person and predict their environment a little better and then graduate towards automation. Open or closed? Start with closed. Understand the risks, asses the opportunity then

open it up with the help of an API. Digital twinning process always sees fruition in the API mechanism.

Now, what does AI not do really well? What does AI suck at today? That's another way of asking this question. I think the best way to reflect on everything that I have shared with you is this - What translates to discovering co-relations? AI is pretty good at this. We are not there a hundred percent, but it is the best use and utilization of AI that we have seen so far. What about the why? AI really sucks at explaining why it is coming to the conclusion that it is and also does not understand causation. Causation is difficult in current implementations in AI. It is important for us to understand that limitation. And what and why not? The creation of new things, that's the ultimate frontier and certainly we are not there yet. So we are good with correlation, not so much with causation or creation. But that's hopefully right around the corner.

Ultimately, how can we think of AI as a county strategy? In our conversations with governments, we typically gravitate towards these seven areas. It always needs to be a national mandate but then you gradually go up the sides here. You need talent development. You need people who understand AI at multiple levels and you need to accelerate research. It will happen by governments embracing an open data and innovation architecture and creating work flow, especially in government models, that embrace the digital twin. That's probably the most valuable thing you can have in your contribution you can make in your domain. Understanding whether something does not have a digital twin and embracing that digital twin; paving the road on how that digital twin can be captured; and finding a digital twin strategy and creating that value equation and ethical questions that will abound the topics of AI. That is how we can embrace this conversation, then it goes back to the national mandate and this is an iterative process. Ladies and gentlemen, as a technologist and an economist it is very un-cool for me to end on a positive note. I have to warn you about something. But the truth is I am very optimistic. I think with AI and these exponential technologies that you heard about, the best is yet to come. We have a lot of massive opportunities. I do worry, however, about one area. And that is a crisis of imagination. The truth is that because of these exponential technologies today, our reach exceeds our imagination. We can do so much more than we realize. But most of us don't realize it. In a way, the biggest risk is not thinking big enough. Which is why I want to share something with you. My favourite quote of all time, this is what happens when you do think bigger. Something magical happens. But

first, if you would like to keep in touch, that's my personal e-mail address. I'd love to hear from you. Here's my favourite quote of all time, 'Intelligence is hitting a target that nobody else can. Genius is hitting a target that nobody else can see.' When you think outside the box, recognize for a while, people are not going to understand the target you are going to hit. They are not even going to see it. But if you stay with it, the genius will be revealed. You guys have been amazing. Thank you so much!

Don't do that. Don't do that.

N.K. Sudhansu – Thank you for this brilliant peep into the present and the potential that the future holds for us, Amin. Now to some questions. This question comes from Abhinav, and he asks, 'In achieving the most efficient outcomes, can AI be unfair? How can AI be efficient and fair at the same time?'

Yeah, that's an excellent question. I don't believe that efficiency always comes at the cost of fairness. But if we are not careful about it, fairness could be easily ignored in the process of pursuing efficiency. Really, I would believe that the vision of success that we always have for us to be more intentional about broadening the scope of what we are optimizing for. To only optimize for efficiency, gets you efficiency and potentially adds unforeseen costs. And we need to broaden that scope and say optimizing for efficiency but also for human impact, also for social implications and that's hopefully how we achieve fairness as well.

Thank you. This is a question coming from Sudambika. She asks, 'Has there been any research on consequences of AI on the human race?'

I'll share one element with you. That is again very close to our hearts. As I mentioned, my wife and I have decided to put all of our life savings into projects that we care about. At TLabs, one of the focus areas that we have is human longevity. There are animals that live in this world today that have outlived their normal life span by more than a hundred percent. This is the equivalent of you and I living together to be 150 years old. So, life extending technology used to be science fiction, now it is beginning to be science fact. And the concern is that economic inequality could very well translate into longevity inequality. The point here is that the vast majorities of life extending technologies we are looking at today leverage some form of AI. Now whether we want life extension, that is a deeper conversation. A vast majority of people do. But, the point is that it should be a choice and not something that allows technology to exclude certain segments of society and include other segments

of society. So think that is an area that is very close to our hearts. It is one thing for somebody to drive a better car than me, because of their higher socio-economic status. But it is a completely different thing for them to have to live longer because of their affluence. And I'm not so sure the society is prepared for that. And this directly links back to AI.

Niranjan Kumar Sudhansu - So, let me ask you a question now. You said that you are not the best guitarist in the world but I'm sure you are one of the best. Do you think in the near future, AI can or machines can create music, instead of just mixing and matching? Can it create something that a human can do?

I presently have no doubt. Yes, absolutely. In fact, that's why I don't play the guitar any more. General Adversarial Networks have demonstrated whet we conventionally call 'creativity'. So, creativity is possible today. But I think deep creativity, true creation is also right around the corner, even though we don't have it right now.

Thank you. A related question comes from Shubham. 'How close, if at all, are we to creating a general AI based self-conscious system?

Could I have four hours on the clock? So, we can go really deep into this conversation. Look, computational consciousness is intractable today. We don't really know. In fact, the term singularity comes from anything that we can't really explain. Those of you with a Math background, you know that a number divided by zero is a form of a singularity. If you have a physics background, you know that a Black Hole is a singularity -the subject matter of Singularity University in TLabs. The concept of a Singularity, the way we define it, is Technological Singularity - the moment when computers start improving on computers. We have no idea what that world looks like. By all indications, this is going to be right around the corner. The vast majority of predictions around Technological Singularity are pointed to the next 20 years. The moment computers start improving on computers, we have no idea what that world would look like and it could be that consciousness becomes an emergent quality of that level of computational power. We do not know and there is no way to know that I am not a robot. And that's not a joke. If you think about it philosophically, all we can see from each other is behaviour. Right, that's the externally visible component of this. And that is all we will see from AI as well when it reaches that point. That's why the whole concept of consciousness, in my assessment, is intractable today.

There are some related questions on privacy issues, I'll just read one of them. 'Artificial intelligence and deep learning require tons of data. Making

available such data requires extensive data collection which gives risk of privacy concerns. How do you handle these concerns?' And there are related questions on privacy issues.

So, privacy is a big concern. Like I said we believe that ultimately there will be market-based solutions to the question of who owns your data. Meaning, you should own your own data and you should be able to license it out as you see fit. That's the way forward. However, the problem right now is that we don't have these market-based solutions. For the most part, my data at the individual level is not very valuable, it is the aggregation of all of our data that's truly valuable and we haven't figured out how to crack that code. There are many block chain projects that are focusing on data privacy and how you might be able to license it out. But the fact is instead of this topic being in the background, it has been pushed to the foreground and I think that is the first step. Having a public discourse about this will lead to innovations that will answer the question properly.

Thank you. A very interesting question comes from Govind. He says, 'How do we manage the human biases that get into the AI systems? And would AI be a better voter than human beings in a democratic election sometime in the near future?'

The topic of bias is a critical one in AI. The truth is, AI is very good at replicating your data and understanding patterns in your data. And if those patterns include human bias and we know human bias is prevalent. Racial bias, sexual bias, all sorts of biases effectively were perpetuating those biases and more critically by amplifying them without recognizing that we are doing that through these AIs. So, this is an area of active research. Again, gladly more and more people are recognizing that the bias exists and AI can do better than the human base line. But again, within the research I have not seen any breakthroughs yet.

The Rules of Derivation: Forces Big and Small

Rod Falcon

My job is to actually just talk about some foresight fundamentals, some of the key terms that we're going to be using today to give all of us a baseline because in a moment, once we're done here, we're all going to be going into our thematic areas. And we're going to start putting some of these ideas and this foresight mindset into practice. So let's go through some of these key terms to give us this baseline. So I'm going to be talking about drivers and forces, signals, forecasts and scenarios. So let's talk about the first two drivers and forces and signals for us as futures. They really represent concrete evidence, the concrete evidence that we need to build our forecasts. In many ways, they are the building blocks of forecast, concrete evidence of what's changing. So for us, drivers and forces are often large macro trends that are really shaping a space like the future of healthcare. Or maybe even the entire country of India. But there are these future forces that are really shaping change. And it's really important to identify those and think about them in a very systematic way. So to do that, we often use a number of different categories. To be comprehensive, we think about actors, tools, practices, a lot of different categories. But I think my best, my favorite way to organize these is using the heuristic of STEEEP, which stands for social, technological, economic, ecological, or environment and policy. And when you do that, and identify drivers within these categories, it allows you to bring some coherence and some organization to identifying those drivers. So in any foresight project, you want to think systematically through these large driving forces of change.

By adopting STEEEP, its almost ensures that you're thinking broadly and that you're not just looking at technology, but you're trying to understand those technologies and the space, you're forecasting in a larger context and that's really important.

So another form of concrete evidence of what's changing, is what we call signals. So when we talk about signals, I often like to invoke the words of the science fiction writer, William Gibson, who said, the future is already here. It's

just not evenly distributed. And for me, it's a reminder to ask the question, where do we see the future today, and to actually look for the future in the present? And that's kind of one of the key practices that you're going to be doing. Many of you have already begun identifying signals. We heard a lot of the many signals in the presentation earlier today. But to ask yourselves, where do I see the future today? Those are the signals now. This is critically important as part of a foresight practice. So for us signals are small or local innovations that have the potential to scale, either in geographic distribution or in their impact, but there are small things that we might see.

May be, we have this suspicion that over a short period of time, they evolve into a social and/or economic impact. For us, they're either a product or service, a new business initiative that you heard of, a new research project, even a new data set might actually reveal something about what's changing and something new. But it's really important to remember that a general trend or a technology category is not a signal. For us signals are very specific cases. You've been talking and hearing a lot about Artificial Intelligence. So, for us, Artificial Intelligence is not a signal. It may be a driver or a force, but it's not a signal. For us a signal would be a very specific application or a very specific case.

This was from Wired a few months ago and you can see the headline - "Can AI be a fair judge in court?" Estonia thinks so. Estonia plans to use an Artificial Intelligence program to do some of its small claims in court. In other words, they're going to employ an AI as a judge. So AI is the larger driver force. The specific application in this case in Estonia is a signal. And so we're often looking for signals, multiple signals, bringing them together, and that becomes the evidence of a potential direction of change. They're the building blocks of forecast. It is therefore that in our practice, we also very systematically asked the question, what and so what?

So, what is the actual case itself? This is Estonia, they're using an AI robot judge to process some of the claims in courts. It's also speaking to Sony for larger policy initiatives like building smart government services. There are so many implications that arise here - the ethics questions around can a judge really be fair.

So all these different implications are what you would identify. A lot of people that I've been talking to recently have noted that there's a lot of conversation online, especially in social media channels, about mental health and depression and things like that. But that observation is not a signal. It's just an

observation. So again, when we're talking about signals, you have to be very specific. So a specific example is this, artists using this hashtag - *mental health warriors* on social media, or actually using art and creating memes that are addressing a lot of the mental health issues and depression here in China. Here in India, they're using this to really open a lot of conversations. In many cases, as many of you know, talking to people about depression can be really difficult. So they're doing this on social media. This is a very specific case. And again, we go through the discipline of identifying the *what* and *so what*, in this case, it's young artists throughout India that have started this project and are really identifying as mental health warriors on social media.

So what makes a good signal. And again, this is really important because in a moment, we're all going to be talking about signals and identifying them. You need to ask yourself three questions. Is it specific? Again, give me a concrete example. So you may identify a big, large category, but try to think of a current concrete example. Ask, is it current? Is it within the last few years? And is it compelling? Only you can answer this question, but for me, it usually means that I'm shaking my head about this. It's challenging my world view. I've never seen this before, where I have this sneaky suspicion that if more and more people did this, it would just be so impactful. So those are the kinds of questions you should be asking yourself.

Establishing this baseline for what our forecasts tell us is simply a statement about a possible future. But there are a few other sort of characteristics. It needs to be plausible and internally consistent. It needs to have this sort of internal logic that works in our reality. It needs to be provocative and not predictive in our work. Prediction is not the metric, the metric that we care about is provocation. Does it get you to think differently? Does it challenge you to think about more than one possible future? So getting you to imagine more is really the metric and being provocative. Is it founded on present day facts? Do you have drivers and signals that are the evidence, that are going to be the building blocks of your forecast?

And then finally, can you apply it to different concepts at different levels? Can you apply it at a city or urban level, at a national level and kind of thinking through those skills, those skills become really important as you build your forecasts. In other words, forecast really brings together signals and drivers in a coherent story about a possible and plausible future. And they can be expressed in all sorts of different ways and I'll give you a few examples. And technology, we're often forecasting different technology capacities, we might

use different organizational domains. Forecasts can take a lot of different forms that they can be described in, and a lot of different ways. We use a lot of different formats. One of our favorite formats is to describe them in a map of the decade.

This is a project that we did for the World Bank, their climate funding, they were asking the question, what's the future of climate action? We know that we're in the middle of a climate crisis. In fact, any forecast that you read from us or anyone else that doesn't include the climate crisis is really an incomplete forecast. The project was trying to forecast all the variety of spaces that will see climate action. One of the specific forecasts that's on the map is viewing climate as a growth space. We know that it's going to burden many different governments and institutions and there's a lot that we need to respond.

But there's also a huge opportunity in viewing it as a growth area, from being seen as a burden to being understood as a profitable investment.

Scenarios sometimes integrate multiple forecasts even as they describe a future state and you get to describe them as if you do that from within that future world. The big idea is that by putting yourself in a scenario, you pre-experience the future. One format that our scenarios take is something that we call *artifacts from the future*. These are graphic illustrations, as if our forecasts were to come true. There is an app called *Day maker* and it's trying to describe a world where the devices that we have in our hands or in, on and around our body are collecting a lot of emotional biometric information on ourselves. So this imagines a world where, let's say you're on a train track, and you get an email, you're checking your email, except this time, you understand that there's a woman just down on the platform that has been experiencing a lot of stress, and could really use an intervention. And because you're part of this network, it has identified you to be this person. So you would go and talk to this woman and hopefully, make her day much better and then prevent any further stress or other issues that may occur.

So, this is one form of scenarios again, trying to immerse yourself in those possibilities and we'll be talking more and more about scenarios as we move through our day today. This was a walk through our basic terminology.

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