TESTIMONY OF PROF. MARTIN A. SCHMIDT, ACTING PROVOST, MASSACHUSETTS INSTITUTE OF TECHNOLOGY ON NOVEMBER 13, 2013 AT 2:30PM, AT THE HEARING BEFORE THE SENATE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION ON THE ROLE OF MANUFACTURING COLLABORATIONS IN A 21ST CENTURY INNOVATION ECONOMY

Chairman Rockefeller, Ranking Member Thune and members of the Committee:

Thank you for inviting me today to discuss the role of manufacturing collaborations in our innovation economy. As requested, I will review key findings on that issue from MIT's just-released study on Production in the Innovation Economy – "PIE," as well as the Advanced Manufacturing Partnership – "AMP" - project. I have had the privilege to serve for three years on the faculty committee that prepared this MIT advanced manufacturing report, and have also served as the Technical Co-Lead on the university side for the Advanced Manufacturing Partnership.

Very often, the importance of a robust domestic manufacturing base is expressed in three contexts; jobs, economic and national security, and innovation.

At MIT, we have chosen over the past 3+ years to focus on the innovation question. Specifically, is a production ecosystem vital to our innovation processes, what level of production is needed, and how can we strengthen this area? This is not to say that matters of security and jobs are not very important, but on innovation we believe we have something particular to say, and further, as you know, technological innovation is the dominant factor behind economic growth and therefore jobs.

The MIT Production in the Innovation Economy (PIE) Study

MIT's manufacturing study was led by 20 members of the MIT faculty from a wide range of fields – engineering, science, economics, political science and management. It was data driven, undertaken over three years. It included interviews with over 250 manufacturing firms, small, medium and large. We conducted firm interviews in 21 states, but focused particularly on in-depth interview efforts in 4 states -- Ohio, Massachusetts, Georgia and Arizona -- which have quite different manufacturing economies and sectors. We also studied production in some 150 startup and entrepreneurial firms. We conducted interviews with an additional 78 firms in 7 other countries, and tried particularly to understand the manufacturing success of firms in Germany and China. We conducted, too, a major survey on workforce needs, sampling hundreds of manufacturing firms. Our report was recently released in book form; a second volume will come out this winter with the detailed backup chapters for the first overview volume. A preliminary summary of the MIT report can be found at: http://web.mit.edu/press/images/documents/pie-report.pdf.

For a time, U.S. manufacturing thought we could *distribute* manufacturing – we could innovate here and produce there. And to stay strong our major firms needed to be participating in major markets abroad.

This view is perhaps best embodied in Apple, a company that no one would dispute has an exceptional track record at delivering highly innovative new products, but is able to do this without keeping its manufacturing under one roof, let alone in the same country. We found that this separation of design from manufacturing can work for firms in a sector such as consumer electronics, where there has been tremendous standardization of the production processes and development of robust digital design environments, In addition, in the case of Apple, their huge market clout allows them to form unique partnerships with suppliers that emerging companies are not able to replicate.

But in most sectors – particularly where we are producing complex, high value goods - the study found that there were very close, critical links between innovation and initial production stages. Moving from innovation to product design can take years and is highly creative – there are critical feedback loops where the innovation is reworked as the product idea emerges. If you shift production abroad, we found that in many cases innovation capability has to follow it, or the innovation process is severely slowed down.

The Gillette company provides an example of production-innovation integration. It's is hard to imagine that a commodity product (e.g. a disposable razor) is manufactured first on a 30-acre waterfront site in downtown Boston, just two blocks from some of the most expensive office real-estate. Why is this the case? Well, in fact, razor blades turn out to be a highly complex good – they use, among other things, nanoscale diamond–like carbon coatings deposited in high vacuum (to keep the blades sharp), laser-welded materials, custom-formulated polymers for the blade suspension, and high-precision molded parts. All of this new production capability has to come together to manufacture these parts in high volume. Differences of pennies in the manufacturing costs can translate to significant profits or losses in this multi-billion dollar market. What Gillette has learned is that they must make these products in the same location where they interact with their customers and where they design the next generation products. This linkage of production to innovative design is critical to the success of Gillette. We have also seen this in a recent study we have done at MIT on advanced biomanufacturing. For example, in one sector of biomanufacturing, we found that 80% of all clinical production facilities are within 100 miles of the company's R&D center.

Innovation has been the U.S. strong suit – it's what we do best. But if important parts of innovation have to follow production, we could be affecting our innovation strength. And it is innovation that is the critical factor behind growth.

3) The Scale-Up Problem

and generates electricity to recharge your mobile device when you are 'off the grid'. In fact, this product, when powered by a disposable fuel cartridge, will repeatedly recharge your mobile phone for 2-3 weeks, meaning that 'pound-for-pound' it has an order of magnitude more energy than the best battery you can buy. However, it hasn't been easy to get to this point. It's taken more than 10 years (a common time frame for disruptive new products using new technologies), it's required well in excess of $100M, and even today the company is working hard to identify investors to support the scale up of this fully functioning device to volume production.

Many of the challenges Lilliputian Systems faces are those that we hear over and over again. Namely: it takes a long time (especially if you need to rely on offshore production and development capacity) and domestic sources of capital for production infrastructure are hard to find (which encourages companies to seek foreign investment and to transfer production overseas).

Today, to get through this stage small U.S. firms increasingly do need to reach abroad. But remember the PIE study showed us clearly that in many industrial fields innovation and production need to be integrated. So unless we can solve this scale up problem, I worry that tomorrow's innovative industrial companies - built on the next generation of technology advances – may increasingly come from abroad.

The Connections Between the PIE Findings and AMP

The key findings of the PIE study link quite closely with the Advanced Manufacturing Partnership (AMP) project, the collaboration between industry and universities that Secretary Pritzker has described.

Re: Rebuilding the infrastructure –

AMP's July 2012 report recommended industry-university-state and local government collaborations in which the federal government would cost-share, built around "Manufacturing Institutes." These would be joint efforts to advance the development of critical new production technologies that could be transformative across multiple manufacturing sectors. They would support applied research, technology demonstrations and testbeds, and build collaborations between small and large firms and researchers. They are somewhat similar to the Fraunhofer Institutes so key to Germany's production system.

These manufacturing institutes fit with the MIT PIE recommendations on rebuilding our industrial infrastructure – they could fill a critical gap.

While the MIT PIE report found we didn't have a critical skilled workforce problem at this time, we will need new training and education if we are to shift to advanced manufacturing, If we don't have the trained talent to move into these new areas, we'll never get there. AMP recommended expanding the role of community colleges for this role. We can also apply the lessons we are learning in online education to develop new highly effective training modules for both workforce and engineer education.

and universities, and local and state governments can work together to build strong industries taking advantage of regional assets and expertise. Federal programs can support regional economic development, the sharing of best practices, and the development of capabilities essential to defense and other national needs.

With the AMP effort moving into its next phase and Congress giving serious consideration to the role of manufacturing in maintaining U.S. competitiveness, we have a real opportunity to strengthen our innovation ecosystem in ways that will help rebuild our economy.

Thank you.