Remarks on Computing the Future & Turing Panel

College of Computing Launch

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Good evening, everyone! I'm so pleased to be here as we launch the next great step in computing at MIT.

The Stephen A. Schwarzman College of Computing will join our proud history of great accomplishments and play a vital role as MIT continues to lead in the field that is shaping humanity's future.

It has become almost cliched to reflect on the impact of computing on every part of our lives—how we work, live, play. I think the true power of computing becomes clear in its invisibility. Many of the most powerful forces in our lives—electricity, government, even running water—operate in the background. We don't think about them most of the time. They're just *there*, making our lives easier and usually better.

But that wasn't always true. Once upon a time, these were remarkable innovations that were only for the very lucky few.

Today, computing has joined that list. In the course of only a few decades, it has gone from a task reserved for experts to something so normal that we don't notice how we depend on it.

But that ordinary feeling masks a truly extraordinary power—a power that's only possible due to advances made in computer science, many of them right here at MIT.

From the beginnings of our field, MIT has played a pivotal leadership role. Over the next few decades, advances in artificial intelligence and robotics, systems and theory, and their applications, have the potential to transform not only academic disciplines, but entire economies.

As humanity works to solve problems ranging from climate change to curing disease, removing inequality, ensuring sustainability, and eliminating poverty, computing opens the door to powerful new solutions.

And with the new College of Computing as our foundation, I believe MIT will be at the forefront of those solutions—a position that we're quite comfortable holding.

After all, this is where the idea of machines with human-like capabilities really comes from.

In 1956, Marvin Minsky went to New Hampshire with a group of his colleagues. Out of that summer was born the idea of Artificial Intelligence as a field of study—the very basis of what brings us together here today.

But Minsky was hardly alone in his leadership of our field.

CSAIL—the organization that I'm proud to represent—also grew out of Project MAC, Bob Fano's pioneering work. Project MAC led to the development of time-sharing computing that laid the foundation for many of today's software systems.

Project Athena brought computation to all students on our campus during the 1980s, an important nod to what the future would become.

The first computer to display graphics, the first computer conversationalist, the first video phone, the first mobile robots—they were all born here, along with crucial research contributing to the invention of Ethernet, encryption, and the World Wide Web.

I'm honored to be able to recognize the work of these pioneers who have advanced computer science, and through their work inspired many applications and businesses.

I've heard people call the Turing Award the Nobel Prize of Computing, but I'm not sure even that is strong enough to convey the incredible impact these award winners have had.

I've mentioned Marvin Minsky already, recognized for his central role in creating, shaping, and advancing the field of Artificial Intelligence.

Since Minsky's win in 1969, eight other MIT CSAIL computer scientists have received this prestigious award.

- Fernando Corbato, known to everyone as Corby, was recognized for leading the development of time-sharing computer systems.
- Butler Lampson, received the award for contributions to the development of distributed, personal computing environments.
- Ron Rivest, recognized for his work on RSA cryptography, something we're all thankful for every time we place a secure credit card transaction online
- Barbara Liskov, laid the foundation for object-oriented programming languages and system design driving practically every industry
- Silvio Micali and Shafi Goldwasser, received the award for laying the foundations for the science of cryptography
- Michael Stonebraker, was recognized for extraordinary thought leadership underlying modern database systems
- And, Tim Berners-Lee, our most recent winner, inventor of the World Wide Web—a technology that democratized access to information and is used by everyone.

Just try to imagine a day without the World Wide Web and all that it enables – no online news, no electronic transactions, no digital media, no social media. And imagine what today might be without the mention of computer systems, Ai, databases, and cryptography.

It's impossible. It's also hard to imagine a group of more impactful scholars contributing to computing anywhere, and we're proud to have their support for this new undertaking. As the MIT Turing Scholars wrote in an open letter, "Creating the new school will...allow us to recognize the unparalleled history of computing innovation at MIT."

I could go on all evening about MIT's incredible history. But I won't—mostly because I want to save some time to talk about our vision for the future, and how the incredible minds at MIT can lead us *into* that future.

Our scholars are laying theoretical foundations and applying those foundations to big ideas. Some are even starting businesses based on their research.

Among our current research projects, you'll find ambitious goals in core aspects of computing: like developing approaches to software and hardware that can dramatically improve computing capabilities over the next 50 years; using computation to understand comprehensibly human intelligence; a worldwide information infrastructure that respects privacy; hack-free security systems, and also goals to make the world better, like developing a car that will be both your friend and your guarantee to never cause a collision; truly personalized health care; winning the cancer and depression wars; making voting truly secure; and so much more.

At MIT CSAIL, we have researchers devoted to vigorously exploring the foundations of computing and asking questions around complexity, computability, non-determinism, approximation, noise, interaction, scalability. These central questions must be answered to enable all the applications of computing.

Being at MIT, surrounded by these great minds, is incredibly inspiring. In my own work, I've been strongly influenced by the MIT secret sauce for turning the impossible into the possible.

Personally, my passion is developing the science and engineering of intelligence —by which I mean understanding its mathematical and biological foundations, and then building machines that embody them. I imagine a future with AI and robots supporting people with cognitive and physical work–with the same pervasiveness with which smart phones support us with computing work. And I am not alone in this quest.

That's the kind of research you'll find at MIT.

While computing stays central, the College will also allow us to expand and deepen the connection between computing and other disciplines. With an approach President Reif calls "creating bilinguals", our students will be equipped to help us answer some of the major questions facing our field—and our world.

As we dream of traveling to the stars, curing human disease, protecting our planet, improving our cities, enhancing quality of life, and even understanding the nature of life itself, computing will be at the center of it all.

As ordinary as computing has come to feel, I assure you, the future we imagine is anything *but* ordinary.

Now, it's one thing to hear me talk about that future—but it's another to see it for yourselves. So before we close, I'd like to give you two examples from my field, robotics.

Today, industrial robots perform fixed tasks much better than humans, but remain isolated from people on the factory floor because they are large and heavy and dangerous to be around. But with our world so changed by computation, can we imagine a future when robots and AI systems get to work side by side with people to help with cognitive and physical work?

To make a world with helpful machines possible, we need to expand our view of what a robot i*s*, what it looks like, and what materials it can be made of, what it should be tasked to do.

For example, we can make soft robot fish out of silicone, and deploy the fish to peek into the secret lives of oceans, which are currently not accessible to us. Let's take a look at what this could look like. Please meet our soft fish robot called SoFi that swims by undulating its tail. This

is an example of basic research to bring machines and materials closer together with machines becoming flexible, more like materials, and materials and materials becoming more intelligent.

(Play video #1 - https://www.youtube.com/watch?v=Dy5ZETdaC9k)

Imagine what we could discover using these robotic fish. Coral reefs are the canaries of the environment, and these robots can help us better understand them—letting us better address issues like global warming.

But robotic fish are only the beginning of what we can imagine.

We can make origami robotic pills—and use these origami robots to create a better future for surgery, one that requires no incisions, causes no pain, and carries no risk of infections. We're already closer to these robots than you may think. This origami pill has a robot made out of sausage casing (so it's digestible) folded inside an ice capsule; once in the stomach, the ice melts, the robot deploys, and is able to remove foreign objects, deliver medicine to a precise location, collect tissue samples, or patch wounds, all without incision, pain, or risk for infection.

(Play video #2 - https://www.youtube.com/watch?v=3Waj08gk7v8)

Maybe someday we can even have drones delivering fresh bread and fruit for breakfast, laundry that folds itself, shirts that can be programmed to change color, and trash cans that take themselves out.

To fulfill any of the big dreams, we'll need great minds working together to solve the foundational challenges of our field, and continuing to pursue seemingly impossible challenges.

It sounds like a tall order—until you realize that's what we've been doing at MIT since the very beginning of our field.

To talk about that proud history, and to give you a better glimpse into what that extraordinary future looks like, I'd like to invite to stage our honored guests. Please join me in welcoming our MIT Turing Award Winners—Tim Berners Lee, Shafi Goldwasser, Butler Lampson, Barbara Liskov, Ron Rivest, and Michael Stonebraker.