



# ACCELERATING THE ADOPTION OF SMARTER MANUFACTURING

## 2021 INDUSTRY SURVEY



**SIEMENS**

**KEARNEY**







## Accelerating the Adoption of Smarter Manufacturing



Smarter manufacturing—the connection of materials science, manufacturing processes and systems engineering—is clearly the imperative of the future. According to industry leaders, this smarter future could have tremendous and far-reaching benefits for U.S. manufacturing, including a more secure and resilient supply chain and more and better jobs coming back to the United States.

A new comprehensive survey of top leaders from several large U.S. manufacturing sectors sponsored by LIFT, the Detroit-based Department of Defense manufacturing innovation institute, Siemens and Kearney, shows that while nearly 90% of the industry knows they must make the move to smarter manufacturing to de-risk their organizations and labor supply, the concept of making such a move is complex and they aren't sure the return on investment (ROI) can be fully realized, so they are looking for partners to help guide them along the way.



The online study polled 500 manufacturing industry personnel at the director level or above with technology and product or product development in their job titles across 10 sectors (aircraft/aerospace, automotive, defense, energy, food/beverage, gas/oil, industrial and commercial machinery, medical/surgical/dental, semiconductors, and shipbuilding/marine) in September 2021. These individuals came from all types of companies, but the study focused on small-to-midsize firms, who are often leading indicators of larger economic trends and are deeply embedded in the supply chains of our industry sectors. More than half of the respondents represented companies of between 250 and 1,000 employees.

The study provided some clear guidance and pathways that could accelerate smarter manufacturing within organizations; namely increased funding and consultation with experts in the space. It is incumbent on entities such as LIFT, Siemens and Kearney, who have ample resources and specific expertise, to help many of these organizations get out of the starting gate and start running more modernized, smarter manufacturing processes. And as companies demonstrate the economic value of the investments, it should help unlock funding for smarter manufacturing from executives and investors.





## Partnerships are Needed to Accelerate Adoption

59%

On a top-line level across industries, three in five (59 percent) respondents said their companies have already been using some level of smarter manufacturing in their production processes.

15%

An additional 15 percent said their companies are currently starting that process, meaning three-quarters of companies surveyed have begun their smarter manufacturing journey.

87%

The respondents' stated feelings about smarter manufacturing overall lined up with this robust rate of adoption, with 87 percent indicating they strongly or somewhat agreed with the idea that their organizations were fully committed to smarter manufacturing,

85%

and 85 percent strongly or somewhat agreeing that smarter manufacturing was a top priority for their organization.

However, underlying those stated intentions was ample skepticism about the proven benefits of smarter manufacturing thus far:

68%

say the investments have not yet shown a positive ROI at comparable companies,

65%

feel, at this point, the costs to adopt smarter manufacturing may outweigh the benefits.

65%

are unsure of where to begin adopting a smarter manufacturing process, and

63%

state they did not see a benefit to smarter manufacturing.

These top-line results reveal a clear willingness by organizations to embrace a smarter manufacturing future in some capacity, but also significant skepticism by those on the front lines in the industry as to whether these big swings will pay off with home runs for their companies and sectors. We know smarter manufacturing makes sense in so many areas, from ensuring a higher standard of quality control in precision products to bringing jobs back to the country. This has not yet been made clear to the majority of those surveyed on a simple ROI metric—and it is critical to demonstrate the significant value smarter manufacturing brings in order to ensure the support from leadership is there for the long term.



To help the manufacturing industry overcome those substantial perception issues, the survey explored ideas that might make some of these respondents and their organization more comfortable with moving ahead more aggressively with smarter manufacturing technologies. These included the need for increased funding and opportunities to consult with experts in implementation of these technologies, which tied for the top response, both at **71 percent**.

Indeed, both of these answers correlate strongly with the big picture messaging, which is that organizations need specific expertise and adequate funds for the large initial investments necessary to go full steam ahead into modernized manufacturing. These experts can also help provide more clear and relevant validation of the economic impact of these changes, which helps to address the ROI question that has likely kept many companies from adopting these technologies sooner.



In addition, **61 percent** of respondents suggested partnering with a software vendor to co-create solutions, which could create a glidepath for some industries that have made relatively less progress on the path to a smarter future. In fact, enthusiasm for this method was highest in the defense, semiconductors, and shipbuilding sectors, with more than three-fourths of respondents across those three verticals expressing interest in this solution.

Digging a bit deeper into this, it is clear that there is broad support across industry for moving toward a more technologically enabled manufacturing process, but even companies doing it well are still not where they would like to be. Many instances of the adoption of smaller and isolated constituent elements of smarter manufacturing have been observed however large-scale adoption at the systems level is rare in small to medium sized enterprises





# Broad Enthusiasm, But a Mix of Challenges

Nearly all companies that have attempted the transition to smarter manufacturing—**98 percent**—reported having encountered at least one significant challenge. This is unsurprising, as making these large-scale changes that underlie so much of a business is bound to be a tall order. The top response for a specific challenge, as reported by **58 percent** of the respondents in the survey, was the complexity of executing successful system integrations.



49%

Another obstacle frequently mentioned by respondents included the lack of skilled workers, identified as an issue by **53%**

of companies—and likely to be a growing near-term problem given challenges with the labor market.

The survey also revealed the costs required to start this type of transition and the lack of current technical expertise on hand as other significant hurdles in the way of greater adoption of smarter manufacturing, identified by 49 percent of respondents to the survey.



48%

Cybersecurity and the time necessary to launch smarter manufacturing processes were also named by nearly half of respondents, with 48 percent of individuals in the industry identifying those two areas as particular challenges.

40%

The lack of robust historical data showing positive return on investment for smarter manufacturing and overall resources required to implement a smarter manufacturing plan were the only other items mentioned by more than 40 percent of respondents to the survey.

31%

Interestingly, only 31 percent of those polled answered that the lack of quantified data to use as a basis for informed decisions was a challenge,

13%

13 percentage points lower than those who mentioned the paucity of ROI data. This shows that manufacturing industry personnel are largely convinced that smarter manufacturing will make their jobs and businesses easier, but they do not yet feel like they have enough data to feel as certain that the substantial investments necessary to begin a smarter manufacturing process will pay off. LIFT, Siemens and Kearney have ample data that shows not just the capability of the smarter manufacturing tools themselves—but that they pay off in the short and long run.



Just one-tenth of respondents indicated that smarter manufacturing was not a top priority for their company, revealing a broad-based desire to adopt these tools. And a paltry 6 percent of those surveyed suggested that the workflow and process changes that would be required by a move toward tech-enabled manufacturing would be too difficult for their organizations.



## Different Timelines for Different Sectors

While the enthusiasm for smarter manufacturing was unified across sectors, there were significant variances in the overall and specific experiences different areas of the manufacturing industry had in adopting more tech-enabled processes.



76%

For example, the semiconductor industry, with 76 percent of respondents reporting the same, is clearly at the cutting edge of smarter manufacturing, which makes sense given the extreme precision required.

42%

On the other end of the spectrum, just 42 percent of respondents in the energy industry and

32%

32 percent in the medical, surgical and dental space are actively using smarter manufacturing—significantly below the survey average of 59 percent.

However, when adding the respondents who indicated their organizations were currently in the process of adopting smarter manufacturing, both sectors had a majority of individuals in those respective industries confirm they were on the journey to tech-enabled manufacturing.



50%

46%

One promising piece of data: no sector of the manufacturing industry polled had more than 50 percent of respondents cite resistance from management as a key factor impeding the transition to a smarter manufacturing process,

with defense and shipbuilding tied for the lead in that category with 46 percent—possibly reflecting the more experienced makeup of senior leadership in those fields. But with such high adoption rates in

so many areas of the manufacturing economy, the value proposition of smarter manufacturing has proven enough to overcome possible skepticism from senior leadership and other legacy stakeholders.

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There is also the fact that smarter manufacturing covers a wide range of processes and tactics. Companies might say they are adopting smarter manufacturing tools and techniques, but the specific ones adopted can vary widely in their relevance and effectiveness. Are these organizations using and building around the right smarter manufacturing tools, or are they just complementary pieces of a larger transition?





# Complexity is The Biggest Hurdle

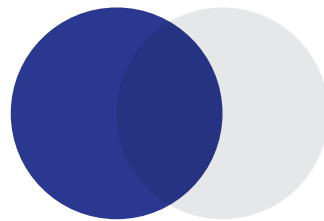
The survey was clear: the main challenge in moving more quickly toward a smarter manufacturing process was the complexity of system integration—or at least as seen and experienced by those in various sectors across the manufacturing industry.

One method that could reduce the perceived complexity is to communicate the move to a smarter manufacturing system as something that could be done in a modular way, linking simple processes with better technology, and, thus, avoiding a disruptive overhaul. For example, many companies are already combining smarter manufacturing processes with more traditional methods, and they could expand and introduce more tools along this natural integration and evolution.

For larger manufacturing companies, they could think about automating one product line to get comfortable with the new processes and optimize for best practices. After that, this new process could be introduced to an entire factory, and then be part of a complete global rollout. This is one way to get companies comfortable with adopting smarter manufacturing processes in a sensible, phased-in way.

# Smarter Manufacturing Journey

While the study overwhelmingly showed that the industry, broadly speaking, is well on its smarter manufacturing journey, what that journey looks like in practice varies widely across the sectors surveyed. There was a clear industry-wide shift toward more automated manufacturing across the country, but the level and progress of adoption of these techniques differed significantly. A common thread was that companies needed more of the basic tools to help them build a roadmap to a more comprehensive, smarter future.



Most industries are adopting technology in their natural sector requirements:

- **Cybersecurity** – leading industries are semiconductors and shipbuilding/marine that are defense or high-technology where information security is paramount
- **Augmented or Virtual Reality** – leading industries are oil and gas and automotive industries where remote workplaces and far-flung global design centers require close collaboration
- **Robotics** – highly repetitive or difficult processes being automated in semiconductor, aerospace and shipbuilding industries are common
- **Artificial Intelligence** – This technology has lagged in the manufacturing industry, though medical/surgical/dental and industrial and commercial machinery have shown 36% are using it somewhere in their business

# The ROI Question



Despite more than four in five respondents saying their organizations have a firm commitment to a transition toward smarter manufacturing, and it being a top priority for their organizations, two-thirds of respondents expressed concern that the return on investment of this transition has not yet been fully proven, and it is not yet clear that the costs outweigh the benefits.

The cost-benefit analysis behind the transition to a smarter manufacturing process also varies significantly by industry, and responses to the survey reflected this. For example, in industries that manufacture high-value items with complex processes, such as semiconductors, respondents endorsed transitioning to a smarter manufacturing solution at a significantly higher rate than average. Respondents working with simpler products were less convinced that spending the money to modernize their manufacturing process would prove worthwhile.

As many of these technical tools become more affordable and the best use cases are identified, the initial costs of setting up smarter manufacturing processes are likely to drop for many of these companies producing goods that are further down the value scale. In addition, a longer track record of success for many companies using smarter manufacturing processes can help companies improve their modeling and projections and provide the ROI justification necessary for many of these firms to make deeper investments into the smarter manufacturing process.



## Talent Wanted

Smarter manufacturing requires higher skill level jobs at higher wages and drives growth both within organizations and the organic industrial base in the U.S. The need for increased talent with the knowledge, skills, and abilities to work in smarter manufacturing is clear.



48%

The skilled worker issue was heavily dependent on industry, with 78 percent of semiconductor industry representatives and

76%

76 percent of respondents from the shipbuilding industry mentioning it as a material issue,

34%

while just 34 percent from the automotive industry called out a lack of skilled workers as a top concern.

70%

When asked specifically about labor concerns, 70 percent of all respondents identified the availability of workers overall as an issue,



with 67 percent mentioning the availability of labor with the necessary technical skills.

67%

A full 55 percent also responded that high school curricula are not aligned with the contemporary needs of the industry, another critical component of solving the employee concerns that can accelerate adoption of smarter manufacturing.

55%

As the pathways to a successful career in smarter manufacturing become more evident, we would expect schools and other sources of career training to also adjust to the new qualifications students pursuing careers in this field need.

Organizations such as LIFT, Siemens and Kearney can serve as resources for developing a modern curriculum that prepares the next generation of the American worker to thrive in the burgeoning smarter manufacturing industry.

## Opportunities Exist on U.S. Shores

While making the transition to a smarter, technologically focused manufacturing process certainly requires significant investment and effort, companies across industries are noticing specific opportunities this shift has unlocked.

Smarter manufacturing can also facilitate production of goods closer to home, lowering transportation costs and reducing the variability of the logistics — a significant stressor for many businesses this year. More than two-thirds of respondents identified its effect on supply chain stability as an area where smarter manufacturing could meaningfully enable reshoring of their processes.

The COVID-19 pandemic's impact on the global supply chain has had many companies and organizations reevaluate their product logistics and sourcing. With a smarter manufacturing process, it can be more cost effective to produce in the U.S.—as well as providing more predictable timing and shipping costs. This sentiment came through in the survey, with respondents indicating that their companies are looking at reversing years of outsourcing and bringing more manufacturing back to domestic facilities. In addition, these companies are looking at more U.S.-based suppliers to reduce geopolitical risk going forward.





It might also come as no surprise that given the chip shortage that has roiled so many industries, semiconductor manufacturers led the way with **90 percent** of respondents in that industry indicating they are looking to bring production onshore. Highly strategic industries like shipbuilding and aerospace also responded in favor of onshoring at a greater than **80 percent** rate.

The respondents identified numerous and varied benefits in making the transition toward smarter manufacturing, which applied unequally across industries. For example, aerospace industry respondents were overrepresented in naming reduced quality control risks as a perk of smarter manufacturing, while semiconductor companies—which have been among the businesses most affected by the unusual activity in the global supply chain—were 35 percent more likely than respondents from other industries to identify the ability to better estimate production delays as a significant perk of smarter manufacturing.

# Smarter Manufacturing in Three Dimensions

One area of tech-enabled manufacturing that has received plenty of attention in recent years is additive manufacturing, or 3D printing. This technology has become significantly cheaper in recent years and enables highly precise, small-batch manufacturing.

83%

Adoption of this technology has been rapid, with 83 percent of respondents saying they use 3D printing as a routine part of their business.

66%

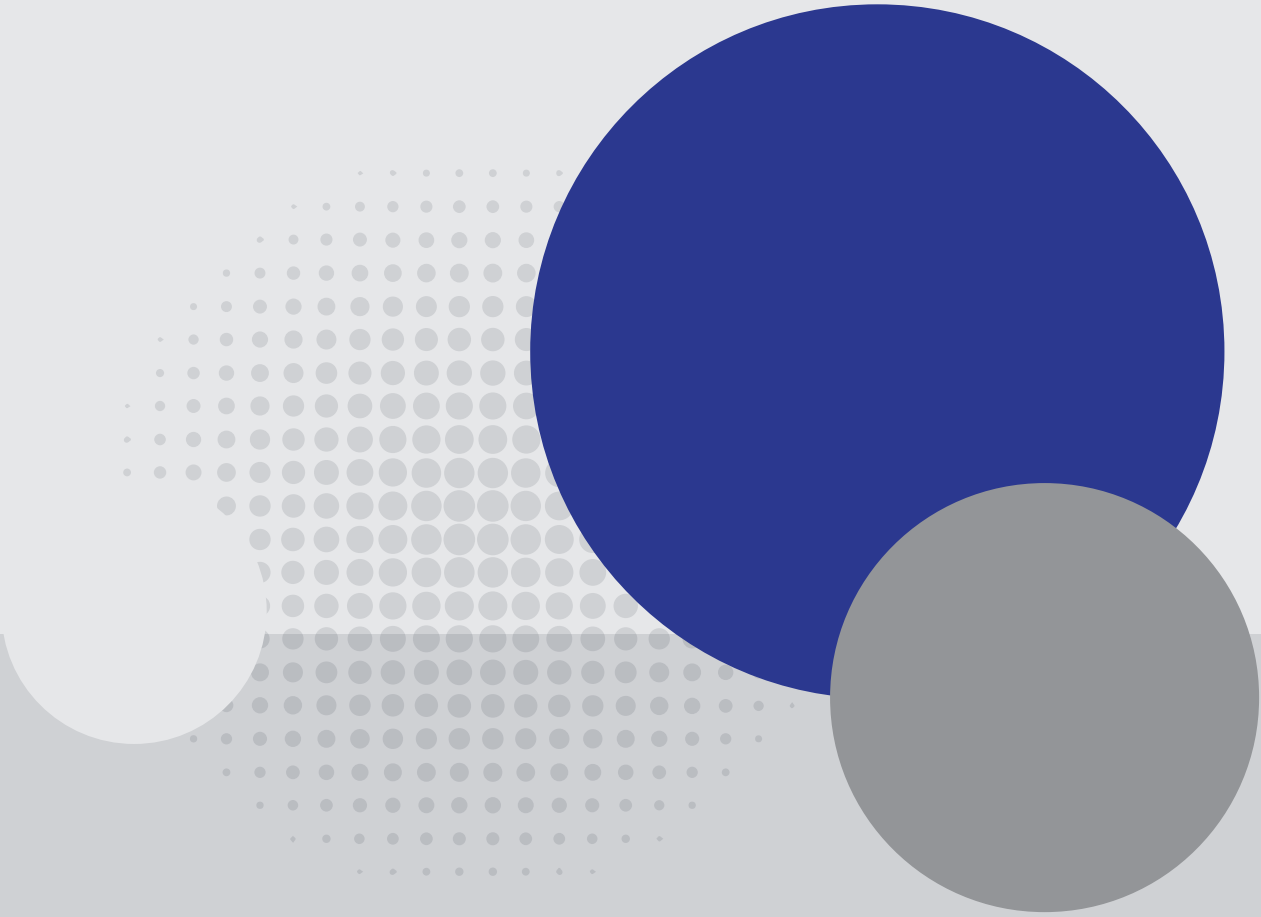
Of that group, 66 percent each use the process for material extrusion and hybrid milling, while binder jetting, material jetting and directed energy deposition round out the top five uses.

80%

The semiconductor and shipbuilding industries lead the way in their adoption of additive manufacturing, with more than 80 percent of respondents in both industries using material jetting, and three-fourths mentioning binder jetting and directed energy deposition as part of their processes.

36%

Wire-arc additive manufacturing is a technology used by a minority of respondents, with the gas and oil industry using it the most, as reported by 36 percent of participants in the survey.

An abstract graphic featuring a large blue circle on the right, a smaller grey circle below it, and a white circle on the left. A halftone dot pattern is visible in the background, partially obscured by the circles.

Given the near-universal adoption—and success—of 3D printing across some of the highest value industries, the path is clear for growth further downstream. But with the complexity of many additive manufacturing technologies, particularly in setting them up, this is one distinct area where expertise from organizations such as LIFT, Siemens and Kearney could really move the needle for smaller manufacturers and get them on track to maximize the impact of 3D printing on their business. The technology is ready, and many of our most mission-critical industries depend on it. The growth of 3D printing is a true smarter manufacturing success story, and a blueprint to emulate for other processes—many of which are being invented today.

## Riding the Wave



One notable success story from Siemens shows how smarter manufacturing can work for all types of companies, including those in highly specialized, niche industries.

Surf Loch is a California-based company that designs state-of-the-art artificial wave pools, such as the one at the new Resorts World casino in Las Vegas. From the top down, Surf Loch embraced smarter manufacturing, utilizing Siemens' Digital Enterprise portfolio to help design and optimize their surf wave technology before building these massive pools that provide hours of fun for guests from around the world.

Surf Loch has a relatively small engineering team, but the open ecosystem and software-based automation helped them work and communicate much more efficiently and provided valuable data that could be leveraged by their partners in building facilities and specialized equipment. The company used NX CAD models to design and test ahead of production—building a digital twin of the pool and wave motion before constructing it in real life. This provided a huge advantage allowing Surf Lock to iterate quickly and achieve greater timing precision through motion control to build an even better product.



# The Race is On, Let's Get Going



Overall, the pace of smarter manufacturing adoption remains uneven across industries, with most respondents benchmarking their progress at 56 percent of services automated—roughly halfway. In industries such as shipbuilding (67 percent) and industrial and commercial machinery (65 percent), this was substantially higher, while respondents in the medical, dental, and surgical industries reported just 45 percent progress.



As many of these smarter manufacturing technologies become cheaper, more user-friendly—and prove their impacts on companies' bottom lines over a longer period of time—all the pieces are in place for adoption to continue to trend rapidly upward. As we've seen in areas like 3D printing, smarter manufacturing quickly moves from novelty to luxury to an integral part of an established production process.

Encouragingly, senior leaders at manufacturing companies across a variety of sectors have also expressed strong interest in accelerating their transition toward smarter manufacturing.

This survey identified distinct pain points and opportunities that the right partnerships can help address so industry can make continued progress toward a more innovative future.

The tools are here for you and your company to accelerate your smarter manufacturing future and plug into the next generation of tech-enabled production. It's time to team up and create manageable, executable milestones with clear ROI, and sensible goals—and Drive American Manufacturing Into the Future.





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