The First Signpost on the Road from Early Adoption to Widespread Application of Industry 4.0 Technologies

2021 Industry 4.0 Technology Adoption Survey Report

IUPUI KELLEY SCHOOL OF BUSINESS

CONEXUS INDIANA

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Executive Summary

The advanced manufacturing and logistics (AML) industries are the backbone of Indiana's economy, employing more than 500,000 Hoosiers and contributing more than any other industry sector to Indiana's gross state product. We make and move products that fuel the global economy—from automobiles, to jet engines, medical devices and medicines.

The global advanced manufacturing and logistics industry sectors, however, are at a crossroads—challenged to adopt smart technologies, automation and data analytics to increase competitiveness, productivity and profitability. How Indiana's advanced manufacturers and logistics companies respond to the advent of Industry 4.0 impacts every aspect of the Hoosier economy as well as the global economy.

It's against this backdrop that Conexus Indiana and the Indiana University Kelley School of Business Center for Excellence in Manufacturing launched an annual survey of Indiana manufacturers to measure Indiana's progress toward Industry 4.0 adoption. Our first study, "Charting Indiana's Path from Early Adoption to Widespread Application of Industry 4.0 Technologies," was published in 2020. "The First Signpost on the Road from Early Adoption to Widespread Application of Industry 4.0 Technologies" is our second report, the findings of which clearly show progress and momentum.

Key 2021 report findings:

- Indiana companies are increasing implementations of Industry 4.0 technologies. In 2020, about 20% of respondents had successfully implemented or piloted an Industry 4.0 technology. The figure more than doubled this year with 43% of companies having successfully implemented or piloted an Industry 4.0 technology.

- More companies are dedicating resources to Industry 4.0 technology adoption at a strategic/company-wide level. The number of companies with technology adoption budgets rose from 16% to 29% year-over-year, and those with strategic roadmaps for technology adoption rose from 12% to 23%, nearly doubling in both cases.

- Additive manufacturing, collaborative robots (cobots) and machine vision are making big moves on the adoption curve. Both large and small companies are reporting rapid adoption of these Industry 4.0 technologies, and their benefits are becoming increasingly apparent.

- Budget restriction is no longer the standout obstacle to technology adoption. And there is hope that budget restriction will continue to fall with the expansion of Indiana's Manufacturing Readiness Grants program in 2021. Within the survey population, several of the companies received matching grant funding to execute a technology adoption project and credited the grant with either enabling (34%), accelerating (26%) or expanding the scope (34%) of the project.

- Big data and analytics, augmented/virtual reality, artificial intelligence (AI) and machine learning (ML) are still emerging, but are expected to be implemented in the next 5 years.

- Most Hoosier manufacturers (68%) are collecting some data, but nearly two-thirds (65%) reported only a 'basic' data infrastructure with manufacturing data available to a limited number of personnel or departments. In other words, companies are collecting manufacturing data but are not yet capturing its full value.

- Hoosier companies are preparing for digital plant initiatives and agile manufacturing capabilities. Machine vision, big data and analytics, additive manufacturing, sensor technology, Internet of Things (IoT) and cobots round out the top six technologies expected to be implemented in the next 5 years.

- Enhancing/optimizing productivity is still the top strategic objective and key driver of Industry 4.0 technology investments at Hoosier companies.

Introduction

Indiana's advanced manufacturing and logistics (AML) industries are strong and resilient and have earned their position as the Hoosier state's leading employers, contributing more than any other sector to Indiana's gross state product. This strength and resilience evolved over time.

The first industrial revolution introduced water and steam power in the late 1800s. Industry 2.0 saw electricity drive development of sophisticated machines to improve mass production. The early stages of automation defined Industry 3.0. These eras have enabled Indiana's AML sectors to continuously reinvent themselves, forming the basis of today's digital transformation known as the Fourth Industrial Revolution (Industry 4.0).

In the first quarter of 2020, Conexus Indiana and the Indiana University Kelley School of Business Center for Excellence in Manufacturing conducted a survey to measure Indiana industries' readiness and early adoption of Industry 4.0 technologies. Charting the positions of Indiana companies on the technology adoption curve was a first and important step in developing strategies to support successful journeys into Industry 4.0. Key findings were published in the report "Charting Indiana's Path from Early Adoption to Widespread Application of Industry 4.0 Technologies" and showed that Hoosier firms were in various stages of technology adoption. Specifically, the report revealed that relatively few companies had either a strategic roadmap (12%) or a technology adoption budget (16%) for Industry 4.0. Among the companies with either a roadmap or a budget, most were larger, established companies. Obstacles to Industry 4.0 adoption included budget restrictions, lack of internal skill and integration challenges with legacy systems.

Industry 4.0 = The Intersection of Manufacturing and Digital Transformation

Indiana AML industries are firmly established in Industry 3.0, which can be characterized as using information and computer technologies to automate processes. Today, many companies automate processes, but the machines they use for automation (such as CNC machines) require a great deal of human interaction and are used primarily for increased capacity and product quality.

Industry 4.0, sometimes referred to as Smart Manufacturing, further integrates digital technologies, such as the Internet of Things (IoT), cloud computing and analytics, and artificial intelligence and machine learning, into company-wide operations and manufacturing processes. Outcomes of Smart Manufacturing are potentially increased production and flexibility/agility, real-time visibility into equipment performance and responsiveness to customer demand. Smart Manufacturing also leverages data to a significant degree for outcomes like predictive maintenance, self-optimization of process improvements and increased production efficiencies. In short, companies aligned with Industry 4.0 are highly connected, digitized, agile and more autonomous than those entrenched in Industry 3.0.

In early 2021, Conexus and the Indiana University Kelley School of Business Center of Excellence in Manufacturing conducted a follow-up survey to measure progress toward Industry 4.0 adoption. The results of our 2021 study show that an increasing number of companies perceive Industry 4.0 as either a positive investment for growth, a necessity to remain competitive or both. Indeed, 50% indicated that Industry 4.0 was either a necessity or a positive investment; a significant increase from last year's 34%. The needle has moved on the perception of Industry 4.0 value, with resources increasingly being allocated in that direction.

The headline finding from the 2020 report was that only 16% of companies had a budget for technology adoption, with budgetary restrictions by far the biggest obstacle inhibiting progress. This year, 29% of companies have a budget for technology adoption, nearly double the percentage for 2020. And while budget restrictions remain a top obstacle in 2021, our study indicates that it is no longer an insurmountable obstacle for most manufacturers.

Among the broad set of technologies commonly associated with Industry 4.0, there are several more widely adopted than others. Results in 2021 indicate that manufacturers are more likely to embrace and implement technologies such as additive manufacturing, sensor technologies, machine vision and cobots. What these technologies have in common is that they are rapidly maturing, widely understood, have relatively minimal barriers to implementation, and most importantly, directly impact production capability, capacity, quality and speed in ways that augment a tight labor supply.

Some of the technologies that are less commonly implemented (or even expected within the next 5 years) include: blockchain, big data and analytics, augmented/virtual reality, artificial intelligence and machine learning. Perhaps these are perceived as still emerging and/or less directly engaged with the physical processes and tasks of production. More likely, there are larger barriers to implementation as these technologies often require broad infrastructure or systems-wide integration. Nearly two-thirds (65%) of companies reported just 'basic' data infrastructure with manufacturing data only available to a limited number of personnel or departments. Investment in digital infrastructure is often a prerequisite for data intensive applications, which may be hindering widespread adoption of certain technologies.

There is much room for optimism as it is clear Hoosier companies are continuing to make progress in their respective digital journeys in the Fourth Industrial Revolution. They are starting to aggressively lean into technologies that directly impact targeted areas of production. But digital solutions that fully integrate and optimize processes across company-wide operations remain a few years away as companies lay the foundations for implementation.

Study Methodology and Demographics

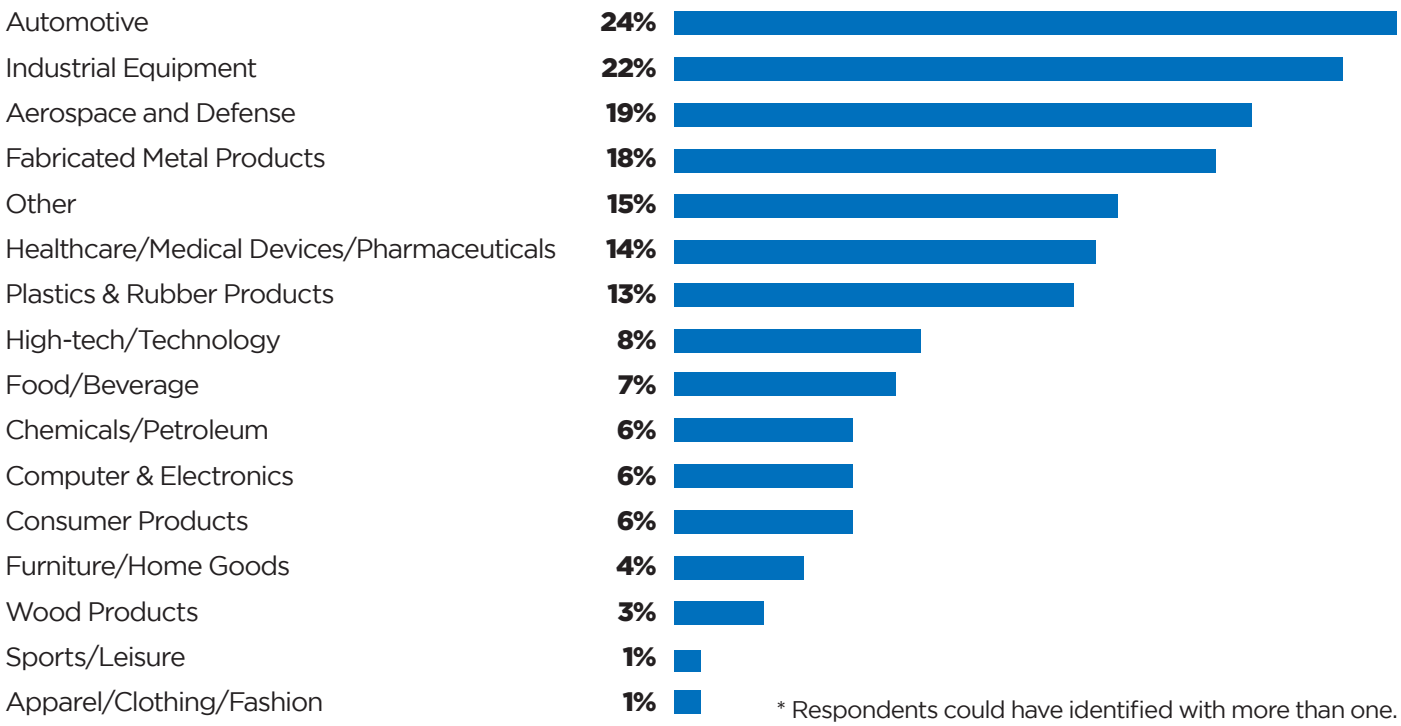
Indiana is home to AML industries that are consistently strong in manufacturing employment and output. Accounting for more than $100 billion of Indiana's economy, Indiana manufacturers employ 17% of the Hoosier workforce–the largest share of any industry sector. Employees of Indiana's manufacturing industry earn an average annual compensation of more than $79,000.[1]

The largest of Indiana's manufacturing firms (those with 5,000 or more workers) employ 35% of manufacturing workers and contribute 41% of payroll. Manufacturers that employ fewer than 5,000 employees make up more than 64% of the workforce and contribute nearly 60% of payroll. Together they manufacture a diverse range of products, including automobiles and automotive parts, chemical products, medical devices and pharmaceuticals, aerospace and defense equipment, industrial goods and many more.

Conexus Indiana engaged with nearly 200 companies, mostly manufacturers, as part of its 2021 survey, with 135 of those companies completing the survey (compared to 110 complete responses in 2020). Participants were from a wide cross section of businesses throughout the state, including more than a dozen different manufacturing sectors highlighted in **Figure 1**.

Small, medium and large enterprises—as determined by both revenue and number of employees—were all well represented in the responses. Most responses were from well-established organizations with a long track record of operation, which represents the mature businesses that have traditionally been the core of Indiana's manufacturing economy. Small to medium enterprises made up most of the sample population (54% of respondents have revenues of $0-$50 million and 81% have 1-999 employees). (See **Figures 2, 3 & 4**)

FIGURE 1 INDUSTRY SECTOR MIX



* Respondents could have identified with more than one.

[1] "2021 Indiana Manufacturing Facts." Accessed August 24, 2021. https://www.nam.org/state-manufacturing-data/2021-indiana-manufacturing-facts.

FIGURE 2 ANNUAL REVENUE

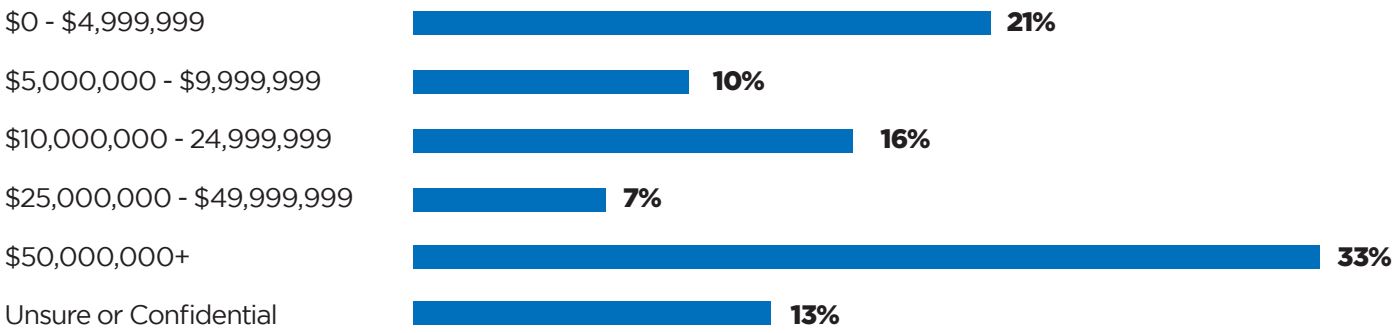
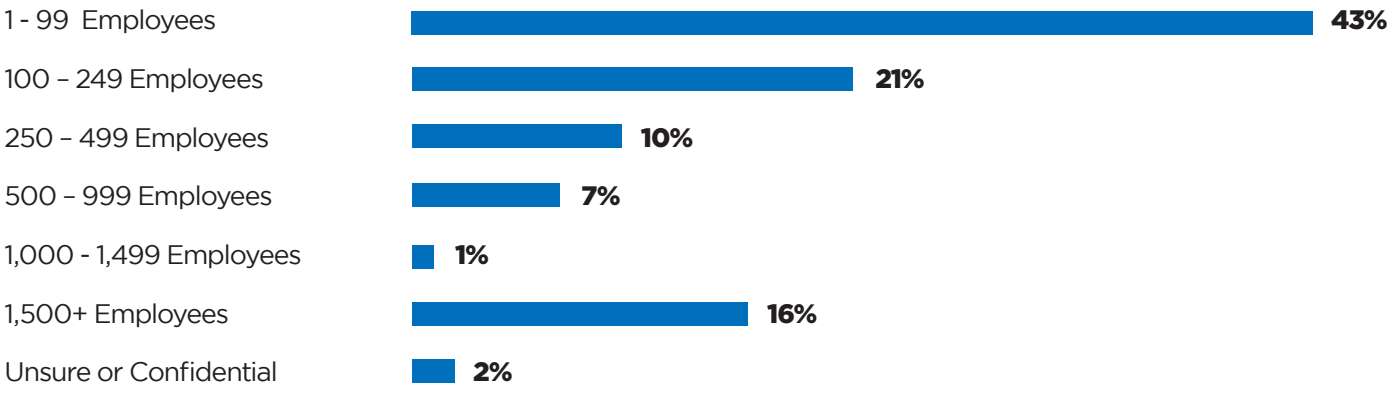


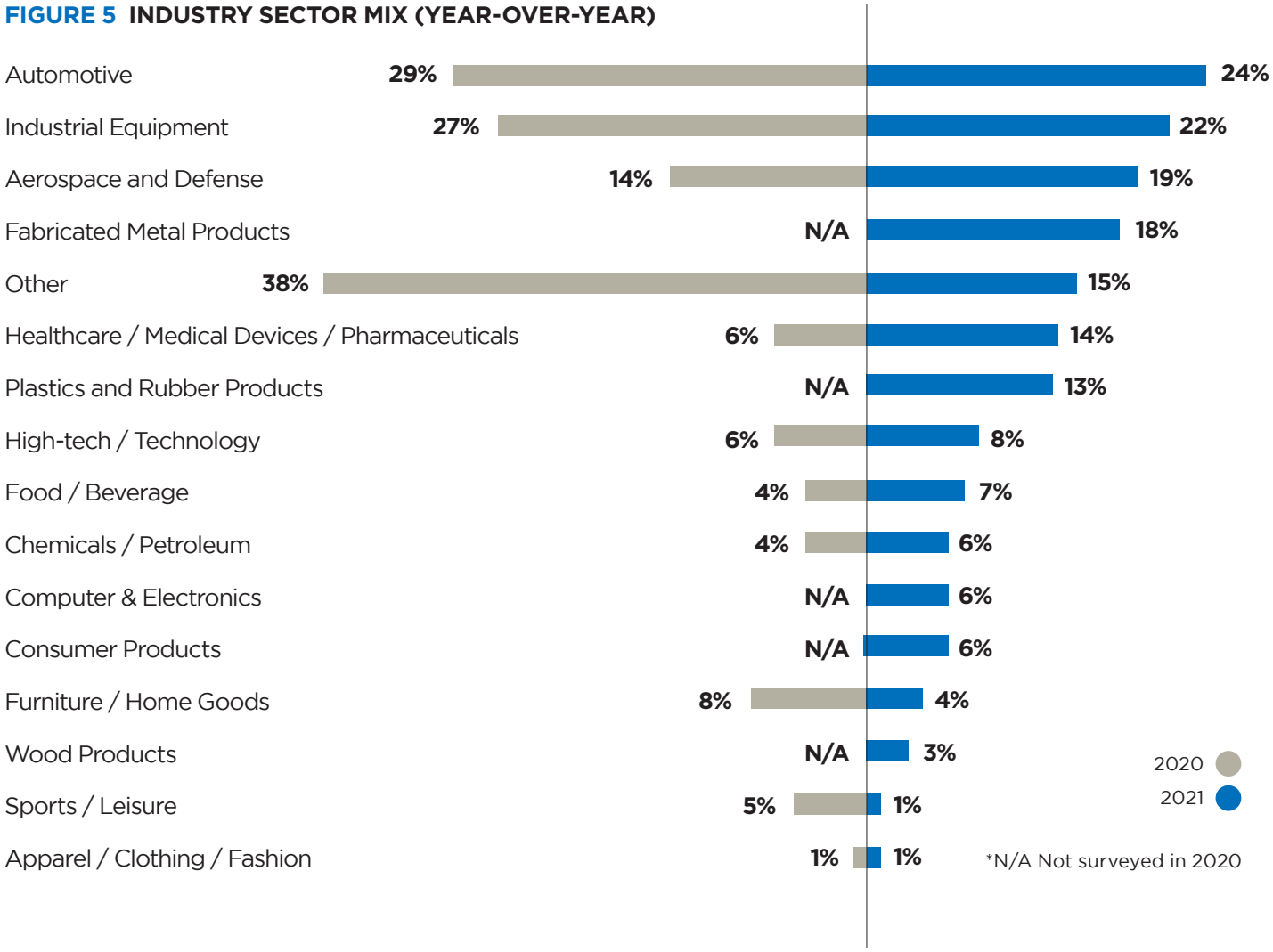
FIGURE 3 YEARS IN BUSINESS

FIGURE 4 NUMBER OF EMPLOYEES



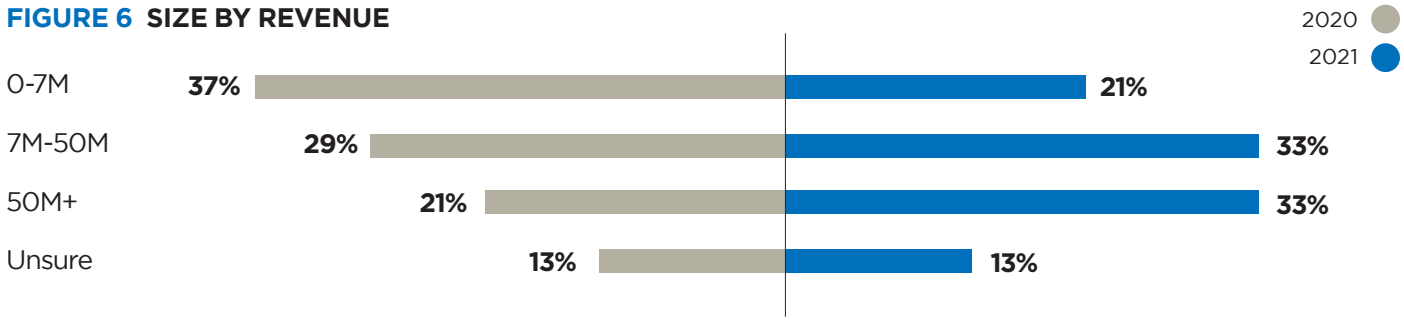
Comparing participants in the 2020 study with those in 2021, both included more than a dozen different sectors and participants from a wide cross section of manufacturing throughout the state. As in 2020, Automotive, Industrial Equipment and Aerospace and Defense comprised the top three sectors in 2021. It is worth noting that the percentage of companies identifying with the "Other" category decreased from 38% in 2020 to 15% in 2021 as the number of categories was expanded in 2021 to better illustrate the diversity of sectors served by Indiana's manufacturers. (Figure 5)

FIGURE 5 INDUSTRY SECTOR MIX (YEAR-OVER-YEAR)



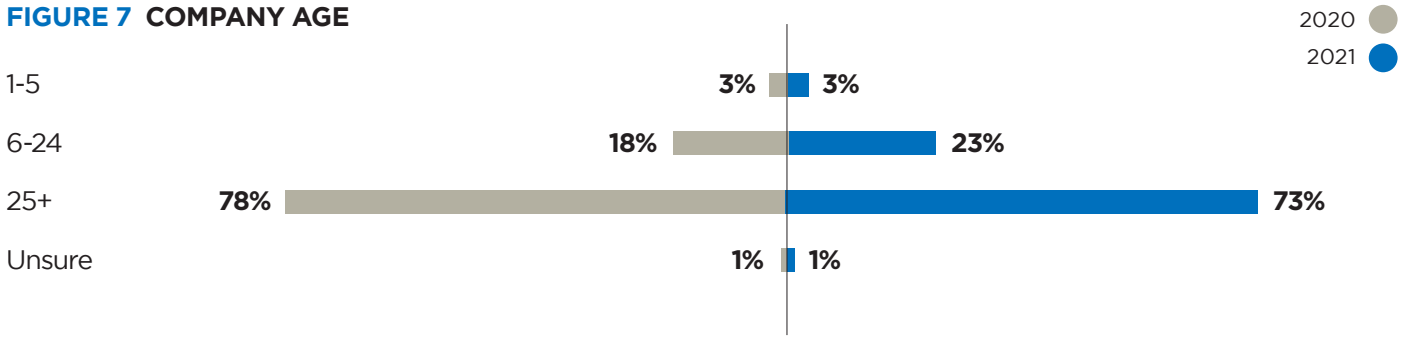
Like 2020, the 2021 study contained a mix of small, medium and large companies as measured by revenue. However, in 2021 fewer small companies and more large companies participated. While it is unclear why this mix changed, it is worth noting that the 2021 results may be slightly skewed toward the perspectives of large manufacturers. Despite this increase in large company participation, small to medium enterprises still made up most of the sample population (54% of respondents have revenues of $0-$50 million). (Figure 6)

FIGURE 6 SIZE BY REVENUE



The maturity of Indiana's manufacturing base in terms of company age continues to be apparent in 2021 just as it was in 2020. About three-quarters of manufacturers have at least a 25-year history, and some are much older. Almost a quarter are in the 6- to 25-year range. At the other end of the spectrum, very few manufacturers younger than 5 years participated in this year's study. (Figure 7)

FIGURE 7 COMPANY AGE



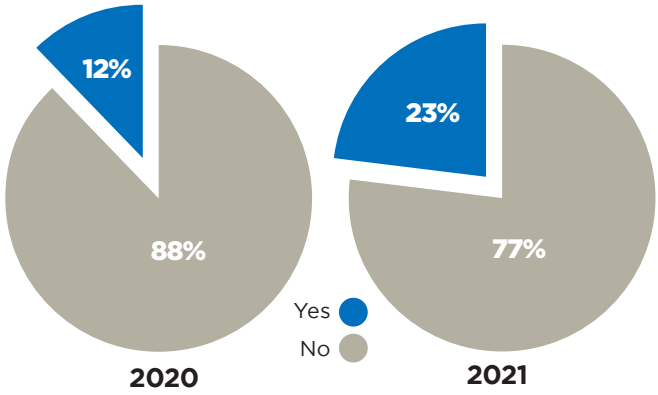
Budgets and Strategic Roadmaps

The 2020 report noted that manufacturers have unique strategies for the markets in which they sell their products and therefore there is no universal approach to adopting new technologies. Companies adopt technologies at various points throughout the evolution of their business.

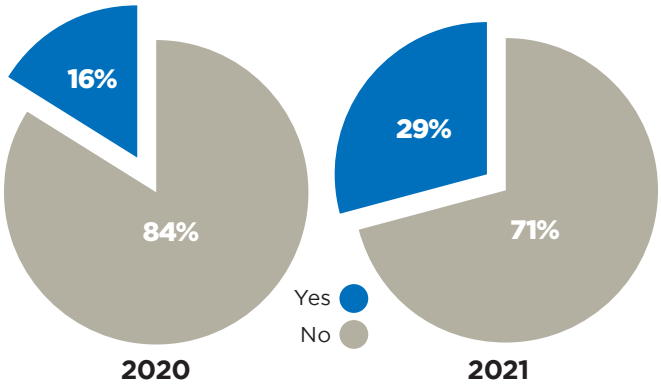
Companies were asked whether they had a strategic roadmap and/or a budget for technology adoption in both 2020 and 2021. The needles moved significantly, almost doubling over the prior year, for both dedicated budgets and strategic roadmaps. The number of respondents who said they had a budget for technology adoption rose from 16% last year to 29% this year (Figure 8). Survey respondents who said they had a strategic roadmap for technology adoption rose from 12% to 23%. (Figure 9)

This suggests that technology adoption, or plans for adoption, accelerated considerably in the last year, albeit from a slow start. And it's remarkable that this has occurred during a global COVID-19 pandemic. One reason could be that manufacturers increasingly recognize the need for Industry 4.0 investments despite the pandemic. Another reason could be that companies have progressively turned to technology while wrestling to maintain production and meet demand amid labor shortages and cumbersome pandemic protocols.

COMPANIES WITH A STRATEGIC ROADMAP



COMPANIES WITH A TECH ADOPTION BUDGET



Adoption by Company Revenue and Age:

Large companies are allocating budgets and developing roadmaps at a greater rate than small- and medium-sized companies. (Figures 10 and 11) Legacy companies, those in business for 50 years or longer, also are most likely to have roadmaps and budgets for technology adoption. (Figures 12 and 13)

FIGURE 10 DEDICATED BUDGET FOR TECH ADOPTION - BY REVENUE

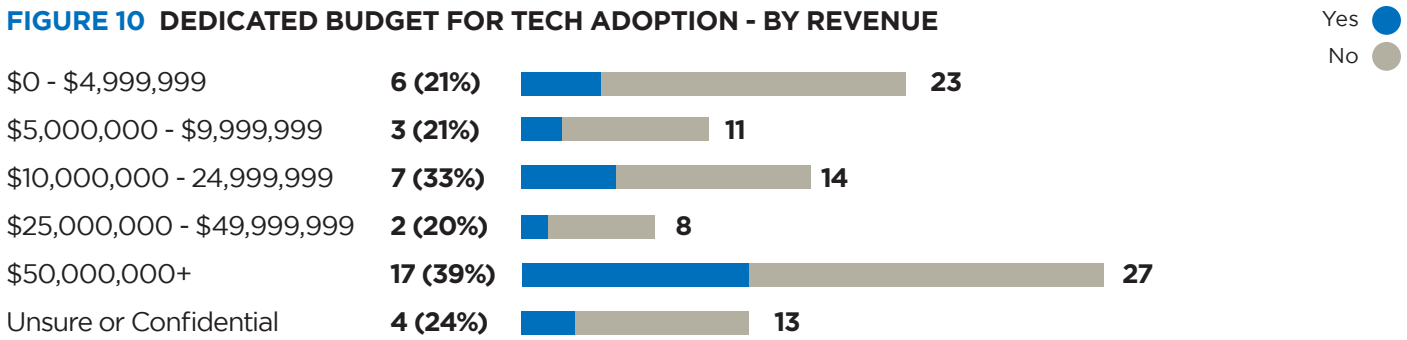


FIGURE 11 DEVELOPED A STRATEGIC ROADMAP – BY REVENUE

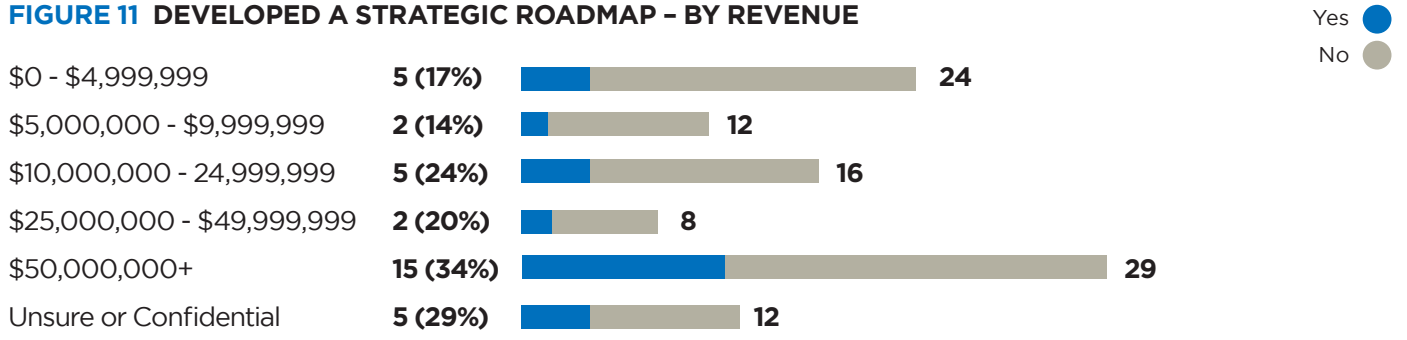


FIGURE 12 DEDICATED BUDGET FOR TECH ADOPTION - BY AGE

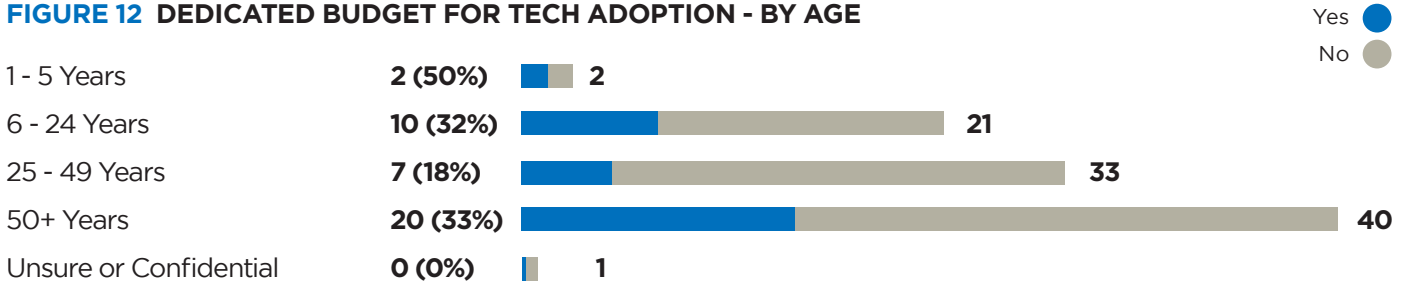
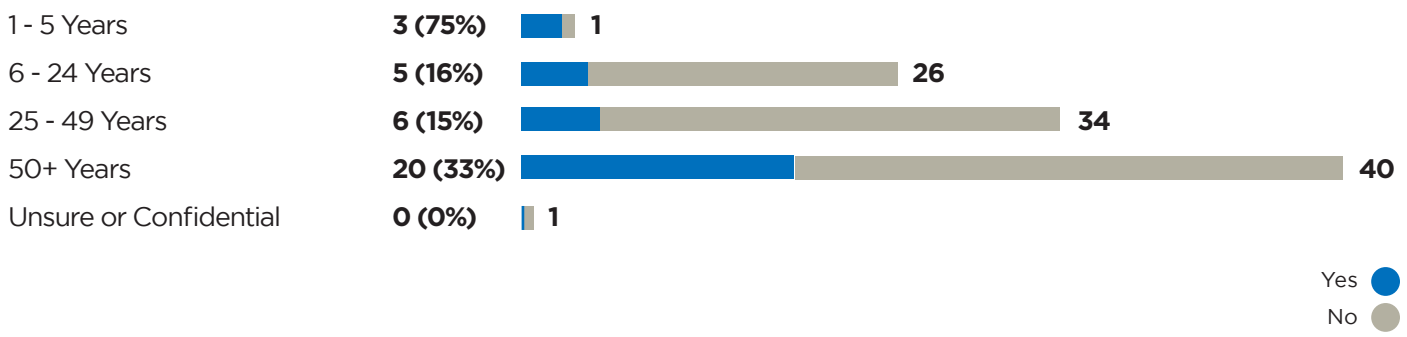


FIGURE 13 DEVELOPED A STRATEGIC ROADMAP – BY AGE



Adoption by Sector:

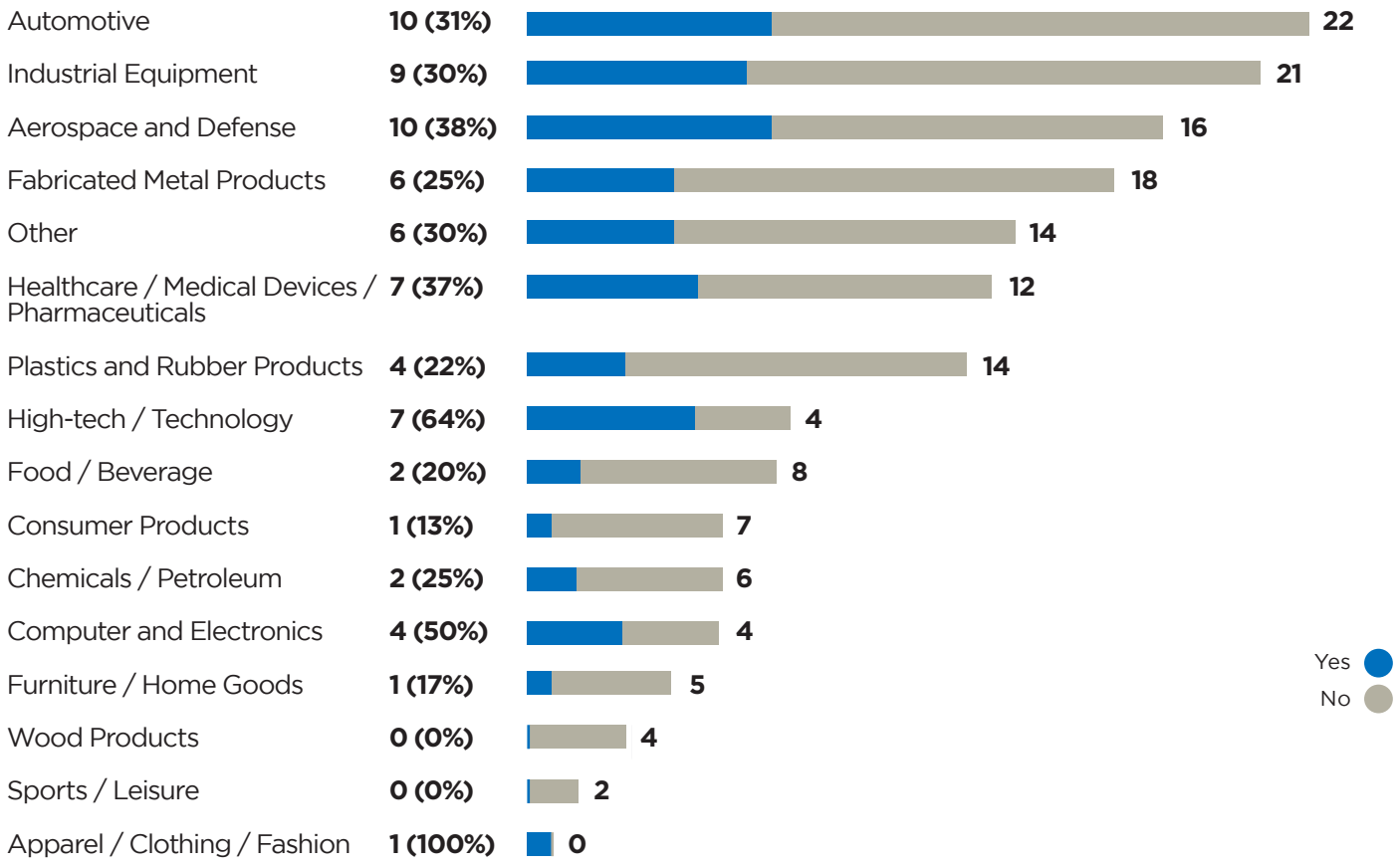
Manufacturers in the Aerospace and Defense, Automotive and Industrial Equipment sectors are likely to have a budget and a roadmap for technology adoption. (Figures 14 and 15) This was the case in 2020, as well.

The more general category of Fabricated Metal Products (new for 2021) also has a significant percentage of manufacturers with budgets and roadmaps. This is possibly driven by the advent of newer generations of robotic welding and sophisticated cutting platforms, such as fiber lasers with rich technology features, that smaller manufacturing shops serving diverse and niche industries are adopting. These shops are experiencing either, and sometimes both, the constraints of

Lamar Schlabach, General Manager, Jomar Machining

"For one thing, it's the amount of welding we do on a [grinding] blade. It's pretty hard on a worker to do that... the blade is, you know, 550 degrees... nobody wanted to do that kind of welding under such heat... So that was one reason for the robotic welding. And then the second [reason] is that we couldn't find help to go around the clock. So, we chose to go with lights out manufacturing where we can load the robot up, and it runs itself. It's actually a dual robot, there's a robot that handles the part and then there's a robot that welds the part. We can actually go completely lights out without any human interaction."

FIGURE 14 DEDICATED BUDGET BY INDUSTRY SECTOR



tight labor supply for welders or new market opportunities in areas like electrification that require advanced fabrication techniques. They are becoming increasingly interested in, planning for, and making investments in these new technology platforms.

Companies identifying with the high-tech/ technology sector or healthcare / medical devices / pharmaceuticals have the highest percentage of roadmaps and budgets; in fact, very few had neither budget nor a roadmap. It's not surprising that companies routinely involved in new product technology also tend to plan for new process technologies as well as resource their plans with appropriate budgets. It suggests that perhaps progress

Jack Anderson, Engineering Manager, PWR North America

"The project of manufacturing cold plates for cooling power electronics here in Indy started with a capability that we had in an Australian facility with a fiber laser cutter, as well as the increasing need of customers here in North America. They are increasingly acquiring more and more cold plates for batteries and power electronics and autonomous vehicles. We knew that a fiber laser cutter with our proprietary machine vision verification system was the way to go. And that's where this technology adoption project started."

FIGURE 15 COMPANIES WITH A STRATEGIC ROADMAP

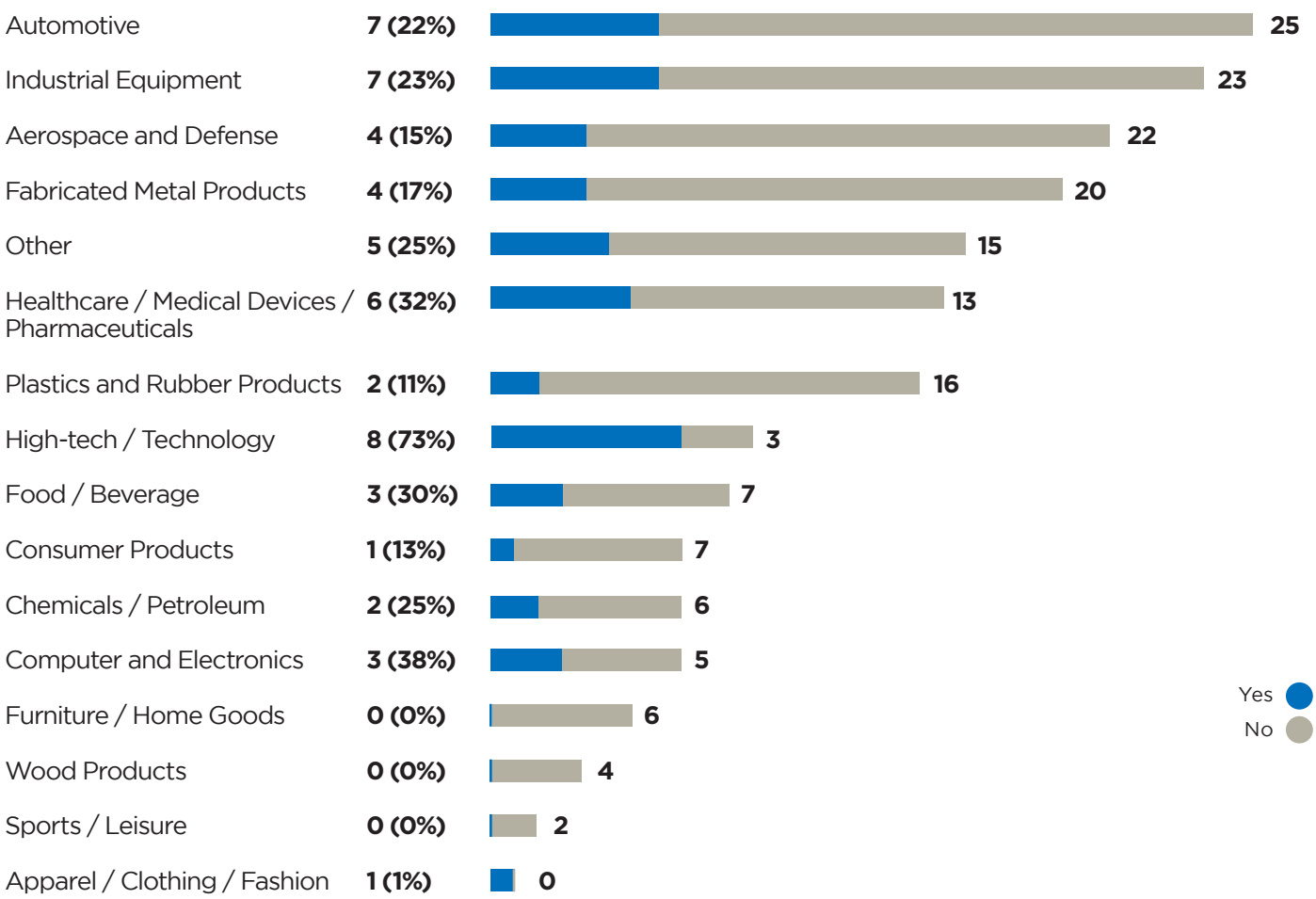


FIGURE 16 PERCENTAGE OF REVENUE ALLOCATED TO THIS BUDGET?

can be made more broadly if manufacturers begin to see themselves as technology-driven regardless of the technology content of the product(s) they produce.

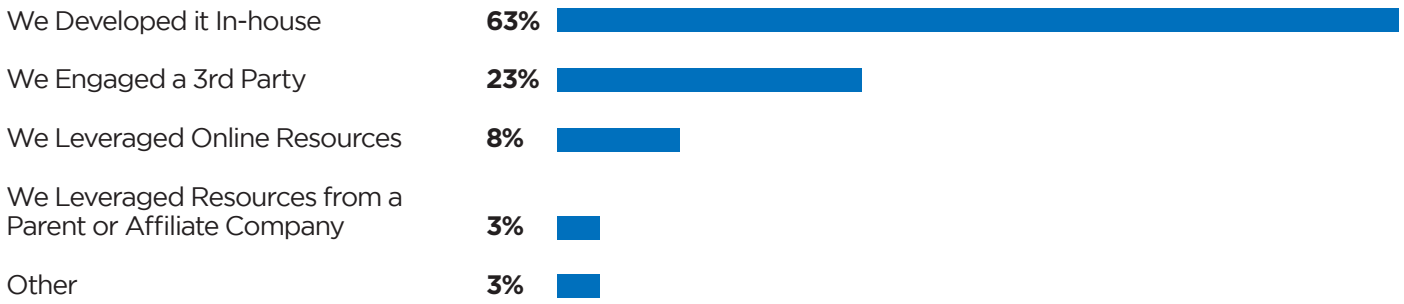
Of those that reported a dedicated budget, about half of those budgets are less than 3 percent of revenue. (Figure 16) Conversely, one-in-ten manufacturers (10%) reported that they budgeted over 5% of revenue for Industry 4.0.

Strategic Roadmap Development

How do companies go about building a strategic roadmap? Given this is a relatively new area of strategic planning, best practices for Industry 4.0 technology road mapping are not well defined. Some companies may consider technology adoption as part of overall strategic planning, while others may view it as a stand-alone process. Of the companies that have developed a strategic roadmap, 63% developed it in-house. Another 23% reported developing a roadmap through a third party, such as a consulting company or university partner. (Figure 17) This 'do-it-yourself mindset' comes as no surprise–Indiana's AML sectors are resilient and have already navigated multiple industrial revolutions.

A strategic roadmap for technology adoption is a highly individualized document. Because companies know their business and manufacturing processes best, they are in a far better position than an outsider to know where things should be heading and what the best next step is in terms of technology adoption. In 2021, 23% of companies have a roadmap, and this is an encouraging improvement over 12% in 2020, but it appears many are still adopting technologies without a strategic roadmap. Perhaps the best approach for companies is to develop a roadmap in-house, as it is an intentional, often comprehensive document and companies can leverage a wealth of knowledge from multiple departments, including engineering, IT and manufacturing.

FIGURE 17 HOW DID YOUR COMPANY GET STARTED ON DEVELOPING A STRATEGIC ROADMAP FOR THE ADOPTION OF INDUSTRY 4.0 TECHNOLOGIES?



Of those without a roadmap, it is most common to use an ad-hoc, case-by-case approach as opportunity arises. Others are looking to gain natural synergies between adjacent functions in a piecemeal fashion. And a significant number of companies still afford a great deal of autonomy to each department, which allows them to work independently in terms of optimizing their own processes, perhaps in isolation. (Figure 18)

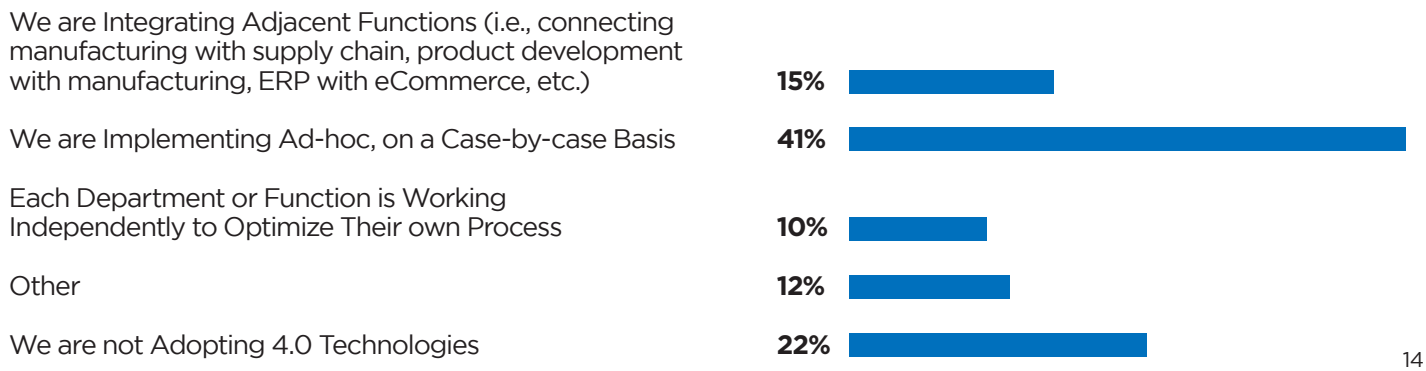
While these three approaches all have short-term advantages, they might prove problematic in the long-term for reasons reminiscent of the "Islands of Automation" trap well-known in the last cycle of Industry 3.0.

Defined: "Islands of Automation"

The term "Islands of Automation" was widely discussed in the 1980s and 1990s as rapidly developing automation systems struggled to communicate and easily integrate with each other.* This was largely for reasons due to technical protocols. Analogous challenges are becoming apparent today as standards are still evolving in areas such as additive manufacturing, IIoT and other emerging technologies. If companies make deployment decisions in functional, departmental and shopfloor silos, as they did in Industry 3.0, they risk endangering success by missing out on connectivity with the larger company and the ability to work together; ironic, given a fundamental tenent of Industry 4.0 is its promise for large-scale machine-to-machine communication and company-wide insight.

**(Giffi, Roth & Seal. Competing in World Class Manufacturing: America's 21st Century Challenge. Irwin Professional (December 1, 1990).*

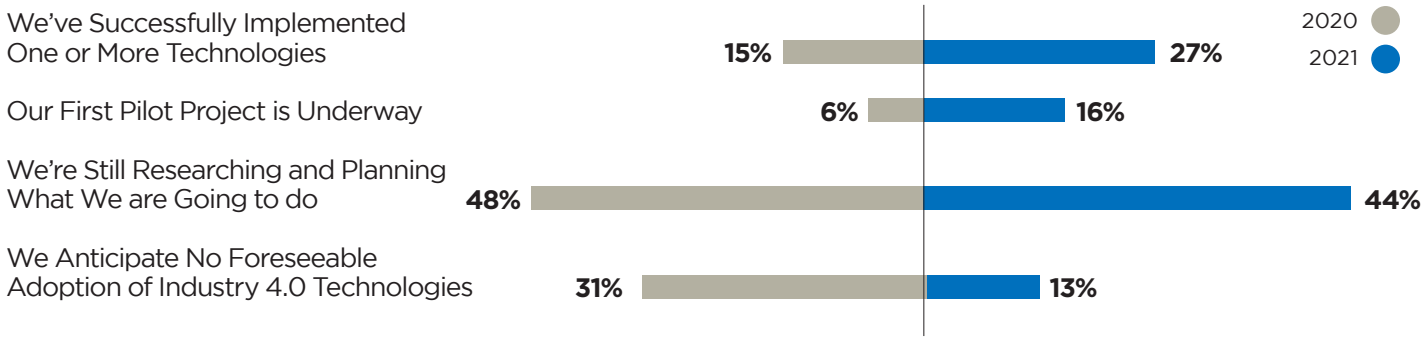
FIGURE 18 TECH ADOPTION APPROACH WITHOUT A ROADMAP



Technologies that Lead and Technologies that Lag

In 2021, Hoosier companies seem well on their way into the Fourth Industrial Revolution. This contrasts with last year when widespread adoption had yet to take root. In 2020's "Charting Indiana's Path from Early Adoption to Widespread Application of Industry 4.0 Technologies," technology adoption was substantially contained to larger companies, and even those companies were mostly in the very early stages. About 20% of respondents in 2020 had successfully implemented or piloted an Industry 4.0 technology. The figure more than doubled this year with 43% of companies having successfully implemented or piloted an Industry 4.0 technology. And the percentage indicating that they anticipate no foreseeable adoption of Industry 4.0 technology declined significantly from 31% to 13%. (Figure 19)

FIGURE 19 LEVEL OF INTEREST IN ADOPTING INDUSTRY 4.0 TECHNOLOGY



However, manufacturers still are not adopting a full suite of Industry 4.0 technologies. Each technology appears to be on its own timetable; some being aggressively adopted, others yet to experience significant uptake, and a mix in between. Further, even among technologies with significant adoption, manufacturers are not universally perceiving them as beneficial. In fact, manufacturers' perceptions of Industry 4.0 technology benefits often lag early in the implementation phase. Pioneering adopters sometimes struggle to optimize the business use cases and identify best practices to maximize the performance of a new technology deployment. (Figures 20 and 21)

IMPLEMENTED AND BENEFICIAL INDUSTRY 4.0 TECHNOLOGIES

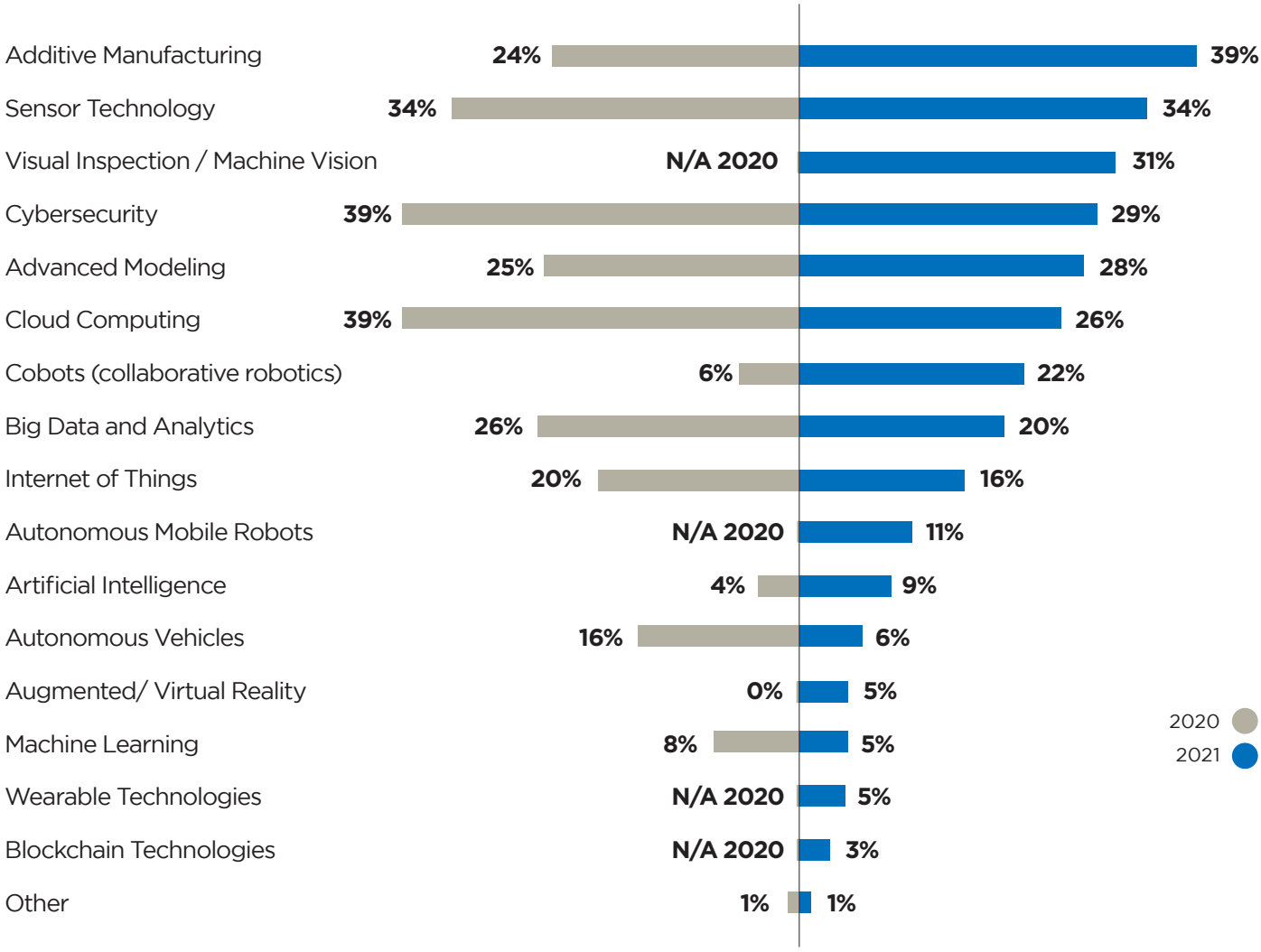
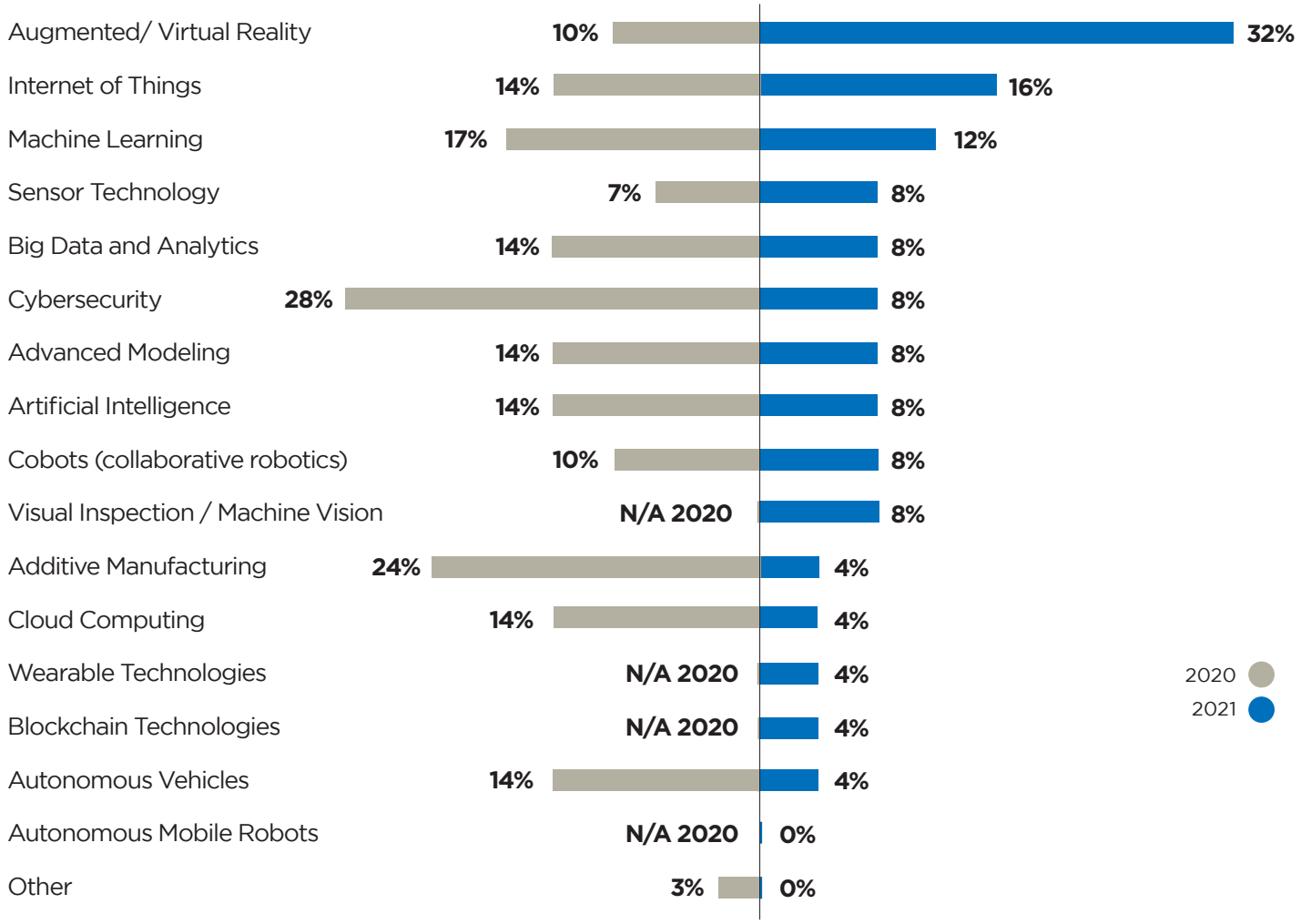


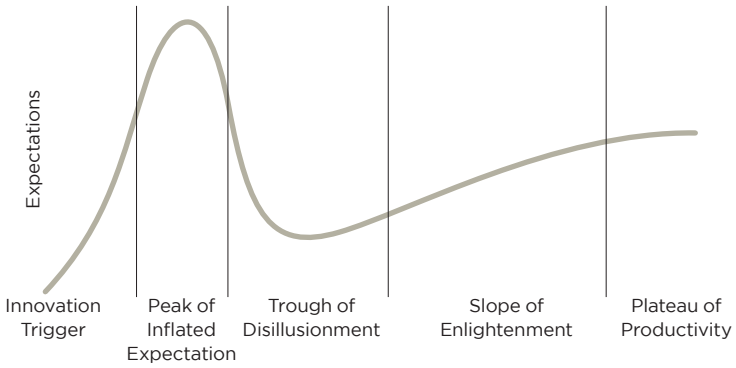
FIGURE 21 IMPLEMENTED BUT NOT BENEFICIAL INDUSTRY 4.0 TECHNOLOGIES



This lag between the point of adoption and realized benefits is often a natural part of the emerging technology cycle and can be further complicated by disparities between speculative hype and shopfloor realities. Several frameworks exist to describe the process of emerging technology adoption– and one of the more popularized frameworks is the "Gartner Hype Cycle."[2] (Figure 22)

Emerging technologies flow through 5 'stages' according to the Gartner Hype Cycle: the Innovation Trigger, the Peak of Inflated Expectations, the Trough of Disillusionment, the Slope of Enlightenment and, eventually, the Plateau of Productivity. This year's survey indicates several technologies are on the move in terms of these stages.

FIGURE 22 THE HYPE CYCLE



Additive manufacturing, cobots and machine vision are making big moves on the adoption curve year-over-year with rapid adoption in both large and small companies. And companies are more apt to see their implementations as beneficial. These technologies are more mature as compared

[2] "Understanding Gartner's Hype Cycles" Accessed October 18, 2021. https://www.gartner.com/en/documents/3887767/understanding-gartner-s-hype-cycles

to some other Industry 4.0 technologies, and manufacturers have likely overcome many early adoption hurdles, including cost, talent shortages, integration risk, business use case selection, best practices and necessary training. Many companies now have a strong sense of how to maximize benefit of these technologies, which increases the odds of moving beyond pilot projects and initial deployments into wider adoption.

Leading Tech: Additive Manufacturing

The percentage of companies reporting beneficial implementations of additive manufacturing jumped considerably from 24% in 2020 to 39% in 2021. Additive manufacturing also saw a 6-fold decrease in the number of implementations perceived as not beneficial, from 24% to 4%. This implies that additive manufacturing has perhaps secured its first footholds of value within Hoosier manufacturers and is likely here to stay. (Figure A)

While additive manufacturing is becoming widely established among Hoosier manufacturers, it has yet to gain strong traction in production. Seventy-six percent of companies reported use of additive is still limited to some form of prototyping or customized tooling and fixtures, while only 24% percent said they are using additive manufacturing for either limited or full-scale production. (Figure B)

With additive, there seems to be a progressive march through sophistication of use case. It begins with early-stage prototyping, moves on to fabrication of custom tools and fixtures, gets refined for functional prototypes, and then eventually into production – initially with low volume, niche applications and ultimately into full-scale, high volume production. That progression appears deceptively smooth and linear according to the data in Figure B. However, there are several complexities and multiple stages of process investment, talent development and technology upgrades involved.

FIGURE A ADDITIVE MANUFACTURING (3D PRINTING)

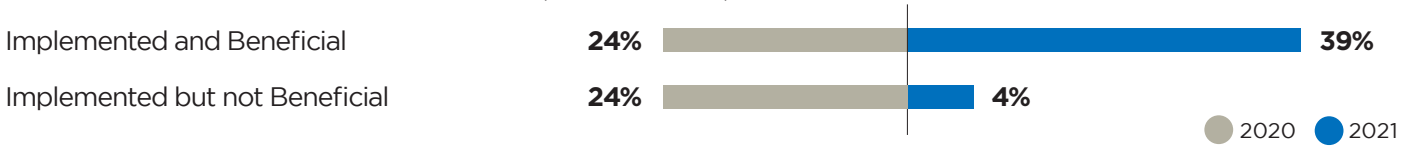
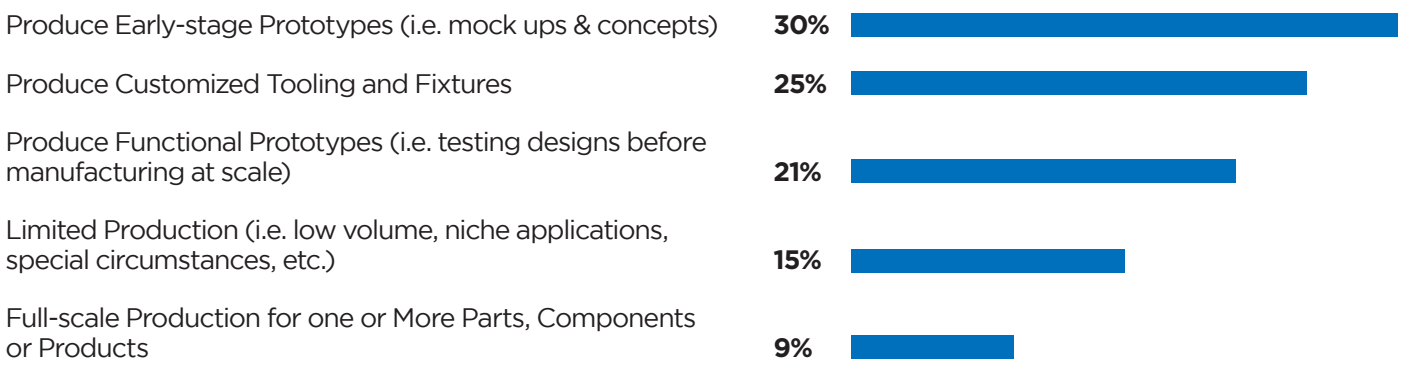


FIGURE B HOW IS YOUR COMPANY USING ADDITIVE MANUFACTURING / 3-D PRINTING?



Take talent for example: The expertise to operate a sophisticated, end-to-end additive process is rarely available on the shopfloor, and hence, building a talent pipeline for additive manufacturing can be especially challenging. The required knowledge can encompass materials science, application engineering, production implementation, maintenance, and IT, and often spans diverse roles such as operators, machinists, technicians, quality, materials handling and environmental, health and safety.

Further, cost structures can be industry-specific and even part-specific. Additive manufacturing may make sense for production of specialized parts in Aerospace where enhanced performance commands a premium and can be achieved by the increased design envelope afforded by additive manufacturing. The same may not be true for high volume components in industries such as Automotive.

Finally, and similarly challenging, the standardization of additive manufacturing remains in the very early stages. No two companies approach additive manufacturing in the same way. This seems to be true for both the firms developing additive systems and for the companies adopting them for use. Best practices are not standardized across the industry—at least not like they are in CNC machining.

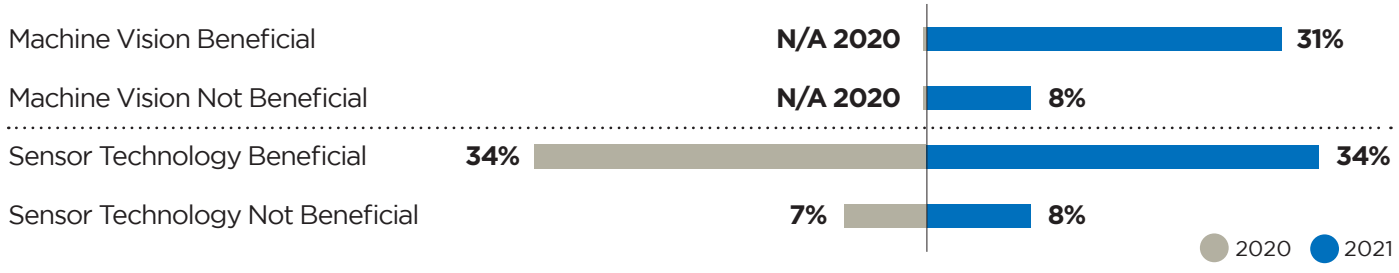
Bill Jarosinski, Director of R&D Materials, Praxair Surface Technologies

"Praxair Surface Technologies' customers in aviation and other industries rely on the multiple benefits of additively-produced parts and tooling. New complex geometries create advantages not available when using traditional machining methods; producing improved quality, performance and cost savings that will become the new industry standards."

Leading Tech: Machine Vision and Advanced Sensors

Machine vision (new category for 2021) and advanced sensors are also common technologies with implementations reported as beneficial 31% and 34%, respectively by respondents. Both were indicated as not beneficial by only 8% of respondents. These technologies have become relatively inexpensive in recent years and easy to integrate with legacy systems. Likewise, both seem to provide immediate value and a clear return on investment (ROI) and can be quickly updated to respond to changing needs on the factory floor. (Figure C)

FIGURE C VISUAL INSPECTION / MACHINE VISION & SENSOR TECHNOLOGY



Leading Tech: Cobots

A similar adoption trend holds true with cobots. Cobot adoption soared from just 6% in 2020 to 22% in 2021 for companies rating the technology as beneficial. And fewer companies indicated cobot implementations as not beneficial (10% down to 8%). Cobot adoption is rapidly advancing in companies of all sizes as even small companies are starting to recognize positive aspects such as ease of programmability and flexibility to redeploy them around the shop floor as needed. They see cobots as not only a way to augment a tight labor supply but also an opportunity to minimize repetitive human motions. (Figure D)

FIGURE D COBOTS (COLLABORATIVE ROBOTICS)

Leah Konrady, CEO, Konrady Plastics

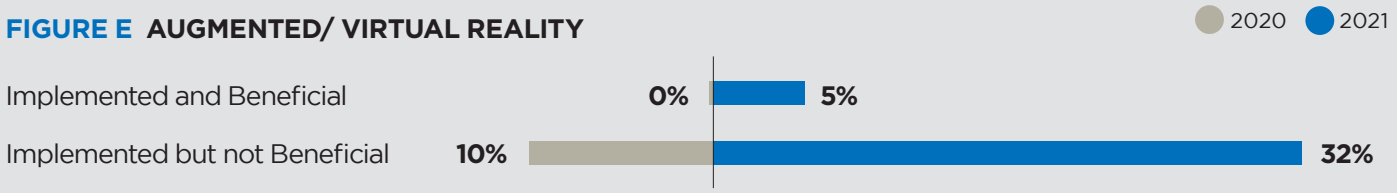
"If you really want to be competitive in the U.S. in manufacturing, you have to be in the business of automation. There's no way around it. Time and time again, I come back to automation. The company culture, in the past, has been focused on buying machines, and now we're moving toward coupling the machines with cobots. Our company culture is shifting to thinking more about automation and its benefits. One of my initial concerns was related to training and thinking it was going to be too difficult for our machinists to learn. Turns out, if you can program a CNC lathe, you can learn to program a cobot. It wasn't nearly as much of a challenge as I thought it was going to be."

Lagging Tech: Augmented Reality/Virtual Reality

Augmented and virtual reality (AR/VR) also made advancements this year in terms of adoption, but appear to be among those technologies where perceived benefit lags. Only 10% reported implementation in 2020, and all of them categorized such technologies as not beneficial. Implementation was much higher in 2021, but benefit has yet to be realized. In 2021, only 5% found AR/VR beneficial while 32% implemented and have yet to achieve benefit. (Figure E)

Why so? Perhaps AR/VR is a prime example of companies' willingness to experiment based on hopeful expectations but then struggling to successfully implement such technologies in a way that captures value. The reasons might be a combination of underestimating initial development costs and an evolving ecosystem of technology platforms, integrators and service providers. For example, a great deal of content like images, videos and documentation needs to be created and curated before it can be integrated into an AR/VR solution. The physical world needs to be properly represented before it can be effectively digitized, and that is often a bigger task than expected. And determining the balance of what should be developed in-house versus outsourced to a partner, and who that partner should be, can be situational and confusing.

FIGURE E AUGMENTED/ VIRTUAL REALITY



Nathan Love, Technical Training Manager, Samtec

"When Samtec went through the process of building a new AR/VR solution, it opened up the door for creativity to improve our existing manufacturing processes. The team had to create hundreds of new videos and written documents with images, and these now serve as a 'one-stop-shop' for process documentation. The documentation and content creation did surprise us a little bit as a large cost but developing the documentation does provide value in and of itself, even if the technology is never deployed."

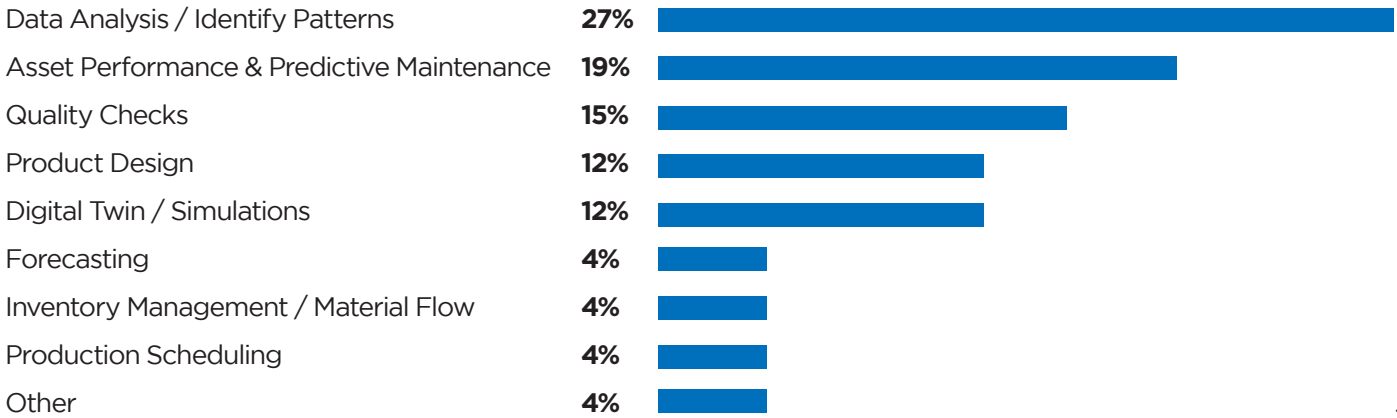
Lagging Tech: Artificial Intelligence

Implementation of artificial intelligence (AI) stayed about on par year-over-year but did make gains in perceived value. Implementations in 2021 were proportionally much more likely to be indicated as beneficial than they were in 2020. (Figure F) Nevertheless, AI adoption is certainly not yet widespread. The narrative in the media is often that AI is here–already eliminating some basic positions and will soon compete with mid-level managers. This is not yet the case in manufacturing and may remain so for some time. The sophisticated level of digital infrastructure needed to implement AI is not yet pervasive, talent with specialized expertise is in very limited supply, and even once those challenges are overcome, it will likely take time for shifts in company cultures before managers will begin to trust algorithms over human judgment.

When companies do incorporate AI, the scope is often very narrowly focused. As with the adoption of additive, AI adoption in manufacturing seems to experience a progressive march from simple to more sophisticated use. (Figure G) It often starts with simple data analysis such as assisting humans in finding patterns they cannot easily identify for themselves. When it does get deployed in a way that it can autonomously affect decisions it is usually kept at the periphery of critical production decisions. For example, it might be used in areas like performance monitoring and predictive maintenance. As trust is built, AI might expand into core production activities such as quality control monitoring, usually as a feature inside a technology package like machine vision. Higher order functions like forecasting, inventory controls and production scheduling are still very rare to see in Indiana's manufacturing base.

FIGURE F ARTIFICIAL INTELLIGENCE

FIGURE G HOW IS YOUR COMPANY USING ARTIFICIAL INTELLIGENCE?



Technologies on the Horizon

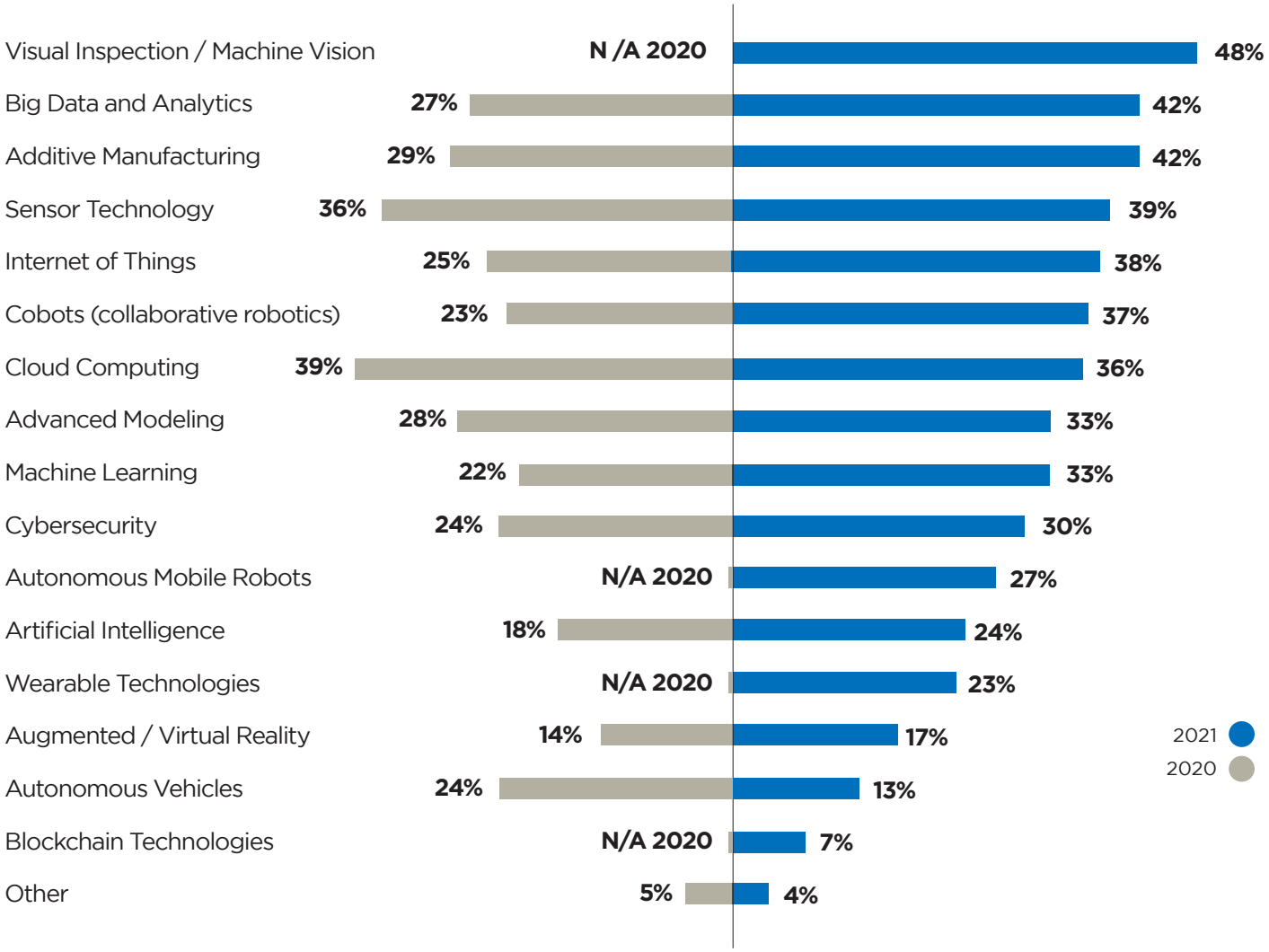
Survey participants were asked to look 5 years into the future to predict which technologies they most anticipate. (**Figure 23**) An overall observation from the set of responses is that nearly all technologies, across the board, are more anticipated for the future than they were last year. The only exceptions were cloud computing and autonomous vehicles. Cloud computing is a mature technology that most companies have considerable experience with already, so while its use may expand and extend further to the shop floor, respondents may not have considered it 'new' for the future. And in the case of autonomous vehicles, the category of autonomous mobile robots was added this year to differentiate between material handling systems within the plant and vehicles that move between facilities. This new category likely split the responses that would have been reported together last year.

Another category that was added was visual inspection/machine vision. Some manufacturers have been using camera systems for process monitoring and quality control for many years, so it's not a new technology. However, these systems have continued to rapidly advance with Smart Manufacturing features and are often the mechanism through which base technologies like machine learning and AI get deployed. The category was added to the survey because experience and anecdotal evidence suggested that it continues to gain momentum among a widening demographic of manufacturers. The addition was warranted as it captured the top spot for most anticipated new technology with almost half of respondents indicating that they plan to deploy it in the next 5 years.

Big data and analytics, additive manufacturing, sensor technology, IoT, and cobots round out the top six, in that order. Additive manufacturing and sensor technologies are not surprising as they were the top two technologies indicated as being implemented already and perceived as beneficial. (**Figure 20**) Planning to do more of what has proven beneficial makes sense. But neither big data and analytics nor Internet of Things had a particularly strong showing among technologies that have already been implemented and beneficial. In fact, implementations of both were notably indicated as not beneficial. (**Figure 21**) Perhaps this is a case where the vision is strong for data-rich, digital plants, but it will take iterations of investments in sensors, infrastructure and other pieces of the digital puzzle to get there.

Predicted laggards looking 5 years out include autonomous vehicles (separate from autonomous mobile robots), blockchain and augmented and virtual reality. Vehicles that are fully autonomous and practical for moving between manufacturing facilities simply don't exist yet and might not for quite some time. Blockchain is difficult to understand and usually must be adopted across multiple parties to prove its benefit. It's not a surprise that both are underdogs in terms of near-term implementation. Augmented and virtual reality, however, is notably different. AR/VR is more tangible and accessible, and implementations are occurring. But as discussed earlier, those who have implemented AR/VR often struggle to capture true benefit. Is AR/VR somewhere in the "trough of disillusionment" of the Gartner Hype Cycle, causing survey participants to discount their plans for it? Will companies continue working with it until they achieve success that can be replicated and scaled, nudging AR/VR into the "slope of enlightenment?"

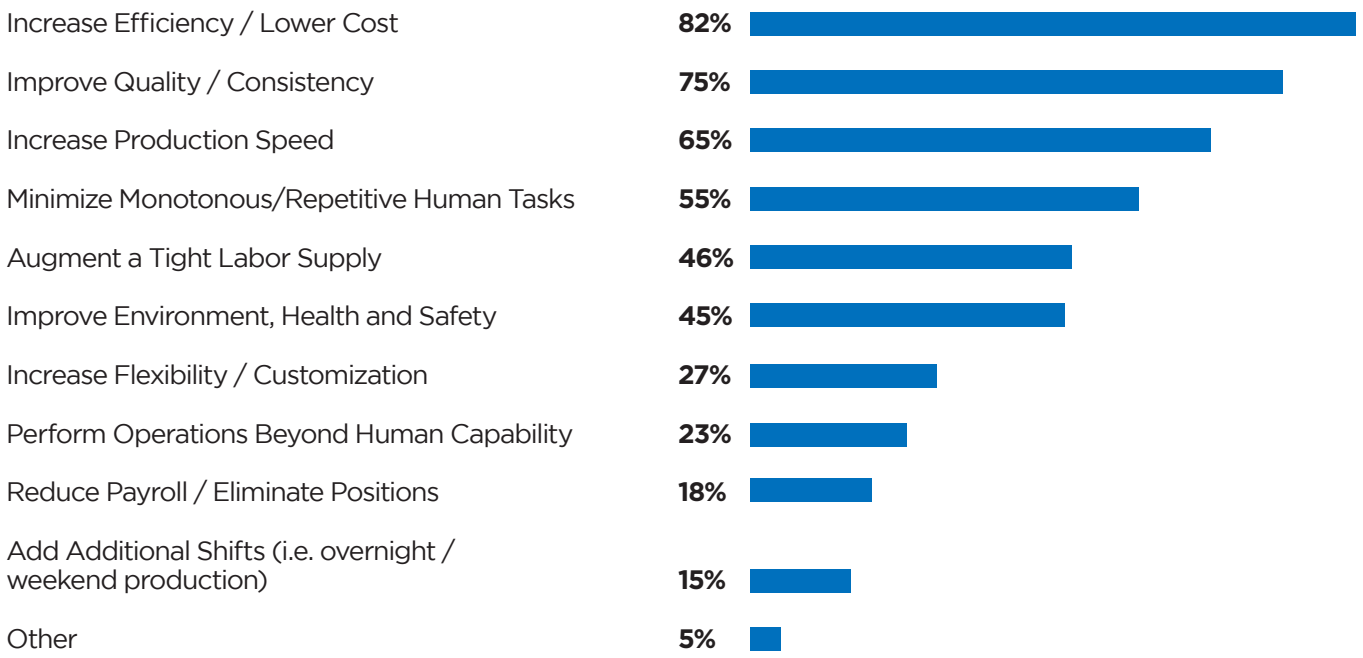
FIGURE 23 INDUSTRY 4.0 TECH COMPANIES EXPECT TO IMPLEMENT IN THE NEXT 5 YEARS



Workforce Implications & Automation

Automation is not threatening jobs—at least not the ones that workers want. Manufacturers cited efficiency, quality and speed, respectively, as the top motivators for automation and rarely cited reducing payroll and eliminating positions. Among the motivations explicitly related to labor, respondents said automation allowed them to minimize monotonous and repetitive tasks, augment a tight labor supply, improve environmental, health and safety and perform tasks beyond human capability. The only motivation that scored lower than eliminating positions was adding additional shifts for nights and weekends. When it comes to technology adoption, Hoosier manufacturers appear squarely focused on workforce productivity with less physicality and monotony—all performed in a safe environment. (Figure 24)

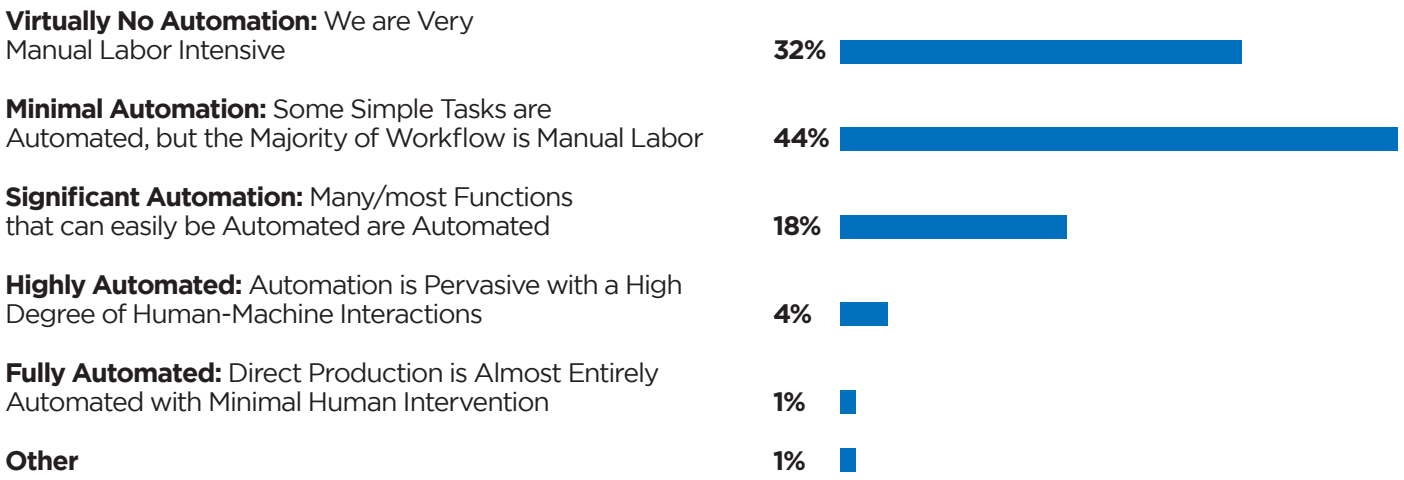
FIGURE 24 WHAT ARE THE MOTIVATIONS FOR IMPLEMENTING AUTOMATION AT YOUR COMPANY?



Humans will continue, for a long time to come, to operate, maintain and run equipment as well as step in to make decisions and adjustments. But, there is a growing consensus that "if we can't find people to ride a forklift, we'll automate it and move on." And frankly, more of that may be needed to preserve the future of Indiana's manufacturing jobs.

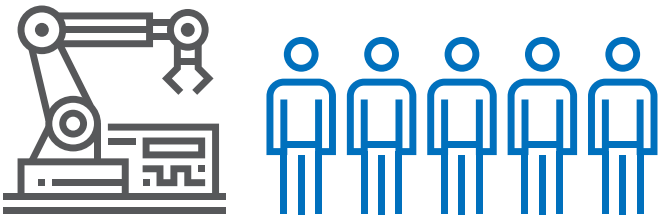
Most Indiana companies feel they are operating with a relatively low level of automation as 76% of respondents reported having either virtually no automation (32%) or minimal automation (44%). (Figure 25) Less than 4% characterize themselves as highly automated and virtually nobody sees themselves as fully automated. Significantly reducing the number of companies with no automation and increasing the number that are highly automated is going to be an important next step in the future health of Indiana's manufacturing sector.

FIGURE 25 AT WHAT LEVEL IS YOUR COMPANY OPERATING WITH ROBOTIC AUTOMATION?



To benchmark against others, the 2021 survey included a question on "Robot Density," which is a broad measure of automation in manufacturing and focuses on the number of industrial robots relative to the number of human workers. Participants were asked to gauge the ratio of robots to workers on a sliding scale with the top of the scale (100%) being all robots, the bottom (0%) being all workers and the midpoint (50%) representing equal numbers of robots and workers. Indiana companies subjectively scored themselves high in robot density. They collectively reported 1 robot per 5 workers. (Figure H) As a benchmark, the International Federation of Robotics reported in January 2021 that the average for manufacturing is 113 robots per 10,000 workers globally, and 228 robots per 10,000 in the United States.[3] A lack of a universally clear and accepted definition of what constitutes an industrial robot may account for some of Indiana's high, self-reported robot density. The International Federation of Robotics likely has a much narrower definition for what constitutes a robot whereas manufacturers may be more apt to describe a wider range of automated systems as robotics. Nevertheless, Indiana companies perceive themselves to be more automated than others.

FIGURE H ROBOT DENSITY



"1 robot per 5 workers"

[3] WorldRobotics2020. *"Robot Race: The World's Top 10 Automated Countries"* (January 27, 2021). Accessed October 18, 2021. https://ifr.org/ifr-press-releases/news/robot-race-the-worlds-top-10-automated-countries

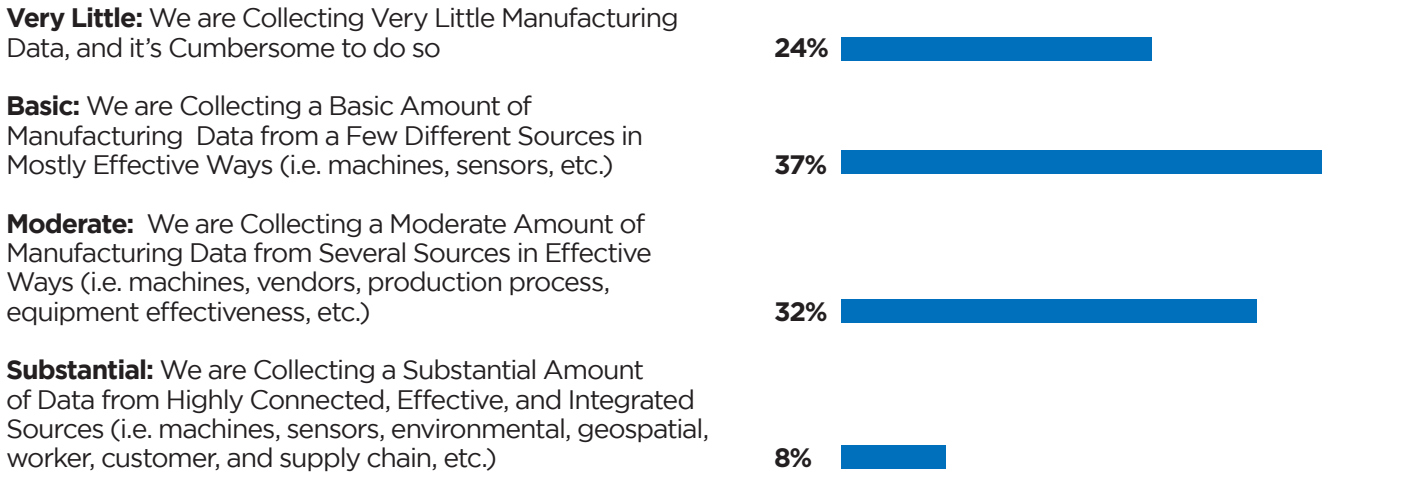
Data Infrastructure

In the Fourth Industrial Revolution, companies should be stretching to integrate an array of digital technologies into company-wide operations and manufacturing processes. The vision is for a new normal of hyper-connectivity, machine-to-machine communication and data rich environments. It should drive decisions at all levels, often autonomously, and it will only be achievable with robust data infrastructure. The survey asked participants how much data they are collecting, how useable it is and how they are using it.

Only a small number (<8%) report that they are collecting a substantial amount of data from highly connected, effective and integrated sources. (Figure 26) The good news is that many more are on a digital journey and may not be far behind as the majority (69%) say they effectively collect at least a basic or moderate amount of data from multiple sources. There is no reason to believe this group won't continue the journey, improving over time. More concerning is to see that almost a quarter (24%) say they are collecting very little manufacturing data or that it's cumbersome to do so. Those collecting very little data may be severely challenged as the road forward without granular data becomes more difficult.

How useable is all this data? Nearly two-thirds (65%) say that it's generally available and accessible to the limited number of people who know how to get it and need to work with it. A small number (14%) are a step more advanced indicating that the data is widely available and accessible with ease and on demand through a robust infrastructure. Virtually no manufacturer (<2%) claims to have a sophisticated infrastructure where they deliberately manage data in terms of its organization, remote (cloud) vs local (edge) systems, or accessibility. And about 20% say they have only sparse infrastructure, and data

FIGURE 26 HOW MUCH MANUFACTURING DATA IS YOUR COMPANY COLLECTING?



is too hard to access or work with; probably the same group that reports not collecting much data. (**Figure 27**)

Those that have access to useable data do tend to make use of it. Almost one-third (32%) say that it is important and central to decision making by key personnel, and another third (37%) say that it is beginning to impact decision-making more and more. Rarely (11%) does it get shared and used company wide. It also appears only topically leveraged as 2% indicated that they rely on it for deep value chain analysis. (Perhaps an opportunity for machine learning and AI to be turned onto this sea of data?) And literally no manufacturer reports integration of data with others in their supply chain; begging the question of if the concept of supply chain transparency is still more theory than practice. (**Figure 28**)

"One reason the process [supply chain transparency] has become increasingly important is that more consumers are demanding it... Across industries, this growing segment of discerning consumers seeks information on product ingredients and materials, where products come from, and the conditions in which they were produced."[4]

FIGURE 27 HOW USABLE IS THE DATA YOUR COMPANY IS COLLECTING?

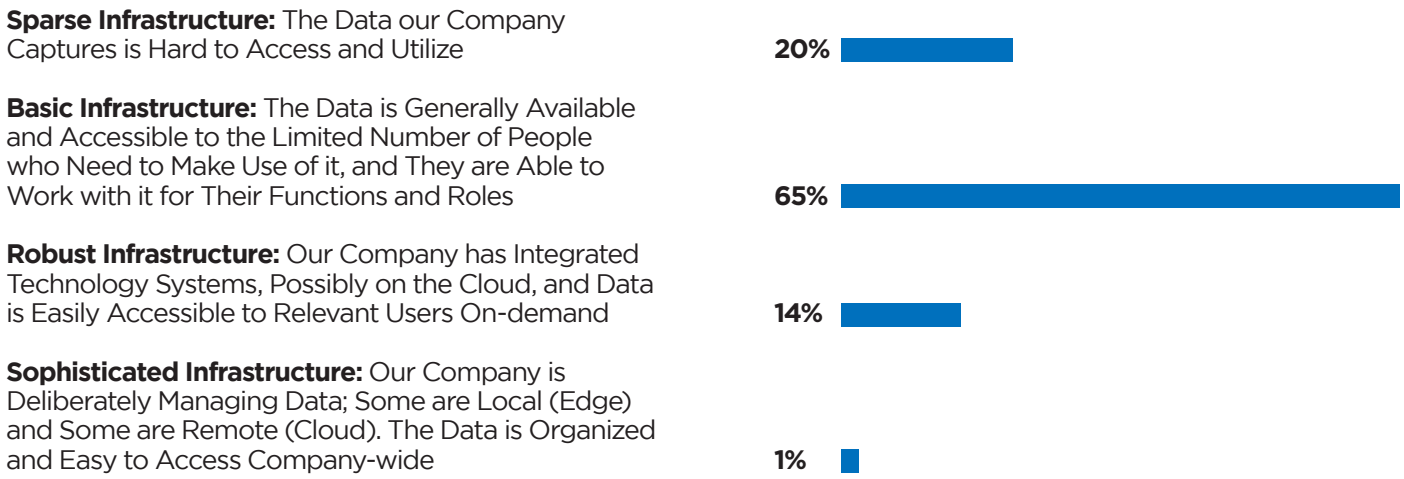
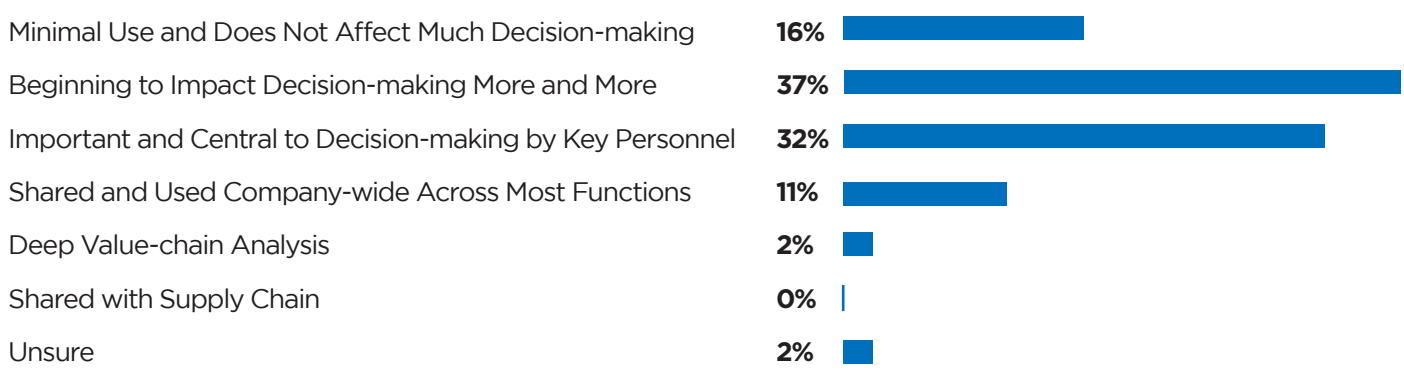


FIGURE 28 HOW IS YOUR COMPANY USING THIS DATA FOR ANALYTICS AND DECISION-MAKING?



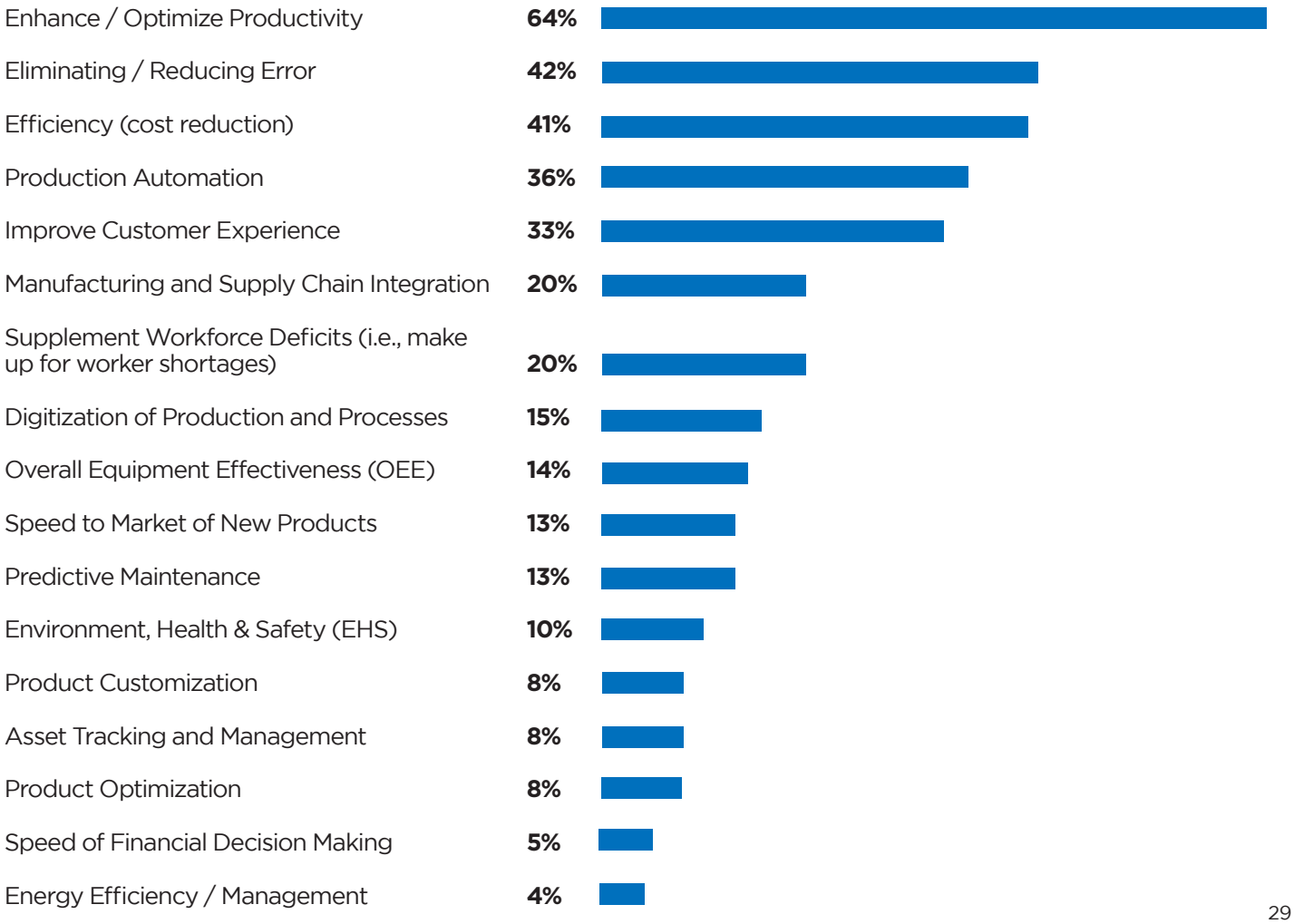
[4] Bateman, Alexis & Leonardo Bonanni. "What Supply Chain Transparency Really Means." Supply Chain Management (August 20, 2019). Accessed October 18, 2021, Harvard Business Review: https://hbr.org/2019/08/what-supply-chain-transparency-really-means)

Making the Business Case for Industry 4.0

The business case for Industry 4.0 is complex. New opportunities regularly arise in the digital 21st century, while the traditional priorities of quality, speed and cost remain. Meeting rapidly changing market conditions and rising customer expectations, with a competitive price point, is not easy. Indiana's AML industries have a firm foundation of Industry 3.0 to build upon as they layer in Industry 4.0 concepts, such as mass customization, digitization, speed to market of new products and increased responsiveness to customers. It will, however, be a transition from 3.0 to 4.0 as evidenced by the top objectives that continue to drive technology investments, including: efficiency, enhancing/optimizing workforce productivity and eliminating/reducing errors. (Figure 29) Companies are investing in 4.0 technologies, but they are doing it for 3.0 reasons. It is all about productivity with objectives like mass customization and speed to market of new products still a little further down the priority list.

A focus on productivity at the onset of Industry 4.0 is crucial. In their work as part of the Indiana GPS Project, scholars at the Brookings Institution found that, between 2007 and 2019, productivity among Indiana's advanced industries grew at just 0.4% annually

FIGURE 29 PRIMARY STRATEGIC OBJECTIVES OF IMPLEMENTING INDUSTRY 4.0-RELATED TECHNOLOGIES



while these same industries nationwide increased their productivity by 2.7% per year. As a result, the state now lags nationwide advanced industry productivity by 20%. Fortunately, manufacturing in Indiana was able to hold onto a productivity advantage for longer than the rest of the advanced industries in that "Manufacturing productivity in Indiana has historically exceeded the national average since 2007; by 2015, however, its edge had fallen to less than 3% from a high of 16% in 2010. While the state's manufacturing productivity growth accelerated in 2010 and 2011 in the wake of the Great Recession, such gains have significantly slowed, leading to a convergence with the rest of the nation."

Brookings identifies several factors that contribute to this productivity decline, but the most glaring issue is an apparent chronic underinvestment in technology. New data made available through the GPS Project finds Indiana industries rank just 37th nationwide in per-employee investment in IT—ranking the state sixth of seven among neighboring and nearby states. Relatedly, the digital content of Hoosier jobs—essentially how much time Hoosier workers use a computer in their work—ranks in the bottom third of all states. This is concerning because there is a clear correlation between digitization and wages. And of greater and particular concern to Indiana, its advanced manufacturing sector saw declining digitization between 2012 and 2019.[5]

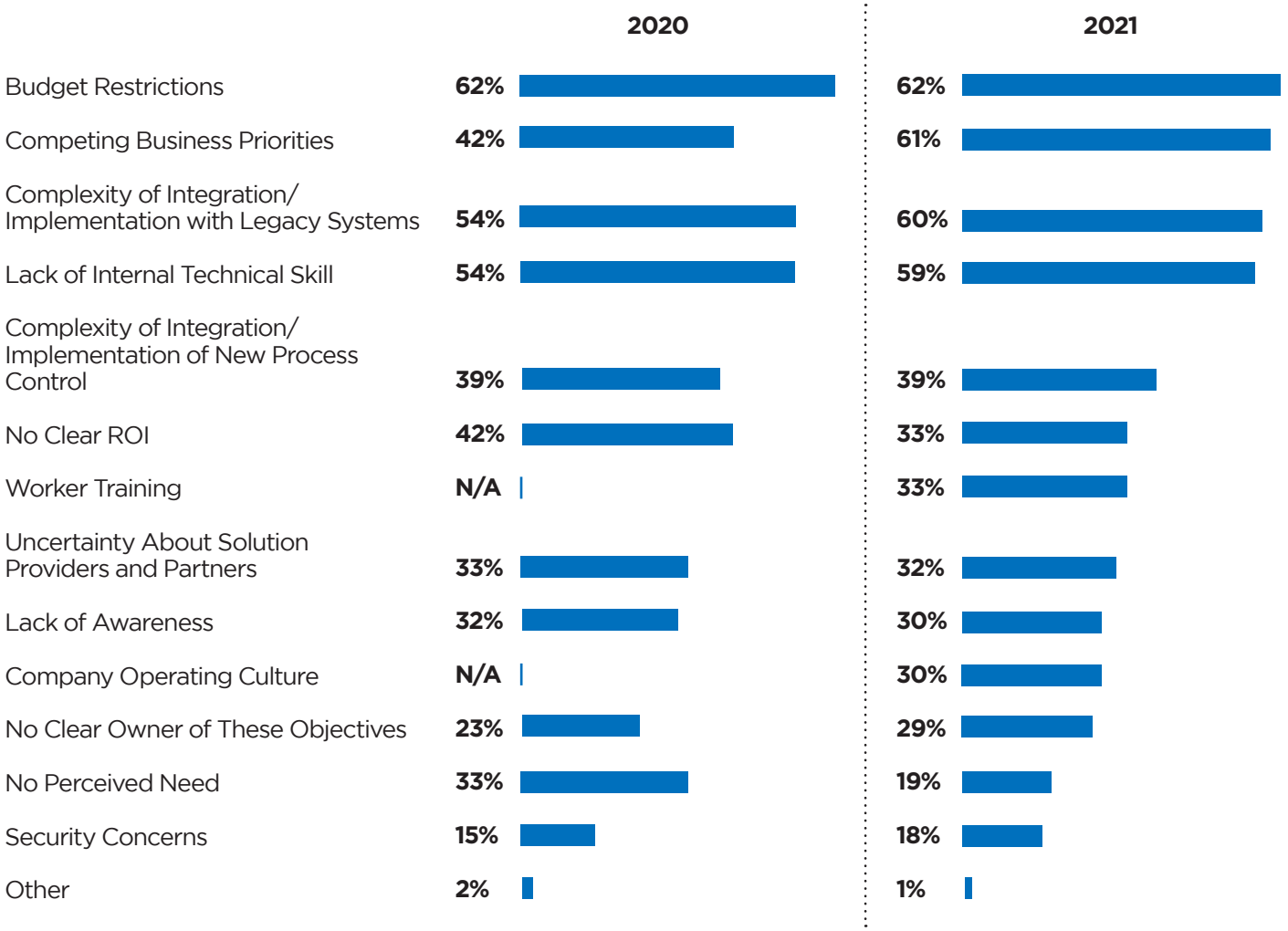
So, it is largely positive that technology investments at Indiana's AML companies continue to place an emphasis on productivity gains—the so called low-hanging fruit. Eventually, however, it is hoped that a shift in business strategy will begin to incorporate some of the more 'complex' Industry 4.0 objectives.

[5] *"State of Renewal: Charting a New Course for Indiana's Economic Growth and Inclusion."* Brookings Institution. Accessed October 18, 2021: https://indianagpsproject.com/wp-content/uploads/2021/02/2021.02.10_BrookingsMetro_Indiana-State-of-renewal-sm.pdf

Barriers to Industry 4.0 Technology Adoption

Last year's study revealed 'budget restrictions' as the standout obstacle to technology adoption (Figure 30)—and even led to a state-funded grant program available to Indiana manufacturers willing to make capital investments to integrate smart technologies and processes. The Manufacturing Readiness Grants program developed and launched in the summer of 2020, partly in response to last year's study, was likely a significant contributing factor to an increase in companies now budgeting for technology adoption (16% in 2020 to 29% in 2021). While budget restriction is still a top obstacle, it is no longer a standout obstacle for small to medium manufacturers. And there is hope that budget restrictions will continue to decrease with an expansion of the grant program in 2021.

FIGURE 30 MAJOR OR MINOR OBSTACLES FOR INDUSTRY 4.0 TECH ADOPTION

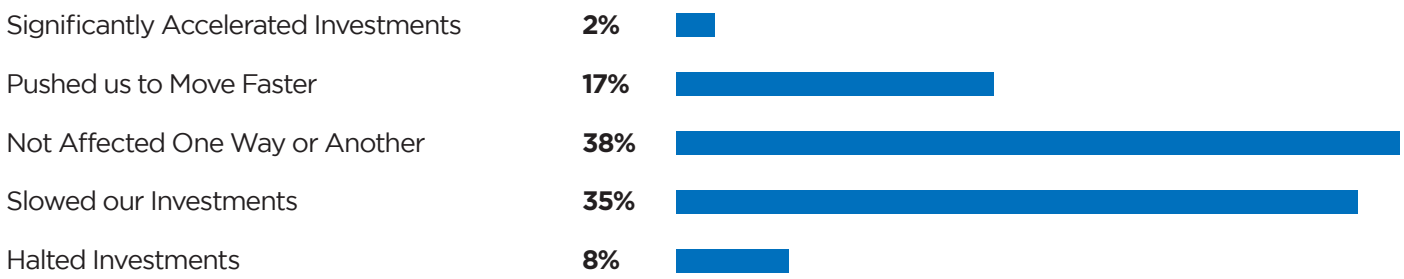


Another positive sign in 2021 is that respondents were much more likely last year to indicate that they were unfamiliar with Industry 4.0 than they were this year. It's possible that some of the existing talent within these companies have begun to familiarize themselves to a point where they feel more confident to take initial steps.

The complexity of integrating new technology with legacy systems continues to be a challenge, and likely will for some time until those systems are replaced or upgraded.

Finally, we would be remiss if we ignored the impact of COVID-19—the largest worldwide pandemic in more than a century—and its impact as a potential driver of change during the study period, especially as it pertains to adoption barriers. The 2020 survey closed on March 6, 2020, the same day that Indiana confirmed its first case of COVID-19. By the time this study started in 2021, the pandemic had been affecting the economy for a full year, and companies were factoring it into their strategic planning. Regarding technology adoption, less than 38% said that the pandemic had no effect, more than 43% either halted or slowed their investments, and 19% accelerated investments. (Figure 31)

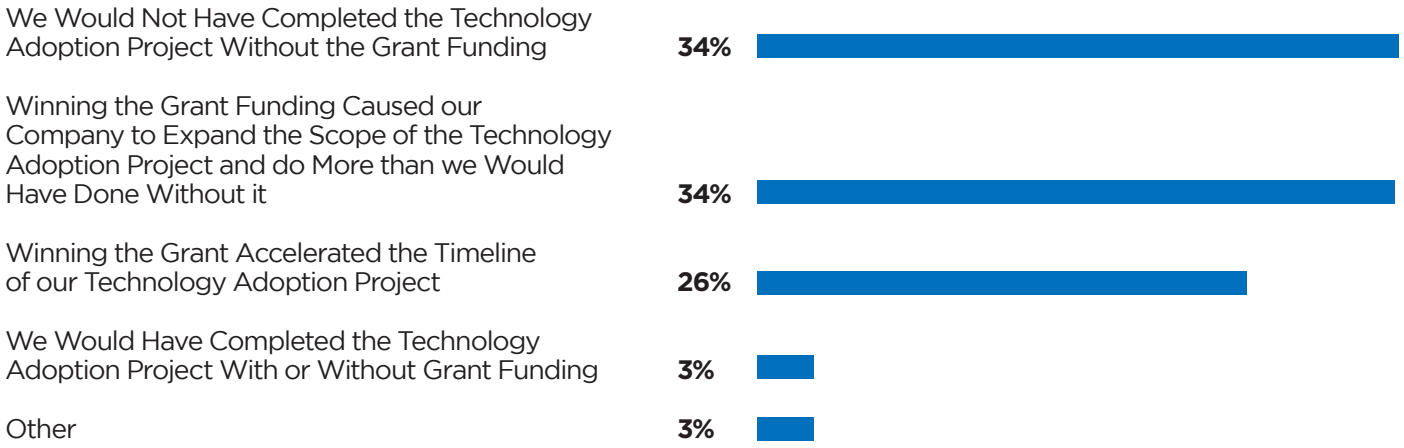
FIGURE 31 HOW HAS THE COVID-19 PANDEMIC AFFECTED YOUR COMPANY'S INVESTMENTS IN INDUSTRY 4.0 TECHNOLOGIES?



COVID-19 brought heightened awareness of the digital tools and infrastructure needed to respond to major unplanned disruption and may well be the turning point that accelerates digital transformation. It certainly was a major impetus in the creation of the Manufacturing Readiness Grants program in the summer of 2020, and grantees testify to its positive impact on reducing barriers to technology adoption, namely budget restrictions. Several of the companies that received matching grants to execute a technology adoption project have credited it with either enabling (34%), accelerating (26%), or expanding the scope (34%) of the project. (Figure 32)

In recent years, Conexus has placed an increased emphasis on digital transformation within the advanced manufacturing sector. As the COVID-19 pandemic took hold, this need became abundantly clear. Small and medium-sized manufacturers across Indiana were anticipated to struggle to make use of shop-floor technology to respond to the

FIGURE 32 HOW DO YOU FEEL THE MANUFACTURING READINESS GRANTS PROGRAM IMPACTED YOUR COMPANY?



Governor's entreaty to retool manufacturing operations and turn out specification-grade masks, gowns and other personal protective equipment at a scale sufficient to satisfy demand for the State's response to the COVID-19 pandemic. Acting quickly, in late April 2020, the Governor as chair of the Indiana Economic Development Corporation (IEDC), recommended that the IEDC allocate its last unobligated funds to a new Economic Activity Stabilization and Enhancement (EASE) initiative, which included $4 million for the Manufacturing Readiness Grants program; a program to financially incentivize companies to adopt smart, innovative and emerging Industry 4.0 technologies.

Following the creation of the Manufacturing Readiness Grants program, IEDC turned to Conexus to design, implement and administer a robust and comprehensive process for review and recommendation of proposals while drawing on its deep network of manufacturing firms of all sizes to encourage the state's largest industry sector to take advantage of this opportunity. The program proved overwhelmingly successful, yielding more than $50 million in matching commitments in response to the initial $4 million seeded by the State. This rapid uptake prompted the Indiana General Assembly to appropriate an additional $20 million to the program in the State's current budget—a move consistent with Brookings' recommendations offered as part of the GPS Project.

The initial success of the Manufacturing Readiness Grants program is apparent in the results of this study in the form of the already mentioned near doubling of the number of manufacturers that now report budgeting specifically for technology adoption (29% in 2021 vs 16% in 2020). And the five-fold increase of funding ($4 million in 2020 vs $20 million that became available July 1st, 2021) is expected to drive results even further in future studies.

Recommendations & Next Steps

While our 2020 report formed a baseline for Industry 4.0 technology adoption at Indiana companies, the 2021 report shows a great deal of progress has been made in only 12 months. Indiana companies have greater awareness of Industry 4.0 opportunities and they are planning and budgeting for it more aggressively. Moreover, many manufacturers are leveraging newly available resources, such as the Manufacturing Readiness Grants program, to enable, accelerate and expand the scopes of technology investments. But what are the next steps for Conexus Indiana and our partners to position Indiana as the center of innovation and digital transformation?

Conexus Indiana will continue work begun in 2020 that has resulted in significant gains, including the Manufacturing Readiness Grants program and events that bring together stakeholders to share best practices and learn about emerging technologies. Conexus will continue to build on that foundation of success through numerous strategies such as supporting ways to collect and leverage manufacturing data to help inform technology adoption strategies and serving as a connector to Indiana's various resources dedicated to Industry 4.0 technologies.

Expand What Works: Grow Awareness of and Participation in the Manufacturing Readiness Grants Program

The program's impact on technology adoption state-wide is clear—budget restrictions as an obstacle have been substantially mitigated and the number of companies now budgeting for Industry 4.0 technology adoption nearly doubled. More than 270 Indiana companies applied for Manufacturing Readiness Grants since the program's inception in June 2020 through Q3 of 2021. Through Q3, 2021, 122 awards totaling nearly $9.7 million in grants to Hoosier companies in 50 of Indiana's 92 counties had been publicly announced to support more than $68 million of technology-based capital investment, with almost all of it at small-to-medium firms (<500 employees).

These grants can be leveraged beyond the direct impact of the awards themselves. Many grant applicants consent to participation in case studies of their grant funded projects "to share learnings and best practices about Industry 4.0 technology adoption in the public domain." Several case studies have already been published and dozens more are in progress. Individually, they serve as examples for others to emulate. Collectively they form a portfolio of success and contribute to the narrative of smart manufacturing in Indiana. (https://www.conexusindiana.com/smart-manufacturing/case-studies)

Continue the Momentum: Launch a State-wide Initiative Focused on Bolstering Data Infrastructure & the Effective Use of Artificial Intelligence, Machine Learning & Big Data Analytics at AML Companies

The new program should seek to bolster data infrastructure as well as the effective use of manufacturing data through big data analytics, AI/ML, and other emerging technologies. Many Hoosier companies are collecting manufacturing data (68%), but few are using and sharing the data company-wide (11%), and a mere 1.5% of companies are using the data for value chain analysis. A new program could aim to both help companies capture the full value of its manufacturing data and provide tools and resources to leverage the data in practical and innovative ways. Emerging technologies yet to see widespread adoption, such as big data and analytics, artificial intelligence (AI) and machine learning (ML),

and IoT, should be a focus for the program's resources and objectives.

Increase AML Engagement with Indiana's Cluster of Digital Transformation & Innovation Resources

Indiana is rich with a cluster of collaborative resources focused on accelerating Industry 4.0, and these resources are perhaps some of the most valuable assets for Indiana companies to explore and leverage. For example: Purdue University's Indiana Manufacturing Competitiveness Center (IN-MaC), University of Notre Dame's iNDustry Labs, Wabash Heartland Innovation Network (WHIN), Indiana IoT Lab, Indiana 5G Zone, Ivy Tech's Smart Manufacturing and Digital Integration AAS and many more. Several others have also been announced in the last year, including:

- Emerging Manufacturing Collaborative Center (EMC2) is a cross-sector manufacturing innovation center that enables its members to design and deliver cutting edge manufacturing technologies. Founded through a public-private-partnership, the Center will operate a functioning 60k ft2 manufacturing floor that will serve as a showcase for new capabilities as well as a platform for collaborative research and development, especially focused on technology insertion and adoption. EMC2 will also have offices, shared office space, collaboration environment, and a 100-person training/workshop classroom that can be divided into two 50 person rooms. The Center will support the long-term growth of the State of Indiana's manufacturing industry, which is a key driver of Indiana's economy. (https://emergingmanufacturing.com)
- AnalytiXIN is a digital community, including a place-focused collaboration hub in Indianapolis, that strengthens connections and encourages engagement of academic data science R&D talent with their industry peers to drive sustained innovation within Indiana. (https://analytixindiana.com)
- Center for Applied Robotics and Automation at Vincennes University, which will focus on collaborative robots that are designed to work alongside humans in manufacturing and logistics settings, among others. The center will involve a combination of developing credentials around cobots and certifications that will be based on applications of industry standards, as well as related programming. (https://www.vinu.edu/web/external-relations/b/vu-jasper-unveils-collaborative-robots-lab-bringing-advanced-technology-to-dubois-county)

About Conexus Indiana

Conexus Indiana, a nonprofit membership-based organization, accelerates, promotes, and grows Indiana's advanced manufacturing and logistics sectors by collaborating with industry, education and public-sector leaders to optimize Indiana's competitive advantage as a global leader in making and moving products. Founded in 2007 by industry leaders as part of the Central Indiana Corporate Partnership (CICP), Conexus Indiana develops education and training programs, educates the public and public sector about the importance of the industry to Indiana's health and vitality, supports business development and technology integration strategies, and delivers on talent attraction strategies to support Indiana AML and improve opportunities for Hoosiers.

Since its inception, Conexus Indiana has launched and delivered industry-driven curricula, career awareness, and work-based learning opportunities to nearly 10,000 Hoosier high school students, equipping them with the skills to begin a manufacturing or logistics career upon graduation or to pursue further education. In recent years, Conexus Indiana expanded its talent development programs to post-secondary students and unemployed and underemployed Hoosiers. These programs support the AML's growing need for tech-conversant, problem-solving and collaborative talent. These talent development programs, in addition to Conexus Indiana's Industry 4.0 research and thought-leadership platforms and the organization's growing networked community of experts, are foundational to Indiana's successful transition to Industry 4.0 and sustained business growth.

About Indiana University Kelley School of Business Center for Excellence in Manufacturing

Manufacturers are caught in an ongoing revolution that requires them to consistently invest in their facilities, staff, and automation to keep up with competitors. As soon as they progress forward, the bar moves again.

The IU Kelley School Center for Excellence in Manufacturing tracks this revolution and monitors trends to provide business leaders insight into this ever-changing industry. Our center finds and illuminates the most effective trends for companies while helping our students develop the skills that managers need.

An increasing number of undergraduate and MBA students who study supply chain management are pursuing careers in manufacturing. We help them develop the understanding, vision, and flexibility necessary to enter this industry and lead these companies into the future.