

[SLICE OF MIT THEME MUSIC]

ANNOUNCER: You're listening to the *Slice of MIT Podcast*, a production of the MIT Alumni Association.

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HOST: When MIT was founded in 1861, the Institute originally filled Boston's newly developed Back Bay neighborhood. In the decades that followed, the departments and students increased, and in 1916, MIT crossed the Charles River for a new campus in Cambridge. Since its move, the Institute continued to establish itself as one of the world's top universities, and its alumni and faculty have tackled society's most pressing challenges.

Earlier this year, as part of MIT's campus centennial celebration, the Institute hosted the symposium Beyond 2016-- MIT's Frontiers of the Future. In this *Slice of MIT Podcast*, you'll hear a selection of the faculty presentations that took place at this symposium.

You'll hear how a solar panel is creating more drinkable water in rural India, how texting is helping transform Kenya's financial system, how cities can help solve climate change, how mucus is solving global health problems, and more. A large disparity in wealth and standards of living exists between the industrialized and developing economies. Although access to technology is limited in developing countries, the opportunity and need for innovation has never been greater.

Assistant Professor and MIT alumnus Amos Winter is the Director of Global Engineering and Research Lab. It focuses on giving poor communities around the world access to high-performance technology that helps address their fundamental needs.

Amos is currently working on developing solar-powered water desalinization stations to make drinkable water more available to many parts of India. He discussed how these impoverished areas can be turned into flourishing markets.

AMOS WINTER: And what I think is exciting about this is that we can use the constraints of those markets to drive innovation and create high-performance, low-cost solutions that work worldwide.

Why would you think about design in emerging markets specifically? Well, if you look at a lot of indicators for human health and well-being, things like clean water and sanitation and maternal

health, a lot of the problems that are indicated by things like the UN Sustainable Development Goals, a lot of these challenges are, by and large, solved in countries like the United States, but they persist and affect billions of people in poor countries.

And I think the reason is, if you think about the technologies we have in this country, you can adapt those, adding features, removing features, to move up and down a price and performance curve. But the problem is that in the developing world, people still demand a pretty high performance in what they want in their products, but the price point may be fundamentally different than what we pay for those same solutions in wealthy countries.

And when you find yourself in a disparity like this, there's no way to adapt your way down to that existing technology curve to get to the intersection point. You have to jump off it. You have to create disruptive innovations.

HOST: So how does a country innovate and establish an entrepreneurial environment? In 1978, China was one of the poorest countries in the world. Now, its GDP is second only to the US.

YASHENG HUANG: We're celebrating the first 100 years in Cambridge, and that century also coincides with the American century. The next 100 years in Cambridge of MIT is likely to be shared among the United States and China and also other countries. Do we understand each other? Can we work together to solve global problems? Will we be friends or foes?

HOST: That was Professor and MIT Sloan Associate Dean Yasheng Huang, who compares the degrees of entrepreneurship between the US and China and discusses China's limitations in innovating.

HUANG: China has grown very fast, but can the country continue to grow? And this is a very current topic. If you look at *The Economist*, in one issue they talk about the dangers of the rise in China, and then in the next issue they talk about the dangers of fall in China.

And there's an additional question of whether or not the Chinese growth is achieved at the expense of welfare. Food safety, the environment, these are huge issues in China. China, we know, is able to produce and manufacture at a large scale, but can the country innovate? This is a country that doesn't have democracy. It doesn't have freedom of ideas.

HOST: Huang describes two types of entrepreneurship-- replicative, which is driving China's economy, and innovative, which is commonly seen in the US. Huang points to a picture of an Apple Store in the city of Kunming as an illustration of replicative entrepreneurship.

HUANG:

You will probably ask, why is that an example of replicative entrepreneurship? Isn't Apple one of the most innovative companies in the world? Yes, Apple is.

But the problem is, Apple has never opened a store in Kunming and in China. There are actually three fake Apple Stores nearby. There's even a fake Goldman Sachs in Shenzhen. Replicate products is one thing. Replicate an entire organization is quite something else.

The thing about replication strategy is that it is less demanding on the kind of political and economic situations that you have. Because in a replication strategy, the goal is given. The task is to figure out, what is the best way to implement the goal?

We know that funding is necessary for that. We know that we need to have basic physical and social infrastructures. We know we need to have a friendly business environment. China has a lot of those.

The issue is, for innovation strategy, whether or not China can have the institutional conditions to pursue innovation strategy. Those strategies require more from the institutions because the goal is not given. You need searches. You need trials. You need errors.

And there you need freedom of ideas. You need rule of law and intellectual property right. You need a high level of trust. You need risk capital. You need to enable the government but also constrain government. China currently doesn't have those.

HOST:

So we know there's a major gap between industrialized and developing countries. And we know innovation can come from governmental and social infrastructures that promotes the freedom of ideas. So what happens when technology is used to solve these problems?

[MUSIC PLAYING]

Associate Professor Tavneet Suri focuses on regional development in sub-Saharan Africa.

TAVNEET SURI:

There's been this explosive growth in the use of the mobile phone in Africa. And accompanying it has been this set of innovations around financial inclusion-- the ability to use your mobile phone like you would a bank account.

One of the most famous and most successful products that looks like this is called M-Pesa in Kenya. M for mobile, "pesa" means "money" in Swahili. And this is-- think of Apple Pay but

minus the credit card, minus the banking infrastructure. It works entirely on your cell phone and by SMS. So I can basically send money to anybody in the country via SMS.

Over the last eight years, we've been documenting what M-Pesa or what mobile money has been doing to households in Kenya and how it's affecting their financial lives. By 2014, about 96% of households in Kenya had a digital account on their phone. This might be the fastest adoption of anything that we have on record to date.

HOST: Suri argues M-Pesa has allowed Kenyans to become more financially resilient, which has helped their economy while raising their standard of living.

SURI: They were able to deal with these bad events coming their way. OK, once people are more financially resilient, what do you do? Are there longer-term effects? Mobile money in Kenya led to about a 2% reduction in poverty. And most of this is coming because of, once I'm more financially resilient, I can make higher-risk, higher-return investments because I know that I can lean on John to help me should the world go bad.

Women in households switch occupations as a result. So they used to be largely in agriculture, and they're switching into running small businesses. Because again, if my business fails, I know that I have a back-up. I have some insurance from people that will let me deal with this bad event.

So overall, M-Pesa and mobile money in Kenya has had these very strong both short-term financial resilience effects, as well as these longer-term effects on welfare. And the future in Africa is pretty amazing when you think about financial services.

Given the complete lack of banking infrastructures and financial services, the internet and mobile phones are going to provide an avenue to completely transform financial transactions and payments. Mobile phones are now adopted by almost everybody. You've seen mobile broadband go up and get adopted. Data costs are falling dramatically.

And as you see this happen, you've also seen the growth of messenger services like WhatsApp that's one of the most used messaging services in Africa now. You can see the room for integration between messenger services and the internet to create this boom in the ability for people to do financial transactions that we've largely taken for granted here.

HOST: M-Pesa and similar services have helped transform Kenya's economy and drastically improve the lives of the people who live there. But technology's impact goes much farther than

exchanging electronic money.

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When thinking of ways to improve human health, mucus might not be the first solution that comes to mind. Professor Katharina Ribbeck says it's an unsung hero that's been taming potential diseases for thousands of years.

Ribbeck describes the rise of antibiotics as an arms race against diseases. But as these preventive medicines get stronger, so do viruses, which could turn into superbugs. Katharina argues that we can use mucus to work with them, which could strengthen and expand bodily functions in the process.

**KATHARINA
RIBBECK:**

I'm convinced, actually, that it can help us find new ways of protecting our health and protecting ourselves from infection. And we want to use engineered mucus to stop the growing threat of antibiotic resistance. But we also want to use engineered mucus to domesticate microbes, which could potentially help humans thrive on the planet. Imagine, we could learn how to stop the arms race.

These critters could help us adapt to harsh conditions and, for example, help us build food in the digestive tract. This could solve starvation. Microbes could also help us become more salt-tolerant. Imagine, we could drink saltwater. This could solve the drink water problem.

And microbes potentially could also help us tap entirely new sources of food by extracting nutrients and minerals from materials which we don't currently think of as food, such as substances found on other planets. This could help us colonize new planets.

Now, this may seem a bit far out. But remember that bacteria live in all sorts of places we consider uninhabitable, for example, geothermal vents. And if they live there, they can extract nutrients, minerals from materials in their environment, and they can feed us too.

340 years ago, Leeuwenhoek discovered a mysterious new world with tiny, wild things. And more recently, we learned that these wild things live with us in the ecosystem of our body inside our mucus. By engineering mucus, we have the possibility of domesticating microbes, opening an era of new opportunities for mankind. Remember this next time you blow your nose.

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HOST: Research at MIT builds on existing technologies to advance human development. But what happens when new technology collides with current markets? Professor Heidi Williams is working to unravel the causes and consequences of innovation in health care markets. She says the intersection of public policy, market behavior, and institutions all affect technological changes and discusses how these changes affect established institutions.

HEIDI WILLIAMS: We can ask questions like, why don't we have the HIV vaccine? Why don't we have the cure for cancer? And it could just be that the science of those challenges is too hard. Maybe we don't have a cure for cancer because there aren't a lot of incentives for either private research investments or publicly-funded research investments to be working on certain problems.

And is there a way that we can better design public policies in order to align the private rewards that firms get or the private rewards that scientists would get working in universities to coming up and developing a cure for cancer in a way that's more commensurate with the social contributions of those technologies?

HOST: Current public policy establishes a financial disincentive for companies to develop certain drugs that could benefit patient treatment. In her data research, Williams determined if there were shorter clinical trials, there would be more drugs that treat early-stage cancer. This would benefit patients in terms of improving their health relative to these longer clinical trials.

WILLIAMS: A lot of the scientific and engineering challenges are things that we need to have collaborations between scientists and social scientists to try to solve. Advances in science and engineering, I think, can create new policy challenges that create room for economists and other social scientists to make a contribution.

But on the flip side, the role of economics can really be helpful in improving the design of public policies and to make it so that we have more opportunity to discover these missing inventions that could have a lot of benefits for individuals.

HOST: Public policy is only part of the social infrastructure that facilitates innovation. Professor and MIT alumnus John Fernandez says cities have a critical role in understanding what kind of progress needs to be made to solve global challenges, including climate change.

JOHN And the new future is climate change. It's something that we are contending with. It's

FERNANDEZ: something that is, for me now, very much an accepted part of our future. It's our new future. And what I'd like to emphasize is that cities have a pivotal role in that new future.

Why have we politically, and maybe as a society individually, come to accept that there is a large-scale change in our Earth systems and that it has consequences for us as a civilization? Because the climate has changed very significantly in the past. In fact, the Earth has been covered in ice and snow. We've lived-- this species, our species, has lived through ice ages in the past. And so why now?

What's important about now is that we are now 7 billion-plus strong. Not only can we boast of having extended our species to every corner of the globe, but we've done so very, very exquisitely attuned to our climate, the climate that has allowed us to build our civilization. Our cities, our infrastructure, power systems, agriculture, logistical networks, supply chains are based on this very stable climate.

But for most of the history of our species, most of us lived in rural or agricultural settings. So we are now substantially an urban species. And that urban species, hundreds of millions of us, live on the coast, very much dependent with transportational networks and, again, quite dependent on but also quite vulnerable to changes in the climate. Arctic ice melting, ocean thermal expansion may have potentially catastrophic effects for human settlements, not just cities, but also rural and smaller settlements like villages.

HOST: Over the past several centuries, people around the world have been rapidly urbanizing. This trend is expected to continue over the next several decades, bringing energy and environmental sustainability to question.

FERNANDEZ: The rate of urban expansion is completely unprecedented. And in 2008, we crossed the threshold, where more people now live in cities than live in agriculture and rural areas.

And the future is challenging, and in the challenge lies the opportunity. In the next 30 to 40 years, we will be doubling the urban population. Very important to realize that that doubling in the urban population, 90% of it's going to happen in developing regions. So there is a link between mitigating and adapting to climate change and development.

So cities today, the frenetic, energy-intensive cities of today, account for 2/3 of global energy consumption, 3/4 carbon emissions. And between 2005 and 2050, urban energy is going to triple, as well as the land area, the extent of cities.

The sustainability or the resource efficiency pathways for our urban world will require us to look at multiple pathways, the pathways that are both technologically but also socially and developmentally appropriate for those cities in those regions.

Part of the way to do this is to understand the appropriate suite of technologies and then to deploy and develop whatever science and engineering is necessary to bring those technologies to bear in a cost-effective way.

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HOST:

Since MIT made Cambridge its home 100 years ago, the Institute has established itself as a world leader in pushing the boundaries of human creativity, research, innovation, entrepreneurship, and progress.

MIT's diversity and interdisciplinary studies reflect the need for collaboration of different fields to tackle society's most pressing issues and improve the lives of millions of people. And its emphasis on research shows its tireless pursuit of a greater understanding of the world around us so we can create a better world.

What do you think about all this research that's happening at MIT? Tweet your thoughts on this episode to @MIT_alumni. And if you want to hear more surprising, insightful, and quirky stories about MIT, subscribe to the *Slice of MIT Podcast* on iTunes.

Please rate the podcasts and leave a review. Tell us what you liked and didn't like about this episode, and let us know what type of stories you'd enjoy hearing in the future. Special thank you to all of the MIT faculty that participated in the 2016 and Beyond Symposium.

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