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*“Robots Made in America: Advancing U.S. Leadership in Manufacturing and Automation”*

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Chairman Obernolte, Ranking Member Stevens, and distinguished Members of the Subcommittee, thank you for the opportunity to testify today on a matter of national importance.

American manufacturing faces two distinct but related crises, and robotics — deployed thoughtfully — could address both simultaneously. The first is a labor supply problem. The second is a competitiveness problem. They are connected because the same technological and organizational transformation that could attract workers back to manufacturing could also make American firms much more competitive in global markets. These technologies would allow improved wages and working conditions that would attract workers to the jobs that firms are unable to fill at current wages, and would improve the competitiveness of U.S. firms, promoting onshoring and entry into new markets, by reducing direct labor costs and facilitating greater precision.

The degree to which robotics delivers on this promise depends enormously on how we develop and deploy these technologies. Gains are far more likely to materialize if automation is designed to augment worker skill rather than replace it.

Done right, the U.S. could see a virtuous cycle, in which a stronger manufacturing base supports a more vibrant automation equipment industry, which in turn strengthens overall manufacturing —and both of these developments lead to more and better jobs in manufacturing.

I will elaborate on each of these points below.

## **I. ROBOTICS CAN ADDRESS WORKER SHORTAGES**

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In recent years, manufacturers have persistently complained that they can't find sufficient workers. To take one of many examples, in 2024 the Manufacturing Institute, a nonprofit aimed at developing America's manufacturing workforce, and Deloitte, a consultancy firm, surveyed more than 200 manufacturing companies; more than 65% of them said recruiting and retaining workers was their No. 1 business challenge<sup>1</sup>.

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<sup>1</sup> For additional examples, see *Agentic AI in Engineering and Manufacturing: Industry Perspectives on Utility, Adoption, Challenges, and Opportunities* Kristen M. Edwards, Maxwell Bauer, Claire Jacquillat, A. John Hart, Faez Ahmed MIT Working Paper, March 2026.

As an economist, I find this puzzling: why are supply and demand not coming into balance? To answer this question, it's important to note that the manufacturing wage premium that once made factory work a path to a middle-class life has eroded substantially over the past three decades. A Federal Reserve study finds that the premium has disappeared entirely when measured by hourly wages.<sup>2</sup> The median wage for an American production worker is now lower than the national median wage. In 2024, a quarter of the 9 million production workers earned less than \$18 per hour — the starting wage at Walmart.<sup>3</sup>

For many workers, a manufacturing job means harder physical conditions, less pleasant surroundings, and greater occupational health risk — for wages that no longer compensate for those disadvantages. Manufacturers complain that they cannot find workers, but the more precise diagnosis is that they cannot find workers at the wages they are currently offering, and their productivity does not yet support higher wages. This is a wage shortage as much as a skills shortage. However, given their thin margins, many manufacturers can't simply raise wages and stay in business — they must transform their business models.

Robotics and smart manufacturing offer a path out of this trap — but only if the productivity gains they generate are shared with workers. When automation handles the most physically demanding, dangerous, and repetitive tasks, it can improve working conditions directly while also raising output per worker. Higher output per worker makes higher wages sustainable. The challenge — which I will return to in the next section — is that this virtuous cycle is not automatic. It requires deliberate choices about how automation is implemented and how the gains are distributed.

Some fear that robots will in fact lead to massive job loss, but this is unlikely. While automation means that labor per unit of output falls, automation is likely to raise demand for total output, as prices fall and incomes rise. Careful studies, such as those summarized in Autor, Mindell, and Reynolds (2022) find support for this view. The experience of Germany, Japan, and South Korea

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<sup>2</sup> Bayard, Kimberly, Tomaz Cajner, Vivi Gregorich, and Maria D. Tito. “Are Manufacturing Jobs Still Good Jobs? An Exploration of the Manufacturing Wage Premium.” FEDS Working Paper No. 2022-011R1, March, 2022. <https://ssrn.com/abstract=4077451> or <http://dx.doi.org/10.17016/FEDS.2022.011r1>

<sup>3</sup> Armstrong and Liu, 2026. “The ‘New Manufacturing’ Workforce,” MIT Working paper.

— all of which have high robot density alongside high manufacturing employment and wages — demonstrates that the pessimistic displacement scenario is not inevitable.

While job quantity is unlikely to decline, job quality may well be at risk. Although the new technology almost always creates enough new wealth to leave everyone better off, actually distributing this income widely sometimes takes a very long time. For example, the Industrial Revolution in England meant the mechanization of industries such as agriculture and weaving, leading to dramatic increases in output. However, wages stagnated for half a century, from about 1790-1840, and workers' living standards declined. The Enclosure Movement removed small farmers' and grazers' access to land, enabling agriculture to be mechanized on the resulting large holdings; the mechanization also reduced the skills needed for farming. Similarly, skilled handloom weavers were replaced by unskilled factory workers (including children), and the weavers' wages fell dramatically. Eventually, wages did grow at a rate commensurate with (and sometimes exceeding) productivity growth, thus enabling workers to share in prosperity. But these changes did not occur automatically; they depended upon the rise of new institutions, such as unions, public education, and universal suffrage.<sup>4</sup>

## II. ROBOTICS CAN ADDRESS COMPETITIVENESS GAPS

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On the competitiveness side, the strategic stakes are high. China has deployed a coordinated industrial strategy combining massive subsidies, state-directed investment, and explicit policy requirements designed to accelerate robotics adoption and capability-building at scale. As a result, China now operates more industrial robots than the rest of the world combined.<sup>5</sup>

The consequences of falling further behind extend beyond any individual factory. The capabilities required to produce sophisticated goods underpin the defense industrial base, the ability to surge

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<sup>4</sup> Groshen, Erica L, Susan Helper, John Paul MacDuffie, and Charles Carson. "Preparing U.S. Workers and Employers for an Autonomous Vehicle Future." W.E. Upjohn Institute for Employment Research, February 27, 2019. [https://research.upjohn.org/cgi/viewcontent.cgi?article=1039&context=up\\_technicalreports](https://research.upjohn.org/cgi/viewcontent.cgi?article=1039&context=up_technicalreports)

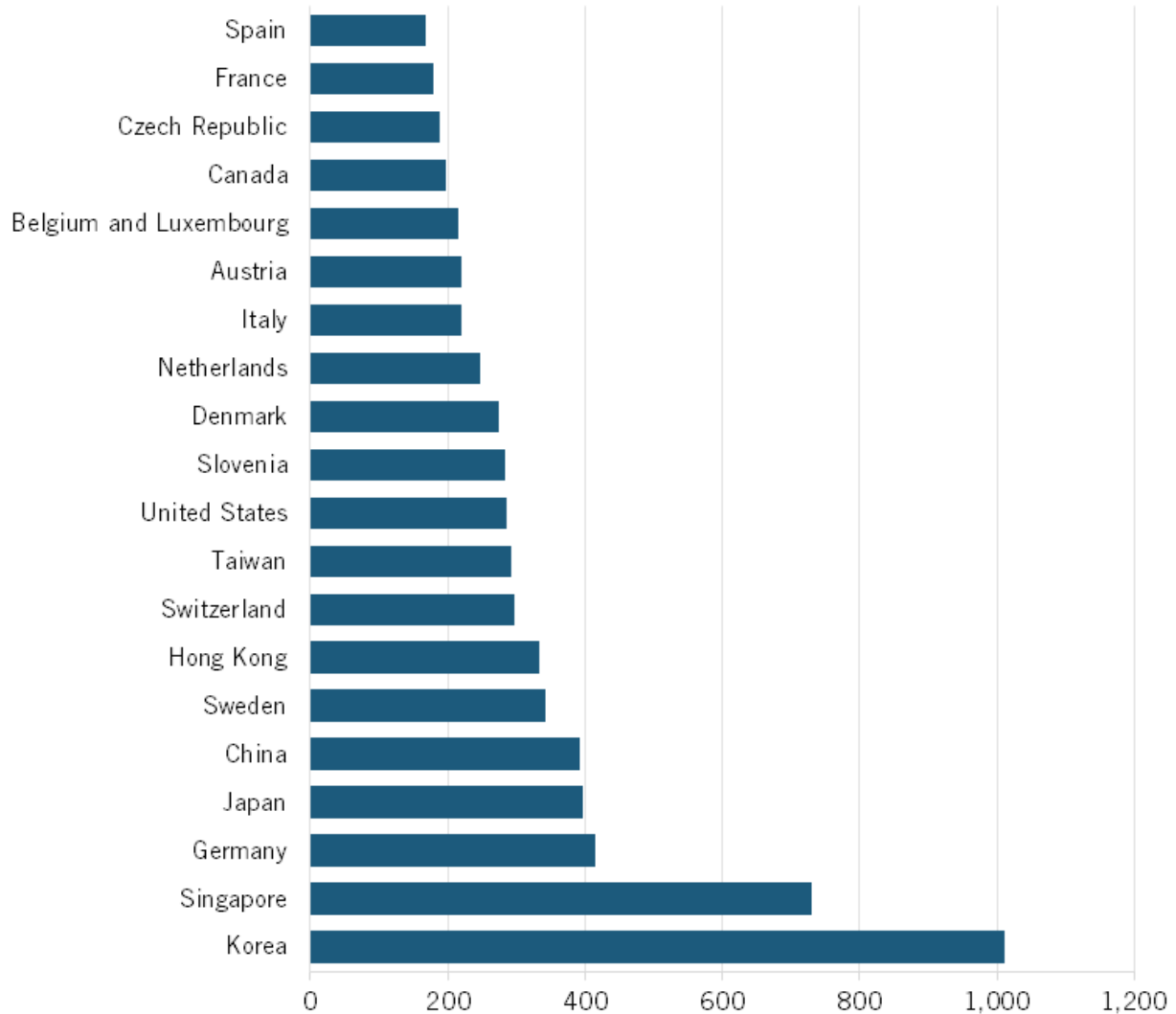
<sup>5</sup> Tobin, Meaghan and Keith Bradsher. "There Are More Robots Working in China Than the Rest of the World Combined." *The New York Times*, September 25, 2025. <https://www.nytimes.com/2025/09/25/business/china-factory-robots.html>

Bradsher, Keith. "An Army of Robots Is China's Weapon in Trump's Tariff War." *The New York Times*, April 23, 2025. <https://www.nytimes.com/2025/04/23/business/china-tariffs-robots-automation.html>

production in a crisis, and the feedback loops between users and developers that sustain long-run technological leadership. We experienced this vividly during the COVID-19 pandemic when we lacked the domestic capacity to rapidly produce essential medical supplies, and again with semiconductors, when dependence on foreign-made chips cascaded into disruptions across dozens of industries. An adversary that dominates the global robotics supply chain will exercise leverage not just over commercial markets but over our own military readiness.

Robotics adoption also offers a path toward onshoring production that has been lost to low-wage competition. By reducing direct labor costs and enabling greater precision and consistency, automation can shift the competitive calculus in favor of domestic production for a broader range of products. The path, however, is not easy; adoption rates in the U.S. remain low, as Figure 1 shows.

**Figure 1: Industrial robots per 10,000 manufacturing workers, 2022**



**Source:** International Federation of Robotics, cited in Robert D. Atkinson, Meghan Ostertag and Trelysa Long. “A Time to Act: Policies to Strengthen the US Robotics Industry.” Information Technology & Innovation Foundation, July 18, 2025.  
[https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/#\\_edn11](https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/#_edn11)

**The Barriers Faced by Small and Medium-Sized Manufacturers**

The promise of robotics for American manufacturing will not be realized if only large firms can afford to adopt it. Small and medium-sized manufacturers (SMMs) — which account for the

overwhelming majority of manufacturing establishments and much of employment — face at least three daunting barriers to adoption<sup>6</sup>:

1. Designing a desired future state (integrated new product/process plan). Successful adoption of robots means more than simply bolting them on to an existing process. As economist Erik Brynjolfsson has observed, “the biggest gains from a powerful general-purpose technology usually arrive only after firms invest in the complements: reorganizing workflows, retraining workers, redesigning processes and building the intangible capital needed to use the technology effectively.”<sup>7</sup> Making these investments requires marketing knowledge and/or relationships with customers, as well as intelligence about technologies, and the ability to integrate these into a product/process plan. Most small manufacturers lack the dedicated technical staff to identify, evaluate, and implement appropriate robotics solutions, and the risks of a bad hire or a failed implementation can be existential for a firm operating on thin margins.<sup>8</sup>

Gaining this knowledge benefits greatly from talking with others, i.e., building a community of practice, that would include peer-to-peer elements, improved supplier-customer relationships, and one-on-one technical assistance. These are discussed below.

2. Finding workers who can implement, operate and improve that process. As noted above, the U.S. faces a wage shortage as much as a skill shortage. To enable firms to have the margins to raise wages, many will need an organizational transformation — they can’t just fix the workers, but need new investment in equipment and software (e.g., in sensors, data collection), new structures (to give workers the incentive and the capability to participate in analyzing all the data that will be generated).

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<sup>6</sup> For examples, see: Colombari, Ruggero, et al. “The interplay between data-driven decision-making and digitalization: A firm-level survey of the Italian and US automotive industries.” *International Journal of Production Economics* 255 (2023): 108718; Berger, Suzanne, and Benjamin Armstrong. “The puzzle of the missing robots.” (2022).

<sup>7</sup> Erik Brynjolfsson, quoted in Torry, Harry. “The Economy Is Growing, Jobs Aren’t. Why That Might Be OK.” *The Wall Street Journal*, 2024.  
<https://www.wsj.com/economy/jobs/the-economy-is-growing-jobs-arent-why-that-might-be-ok-5c50a535>

<sup>8</sup> Helper, Susan, Elisabeth Reynolds, Daniel Traficonte, and Anuraag Singh. “Technology, Skills, and Digital Innovation at Large Manufacturing Firms.” *Factories of the Future*, Research Brief 19, January 2021.  
<https://workofthefuture-taskforce.mit.edu/wp-content/uploads/2021/01/2021-Research-Brief-Helper-Reynolds-Traficonte-Singh4.pdf>

Successful adoption of robotics and smart manufacturing is difficult under a traditional “Taylorist philosophy that “brain work” and “hand work” should be separated. Many small manufacturers operate with management practices and organizational structures developed for a different era, in which tasks were fixed, hierarchies were clear, and the division of labor between humans and machines was stable. Instead, what is needed is a modern organization in which shop-floor workers have the skills, authority, and incentive to engage with data, solve problems, and suggest improvements. Making that transition is hard, and carries real risks for firms that lack the bandwidth to experiment.<sup>9</sup> More on this below.

Financing the investments needed/providing demand assurances. Small firms often cite a “lack of access to capital” as a barrier, with the implication being that they could offer investors a good rate of return if only they could get a loan or some equity. In some cases, this is true: U.S. investors frequently rely on “hard” financial metrics and cannot easily assess “soft” operational indicators — the quality of a firm’s workforce, its delivery reliability, its investments in R&D.<sup>10</sup> Small manufacturers may be caught in the middle — large banks find it too expensive to do due diligence for a small loan, while community banks and CDFI’s have loan limits that are too small (manufacturing investments even for a small firm can easily exceed \$1 million).

However, in many other cases the issue is that the firm in its current state would not offer an attractive return to investors. Fixing the problem depends on understanding why that lack of ROI exists. Frequently the issue is that their foreign competition is subsidized or benefits from labor and environmental practices that would not be legal here, which suppresses prices and compresses margins. With thin margins, firms lack the retained earnings to self-finance major technology investments. In this case, it is important to address the underpricing problem, rather than to offer loans that a firm can’t pay back.

Another issue that is often conflated with capital access barriers is demand-side uncertainty. A small supplier considering new automation faces a fundamental problem: the productivity

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<sup>9</sup> Helper, Susan, Raphael Martins, and Robert Seamans. “Who profits from industry 4.0? Theory and evidence from the automotive industry.” *Theory and Evidence from the Automotive Industry (January 31, 2019)*. NYU Stern School of Business (2019). [2021-Research-Brief-Helper-Reynolds-Traficante-Singh4.pdf](#); Berger, Suzanne, and Benjamin Armstrong. “The puzzle of the missing robots.” (MIT Working Paper, 2022).

<sup>10</sup> The White House. “Building Resilient Supply Chains.” Economic Report of the President, April 2022, Chapter 6. <https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/04/ERP-2022.pdf>

gains from that investment often depend on whether its customers will commit to volumes sufficient to justify the capital outlay. Without that demand-side certainty, even a clearly beneficial investment may be too risky. Conversely, if investors believe that demand will be forthcoming, they will be happy to invest, resolving capital access problems. This coordination failure — where individually rational caution produces collectively irrational underinvestment — is a classic market failure that government policy must address.

### **III. THE CASE FOR WORKER-CENTERED AUTOMATION**

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The gains I described in the previous section — better wages, stronger competitiveness, onshored production — are not the automatic result of deploying robots. They depend critically on how automation is designed and implemented. The evidence strongly and consistently favors a worker-augmenting model over a worker-substituting one, both for firm performance and for workforce outcomes. This is not merely an ethical preference; it is a finding about what actually works.

When automation is designed primarily to replace workers performing specific tasks — and when firms lack the organizational capacity to redeploy affected workers into higher-value roles — displacement is the likely outcome, and productivity gains are often smaller and less durable than anticipated.<sup>11</sup> When automation is designed instead to augment worker capabilities — handling dangerous, repetitive, or physically demanding tasks while expanding workers’ scope to exercise judgment, solve problems, and contribute to process improvement — the outcomes are better for both the firm and its employees. Workers with meaningful roles in problem-solving catch errors early, identify process improvements, and adapt quickly when products or customers change. That flexibility is enormously valuable.

Research on worker-centered robotics design is exploring several promising directions:

1. Systems that allow workers themselves to program and adapt robots — rather than requiring specialized engineers for every modification — give shop-floor workers ownership of the technology and allow faster iteration. Robots and other automated equipment generate a lot of

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<sup>11</sup> See: Simon, Ruth. “An Ohio Factory’s Test: Will Higher Wages Help More Than They Hurt?” *The Wall Street Journal*, August 6, 2021.

<https://www.wsj.com/articles/ohio-factory-jobs-pay-raise-small-business-ppp-11628202983>

data. Making this data available on the shop floor (where workers can combine it with the experiential knowledge they gain from physical proximity — knowledge that engineers don't have) yields the potential for faster problem-solving, more satisfying and higher-paid work.

2. Collaborative robots (“cobots”) are designed to work alongside humans rather than in segregated cells that exclude them; they are often — but not always — adopted in a worker-augmenting way. An example of a non-enhancing cobot use is where the worker’s job becomes simply to hand a part in the correct orientation to a cobot, who then performs the operation. A better (more productive and more fulfilling) option would be that the worker would program the cobot (especially now that “low code” or “no code” options are available) to proactively support a worker (for example, anticipating their needs and procuring things, like an assistant in a manufacturing setting), as Professor Mike Hagenow at UW Madison is exploring.
3. Robotic exoskeletons that reduce physical strain, enabling workers to perform overhead or heavy tasks without the cumulative injury that shortens manufacturing careers, represent a third frontier.<sup>12</sup> The broader principle is that technology design choices are not neutral. The degree to which automation benefits workers rather than displacing them is partly a function of choices made by engineers and managers — choices that policy can shape.

#### **IV. STRATEGIC SYNERGY: WHY BUILDING A U.S. ROBOTICS INDUSTRY REINFORCES OVERALL MANUFACTURING COMPETITIVENESS**

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The development of a competitive U.S. robotics manufacturing industry<sup>13</sup> is not merely a separate goal alongside stronger manufacturing competitiveness — it is synergistic with it, in ways that compound over time.

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<sup>12</sup> Harvard Biodesign Lab. Soft Exosuits research program. [biodesign.seas.harvard.edu/soft-exosuits](http://biodesign.seas.harvard.edu/soft-exosuits). Ford Motor company is applying them in some assembly plants.

<sup>13</sup> This statement applies to robots and automation broadly defined, as in the proposed legislation for a National Robotics Commission, whose remit would include “Machines that—

(i) can sense their environment;

(ii) have the capacity to process the information they sense; and

(iii) are organized to act directly upon their environment.” — which would seem to apply to most advanced manufacturing equipment. “National Commission on Robotics Act.” HR7334.

<https://www.congress.gov/bill/119th-congress/house-bill/7334/text>

The first synergy runs from users to developers. A vibrant domestic user base for robotics — manufacturers who are actively deploying, adapting, and pushing the limits of robotic systems in real production environments — generates the kind of specific, practical feedback that drives innovation. Problems that only become visible on a factory floor, in the hands of a maintenance technician or a line operator, are precisely the problems that separate good robotics from great robotics. When the user base is domestic and the developers are domestic, that feedback loop is tight, fast, and commercially productive. When the user base is abroad — as is increasingly the case — those signals flow to foreign developers, and the innovation they drive strengthens foreign competitors.

“For us to be good builders of robots in America, we first have to be good users of robots and right now we are severely lacking in the adoption of robotics much more than we are lacking in the production of robotics,” Samin Farid, CEO of Formic wrote to me in an email on April 17. “Lots of examples of this. Most recently for example, we’ve been able to cut the cost of robot deployment by about 60%. Most of that came from our experience deploying robots across 100+ facilities, we learned about all of the operational and mechanical similarities and differences between these sites, as well as all of the different common failure, modes of the robots, places where the grippers would have issues, or the vision systems would have issues, and by consolidating all of that experience, we were able to design and build our own version of this robot that was significantly cheaper and much more capable.

Another area where this experience is super helpful, is around training data for the robots themselves. And having lots of robots deployed in the field, we were able to generate lots of training data, in particular, lots of training data about the places where the robots fail, how they fail, and how they are recovered by humans — and combining all of that, we were able to train new AI models for the robots that perform much better across the fleet as well.”

## V. A HIGH-ROAD STRATEGY: ENSURING ROBOTICS SERVES WORKERS AND COMMUNITIES

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The central policy challenge is to create conditions in which robotics adoption follows what researchers call a “high-road” or “good jobs” strategy: one in which highly-skilled workers produce innovative and high-quality products, their productivity enables wages sufficient to attract and retain talent, and firms compete on quality, precision, and responsiveness rather than on a race to the bottom on labor costs or environmental standards.<sup>14</sup>

A high-road strategy in manufacturing typically involves several mutually reinforcing elements. Workers with broad skills and meaningful roles in problem-solving and process improvement generate productivity gains that support higher wages. Those wages attract better workers, reducing turnover and its associated costs. Flexible equipment and broadly skilled workers allow firms to compete on customization, fast delivery, rapid product ramp-up, and resilience — dimensions of competition where cheap-labor strategies cannot easily follow. Supply chains built around collaborative relationships between anchor firms and suppliers, rather than pure price competition, invest more in shared problem-solving and reduce the coordination failures that slow innovation.

A high-road strategy requires that workforce training be redesigned to address not merely skill acquisition, but the organizational structures that allow workers to use those skills. Greater worker voice in process improvement, clearer career ladders, compensation tied to productivity gains — these are the organizational complements that determine whether technology investments actually pay off. Training programs that prepare workers for jobs defined entirely by employers, without attention to how those jobs are designed, will not reliably produce the outcomes they are after.

On the demand side, government procurement — including advance market commitments for domestically manufactured robotic systems — can provide the demand certainty that allows

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<sup>14</sup> Helper, Susan, and Raphael Martins. “The High Road in Manufacturing.” (2020), in Osterman, Paul ed MIT Press; Ton, Zeynep. *The good jobs strategy: How the smartest companies invest in employees to lower costs and boost profits*. Houghton Mifflin Harcourt, 2014.

domestic manufacturers to invest in capacity and capability-building.<sup>15</sup> Procurement standards that incorporate job quality conditions — requiring that firms receiving federal contracts meet standards for wages, benefits, safety, and worker voice — can create market incentives for high-road strategies that individual firms cannot easily create on their own.

Occupational health and safety deserves particular attention in any robotics strategy. The potential of robotics to reduce occupational injury is substantial. Many of the most dangerous tasks in manufacturing — heavy lifting, exposure to toxic substances, repetitive motions that cause cumulative injury — are tasks that robotic systems can perform. OSHA, NIOSH, and NIST should be resourced to develop standards and guidance for worker-safe robotics implementation. Programs that support robotics adoption should condition funding on demonstrable improvements in health and safety outcomes.

A word on market shaping versus passive market response. The most effective industrial policies do not simply correct market failures after the fact; they actively shape the markets in which firms and workers make decisions.<sup>16</sup> This includes defining product and process standards that promote safety and interoperability, promoting competition on quality and cost while protecting against races to the bottom on labor and environmental standards, and attending to barriers to entry that prevent competitive markets from working. Government convening, technical assistance, and information-sharing — not just subsidies — are essential tools. And conditions attached to public support — requiring that firms that receive grants and loans provide good jobs and meet environmental standards are essential to ensuring that public investment produces public value.

It is important that an industrial strategy address both supply and demand in the sector it aims to promote. Some examples of policies that fail to do this are the Jones Act (which mandates demand for U.S. shipping, but does not provide a program to supply such ships in a modern way), tariffs when implemented without complementary policies (see more below). Conversely, supply-only

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<sup>15</sup> The White House. “Building Resilient Supply Chains.” Economic Report of the President, April 2022, Chapter 6. <https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/04/ERP-2022.pdf>

<sup>16</sup> Mazzucato, Mariana, and Josh Ryan-Collins. “Putting value creation back into “public value”: from market-fixing to market-shaping.” *Journal of Economic Policy Reform* 25.4 (2022): 345-360.

policies can falter when demand is not forthcoming, as in the delayed plans of the CHIPS act, and of PPE facilities subsidized by the government but not benefiting from a procurement policy<sup>17</sup>.

Below are thoughts on specific policies. They are organized by the three barriers to SME robot adoption mentioned above, followed by thoughts on coordination across the policies.

**1. Policies to build a community of practice and provide technical assistance.**

To build the user community, and the synergy between robot users and robot makers described above, developing a community of practice is key. In such an environment (both physical and virtual) stakeholders can come together to engage in design and implementation of worker-centered automation, and achieve the user-builder synergies described by Formic above.

One way to do this is to create a physical place for people to come together, such as a test bed. Ray Boeman of the Startup Research Facility suggests a testbed that would “seek to integrate smart and secure technologies in, for example, digitalization, advanced sensors/sensing, AI/Machine Learning, and engage established capabilities and expertise of Manufacturing USA Institutes, National Labs, and leading academic universities, working with key industry associations, to reduce individual investments. It is envisioned that the testbed would serve as the physical validation site, accessible by all the aforementioned stakeholders as well as their collaborators and industry directly.” Other kinds of facilities with shared equipment would allow SMEs to try out equipment before they buy it.

A crucial need identified above is to design worker-centered robotics, to achieve the twin goals of better jobs and more competitiveness. Congress could fund small grants that bring together researchers, engineers, and labor representatives to design more of the kinds of robots mentioned above, and to adopt them in ways that achieve both firms’ and workers’ goals. Effective participatory design requires understanding and compensating it as work— giving workers voice and sufficient training to participate meaningfully. Government facilitation of tripartite

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<sup>17</sup> For examples of efforts to link supply and demand analysis, see [Building-Resilience-through-a-Made-in-America-Industrial-Strategy.final\\_.pdf](#)

participation (through grants and demonstration projects in the public sector) can help stakeholders achieve these goals<sup>18</sup>.

The Manufacturing Extension Partnership (MEP) is the most important existing vehicle for reaching small and medium-sized manufacturers. MEP centers provide technical assistance, technology assessment, and process improvement support to firms that cannot afford these services on their own. However, its current configuration has limitations that Congress should address. MEP centers vary significantly in their technical depth on advanced technologies like robotics, and many centers need investment to build the expertise necessary to guide manufacturers through complex automation decisions. MEP should be explicitly resourced to provide hands-on robotics assessment and implementation support, not merely information and referrals. Perhaps the robotics efforts could be guided by a national center(s) of excellence chosen on a competitive basis — but the “boots on the ground” advantages of state-level offices should be retained. MEP should explore ways to involve lead firms and to serve their supply chains, even when they cross state lines. The national centers of excellence could be organized to enable greater investment, firms should pay lower (but not zero) co-pays, longer planning horizon, more national coordination (but state operations are still important) – e.g., set up supply chain centers of excellence with involvement by lead firms.

Some policies to promote awareness do not have to cost very much. For example, Chinese policies include not just subsidies, but also efforts to focus company investment in developing capabilities, such as requiring automakers to provide videos showing how they might use robots in assembly, and races in which robots compete with humans to run a marathon. In 2025, the Beijing municipal government held a half-marathon for 12,000 runners and 20 humanoid robots. Only six robots finished the race, and the fastest of them took nearly three times as long as the fastest runners. But the event helped draw attention to robots.<sup>19</sup> Progress since then has been swift: In this year’s race,

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<sup>18</sup>See Friedler, Sorelle, Serena Booth, Andrew Schrank, and Susan Helper. “A people-first vision for the future of work in the age of AI.” Brookings Commentary, March 25, 2026.

<https://www.brookings.edu/articles/a-people-first-vision-for-the-future-of-work-in-the-age-of-ai/>; Mindell, David A. *The New Lunar Society: An Enlightenment Guide to the Next Industrial Revolution*. MIT Press, 2025.

<sup>19</sup>Bradsher, Keith. “An Army of Robots Is China’s Weapon in Trump’s Tariff War.” *The New York Times*, April 23, 2025. <https://www.nytimes.com/2025/04/23/business/china-tariffs-robots-automation.html>

held April 19, the fastest humanoid easily beat the world record for humans, and 40% of the humanoid entrants completed the course autonomously.<sup>20</sup>

Tax breaks for individual firms are often mentioned as a way to bring down costs of adoption. However, these “tax expenditures” reduce funds available for the kinds of information provision and community-building; they do not promote cross-stakeholder problem solving. While general tax breaks for equipment purchases (such as those in the OBBBA) may be useful, a robot-specific tax break in addition leads to complexity for both taxpayer and tax administrators; the funds may well be better spent on information provision.

## **2. Workforce Policies**

Many commenters argue that the key problem in manufacturing is its image, as offering “dumb, dirty, dangerous, work”; the solution that flows from this analysis is an image campaign.

The argument presented in section II above about manufacturers’ hiring difficulties suggests a different set of solutions: to improve the reality of manufacturing, by improving pay and to in fact upgrade production processes.

The Department of Energy’s Battery Workforce Initiative offers an instructive model for what more ambitious programs can accomplish.<sup>21</sup> By bringing together employers, unions, researchers, and training providers to jointly design standardized occupations and training curricula, the initiative demonstrates that it is possible to design new technologies and new jobs simultaneously — rather than simply asking workers to fit themselves into job definitions that employers set unilaterally. This collaborative approach should be replicated for robotics and smart manufacturing more broadly.<sup>22</sup>

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<sup>20</sup> <https://www.nbcnews.com/world/china/humanoid-robots-race-humans-beijing-half-marathon-showing-rapid-advanc-rcna340842>

<sup>21</sup> U.S. Department of Energy, National Energy Technology Laboratory. “Goals and Progress of the Battery Workforce Initiative (BWI): September 2022–November 2024.” 2024 Interim Report. December 2024. <https://netl.doe.gov/sites/default/files/2024-12/Final%202024%20BWI%20Interim%20Report.pdf>

<sup>22</sup> For additional examples in an AI context, see Friedler, Sorelle, Serena Booth, Andrew Schrank, and Susan Helper. “A people-first vision for the future of work in the age of AI.” Brookings Commentary, March 25, 2026. <https://www.brookings.edu/articles/a-people-first-vision-for-the-future-of-work-in-the-age-of-ai/>

A specific program that would address robotics is being developed at MIT, to define and train for an occupation called a “technologist.” “Given the technologist’s critical role to collaborate with technicians, engineers, and management, TechAMP develops essential leadership skills tailored for technical professionals. Through lectures, discussion, and simulated activities, they learn to communicate effectively, foster collaboration, manage conflict, provide feedback, and influence different stakeholders through structured frameworks and hands-on activities.”<sup>23</sup>

Ontario, Canada operates a program that subsidizes small firms to work with and train students and recent graduates on innovation-related projects, thereby reducing the risk of bad hires in technical areas where the firm has little experience.<sup>24</sup> A U.S. equivalent could help small manufacturers build internal technical capacity in robotics and related fields without requiring them to make permanent hires before they have assessed whether the technology is right for them.

I would be remiss not to mention apprenticeship, which is a key way that German SMEs achieve high robot density. Due to long-standing and widespread availability of this training, which is designed in part by employer and worker representatives, and combines instruction in general principles with real-world applicability, small firms do not face the barriers to identifying and hiring skilled workers that U.S. firms do. Over half of Germans enter apprenticeships, many in combination with college.<sup>25</sup>

### 3. Finance/Demand Policies

The U.S. currently lacks financial institutions that can provide medium scale (\$1-5 million) loans of medium complexity. One possibility is that the Export-Import Bank could also play a larger role in supporting domestic manufacturing competitiveness. Due diligence on small loans is nearly as expensive as that on large loans; perhaps there are lessons to be learned from the German development bank, KfW (which in turn learned from the U.S. Depression-era Reconstruction Finance Corporation).<sup>26</sup> Among the reforms worth considering: removing the requirement that

<sup>23</sup> “The ‘New Manufacturing’ Workforce,” by Ben Armstrong and John Liu, MIT Working Paper, March 2026.

<sup>24</sup> Ontario Centre of Innovation. TalentEdge Internship Program (NGNP). [oc-innovation.ca/program-nav/talentedge-internship-program](https://oc-innovation.ca/program-nav/talentedge-internship-program).

<sup>25</sup> Niranjana, Ajit. “What is Germany’s dual education system?” DW, June 4, 2018. <https://www.dw.com/en/what-is-germanys-dual-education-system-and-why-do-other-countries-want-it/a-42902504>

<sup>26</sup> “Robots and Humans in the Loop: Revitalizing Industrial Ecosystems,” by Anna J. Waldman-Brown, PhD dissertation, Massachusetts Institute of Technology, September 2023.

borrowers must export during the term of the loan, which is too short a horizon for rebuilding a manufacturing base that was neglected for decades; managing the bank's loan portfolio as a portfolio rather than requiring each individual loan to carry low risk; measuring job quality, not merely job quantity, in program performance metrics (for example, counting only jobs that pay above 125 percent of the county median wage); and expanding the bank's target industries to include energy infrastructure and grid modernization.

As mentioned above, issues of capital access are significantly eased by more certain demand. Some ideas to do this:

- A program that offered grants to a lead firm and its suppliers applying together for funding (to be matched by the larger firm) would provide several benefits. The large firm's support would demonstrate that it is committed to these suppliers and believes these suppliers are viable and strategic. It would also ease a key problem that small firms face: providing them with crucial demand-side certainty greatly reduces the danger they face in making investments in new products or processes since they don't have the profits to place bets that might go bad. This arrangement would also reduce the government's vetting costs of small suppliers, since the large firm would have already done some vetting and would be sharing the risk. Ontario, Canada has a program that is a bit like this (though it is more aimed at startups than established small- and medium-sized enterprises).
- The AM Forward initiative, developed during the Biden Administration, addressed several interrelated market failures at once — lack of capital, inadequate information about new technology, and insufficient customer commitment — by building on supply-chain relationships between large manufacturers and their smaller suppliers.<sup>27</sup> The core insight was that a large firm's co-investment and endorsement of a small supplier's technology adoption

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<sup>27</sup> Council of Economic Advisers, The White House. "Using Additive Manufacturing to Improve Supply Chain Resilience and Bolster Small and Mid-Size Firms." May 9, 2022.

Available at: <https://bidenwhitehouse.archives.gov/cea/written-materials/2022/05/09/using-additive-manufacturing-to-improve-supply-chain-resilience-and-bolster-small-and-mid-size-firms/> See also AM Forward program page: [astroa.org/project/am-forward](https://astroa.org/project/am-forward).

provides information and demand-side certainty that government alone cannot replicate. Programs modeled on this approach — should be extended to robotics.<sup>28</sup>

- Government procurement — including advance market commitments for domestically manufactured robotic systems — can provide the demand certainty that allows domestic manufacturers to invest confidently in capacity.<sup>29</sup> Procurement standards that incorporate job quality conditions — requiring that firms receiving federal contracts meet wage, benefits, safety, and worker voice standards — can create market incentives for high-road strategies that individual firms cannot sustain on their own against competitors who externalize those costs.

The government has promoted purchase of advanced equipment by its suppliers. For example, the Department of War’s Industrial Base Analysis and Sustainment program (IBAS) uses mechanisms such as Other Transaction Agreements (OTAs) (e.g., the Cornerstone OTA) and the Defense Production Act (DPA) Title III to incentivize contractors to acquire capital equipment and modernize manufacturing.

On tariffs: robotics adoption by domestic manufacturers in the near term depends partly on affordable access to robotic equipment, much of which is currently imported. Tariffs that significantly raise the cost of robots could slow adoption by the very small manufacturers we are trying to support, even as those tariffs are intended to build a domestic robotics industry. A thoughtful approach would phase in requirements for domestic content over time — clearly signaling the long-run policy direction while giving manufacturers sufficient runway to build U.S. supply chains. Tariffs could be higher on nations such as China that pose issues of national security and offer large subsidies to their manufacturers. However, such tariffs would significantly disadvantage U.S. manufacturers who import significant amounts of Chinese equipment.

A tariff on imports from China on a narrow definition of robots could potentially slow the application of the Chinese playbook of developing industry dominance through massive subsidies, without increasing costs too much for U.S. robot adopters. According to the International Trade

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<sup>28</sup> Department of Defense, Office of Acquisition & Sustainment <https://www.acq.osd.mil/#:~:text=Since%20mid%2D2023%2C%20the%20Department%20of%20Defense%20has,other%20supply%20chains%20key%20to%20national%20defense>

<sup>29</sup> The White House. “Building Resilient Supply Chains.” Economic Report of the President, April 2022, Chapter 6. <https://bidenwhitehouse.archives.gov/wp-content/uploads/2022/04/ERP-2022.pdf>

Commission in 2024 almost 65% of robotics imports came from Japan, Germany, and South Korea; Mexico contributes another 5.6%. Imports from China are only 4.2% of total robotics imports, or \$29.7million.<sup>30</sup> However, much study should go into the timing, phase-in and phase-out, and HST definition of tariffs, because some industries depend heavily in imports from China of certain types of machinery.

#### **4. Policy coordination**

The market failures impeding the production and adoption of robots in the U.S. are multifaceted and intertwined. Thus, they would benefit greatly from the creation of an expert body such as the proposed National Commission on Robotics,<sup>31</sup> that could carefully design a set of synergistic policies ideally aimed at both the manufacturing and adoption of leading-edge robotics in the United States in a way that improves both job quality and U.S. competitiveness.

## **CONCLUSION**

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The hearing this Subcommittee has convened asks whether the United States can lead in robotics and advanced manufacturing. My answer is yes — but only if we are as deliberate and as strategic as our competitors. China’s robotics strategy did not succeed by accident; it succeeded because it combined capital, demand, workforce development, and coordination among firms in a coherent framework. The United States has the research institutions, the innovative firms, and the workforce potential to compete. What we have lacked is comparable coherence and commitment.

The policies I have described above — building a community of practice, creating joint grant programs that align lead firms and their suppliers, redesigning jobs and workflows to promote organizational transformation, reforming EX-IM to better serve domestic manufacturers, attaching

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<sup>30</sup> Public Comment by the National Association of Manufacturers on Section 232 National Security Investigation of Imports of Robotics and Industrial Machinery

[https://nam.org/wp-content/uploads/securepdfs/2025/10/NAM-Section-232-Robotics-and-Industrial-Machinery-Submission\\_-Final\\_Final\\_October-17-2025.pdf](https://nam.org/wp-content/uploads/securepdfs/2025/10/NAM-Section-232-Robotics-and-Industrial-Machinery-Submission_-Final_Final_October-17-2025.pdf)

Atkinson, Robert D., Meghan Ostertag and Trelysa Long “A Time to Act: Policies to Strengthen the US Robotics Industry.” Information Technology & Innovation Foundation, July 18, 2025.

<https://itif.org/publications/2025/07/18/time-to-act-policies-to-strengthen-us-robotics-industry/>

<sup>31</sup> “National Commission on Robotics Act.” HR7334.

<https://www.congress.gov/bill/119th-congress/house-bill/7334/text>

job quality conditions to public support, and using procurement strategically to create demand certainty — are not novel. What is needed is the political will to pursue them together, at the scale and with the sustained commitment that the competitive stakes require.

I welcome the Subcommittee's questions and thank you for your interest.