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THE COUNCIL

Engineers, don't build the world, shape it!

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Image: Indraprastha Institute of Information Technology, Delhi

Introduction

Prof. Ranjan Bose, Director IIIT-D; Mr Kiran Karnik, Chairman of the Board of Governors; Members of the faculty; and, of course, members of the student body, especially all graduating scholars: Namashkar! Thank you for inviting me to the 11th Convocation of IIIT Delhi.

I am truly humbled for several reasons. First, I am in the company of those for whom I have deep respect. Mr Kiran Karnik engaged in one of CEEW's key projects (on global governance) when it was just a four-month-old institution — and has been a well-wisher ever since. I understand that you have created interdisciplinary research centres for AI, Design, Healthcare, and Sustainable Mobility and I wish to congratulate the university for its focus on the Sustainable Development Goals. For instance, I have engaged with Prof. Jalote's initiative — Enveave — for more than a year and am inspired by his vision to bring talent and innovation closer to solving problems.

Secondly, I am in the company of a friend and colleague, Karthik Ganesan, whose wife — Prof. Shobha Sundar Ram — is a senior faculty member here. Thanks to them, I have visited this campus on several occasions. This is the first time I'm giving a lecture here, and I hope I meet their high bar!

Thirdly, as a non-engineer, I come here with humility and a bit of glee. To my wife, Meghana Narayan, who is also a computer science engineer and now a remarkable entrepreneur of nutritious food, I have this message: "See? I didn't get an engineering degree, but I did give away a few!"

Jokes aside, this is an important occasion, a solemn occasion, when so many of you graduate from one stage of life and enter another. I remember when I graduated, just before the turn of the millennium. Two years earlier India had celebrated its 50th year of independence. By the end of the decade, India had survived multiple financial crises, it had opened its economy, its IT sector was getting noticed across the world, and it was soon to be declared an emerging power. It is the 75th year of independence and before you know it, one of you will be delivering a convocation lecture in the year of our centenary. There are other turns underway now, thanks to technology, the economy, society, and politics. I'll come to these issues later. I have a more straightforward message for you.

Human beings are dexterous creatures. With our simple, opposable thumbs we have been able to hold things, shape tools, and build complex marvels — from bridges spanning vast canyons to rockets shooting into space.

From early childhood, we train our kids to hold a pencil and draw a line. We congratulate those who are the neatest. As a child, I would enjoy those puzzles that would connect seemingly scattered numbered dots to eventually reveal a more familiar figure (a dog or a car, perhaps).

This simple game is at the heart of the message I want to give you today. What are you more fascinated by? The neatness of the lines connecting the dots? Or the final drawn outcome? Or the scatter plot itself? My message to you is "be curious about all three", the randomness of the world we inhabit, the dexterity and process with which you thread a narrative across that landscape, and the beauty of what emerges by our actions.

Engineers are trained to design and build.

The engineer's world is a system of measures and the precise relationships between them.

The engineer's world is also one of imagination, without which we would neither have the pyramids nor the flush toilet.

But that imagination is also limited by the parameters of what seems to be physically possible.

The engineer is, therefore, frustrated by variables that are not always quantifiable, let alone predictable.

If you think I am beating up on engineers, don't worry. I trained as an economist. Our tribe tends to get frustrated if reality does not fit our assumptions!

This tension between engineered order and societal chaos defines much of how human societies have flourished — and perished.

Ask this: We are intrigued by the innovation and orderliness of the sewerage system of Harappa. But 4000 years later, why do we have overflowing sewers and drains in a city such as Bangalore, which boasts tens of thousands of engineers?

Or ask this: Just 65 years after the first manmade satellite was launched into space, we now have the capability to engineer and deploy thousands of micro-satellites, not just by heavily funded and secretive government missions but also those designed by students and delivered via private launch vehicles. Yet, why are we moving backwards from the rules that govern humanity's behaviour in space?

Every month we are losing 1 percentage point of the remaining carbon space to keep temperatures below 1.5°C. We have the technology to fight climate change, but why do we not manage to design accountability for all our actions?

I know you're probably not keen on sitting more exams just yet, but here is the problem statement: How does the engineer, who designs using parameters within their control, factor in the contingencies over which they hold little sway?

Let me illustrate this using four examples.

Example 1: Success of technology versus failure of society

We are living in a techno-centric world. Technological breakthroughs — and widespread dissemination — have driven a lot of the productivity growth in the last three to four decades. Land, labour and capital remain growth variables, but the X-factor has been tech. The Internet has been the most consequential tech advancement of our times. Its widespread use has now created new opportunities, from digital identities and financial inclusion to devices speaking to each other for more optimised production and consumption of goods and services.

Even in the late 1990s, when I was applying for grad school, my access to the Internet was limited to a kiosk in the market, from where I typed out my application essays. Today more than 63 per cent of the world's population uses the Internet. At the same time, according to UNICEF and WHO, in 2020, about a quarter of the world's population did not have safely managed drinking water in their homes; half lacked safely managed sanitation. In the 12 months to October 2022, 170 million people got connected to the Internet. With a simplistic linear projection, by this time in 2030 another 1.4 billion people would have become Internet users. Yet, on current trends, there will remain 1.6 billion people without safe drinking water at home and 2.8 billion without safe sanitation.

Advances in biology and computing power will drive a lot of the emerging technologies in the coming years. Consider the remarkable success in developing, testing and deploying a vaccine against CoViD-19 within 12 months of the virus having been detected, shrinking a process that normally takes years.

But also consider a counterfactual: Suppose CoViD-19 were not a pandemic but a pan-African disease? Would we have got a vaccine so quickly? Would we have got a vaccine at all? Despite pneumococcal disease being the biggest killer of children, pneumococcal conjugate vaccines were not developed at scale until the Global Alliance for Vaccines and Immunisation (a partnership among a few governments and philanthropic organisations) placed an advanced market commitment to buy millions of doses of the vaccines. This drove the prices down and resulted in 215 million children being vaccinated in 60 lower-income countries.

The point is that our techno-centric worldview is a partial one. We should certainly celebrate the success of technology and its potential to change lives. We should also acknowledge the failure of society. It is relatively easier to design a device that purifies water; it is much harder to create the political buy-in for safe provision of water and sanitation. It is easier to sell an air purifier; frustratingly difficult to create a democratic demand for clean air. Technology cannot fix the planet if the people who inhabit the planet don't want to save it — or themselves.

Example 2: Energy transitions versus global energy disorder

Since the time when humans figured out how to start a fire, energy has been at the heart of human civilisation. India is going through four energy transitions. Two of them are well underway, namely access to modern energy sources for hundreds of millions of Indians along with rapid urbanisation, which is changing energy demand patterns in homes, offices, industries, and transport systems. These transitions have been made possible by advancements in technology, business models and policy. In 2015, India had the dubious distinction of having the largest number of people without access to electricity or clean cooking energy. Now, more than 98 per cent of the households are electrified and more than 80 per cent of homes have an LPG connection. Of course, there are gaps in service provision and changes in behaviour that could behaviour. But in general, this is a creditable achievement. The electrical engineers at the last mile who worked night and day to electrify 28 million households in 18 months performed what might have seemed like a miracle.

There are two other transitions, however, which are more complex because they are potentially contradictory and destabilising. With growing energy demand, India will become more deeply integrated into global energy markets. At the same time, it must meet this demand within a rapidly shrinking carbon constraint. Of course, there are technological solutions, which must be tapped. When CEEW began operations, India had less than 20 MW of solar power. Today, it has 60000 MW, 165000 MW of non-fossil electricity capacity, and will be the first major economy that will deploy more renewables in a decade than its entire electricity system. That translates to deploying 10.5 MW every hour, for 10 hours a day, six days a week, 52 weeks a year, for the remaining eight years!

This breathless marathon is a materials, manpower and money challenge of ginormous proportions. But the real challenge is geopolitical. If there is one lesson from 2022 it is that energy security, climate action and geopolitics have now converged. The Russia-Ukraine crisis has sent oil and gas prices skyrocketing. This could be a moment

to double down on clean energy infrastructure, but that raises the question of a new kind of energy dependence. If we shift from importing 80 per cent of crude oil to importing 80 per cent of solar modules, have we become energy secure? To be sure, no country has achieved energy independence (even though leaders across the world have made such promises for more than a century). So, we need to ensure that we are interdependent with countries on whom we can rely for security.

That leads to the other challenge. There is no energy security architecture that serves the interests of the energy demanders of the future or the energy sources of the future. New energy demand will mostly now come from emerging markets. Although the sources for solar or wind or water are far more distributed than coal, oil or gas, the technologies for solar, wind or green hydrogen (as well as the critical minerals embedded in them) remain highly concentrated. The rules to govern these technologies are missing. The institutions to address the concerns of emerging energy economies are absent. In short, the energy transition is not a technological challenge or even a financial barrier. It is contingent on high politics. To mitigate this global energy disorder, we must chart new energy maps, find more reliable sources, integrate with more trusted allies, and build more resilient institutions, which can withstand the coming energy shocks.

Example 3: The globalisation of everything versus the weaponisation of everything

Since the end of the Cold War, a new wave of globalisation swept the world. Goods, services, and ideas were to flow freely (but not so many people, given visa limitations!). Erstwhile closed economies opened up and new institutional frameworks emerged, such as the World Trade Organization.

This wave of globalisation was built on commonly agreed principles: Non-discrimination between trading partners; interoperability (of standards and regulations); a degree of differentiation of responsibilities between rich and poor countries; with the expectation that with convergence of (economic) interests would come eventual convergence of (economic) outcomes — and even political systems. For rich countries, new markets opened; for developing countries, the prospect of rising per capita incomes was attractive. This was the grand bargain.

Thirty years of the globalisation of everything is now giving way to a new reality, the potential weaponisation of everything. Trade rules are designed to get economies to lower import barriers and *buy* things. But there are limits to those rules in getting countries to *sell* things. So, what do we do if suddenly a supplier of critical minerals, which are at the heart of all advanced tech, chooses to restrict exports? At the height of the Cold War, we had an Outer Space Treaty to prevent the weaponisation of space. Yet we are now faced with a prospect of an ungoverned cosmos with state and non-state actors having the power to paralyse our communications, economies, and defence networks.

The growing political tensions between China and the US has resulted in both sides trying to decouple. China wants to become self-reliant in all advanced technology by 2025. The US CHIPS Act prohibits companies from producing semiconductors more advanced than 28-nanometers in China and Russia. The Inflation Reduction Act invests heavily in clean tech but also subsidises domestic industry at the expense of others, including in friendly countries. Japan's new Economic Security Promotion Act aims at supply chain resilience, maintaining core infrastructure and developing a secret patent system to protect critical industries such as semiconductors, batteries, medicines, shipping and aerospace, among others. Japan also fears that hundreds of years of rules-based order of freedom of navigation is now being challenged by China's maritime adventurism.

As a result, the principles guiding international behaviour are shifting. Rather than non-discrimination, we have emerging blocs for trade, minerals, technology. Rather than harmonised standards, we have islands of regulation. Rather than convergence in economic systems, we have divergence of political interests and reduced multilateral cooperation. Even on concerns of common aversion, such as a pandemic, we have witnessed vaccine nationalism in many instances.

In effect, the same technological advances that have driven a lot of our recent economic prosperity — and which were designed to make political borders less relevant — are now being subject to more geographical and jurisdictional control. Is there an antidote to such engineered disorder? Should we create trade blocs or common markets? Will economics dictate political relationships or will the strategic calculus measure how the economy can become, to paraphrase Carl von Clausewitz, "war with other means"?

Example 4: Reforming multilateralism versus global economic (un) governance

Against the backdrop of these tensions, there is growing cynicism about the possibility of global cooperation. Multilateralism is failing to guarantee collective security. It is failing to guard against energy insecurity. It has not reformed enough to offer economic and financial security. And it is still too slow in delivering environmental sustainability.

The world is facing compounding crises: food, fuel, finance, and a continuing fever (pandemic). At the halfway mark of the Sustainable Development Goals, many targets are out of reach and countries are struggling with many development metrics sliding back. Natural resources are getting exhausted, carbon space is shrinking, fiscal resources are stretched, and currency reserves are dwindling.

The reform of multilateral institutions has been on the slow burner for several years. But economic and environmental circumstances have changed. Global economic governance — for finance, technology, and trade — must respond to these changes. But will it?

Unlike 1945, when the Bretton Woods institutions were created to rebuild in the aftermath of the Second World War, today Multilateral Development Banks (MDBs) must deliver solutions to increase resilience *before* severe climate shocks strike. Unlike 1945, when the locus of global economic growth was in countries that also had global currencies, there is now a disconnect between high-growth emerging economies and those that continue to wield controlling power in MDBs. Unlike 1945, when private capital was scarce, now we need solutions where MDBs move beyond project financing to enabling the flow of large volumes of capital into regions that need investment the most. By de-risking private investment, MDBs must crowd in rather than crowd out capital.

There is a need to increase the role of the Global South and close the ever-widening gap on technology access, capability and capacity in developing and emerging markets and LDCs. The move towards a more sustainable planet must also be a move towards a more just planet. It must narrow, not widen, the technology gap. Consider that using distributed energy for rural livelihoods is a USD 53 billion market in India. So, how do we empower communities and ensure the most advanced technologies can be adopted by the most vulnerable?

We must, therefore, shift from repeated failures in technology transfer to a new paradigm of technology co-development. This requires jointly designed research and development programmes, pooling of resources through financial and non-financial incentives, co-ownership of intellectual property rights, management of risks and liability for local adaptation, and an equitable voice in the governance of emerging technologies.

There are also new drivers of global trade that will influence sustainable development, namely catalysts, data, and electrons. Molecules of low-carbon catalysts (such as green hydrogen) will shape industrial processes and products. The digital revolution will need new rules for data privacy, data transparency, and data resilience — but can help to trade power across a much more distributed energy infrastructure. And trade in electrons will also help to integrate low-carbon electricity systems across borders to make our energy systems and infrastructure more affordable, resilient, and secure. Trade rules for each of these drivers would need to evolve. If we managed this potential well and wrote the right rules, these opportunities would be ripe for your algorithmic optimisation!

My final provocation: Engineered efficiency versus the agency of engineers

Remember the scatter plot, the connector lines, and the final picture? In each of the examples I have shared with you, the final picture is less clear and the lines less straight, but the number of dots to connect are many. I hope my examples have illustrated why technology is an enabler not the endpoint — and why I wish that you are curious about dots, lines and pictures.

The legacy of engineers is not in what you build, but in how your invention is used. This phone in my hand is the same that millions of others have, but my engagement with it is uniquely mine. That is where good design comes in. The way energy flows in a house, the way traffic flows on a bridge, the way water flows through an irrigation pump, the way cotton is converted into textile for my shirt, are all examples where good design can yield an engineered efficiency.

There is also the agency of engineers. You can design, not just for efficiency but for good. You can question whether technology is celebrating its own success or is it being put to the service of society. You can look

over the horizon at emerging technologies for a cleaner energy future, but you'd also have to anticipate and prevent energy- and resource-related conflict. You have a choice of remaining in tech-centric bubbles or to reimagine the relationship between corporations, countries and global institutions — all with the citizen at the centre.

The world we've inherited was not like this. It took two world wars, decades of a Cold War, and much human misery for us to design an interdependence that was to deliver a better and common good. That social contract (at the national level) and the grand bargain (at a global level) is now fraying. This is the world into which you are entering your professional lives. This is world that India will navigate as it seeks to become a developed economy. This is the flawed world that our beautiful planet has to contend with.

This is also the world of possibilities. Of cleaner air, safer streets, better food. The basics you might think but where your innovation and ingenuity are needed the most. The world where conflict is not eliminated and consensus is seldom achieved, but where respectful, interdependent, and resilient cohabitation is the desired goal. Will you use your skills, your networks, your technologies, *your agency* to shape such a world?

I am sure many of you chose to become engineers because you like the orderliness of variables you can control. For the things you make, may you design well. You will go ahead and build the world.

But I also hope that at least some of you are excited by the millions of permutations that lines and dots can make, generating new possibilities not just in the built environment, but also in the natural, societal, economic, and political environments. May you be courageous enough to attempt that change. You will go ahead and shape the world.

Congratulations again! May you not just build the world but shape it — in a better image. Thank you.

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Dr Arunabha Ghosh is an internationally recognised public policy expert, author, columnist, and institution builder. He is the founder-CEO, since 2010, of the Council on Energy, Environment and Water, and has led CEEW to the top ranks as one of Asia's leading policy research institutions and among the world's 20 best climate think-tanks. With experience in 48 countries, he previously worked at Princeton, Oxford, UNDP (New York), and WTO (Geneva). The Asia Society honoured him recently with the 2022 *Asia Game Changer Award*, for his and CEEW's "incredible work, which is making a real difference for India and for the planet".

Arunabha advises governments, industry, civil society, and international organisations around the world. He currently serves on Government of India's G20 Finance Track Advisory Group and advises the Sherpa Track for India's G20 Presidency in 2022-23. In 2022, the UN Secretary-General appointed him to the High-level Expert Group on the Credibility and Accountability of Net-Zero Announcements by Non-State Actors. Since 2018, on the UN Secretary-General's nomination, Dr Ghosh has served on the UN's Committee for Development Policy. Arunabha is also a member of the Global Commission on the Economics of Water. In 2020, the Government of India appointed him Co-Chair of the energy, environment and climate change track for India's Science, Technology and Innovation Policy (STIP2020). He was also appointed the Co-Chair of the T20 Task Force on climate and energy for Indonesia's G20 Presidency in 2022.

He is the co- author/editor of four books and dozens of research papers and reports. His 2019 TED Talk on air quality (Mission 80-80-80) has crossed 267,000 views. He is co-Chair of the World Economic Forum's *Global Future Council on Clean Air*. He was a World Economic Forum *Young Global Leader*, an Asia Society *Asia 21 Young Leader*, and a *Kamalnayan Bajaj* Fellow (fellow of the *Aspen Global Leadership Network*). He was previously an *Oxford-Princeton Global Leadership Fellow*.

Dr Ghosh led CEEW into a leading think-tank soon after its founding in August 2010. He was actively involved in conceptualising and designing the International Solar Alliance. He conceptualised and was a founder of the Clean Energy Access Network (CLEAN), an industry body for hundreds of decentralised energy entrepreneurs. He serves on the Board of Directors of ClimateWorks Foundation, and is a member of the Climate Crisis Advisory Group.

Dr Ghosh has advised India's Prime Minister's Office, several ministries, state governments and international organisations on a range of subjects. He was invited by the Government of France as a *Personnalité d'Avenir* to advise on the COP21 climate negotiations. He also advised on HFC negotiations under the Montreal Protocol. He served as a member of an international high-level panel of the Environment of Peace initiative. He served on the World Economic Forum's Global Future Council on Energy. He has been a member of Track II dialogues with ten countries/regions; and formulated the Maharashtra-Guangdong Partnership on Sustainability. He served on the Executive Committee of the India-U.S. PACEsetter Fund. He was a member of the Environment Pollution (Prevention & Control) Authority for the National Capital Region (2018-2020). He has presented to heads of state and legislatures across the world on varied topics including global governance, international relations and human development, climate, energy, natural resources and water, trade and intellectual property, development assistance, conflict and extremism.

Widely published, he was lead author of *Stockholm+50: Unlocking a Better Future (SEI-CEEW, 2022)*, and *Jobs, Growth and Sustainability: A New Social Contract for India's Recovery* (CEEW, 2020). His recent article in *Foreign Affairs* articulates "The New Way to Fight Climate Change". Arunabha's co-authored essay "Rethink India's energy strategy" in *Nature*, the world's most cited scientific journal, was selected as one of 2015's ten most influential essays. He is co-author of *Energizing India: Towards a Resilient and Equitable Energy System* (SAGE, 2017);

Human Development and Global Institutions: Evolution, impact, reform (Routledge, 2016); and *Climate Change: A Risk Assessment* (FCO, 2015). He is the co-editor of *The Palgrave Handbook of the International Political Economy of Energy* (2016). He has been a co-author of three UNDP *Human Development Reports*, including the pathbreaking *Beyond Scarcity: Power, poverty and the global water crisis* (2006).

His regular columns are widely read and have been published in the *Business Standard*, *Financial Express*, *Euractiv*, *Forbes*, *Hindustan Times*, *Indian Express*, *Mint*, *Nikkei Asian Review*, *The Hindu*, *The Times of India*, among other platforms. He has hosted a documentary on water in Africa, featured in *National Geographic* and *Discovery Channel* documentaries on energy and climate change, and delivered a *TED Talk* on air quality. He has been regularly interviewed on Al Jazeera, BBC, CGTN, CNBC, CNN News 18, Gulf News, India Today TV, NDTV, Voice of America, etc.

He holds a doctorate from the University of Oxford (Clarendon Scholar; Marvin Bower Scholar), an M.A. (First Class) in Philosophy, Politics and Economics (Balliol College, Oxford; Radhakrishnan Scholar); and topped Economics from St. Stephen's College, Delhi.

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Organisation: The **Council on Energy, Environment and Water (CEEW)** is one of Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public. In 2021, CEEW once again featured extensively across ten categories in the *2020 Global Go To Think Tank Index Report*, including being ranked as South Asia's top think tank (15th globally) in our category for the eighth year in a row. The Council has also been consistently ranked among the world's top climate change think tanks. CEEW was certified a Great Place To Work® in 2020 and 2021. Follow us on Twitter @CEEWIndia for the latest updates.

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