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Lessons from the Lunar Society

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[slide show follows text]

Roe had asked us to do a little bit by way of summary, and so I sketched some of this last night, and I'm very pleased at how much the earlier talks this morning in ways that I would not have predicted support what I planned to say.

Yesterday, I had the misfortune of having to leave here for the lunch. And that was because I had to go downtown. The Aero Club of New England, which is the oldest aero club, pre-Wright Brothers, was having its annual lunch. And they always give an award. And usually it's a very staid affair without a lot of interest, but I needed to go.

The award this year they gave to Fred Smith, who was the founder of FedEx. And he gave a talk that was just remarkably lucid and smart, and a contextual history of FedEx. He talked about his own experience in Vietnam, in logistics working with the Marine Corps, the role of FedEx in the growth of globalization, and the role of FedEx in exporting and transferring manufactured products like semiconductors across the globe and enabling the Asian semiconductor industry.

Most of the people in the room wanted him to talk about airplanes. But that's not what he talked about. He talked about automation and information technology. The whole tracking your package thing, which we all can do every day, and how that originated at FedEx and why it was so important. And it made me think about the field of the history of technology: are we speaking to the large technological developments that are happening in the world and that people care about?

Greg Galer and I did not coordinate, but I have the same slide there of the -- actually, I got the caption wrong. That one will come up. That's the Ford central station. This image

came out only in the last day or two of the old and the new. This was Wednesday night -- today is Saturday -- the grand opening of that station. Many thousands of people there. Ford Motor Company put \$1 billion into this building and this neighborhood to transform this old railway station into a high-tech R&D center.

I doubt there was a historian of technology there or speaking on the program. But symbolically at least, it was very poignant moment for where we are in this country. Yet in the last day and a half, we've heard very little about the transformation that is currently going on in the United States industry. Through the pandemic there are transformations of work, a great Roe Smith topic, unlike any transformations in our lifetimes.

The pandemic revealed the vulnerability of supply chains and brought that very term, "supply chain" to public discourse, beginning with the great toilet paper crisis. The need to decarbonize the economy, of course, and the ever more present and visible climate crises driving public consciousness of these changes, the shifts in geopolitics driven by the Ukraine War among others, leading to shifts in global supply chains, and much of that leading up to generationally profound shifts in U.S. industrial policy, particularly the IRA (really a Climate Technology Act), the CHIPS Act, the infrastructure bill. Again a Roe Smith theme that hasn't been brought too much up yet: federal support for technological change in the United States.

These three acts together are the largest transformation in federal R&D policy since the end of World War II, maybe since Sputnik. Little noticed in public eye as of yet, probably having little effect on the election, but very profound in terms of what's happening in industry.

Add that to the usual buzz around new technologies. I don't know where AI is going, but at the very least, it has brought together the fact that the information technology world has never been as immaterial as its proponents like to think of it. Most people didn't notice, but Amazon spent almost \$1 billion to buy a data center in Pennsylvania located next to a nuclear power plant because that's what it's going to take for these companies' AI ambitions.

The history of electricity has always been framed by power and intelligence. And now those two things are coming potentially to clash. An article in the *Atlantic* in 2022 that put it this way: America realized that in order to decarbonize, it must re-industrialize. And it cannot de-industrialize to decarbonize. So what does that actually mean and what does this moment mean?

I want to emphasize Roe Smith's intellectual influence around any number of these ideas, and he doesn't toot that horn all that much, but it's quite fundamental to the way I and I think many people in this room and many people out in the world think. Those industrial policy debates never went on without mentioning the Springfield armory.

So if there's one thing I learned from him it's how manufacturing brings together so many of the ideas in the history of technology that we care about -- labor, work, craft, management materials, use and consumption, material culture, and I might add the moral value of making things, automation, of course that world change from the Harper's Ferry book, federal support, and I might add logistics.

I teach my students don't think about a factory as a place where things originate and things are made and things come out of. Factories are nodes in industrial systems. Stuff comes into them. People come into them. Skill and labor comes into them. The stuff is transformed, and it then goes out to somewhere else, usually the user or the consumer through some other form of logistical system.

I want to invoke a couple of names here who are also part of the Roe Smith universe but not here. One is Joel Mokyr who is very articulate and brilliant, on a lot of these and a friend and admirer of Roe. And yet the field of the history of technology, which we heard yesterday, has to some lamentable degree turned away from the material world, not entirely but toward social technologies, has actually been echoed by the country and led by economists who never understood much about technology and manufacturing and still don't, with the exception of that cadre of economic historians for whom Joel Mokyr still carries the flag.

Starting in 2018, I led a group here with the labor economist David Autor, policy expert Liz Reynolds, Suzanne Berger, and many other scholars from MIT, on the Work of the Future.

Many interesting things came out of this. I was shocked at the economists who first sat down and said, "What is the future going to do to us?" And again, a very simple contribution for the history of technology: how are we going to make the future that we want to see made? It's our role to shape the future. That's certainly true at MIT where we create young engineers and lots of R&D papers. But it's also true for anyone who's a user or consumer of technology.

And to their credit, some of them are now thinking about how should AI be shaped in order to best support workers and equitable work. As soon as this project was over in '21, Liz Reynolds went to the White House and joined the team to help put these bills together. Many cases from this book and many, many other studies in the academic world of the ways that historical approaches to technology informed those policy changes.

It's almost like a secondary era in industrial policy, because people are aware of what DARPA did. They're aware of the Springfield Armory. They're aware of these other R&D

endeavors. They've been studying them for years. And people are now trying to do it right, and I'll give you one example. It's actually a controversial example. You cannot build a semiconductor plant in Arizona, which is where they happen to be going, with tens of billions of dollars of federal money, which is what they happen to be getting, without putting a daycare in the semiconductor plant because that was one way that was seen as trying to use federal policy to enable equitable work.

So I've been asking myself how can the ideas from the history of technology contribute to how we think about this industrial transformation? If ever there was a time when we could actually think about industry differently, we have by no means a blank slate but a couple of places to start fresh.

Now, in my own work, I've always addressed big topics that people thought they knew everything about -- ironclad warships. The *Monitor* was the most famous ship in American naval history. Cybernetics, the Apollo lunar landings. Whereas a contemporary approach in the history of technology would say well we don't do that big stuff anymore. We're all into smaller stories of other parts of the system.

But I always attack these big problems partly because I'm interested in mythology. And my undergraduate training in literature has always led me to big narratives. People pay attention to them. And by the way, those big narratives are all susceptible to the same set of interesting techniques that have been developed in this field. And they come out looking different in helpful ways.

So in what follows, I'm going to break all of the rules of the modern history of technology and all of the taboos. Debbie is going to kick me out of SHOT. I'm going to talk about great inventors. I'm going to talk about dead white men. I'm going to talk about origin stories. I'm going to talk about drawing lessons from history, something we're taught not to do in grad school.

I'm going to be United States focused and even talk about how to contribute to national U.S. goals. I'll point out that manufacturing is one of the only bipartisan issues in Congress right now, maybe the only one. And echoing Victor, I'm even going to elevate Samuel Smiles. And the biggest taboo of all, I'm going to look for some optimism and talk about the possibilities of the future in an optimistic way and not solely talk about oppression and alienation.

I want to go back and tell some stories, using all the tools that I've learned from scholars in this room and others. And I recently found myself drawn to the 18th Century, though I'm by no means a native there like our friend Ken here. But as a newcomer, I found

I was able to see a few interesting things and go back and say let's look at the origins of the industrial revolution, three words I've not ever been comfortable with before in my scholarly work, and say what can we learn from the people who were there, for the moment we're at now?

This image shows an 18th-Century upper-class English gentleman. And it's from the Victoria and Albert, the major design museum in England. But when you look closely, you can see that this person is wearing not only stockings, probably made at an Arkwright stocking frame, but also these little metal – actually the word used was toys – buckles, the buckle on the hat, the buckle on the shoes, probably the scabbard for the sword or it's really more of a scepter, and particularly the polished steel buttons on the jacket. These were all Birmingham artifacts, probably made in Matthew Boulton's factory or by one of his colleagues.

Boulton started his career making luxury goods inexpensive for the masses. And I got very interested in this group of people who organized themselves as the Lunar Society in the 1750s to the 1780s.

There was a very good popular book written by Jenny Uglow about it, although I found my way back to Robert Schofield who'd published really the definitive work on the Lunar Society. And this was a moment where Erasmus Darwin, Charles Darwin's grandfather, and Matthew Boulton got together and said let's start taking some of these ideals from The Enlightenment – of course they didn't use that term – and bring them very consciously into the industrial world.

And even though Schofield was a Bernard Cohen student coming up in what we would maybe think of as old school Harvard history of science, he concluded these guys were like an industrial research establishment. They were very consciously bringing scientific work into industry.

Curious if any of you have heard of this person. So William Small, fascinating guy, was a Scottish trained physician, had trouble finding a job in London and went to Virginia in the late 1740s or early 1750s and began teaching at the college of William and Mary. And thanks to his bad luck, the entire faculty there had been fired or quit the year before he showed up because of some combination of drunkenness and political differences.

And he had to teach every class there for two years. And the only thing he knew how to do, instead of teaching the theology that had been the staple of the curriculum, he began teaching what he had learned in the Scottish Enlightenment and both law and literature as well as scientific demonstration. And it happened that the two years that Small taught there,

one of the young students was a callow young slave holder who had basically come there to party and drink, and that was Thomas Jefferson.

For years, scholars had wondered about the intellectual origins of Jefferson's enlightenment philosophy. His library from early in life burned, and so nobody quite knew. They always assumed it was John Locke. And Garry Wills actually wrote a great book on the lost world of Thomas Jefferson where he found that the teachings of William Small shaped his thinking. And Jefferson was very explicit about that. He said, "It shaped the destinies of my life."

Now what's very curious about this and makes that more than a pedagogical curiosity is that Ben Franklin passed through Williamsburg. He met William Small and encouraged him to go back to London. Small went back to London ostensibly to purchase scientific instruments for his demonstrations for the college, which he did. But he shipped them back to Virginia and never went back.

Franklin was living in London at the time. He took Small under his wing and said, "You really ought to move up to Birmingham and hang out with this guy Matthew Boulton. He's an interesting character. They're doing interesting stuff." So Small went to Birmingham. And after he operated on Boulton's daughter, Boulton set him up in medical practice (I might consider doing that the other way around). Small was very gregarious. He never published a scientific paper, but he was a friendly connector.

He started reaching back into his Scottish connection. He's the person who introduced James Watt to Matthew Boulton. And so you have this very interesting historical semi-coincidence that Thomas Jefferson's teacher was the person who introduced Boulton and Watt. In the context -- actually, if you want to get formal, Small dies at age 42 in 1775 and Boulton forms the Lunar Society to take the place of Boulton's informal networking to make it a more formal kind of dinner party group.

And that dinner party group over the next 20 years includes Joseph Priestley. It includes "Iron Mad" John Wilkinson, who ends up boring the cylinders for the first Watt engines, and really brings together so many of these cross currents -- Benjamin Franklin I mentioned -- in this intersection of the Enlightenment science with industry.

And they're digging canals, and in the canals they're digging up fossils, and they're doing geology based on the fossils. And they're bringing minerals to this guy, who Victor mentioned, who's Josiah Wedgwood. And Wedgwood is just this fascinating character, severely disabled by smallpox early in his career, kills his craft career as a potter. But that turns him toward, in some way, larger pursuits in pottery.

And again, to return to some of these themes of material culture, this image is from Wedgwood's Frog Service, which he made for Catherine the Great. It was about 1000 unique pieces. And he actually had developed a method of imprinting wood cut imagery onto ceramic plates. What Catherine the Great wanted was representations of England and English-ness on these plates.

And in this one he actually put his own Etruria factory there, so an early representation of factories as part of English-ness, and then of course marketed these plates broadly. And I won't go too much deeper into Wedgwood here, but if you go back to Ruth Cowan's talk yesterday, everything about her approach is embodied in the Wedgwood story. One of Wedgwood's great insights was to realize that female domestic taste was going to drive his business.

He was very good at learning what that might be and catering to it. Domestic aspiration, again, offering inexpensive goods to the middle classes so they could feel more like royalty drove his business. So did the revival of classical design and classical themes being sent to him by Lord Hamilton from Naples. At that time Pompeii is being excavated and not solely but very largely responsible for the rise of neoclassicism and the ideal of this sort of very idealized whitened Greek world as a representation of what it means to be modern and British in that period.

Wedgwood is a master manufacturer. He builds workers' housing at his site. He is very concerned with protection of workers against lead poisoning, which was a real issue and well known at the time. Not a fully enlightened employer by any stretch, but he did make a work force out of the Burslem much lower quality potter's trades in the area around him.

What I find fascinating about the Wedgwood story is that it has some very interesting parallels with the modern semiconductor business. People were telling him you can't compete with the Chinese. They make incredible, high-quality porcelain. And nobody's going to buy your English pottery at the high end. And he said, "Watch me," and he built a work force and over a 15- to 20-year period revitalized the domestic English pottery business, not least because he was close to his customers, and he understood the taste that was changing quickly.

Also actually the pottery business is not so different from the semiconductor business in that it's a very tightly-controlled process of heating and cooling and chemical transformations and layers and so on. And Wedgwood made technical innovations there.

One of the other things he did was actually intervene in the anti-slavery debates. When the early abolitionist societies were getting going in Britain, Wedgwood was an early

member, and he did what he knew how, which was to make ceramics. He made this famous medallion with an African slave in chains saying, “Am I not a man and a brother?” And the founders of the abolition movement took this medallion up. It was seen on fashionable ladies in London and adorning clothing in various ways.

Wedgwood sent a box of it to Ben Franklin. It had its role in the American abolition movement. And various art historians have said this is actually the most important thing that Wedgwood ever did. Now, the history of abolition in Britain is a complex story. We don’t need to give Wedgwood more credit than he deserves. But it does illustrate here that manufacturing can be an influence on social change. And there are many different ways that have been documented by folks here and elsewhere that actually making things is a way of changing the world.

I mentioned a little bit about Samuel Smiles. Again, roughly speaking, the attitude in the field has always been he’s this sort of ancient hagiographer who made heroes out of inventors, and we want nothing to do with him. I don’t think that’s fair to Smiles actually. You may or may not know that Samuel Smiles coined the term self-help, which is still the largest section of any book store today.

Smiles wrote a book of that name. The first chapter in that book is about James Watt and Matthew Boulton. He also was probably the first historian to identify the Lunar Society as a thing. What I find more interesting here from the point of view of mythology is that Smiles is writing 50 years after even the death of Watt, but he’s part of a transformation of a notion of heroism and national mythology in Britain that had still remained basically admirals and kings battle conquest, force, violence, domination.

And Smiles’s contribution, as was Ben Franklin’s in his own autobiography, was a kind of middle-class collaborative heroism and saying that it’s these kind of non-aristocratic ordinary people -- the Lunar Society folks were all from the Midlands; they weren’t sophisticated Londonites -- who are regularly applying themselves, are the examples that Smiles wanted to follow.

That story has been derided by any number of commentators including Max Weber as ordinary, you know, bourgeois aspiration. But if you go talk to factory owners today in the United States, all they want is workers who don’t drink who can come to work in some regular way. In Franklin’s autobiography, he uses the term “industry and frugality” 37 times in a relatively short book.

I like the word industry. It’s actually my favorite buzzword these days. I don’t count 1.0, 2.0, 3.0, 4.0 type stuff that they do in the press. Industry is a great word because it’s a

human virtue as well as an economic sector. In fact, it was a human virtue before it was an economic sector. And folks have written about the industrious revolution preceding the Industrial Revolution.

The big difference today is we don't have to live on clock time. And the clock was such a dominating feature of all of the industrial history that we know, but at some level, we've been liberated from that mechanical automaton by various digital technologies that allow work to move around in space and time. And Rebecca's work from this morning has illustrated that. So what does modern industrial work look like that's more humane and liberated from clock time.

So I'm just going to close a little bit with these images which you've seen which I think are really pretty bankrupt of the future of industry, not least because there's just no people anywhere. They're totally idealized. They sort of live in these green field sites.

Yet if you take these principles that we've learned from the history of technology and you ask: what would a new industrialism look like and how are we able to build and maintain industrial systems that will supply all of the many human needs in a future? And how can we talk about those futures without being Utopian?

Roz Williams connected me to the work of Lee Vinsel and Andrew Russell on maintenance. We heard some of that in the talks this morning as well. So I'm going to read you a few of what I think a new industrialism ought to look like. This is without saying what the future should be or predicting any future or just trying to say if I ask historians of technology, given what we've learned, what should it look like.

A new industrialism depends on public recognition of the intimate dependence of our lives on industrial systems. Again, go back to the great toilet paper crisis. For Americans, that was their first thought when the world was changing. A new industrialism requires an economics that can account for the indelibly human dimensions of technology – learning, skill, communication, and collaboration (something economics has done very poorly with so far).

A new industrialism requires financial instruments that are tuned to the life cycles of industrial technologies, not the kind of S curve, get rich quick software cycles that we've been living with. A new industrialism should be human centric, recognizing the knowledge and value in work and share the benefits with all who work.

And finally, a new industrialism must see technology as a mediator in human relationships with the natural world. If you look at any industrial system, you always will end up with environmental history, because everything comes from somewhere. And that's been

more and more true if you look at the electric vehicles debate.

People very quickly said okay, it's nice that the car is quiet and doesn't spew a lot of emissions, but where's the lithium coming from? Where's the cobalt coming from? When you drive that car, you're entrained in those global supply chains, and you want to think about what those implications are.

So I end with a little bit of brief advice for young industrialists about ways they might talk about what they're doing. Again, I'm not trying to predict the future. I'm not trying to create rosy visions. I'm just trying to give other people tools for talking about technology in ways that are consistent with this community's understanding.

Marry product improvement to process improvement. That's one of the great lessons of manufacturing. Avoid Utopian innovation speak. That's from Vinsel and Russell, actually. Think in terms of systems. You'll hear the echoes of our friend Tom Hughes there. Emphasize adoption. Design for resilience and flexibility. Get excited about maintenance and repair. Straight out of Vinsel and Russell also. Value knowledge at every level of work. See the human intelligence embodied in every product and system. And then I said form your own Lunar Societies to collaborate and explore.

I'm trying to offer a non-deterministic, non-Utopian language for the kinds of people we teach here at MIT or at any of our universities to think about ways that they can build and improve the world. How do we think about technology moving forward? And it is the moment for now 50-60 years of history of technology to contribute to the world that we want to live in.

SLIDE SHOW FOLLOWS