US manufacturing decline and the rise of new production innovation paradigms

Between 2000 and 2010, US manufacturing experienced a nightmare. The number of manufacturing jobs in the United States, which had been relatively stable at 17 million since 1965, declined by one third in that decade, falling by 5.8 million to below 12 million in 2010 (returning to just 12.3 million in 2016). Certainly, the 2007–08 recession accelerated the disruption, but the causes were also structural, not simply financial. There was trouble with capital investment, output, productivity, and trade deficits. Contrary to what many believed, productivity gains due to robotics or automation have not been the cause of manufacturing employment's decline; the sector has been hollowing out.

This economic disruption has resulted in growing social disruption. While most people in the US assumed the nation was becoming one big middle class, instead a working class facing declining incomes came into clear, angry view during the 2016 US presidential election. The median income of men without a secondary school diploma fell by 20% between 1990 and 2013; for men with secondary school diplomas or some college, median income fell by 13%. The decline of US manufacturing—traditionally a route to the middle class—hit these groups particularly hard. There is now a major income inequality problem.

The question is: can the US manufacturing sector spring back? A core idea now being explored in the US is that new production paradigms could transform the sector. We have seen these new paradigms before: application of steam power in the UK, development of interchangeable machine-made parts, then mass production in the US, and the creation of quality manufacturing in Japan. The United States is now competing with low-wage, low-cost producers, particularly in Asia. Could the economy use its still strong innovation system to develop new production paradigms to drive up production efficiency and drive down costs so it can better compete?

Innovation also carries its own rewards; production innovation can enable more innovative—and competitive—products. Scientists and engineers are now telling us that there may be breakthroughs—new paradigms—available in a series of fields that could significantly change the way we produce complex, high-value technologies and goods, enabling dramatic production efficiencies. Advanced materials, digital production, photonics, lightweight composites, 3D printing, assistive robotics, revolutionary fibres, nano and biofabrication, all offer breakthrough production paradigms. These new technological advances must, in turn, be accompanied by new processes and business models to implement them. While new jobs may not necessarily be created at the production moment, job growth upstream and downstream of production is likely, given manufacturing's role as the major job multiplier in the connected value chains of firms.

Developing such new paradigms is the core idea behind advanced manufacturing

in the US. Advanced manufacturing institutes as a means to nurture such paradigms are now being explored in depth across 14 new institutes, each organised around a potential paradigm. Created through collaborations between industry, universities, and state and federal governments—and cost-shared by all—they are undertaking collaborative research on advanced technologies, shared test beds and demonstration facilities, and new approaches in workforce training. They are an attempt to apply Germany's Fraunhofter Institute model in a US setting, and borrow from the earlier US Sematech collaborative model that in the 1980s and 1990s applied advanced production processes to revive its semiconductor leadership.

This is a highly complex model: each institute typically joins over a hundred small and large firms, regional universities and community colleges, and state and regional agencies, with backing from federal R&D organisations. These R&D agencies are used for funding single scientist principal investigators, not a swarm of diverse collaborators. One federal official has compared creating a manufacturing institute to forming a new nation. The institutes must operate at a regional level because manufacturing firms are embedded in regional ecosystems, but must also bring their new production technologies into implementation at a national level, a complex regional-national balancing act.

The institutes have also become a new delivery mechanism for workforce education, a growing challenge for US manufacturers. If advanced manufacturing is to be implemented, it must have workforce and engineering communities trained for it. The United States has perhaps the most decentralised labour market of any developed economy, which makes such a major "up-skilling" project difficult. The institutes, with their ability to bring together manufacturers, community colleges, state programmes, university curricula, and online tools, with new technology development and testbed facilities, are now pursuing this task.

Perhaps the most interesting feature of the US advanced manufacturing effort is the wide range of diverse technologies aimed at by particular institutes. While some countries are working on single-shot efforts to bring the internet of things into a manufacturing setting, the United States has a shotgun approach, pursuing a wide range of technologies, from materials to digital, to bio, to nano. A big issue in this diverse approach will be pulling the individual institute strands together into a new system. The future factory will not be organised around single technologies; it will merge and connect a series. The institutes are starting to come together to form a network, called ManufacturingUSA. A critical task for this new network will be to turn the institutes' advanced technology strands into an entirely new production system. Hopefully, the potential of this new innovation model will continue to be tested.

References

Bonvillian, William and Singer, Peter (forthcoming), *Advanced Manufacturing: The New American Innovation Policies*, MIT Press, Boston.

OECD (2017), *The Next Production Revolution: Implications for Governments and Business*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264271036-en

OECD (2016), *OECD Science, Technology and Innovation Outlook 2016*, OECD Publishing, Paris.
DOI: http://dx.doi.org/10.1787/sti_in_outlook-2016-en

OECD Forum 2017 issues

OECD work on innovation

OECD work on industry and entrepreneurship

OECD work on the United States

William B. Bonvillian
Lecturer at MIT and Advisor to MIT's Industrial Performance Center