Routledge
Taylor & Francis Group

Research-Technology Management

ISSN: 0895-6308 (Print) 1930-0166 (Online) Journal homepage: http://www.tandfonline.com/loi/urtm20

# The Antidisciplinary Approach

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IRI MEDAL

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## IRI Medal Address

*The antidisciplinary approach of the MIT Media Lab demonstrates how organizations might adapt to and take advantage of the evolving world of permissionless innovation.*

**Joichi Ito**



**OVERVIEW:** The Internet, machine learning, advances in manufacturing, and biotechnology have shifted substantial portions of our research and development to startups and labs that do not fit neatly within traditional disciplines. In this new "antidisciplinary," agile, and networked environment, governments, commercial ventures, and academic institutions are all being challenged to adapt. Some thrive while others struggle. For more than 30 years, the MIT Media Lab has set an example of how, by following a core set of principles, organizations can adjust to and take advantage of evolving trends and transformations.

**KEYWORDS:** Antidisciplinary, Cross-disciplinary, MIT Media Lab, Agility, IRI Medal

I joined the Media Lab as its director six years ago, transitioning from the world of Internet entrepreneurship and open-source governance to academia. I had one way of doing things, and the Media Lab had another. At first, it didn't make sense that I, with my background as a scrappy entrepreneur, could fit in at a huge academic institution like MIT. But the Media Lab was different. It is antidisciplinary—not *against* disciplines, but explicitly seeking out ideas and research agendas that work *across* disciplines, research that falls into the white space between them; it allows students and researchers the freedom to explore—and to fail. And it has produced some ground-breaking inventions that its corporate members have gone on to commercialize with great success. Those differences, I'll argue, provide some important lessons for all kinds of organizations—research labs, companies, even academic institutions—that are being challenged to adapt to the huge waves of change that we're all facing now.

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DOI: 10.1080/08956308.2017.1373047

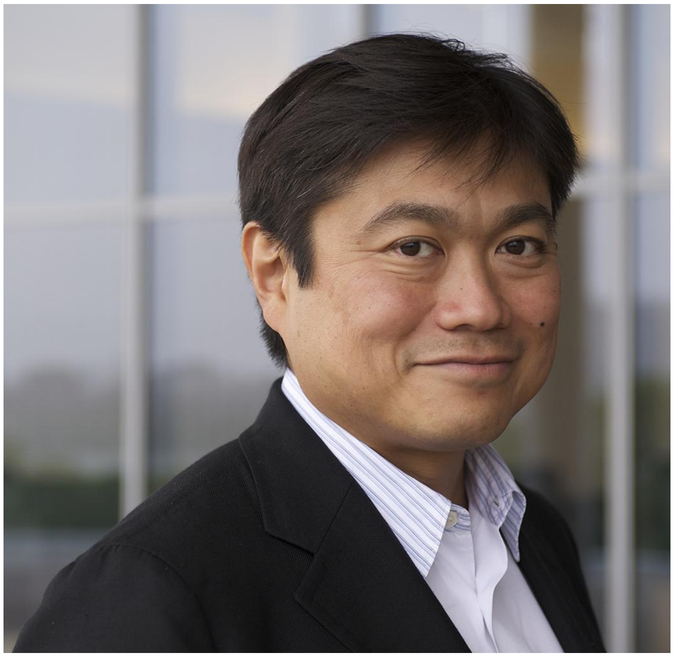


### A Brief History of the MIT Media Lab

The Media Lab is somewhat peculiar, even for a highly diversified university like MIT. That peculiarity arises from the Lab's history. It was founded 32 years ago by former MIT President Jerome Wiesner and a young faculty member named Nicholas Negroponte. Wiesner had stepped down as president several years earlier but wanted to continue working in areas about which he was passionate, and this included bringing the arts and sciences together at MIT. Negroponte, who was promoting a vision of a digital future that included a CAD system on everyone's desktop, was working on computer-aided design in the Architecture Machine Group within MIT's School of Architecture and Planning.

Together, they created the Media Lab, and when they did, they did something you can only do when your partner is the former president of MIT: they broke a bunch of rules. Usually in universities you have labs and you have academic programs, and they tend to work like church and state in a healthy or unhealthy balance: The academic program offers classes to students and grants degrees. Labs are focused on raising funds to conduct specific research focused on real-world impact. The Media Lab is both. It has its own academic program—the Program in Media Arts and Sciences, within MIT's School of Architecture and Planning—and it is also a research lab.

The other unique thing about the Media Lab is its unconventional funding model. I have been told that when the Lab opened, approximately 80 percent of MIT's funding came from government sources and 20 percent came from private sources. The Media Lab was the exact opposite, with



Joichi Ito, 2017 IRI Medal winner, is director of the MIT Media Lab.

80 percent of its money coming from corporate sources. This was partly a result of Wiesner's history; as the science advisor to John F. Kennedy, he was sent to Japan to help that country rebuild its technology and research infrastructure. As a result, many in the Japanese business world felt a real debt to Wiesner. At the time Wiesner and Negroponte were seeking funding for the Media Lab, these companies had some money to spend. So a large amount of the money for launching the Media Lab came from the CEOs and chairmen of Japanese electronics firms. In fact, the Media Lab was even criticized for selling secrets to the Japanese.

The way the Lab handles its corporate support is also atypical for academia. Funds from corporate members do not support directed research, but rather go into one Lab-wide fund, and any IP resulting from Lab research is available to be shared among all the corporate members. In the past, members could choose among different consortia to join based on their research interests, but today there is just one consortium for all members. Currently, the total Lab budget is about $70 million—the majority from the consortium and some from government and other non–IP-generating research grants. I distribute the consortium funds to 25 research groups, which are working on everything from synthetic neurobiology to the future of opera. Each research group is made up of students and led by a faculty member or senior researcher. The really key thing is that the spending is fundamentally discretionary; the groups are allowed to do just about anything they want to do with the money they get.

## How the Media Lab Works

The structure has a couple of major consequences for the way the Media Lab works. First, it helps to create a strong sense of community. In a typical lab, if you're a faculty researcher, you write a grant proposal and your students work with you and together you deliver the results related to that grant. In that system, it's very difficult for people from different labs or departments to work with each other, or even for funding companies to work with each other. Everybody's working on their own grants, and the IP from that research must be protected. At the Media Lab, the consortium owns the IP as a group, so there's no barrier to collaboration. And research progress is presented twice a year when hundreds of people from our member organizations—from LEGO, to Lockheed Martin, to governments—come to the Lab to learn about the current research. Amazingly, even companies that are normally fierce competitors, like LG, Samsung, Toshiba, and Google, join together in this unique member community.

Since we have the ability to fund things in discretionary ways, we also have the freedom to fund things that others wouldn't. The member companies don't support us so that we'll help them do something they're already doing better; they support us because we will do something they would never have thought to do. We have to work in the white space.

That presents some challenges. Let me explain: The world, certainly the academic world, can be seen as a bunch of circles, which are the disciplines, and there's a lot of white space between those circles. You can argue about how big the white space is, but there definitely is white space. If you work in the white space, you often can't get federal funding, which, in turn, makes it difficult to generate the body of work necessary for tenure in traditional academic departments. It is also difficult to raise significant money from individual corporate sponsors unless you can demonstrate that the research outcome could benefit the corporation in a preconceived and obvious way. But at the Media Lab, we work on things the funders probably haven't imagined yet. That's the space that we feel is our challenge. One of the first faculty searches I participated in as the Lab's director was for a "Professor of Other." The description said the candidate needs to be "antidisciplinary." What we meant is that candidates had to be proficient in at least two orthogonal fields, and that what they wanted to do couldn't fit in any existing discipline.

So a lot of things get invented at the Media Lab or by Lab students soon after graduation, things like e-ink or cascading style sheets. Before GPS became ubiquitous, we submitted a patent proposal for a car navigation system; the MIT Technology Licensing Office wouldn't grant us the right to patent it because, they said, "That's ridiculous. How could a car system that's so distracting ever be approved for use?" We weren't allowed to patent car navigation.

The patent portfolio of the Media Lab is peculiar also because it's one of the most-cited portfolios, but it's rarely commercialized directly. Many of the inventions in the portfolio are so far ahead of the curve that the 20-year time limit on US patents often runs out before a product using it

**TABLE 1. Innovation principles for the age of the Internet**

| Innovation principles for the Internet age: | |
|---|---|
| Emergence *over* Authority | Complex, bottom-up systems beat out top-down authority. |
| Pull *over* Push | Resources and innovation should be pulled from the edges rather than controlled from the center. |
| Compasses *over* Maps | Detailed plans (maps) become less valuable than vision, values, and culture. |
| Risk *over* Safety | With the cost of innovation coming down, the focus should be on taking smart risks rather than seeking safety. |
| Disobedience *over* Compliance | Agile, effective innovators will question authority and think independently. |
| Practice *over* Theory | Focus less on theory and more on learning by doing. |
| Diversity *over* Expertise | A nontraditional team approach will be more productive than the abilities of any one individual. |
| Resilience *over* Strength | Resilience will come from failure, especially with complex, self-adaptive systems. |
| Systems *over* Objects | Everything is connected to everything else; to succeed, you must understand the full ecosystem. |
| Learning *over* Education | Fixed educational systems must be replaced with lifelong learning. |

comes to market. That's the secret sauce of the Media Lab. That's where we work—in the discovery phase before an invention is ready to be mainstream. Once we've done that discovery and development, our member companies take those inventions and commercialize them. When other people start getting into an area, we try to get out. For instance, we were into wearable computing more than two decades ago. We've moved on now, but if you go to Google, Facebook, or Samsung, you'll find that many of their teams are constituted in large part by MIT Media Lab grads and even former faculty members. That's what we like to do.

## The Media Lab Mindset

The companies that interact with the Media Lab are seeking that discovery sensibility; they're looking for an exploration rather than a problem-solving kind of thinking. In a book I recently coauthored with Jeff Howe, *Whiplash,* I tried to capture the core principles driving the Media Lab.[1] *Whiplash* grew out of four and a half or five years of discussion that took place as my colleagues and I worked through the collision between the Media Lab's peculiar DNA and the DNA I brought from the Internet world. In those discussions, we developed a set of principles, iterated on over multiple faculty meetings, by asking two questions: What are the principles that define the Media Lab, and what are the principles that drive innovation on the Internet?

Try to remember what it was like before the Internet. Remember when a fax was a cool new thing, or when you had to go through a line of command rather than just send an email to your CEO? Stuff was really hard in some ways, but very simple in others. The economy moved almost slowly enough to be predictable. You had rules you could follow.

Then the Internet happened. A bunch of other things happened at the same time, but the Newtonian laws that had governed how companies operate turned out to be local ordinances that only worked in certain cases. Everything moved faster, everything was hyper-connected. Some models didn't survive. Some models thrived. Some companies—some big companies—were able to survive this transition, and a whole new set of players entered the scene. But the old rules were gone, and a new set of guiding principles emerged. We began to see agile, bottom-up systems outperforming those built around more rigid top-down authority. Organizations with a more creative vision and culture were more likely to succeed than those with elaborate, well-documented plans. The ever-decreasing cost of innovation allowed for—in fact, necessitated—taking more risk. These are the principles that we talk about in *Whiplash* (Table 1). And they are the principles that drive much of what the Media Lab is doing now. Let me just amplify on two of the core principles.

### *Emergence vs. Authority*

The first thing the Internet did was drive down the cost of innovation. Let me start with a story. In the early 1990s, we ran the first commercial Internet service provider in Japan with about $1,500 worth of junk parts we set up in my bathroom. We were also running the first newspaper website in Japan, and I remember when the hard disk failed—the fan failed, and then the hard disk failed, and we were taking turns blowing on the hard disk until somebody could get a new fan.

In the Internet world, we called this "best effort." Your hard disk might fail occasionally, but this approach was so much cheaper than the alternatives that it was nearly free. A telephone company trying to create an Internet service provider would probably have spent millions of dollars building infrastructure. What we did took a bathroom and a couple thousand dollars.

This is permissionless innovation. We didn't ask if we could do this, and we didn't check on what the rules were. We just did what we could do. For the first time, a bunch of students could actually compete with a telco. That was enabled by the openness of the field—everything we ran on those servers was free and open-source software. This kind of activity forces competition, driving the price down to nearly zero—to something that's functionally zero compared to where it was before. When you add Moore's Law

[1] Joichi Ito and Jeff Howe, *Whiplash: How to Survive Our Faster Future* (Grand Central Publishing, 2016).

to that, what you get is a very low cost of networking and computing, which creates an explosion of free and open-source software, which lowers the cost of innovation.

Lowering the cost of innovation is a qualitative change. It doesn't just change what it costs to do something, it also changes how you do it, as well as what you can think about doing. In the old days, we had the cable companies and the telephone companies trying to do multimedia over set-top boxes or kiosks, like the Minitel system in France. These systems cost hundreds of millions—if not billions—of dollars because these companies had to do it all: the lines, switches, computers, database, software, and content. This kind of complexity required a tremendously detailed plan. You would have to get the money, hire the engineers, and then build the thing. I call this MBA-driven innovation.

The Internet is about engineer-driven innovation. Think of Google, Facebook, or Yahoo. I think Amazon is the only one that actually had a plan at the beginning. All of these companies were conceived by a bunch of engineers who built a product before they had any money. Their business model came after they were up and running, and only then did they hire some MBAs and go public.

When you're in an MBA-driven innovation system, you have money, you have permission, you have jobs, you have a whole system of authority that generates the capital required to do something. The talent chases the money because you need so much money to even get started. In engineer-driven innovation, you have a bunch of college students (or dropouts) running around making things and venture capitalists chasing them, trying to get in on a good deal. The money chases the talent. It's a very different dynamic.

For some kinds of projects, where the cost of what you want to do is substantial, spending some percentage of that cost to minimize risk makes sense—building roads or designing airplanes, for example. But if the project is inexpensive—say only a couple hundred thousand dollars—and if the cost of failure is just the failure of that thing, the permission costs can exceed the actual costs. I had a company for which I was trying to get an investment of $600,000; the potential funders spent about $3 million deciding not to do it. If they had just given me the $600,000, I could have shown them whether it worked or not, and if it worked, they'd have made some money. So, a lot of permission granting is a theoretical process, where you actually don't get the answer—you don't even find out if the thing would have worked; you just spend a lot of time and money getting permission to try it. At the Media Lab, on the other hand, we think of every failure as an opportunity to capture information. We think about whether the information we might get is worth the investment. No one asks me for permission to do a project, but twice a year everyone is required to do a demo of the things they've been working on. That's the value of joining the Media Lab: this constant interaction between the researchers and the companies.

The Internet is about engineer-driven innovation.

The key is having the right facilities, the right equipment, to keep things inexpensive. At the Media Lab, when there's a conversation and someone hits on an idea, they're in the shop making it by the afternoon, and by the end of the week, there's a photo of it with a video, a rough demo, and all the files needed for somebody else to recreate it. Again, it's about lowering the cost so that innovation is permissionless—if it costs a lot to even make the demo, you're going to require permission.

### *Pull vs. Push*

I'm going to tell one other story to illustrate another core principle, the idea of pull over push. Pull means you pull things from the network as you need them rather than stocking them in the center and pushing them out. An early version of this is the just-in-time manufacturing system the Japanese automobile companies developed, where instead of having a lot of parts in inventory, they pulled stuff in as they needed it. That system lowered risk and increased agility.

Pull over push is very much a network-centric innovation, on-the-edges sort of thinking. It ties very closely with how Internet innovation has worked—innovation has been taken away from central sources of funding and from academic authority and been pushed to the edges, to Silicon Valley, to dorm rooms, to garages. Pull isn't just for software, which can be downloaded. It's also possible to create hardware on the pull principle.

In 2011, when a devastating earthquake hit Japan, my home was within radiation cloud reach of the Fukushima nuclear power plant, so I was very concerned about my family. I couldn't find much data online, and the data I did find from the government and from the Tokyo Power Electric Company just wasn't believable. There wasn't any good information about how and where the radiation was spreading. So, I went online. I connected with Sean Bonner and Pieter Franken—both friends who were also trying to figure out what to do. We connected with Ray Ozzie, who had just left Microsoft. A friend connected me to Dan Sythe who did the Three Mile Island instrumentation after that disaster. Bunnie Huang helped us figure out how to make the hardware. We connected with Haiyan Zhang from IDEO and Uncorked Studios, which had both made radiation maps online, and the network built out from there.

Within weeks, we were able to bring together a bunch of kids who knew how to do the hardware for Geiger counters and how to make websites, and who had ideas about how to mobilize volunteers to get everything done. We designed our own Geiger counters, mostly using open-source elements, like Arduino components and Pelican cases. We had to create a little bit of software and firmware, and we had to do a little bit of control stuff for the high-voltage control system for the sensor, but mostly it was open source. The problem, we realized, was that there weren't enough sensors in the areas around the reactor. So we said, "Okay, we have to go mobile." We created mobile devices that we put on cars; hundreds of volunteers have been driving around with them, and we now have 70 million data points.

When we started the project to measure and visualize the spread of radiation, the government was against us; they called us amateurs. We still are amateurs, but now, six years later, all the NGOs and all the government agencies depend on us. The Japanese Post Office puts our sensors on their bicycles to collect data as they go around; the Japanese government agencies ask us to verify their data because the citizens trust our data. We've designed more hardware, including a purse-sized Geiger counter, and a company is manufacturing and selling our design. So this is really a mark for the open-hardware movement.

But what's great about this project is how it exemplifies the power of pull. We knew nothing when the event happened, but we were able, through the power of pull, to get every resource as we needed it. And we didn't have a lot of protocols to deal with. There were a lot of protocols that existed, but they didn't anticipate the exact nature of the disaster, and so all of them failed. I'll give just one example. Before the disaster, all the Geiger counters in Japan only measured gamma radiation, because gamma is the one you're usually concerned about—it's the one that punches through material. In almost any conceivable accident, alpha and beta radiation don't really matter because they don't transmit very far, they don't get outside of walls. Nuclear reactors are never supposed to explode, so there was no reason to measure them. As a result, there were no publicly available alpha and beta Geiger counters out there; we had to create them. The point is that this was very much a just-in-time, citizen science movement: a social movement that also involved open-source software and hardware.

This kind of hardware innovation, enabled by the diminishing cost of innovation, is going to start creeping into the institutions at the center. One example is the factories at Shenzhen, China. We send students there every year. Shenzhen is, to me, the Silicon Valley of hardware—they can manufacture just about anything. It's quite amazing. Having grown up in Japan, I remember Japan feeling very proud of its manufacturing history. But in Japan, manufacturing was a bunch of companies building their own stuff—for global markets, but all for Japanese companies. By contrast, all of the world's companies build almost everything in Shenzhen. And so you have all of the intellectual property, all of the know-how, all of the tradecraft of manufacturing in one place. Kids in Shenzhen are taking advantage of this, making hardware as if it's software, iterating, innovating. It is a very different world of hardware that is emerging from places like this.

**Bio is a new digital, not literally, but in the way it will change the world.**

### Bioengineering—The Next Digital

The Media Lab has groups in incredibly disparate fields. We're able to keep moving across disciplines because we don't define ourselves by a specific technology or field; we define ourselves by a point of view, a way of doing things, a sensibility. Back in the late 1980s and 1990s, we were focused on personal computing, interfaces, displays. We continue to do those things, but we moved from them into email and networks, and later into big data and social physics. Now, almost 30 percent of the Media Lab's work has something to do with bioengineering.

Thirty years, ago, when I would give talks about the Internet, the newspaper reporters would fall asleep when I tried to explain that their business was going to change. Nicholas Negroponte said in the 1990s that newspapers would be delivered over the Internet, and everybody laughed at him. I feel the same way when I talk about bioengineering these days, because people think of biology as a hospital, medical, pharma thing—just like people thought of the Internet as an information processing thing. Bio is a new digital, not literally, but in the way it will change the world.

Bioengineering will reshape things a very long way from the medical field. One good example of the way genetic engineering can be turned to industrial use is Sorona, a polyester-like material that is created using plant matter. It uses a synthetic microbe to spark the transformation. It's about 30 percent more efficient and much more ecological to manufacture Sorona than it is to make polyester, so it's now starting to compete very well against polyester. Sorona is a product of industrial R&D; it cost hundreds of millions of dollars and took years and years of research to create it.

That kind of large-scale industrial R&D is starting to change. We're starting to understand genome bricks, the building blocks that make up DNA chains. There are a number of efforts to categorize each set of bricks and to identify what each one does. That kind of modular approach is starting to make genetic engineering look more and more like a computer programming language: you can assemble those bricks, stick them into bacteria or yeast, reboot them, and get them to do a variety of things, like be sensors or create chemicals. There are Media Labs groups looking for specific compounds and building genes around them to do things like trigger wireless systems. They're building circuits where the electronic components are living, organic material.

And the rate at which we can understand this stuff, the rate at which we can program this stuff, and the rate at which we can print this stuff, is increasing substantially, in part because the costs are coming down. In the early 2000s, it cost billions of dollars to sequence a genome. It now costs thousands of dollars, and that cost is actually going down much faster than Moore's Law would predict. Printing genes is also becoming both easier and cheaper. Professor Joe Jacobson, a Media Lab faculty member, helped create a way to print and assemble genes on a semiconductor, which significantly reduces the error rate, increases the speed, and lowers the cost compared to doing it by hand. All of these developments are driving, yet again, a diminishing cost of innovation. Bioengineering innovation, like digital innovation and hardware innovation before it, is going to start pushing to the edges.

In fact, that's already started happening. Shortly after I started at the Media Lab, I was involved in a project to use recombinant DNA to design a bacteria to create violacein, a naturally occurring violet pigment with antibiotic (antibacterial, antifungal, and antitumor) properties. Currently, violacein costs about $200,000 to $300,000 a gram. We can make it much more cheaply than that. Scholars identified a pathway to create violacein and published the gene sequences—the BioBricks for this pathway. A Media Lab graduate and his company created a kit with these BioBricks and guidelines on how to design a plasmid with the bricks. My team and I used online tools to design a plasmid that we assembled and transformed into a bacteria and then published the results in our online lab book. Then we used BioBrick vials to assemble the gene, and we got some decommissioned hardware from MIT to do the transformation and insert the plasmids into the bacteria. We rebooted the bacteria and fed them, and we could see the nice purple of the violacein in the petri dishes, which is the signal things were working. We uploaded them, so that they could be shared with hundreds of other people doing the same thing, along with our lab books, so we could compare our processes with those of other people to see who could design the best violacein factory. Incidentally, we did this at my house—I didn't realize I was breaking a Cambridge ordinance by doing recombinant DNA work in our home without a Biosafety Level 2 wet lab. Something that would have been done in the labs of one single big pharma company in the past was crowdsourced by a bunch of citizen scientists and kids hacking these things in their homes. And this was almost five years ago.

The trend is growing. MIT sponsors an international competition focused on genetically engineered machines. A bunch of high school and college kids—about 7,000 of them—come together every year to share the genetically engineered machines they've created. Some of them are silly, like *E. coli* that makes dog poo smell like winter mints; others are a little bit more useful, like materials that may help us identify land mines. And yes, I know what's going through your head: What could go wrong?

**Bioengineering innovation, like digital innovation and hardware innovation before it, is going to start pushing to the edges.**

But you can't put this genie back in the bottle. With the invention of the stunningly easy and low-cost CRISPR gene-editing technique, it's going to be in your high school student's garage any day now. Given the pace of change, having people come together and talk about the implications of these things is extremely important. The government agencies and academic institutions realize this, at least at some level. Edward You, who is the Supervisory Special Agent in the FBI's Weapons of Mass Destruction Directorate, Biological Countermeasures Unit, did an amazing thing along these lines. At his encouragement, the FBI convened—I think they did so two or three times—all the international biohacking labs. He told them, "We did it wrong with the Internet. We turned all the hackers against us. This is going to be much more dangerous. This could be much worse. We need your help. You need to be on our side to protect the world from existential threats of rogue or accidental biological mistakes." Most of the kids I work with are pretty onboard with that. The Media Lab is a very big part of the biosafety standards, and a lot of the bioengineering work we do addresses safety. Certainly, one of the most terrifying things I can think of is the idea of an extinction event triggered by a mistake your high school kid made in the garage, but I also think the kids who are doing this are thinking more about safety and protecting the world than any of the kids I grew up with on the Internet. That's a hopeful development.

### What's Next

The Media Lab is also working in some other emerging areas that I think will be hugely influential in the long term. One very important emergent technology that's also pushing innovation to the edges is cryptocurrency. Amara's Law says that we overestimate the short-term impact and underestimate the long-term impact of emerging technologies, and I think that's what we have done with cryptocurrencies. Cryptocurrency represents a kind of Internet of value, which may be underestimated at the current time. We have a Digital Currency Initiative at the Media Lab that is focused on the blockchain and cryptocurrencies.

We also have several projects on extended intelligence, which is the way we talk about artificial intelligence at the Media Lab. The key, I think, is that the design of machines and humans has to come together; it has to be a coevolution between humans and machines. Right now, a lot of the companies that are creating AI machines are really focused on automation, not augmentation. They're saying, "Give me your questions, give me your data, and we'll provide a solution." They provide risk scores to prosecutors, judges, and probation boards, but they don't say how they got the scores. So people have to decide yes or no based on a number they don't necessarily understand. The minute a person is no longer able to overrule a machine, whether it's a drone operator being assigned a target or a doctor being given a diagnostic decision, it's not augmentation. We need to keep the human in the loop. We need a system where the machine is a partner; the machine knows when it needs a human, and the human knows when he or she needs the machine. They work together as a team.

### Conclusion

The Internet has significantly diminished the cost of innovation, making the world nearly out of control with innovation. Much of this innovation is happening on the edges—in software, hardware, and now bioengineering. Companies and institutions that are able to manage themselves in the emerging network are going to be the ones that survive, through wave after wave of change. AI or machine learning is going to be the next big bump in this evolution. The impact of AI or BioBricks may appear to create chaos—whether you're talking about jobs or you're talking about the effect on existing businesses—but it will never work to run away from these developments. We may fear losing jobs, but the new jobs that will be created will be the ones we can't imagine yet. When we were building the Internet, we couldn't have imagined the eBays or the Amazons, and we can't imagine which new jobs will result from these new waves of technology. One thing we know is that we will not be the ones imagining the new jobs if we're not doing the work to explore the vast potential of emerging technologies.