



F R O S T & S U L L I V A N

50 Years of Growth, Innovation and Leadership

Transformative Technologies in Manufacturing

Survey: Investments Rise in a Search for Competitive Advantage

A Manufacturing Leadership
Community Report

www.frost.com

Introduction	3
Rethinking the Role of Transformative Technologies.....	4
Accelerating the Adoption of Transformative Technologies	4
Transformative Technology Assessment, Planning Processes Lag.....	7
Manufacturers Target Mobile, Sensor, and Analytic Technologies.....	10
Conclusions and Recommendations	12
Case Study–Flextronics: Transforming the Supply Chain	14
Case Study–L’Oréal : L’Oréal Embraces the Cloud, Social Tools.....	15

INTRODUCTION

In May of 2012, the Manufacturing Leadership Council's Board of Governors, in its annual review of Council research projects, authorized a survey of manufacturing executives regarding their attitudes about and plans for adopting a wide range of potentially transformative technologies, including mobile devices and platforms, advanced robotics, advanced analytics, and 3D printing. The intent of the survey was to assess the strategic and competitive impact that these technologies are having on today's manufacturing enterprises, manufacturers' investment plans relative to these technologies, and the competitive importance that these technologies will have over the next five years. Among the specific areas of inquiry were:

- How rapidly are manufacturers evaluating and adopting potentially transformative technologies?
- To the extent manufacturers are adopting transformative technologies more aggressively, what factors are driving the acceleration?
- Are manufacturers becoming less risk-averse in the evaluation and adoption of transformative technologies?
- How involved are manufacturing CEOs and other C-level executives in assessing the strategic and competitive impacts of potentially transformative technologies?
- What challenges do manufacturers face as they attempt to evaluate and adopt transformative technologies?
- How do manufacturing leaders feel their own companies compare to their competitors in the adoption of transformative technologies?

The survey was developed by the Manufacturing Leadership Council's Editorial Department and was reviewed and approved by the Board of Governors. The survey was fielded to the Manufacturing Leadership audience, including members of the Manufacturing Leadership Council, in July of 2013. The survey received 347 completed responses, primarily from manufacturing executives with vice president titles or higher. Manufacturing verticals accounting for the most responses included industrial machinery and equipment, aerospace, automotive, and high technology.

RETHINKING THE ROLE OF TRANSFORMATIVE TECHNOLOGIES

Manufacturers have had a well-earned reputation for taking a cautious stance toward the adoption of the kinds of technologies that, over the past few decades, have transformed the consumer and enterprise information technology landscapes. They have earned this reputation for very good reasons. Manufacturers require plant floor equipment and systems to operate flawlessly for decades. Failures due to untested or insecure technologies can mean expensive downtime and, worse, unsafe working conditions. It is understandable, then, that manufacturers have tended to avoid risk, often favoring reliable and proven technologies over the cutting edge.

At the same time, traditional organizational silos have tended to isolate manufacturing technology decision-making processes. So, while sales and finance departments in many companies have aggressively embraced Internet- and cloud-based technologies over the past few years, for example, many manufacturing organizations have been slower to do so. Once, transformative technologies such as Ethernet networking and the personal computer, which were rapidly adopted in enterprise IT environments, for example, took years to penetrate the manufacturing space.

But the organizational isolation and risk aversion that once drove manufacturing's reluctance to embrace transformative technologies are rapidly breaking down. Manufacturing is increasingly seen not as an isolated cost center, but as a source of competitive advantage that must be more completely integrated into broader enterprise processes and organizational structures. This recognition of manufacturing's competitive significance is driving many companies to rethink the design of their supply and production networks. It is also leading them to be more receptive to the adoption of transformative technologies, such as advanced robotics and cloud-based technologies.

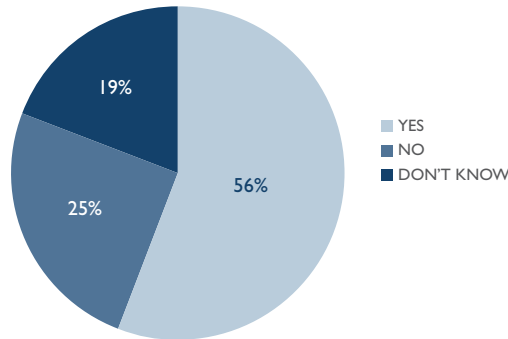
Manufacturing is also increasingly exposed to and impacted by transformative technologies originating in the consumer world. As manufacturing customers, suppliers, and workers adopt and become comfortable with mobile and social networking tools, they expect to be able to use the same tools to enhance collaboration and efficiency in the manufacturing environment. As a result, manufacturing organizations are accelerating their use of mobile devices, sensor networks, and advanced analytics tools to, for example, monitor product performance and manufacturing processes in real time and predict and correct small problems before they blossom into large ones.

ACCELERATING THE ADOPTION OF TRANSFORMATIVE TECHNOLOGIES

As these trends play out, manufacturing executives are clearly driving a more aggressive adoption of technologies such as mobile devices and platforms, sensor and sensor networks, advanced analytics, and advanced robotics, according to the results of the MLC Transformative Technologies survey. And many say their companies, over the next five years, will increase their risk tolerance when deciding whether to adopt these technologies.

Figure 1: Solid Majority Plans to Accelerate Adoption

Q: Does your company plan to accelerate its evaluation and adoption of transformative technologies in the next year or two?

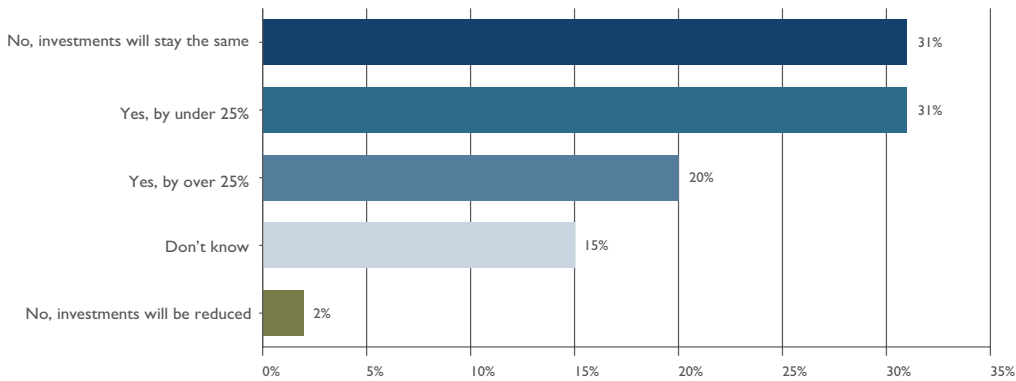


Source: Manufacturing Executive - Transformative Technologies Survey

Nearly 56% of manufacturing executives said their companies plan to accelerate the evaluation and adoption of transformative technologies over the next two years. And 51.3% said their companies will increase the pace of financial investments in transformative technologies.

Figure 2: Healthy Investment Pace in Technologies Expected

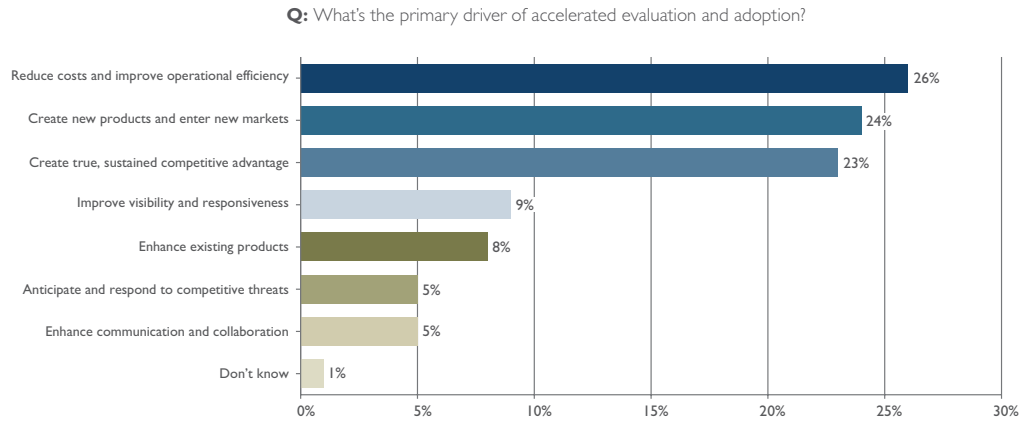
Q: Over the next 2 years, will your company increase the pace of its financial investments in transformative technologies?



Source: Manufacturing Executive - Transformative Technologies Survey

Several factors are driving this increased focus on transformative technologies. Almost 26% of respondents said these technologies will help their companies reduce costs and improve operational efficiency. Another 24.2% said they will be able to use transformative technologies such as 3D printing and new, lightweight materials to enhance existing products. And 23.2% said they believe they can exploit transformative technologies to create a competitive advantage for their companies.

Figure 3: Cost Reduction, Efficiency Primary Drivers of Acceleration

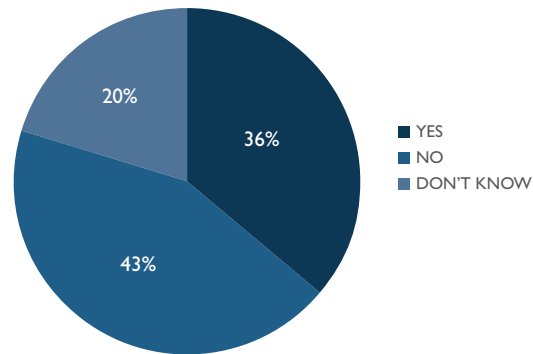


Source: Manufacturing Executive - Transformative Technologies Survey

A significant percentage of respondents—36.3%—even said their companies will be willing to increase their tolerance for risk when considering investments in transformative technologies over the next five years. Today, 20.5% of those surveyed say their companies are willing to accept risks associated with implementing transformative technologies in order to gain competitive advantage. A larger group, 39.2%, said while their companies are willing to accept some risks, their preference is to wait until technologies are proven. And 13.5% said their manufacturing companies today are still risk-averse.

Figure 4: For Many, Risk Tolerance has a Limit

Q: Over the next 5 years, will your company increase its tolerance for risk when investing in transformative technologies?

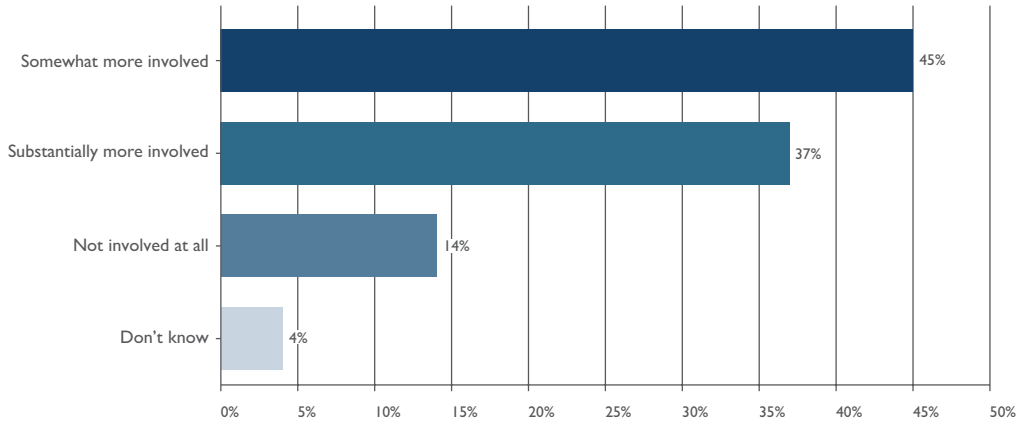


Source: Manufacturing Executive - Transformative Technologies Survey

Why are some manufacturers willing to increase their tolerance for risk when adopting potentially transformative technologies? Nearly 36% said they believe doing so will allow them to increase their competitiveness. And 34.9% said a higher tolerance for risk is necessary because potentially transformative technologies such as advanced analytics and additive manufacturing are arriving and evolving at an accelerating pace.

Figure 5: Top Executives More Involved with Transformative Technologies

Q: Which statement best describes the extent to which your CEO and other C-level executives have increased their involvement in assessing the competitive impact of transformative technologies over the past 2 years?



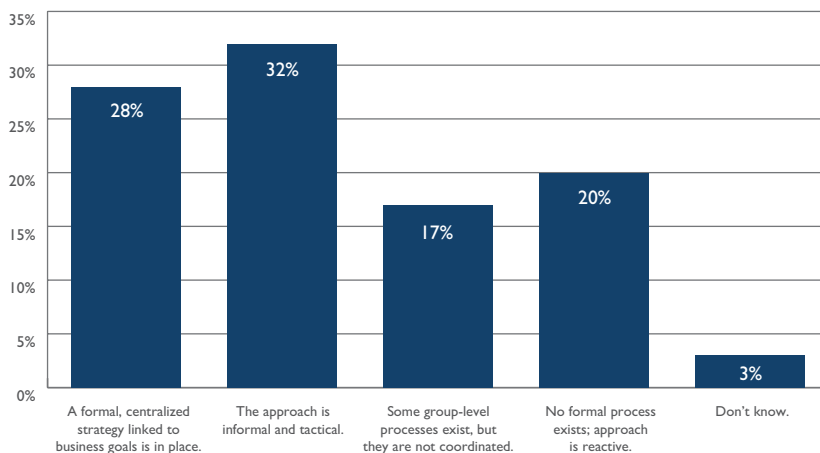
Source: Manufacturing Executive - Transformative Technologies Survey

Not surprisingly, as the perception that transformative technologies can deliver increased competitiveness has grown, so has the involvement of CEOs and other manufacturing C-level executives in identifying the potential impacts of these technologies. More than 82% of survey respondents said C-level executives at their companies are either somewhat more involved or substantially more involved today than they were two years ago in the evaluation of transformative technologies. Of this group, 37.5% said C-level executives are substantially more involved.

TRANSFORMATIVE TECHNOLOGY ASSESSMENT, PLANNING PROCESSES LAG

Figure 6: Only 28% have Formal Strategies for Evaluating Technologies

Q: Which statement best describes your company's approach to evaluating transformative technologies?

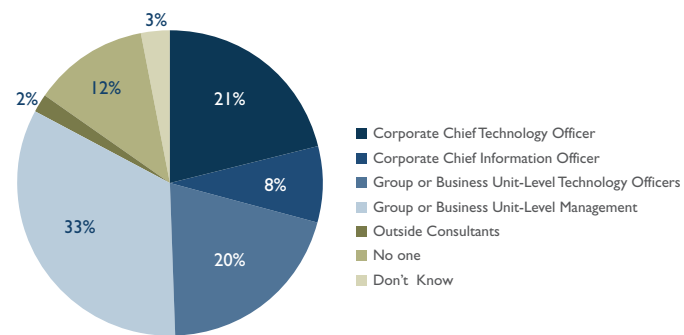


Source: Manufacturing Executive - Transformative Technologies Survey

A powerful majority of manufacturing executives surveyed, 77.6%, judged their companies at least on a par with their competitors, if not substantially or somewhat ahead when it comes to adopting transformative technologies. But, despite this assessment and the significantly greater focus being placed by C-level executives on these technologies, it is clear that many manufacturers today lack formal, strategy-driven processes for evaluating transformative technologies. In fact, the largest group of survey respondents, 32.3%, described their companies' processes for evaluating transformative technologies as informal and tactical. Worse, another 20.2% said their companies evaluate transformative technologies reactively, with no formal process in place. Only 27.7% said their companies use a formal, centralized, strategic process for evaluating transformative technologies and planning investments.

Figure 7: Business Unit Leaders Most Prevalent in Assessing Technologies

Q: Who is most responsible for evaluating the competitive impact of transformative technologies and developing plans to leverage them?



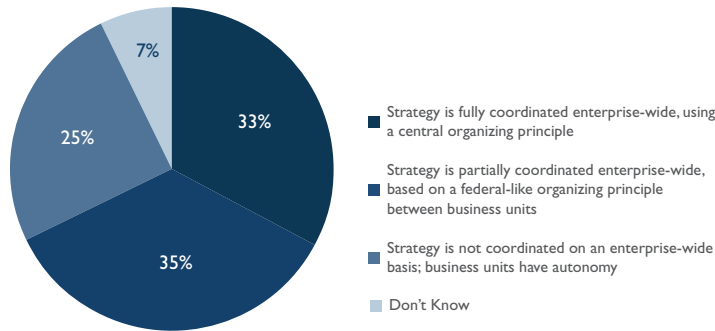
Source: Manufacturing Executive - Transformative Technologies Survey

Manufacturing executives also indicated that responsibility for evaluating transformative technologies and creating adoption plans tends to be spread across the enterprise, with a lack of coordination between groups or business units. Only 21% of respondents said a corporate chief technology officer fills that role at their companies. Just over 33% said group-level managers are responsible for assessing transformative technologies, while another 20.2% said that duty falls to group- or business unit-level technology officers. More than 12% said no one at their companies is responsible for evaluating transformative technologies.

Moreover, only 18.3% of manufacturing executives said their companies maintain an internal research organization to track and evaluate potential transformative technologies. The largest group, 25.5%, relies instead on publications and websites for research on transformative technologies, while 23.5% get their information from customers and partners. A small but noticeable percentage, 16.5%, uses conferences to keep themselves informed.

Figure 8: One-Third Say Tech Strategy is Fully Coordinated

Q: Which statement best describes the degree to which your company coordinates its technology strategy across the enterprise?

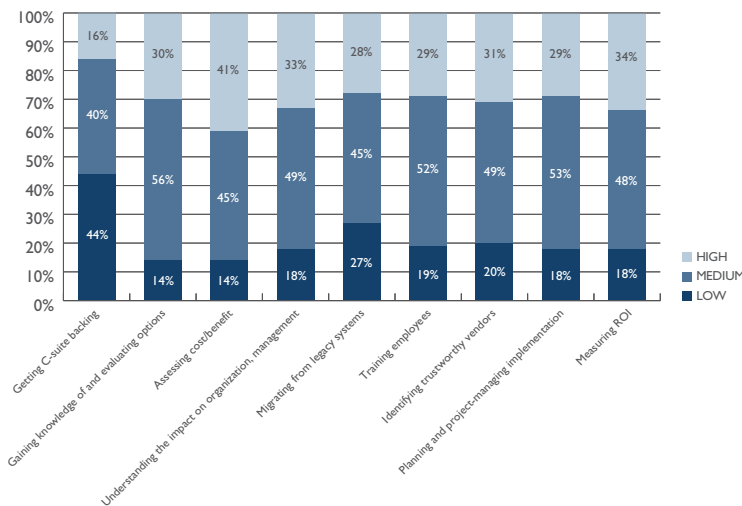


Source: Manufacturing Executive - Transformative Technologies Survey

With responsibility for assessment and planning around transformative technologies spread out at most manufacturing enterprises, a solid majority of survey respondents, 60.8%, indicated, perhaps not surprisingly, that technology strategy is either not coordinated among business units or only partially coordinated.

Figure 9: Determining ROI of Transformative Tech Is a Struggle

Q: How would you assess the following challenges in assessing and using transformative technologies?



Source: Manufacturing Executive - Transformative Technologies Survey

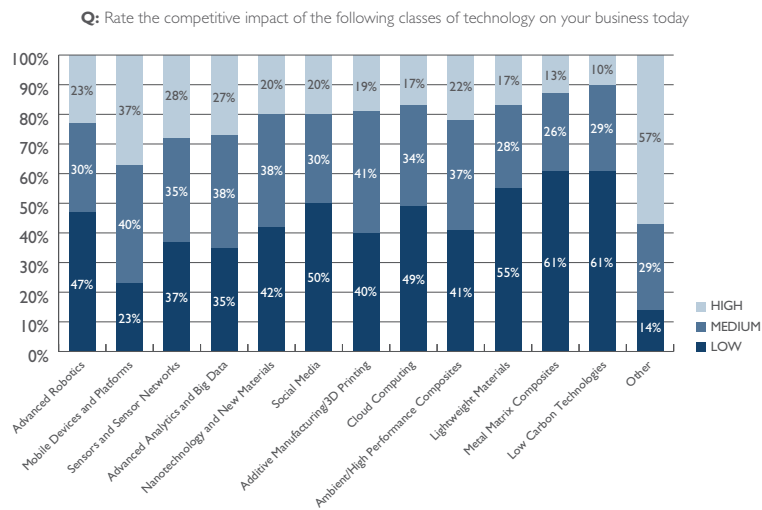
Manufacturers said they also struggle with some significant challenges when attempting to assess and adopt potentially transformative technologies. Just over 40% rated assessing the cost and benefits of transformative technologies as a high or significant challenge, while 34.3% said measuring the ROI of transformative technologies rated high on the scale of challenges. More than 33% said understanding the potential organizational and management impact of

transformative technologies ranks as a high challenge, while 30.8% said identifying reliable vendors for those technologies represents a high adoption hurdle.

With C-level executives actively involved in the assessment of transformative technologies, it is not surprising that only 15.6% of respondents called getting C-level backing for transformative technology adoption a high-level challenge.

MANUFACTURERS TARGET MOBILE, SENSOR, AND ANALYTIC TECHNOLOGIES

Figure 10: Mobility, Sensor Networks Score Highest in Competitive Impact

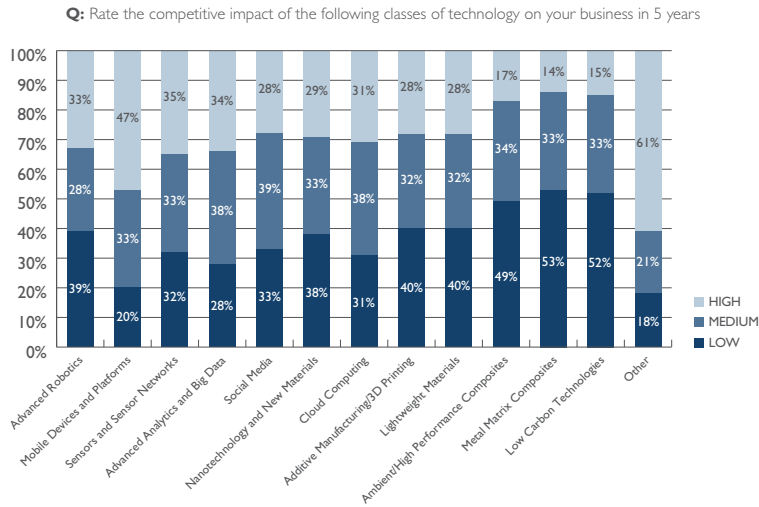


Source: Manufacturing Executive - Transformative Technologies Survey

So which transformative technologies are already helping to make manufacturers more competitive today, and which are expected to have the greatest impact in the near future? MLC survey respondents identified mobile devices and platforms as the transformative technology making the biggest impact today, as many manufacturers use the technology for an ever-widening range of applications, from improving sales and customer service processes to providing access to real-time performance data on the plant floor. More than 37% of respondents said mobile devices and platforms are already having a high impact on their companies' competitiveness today.

Other transformative technologies delivering high levels of competitiveness impact today, according to manufacturing executives, were sensors and sensor networks (27.7%), advanced analytics and big data applications (27.4%), advanced robotics (23.1%), and lightweight materials (21.9%).

Figure 11: Cloud Computing, Social Media Expected to have Bigger Impact in Future

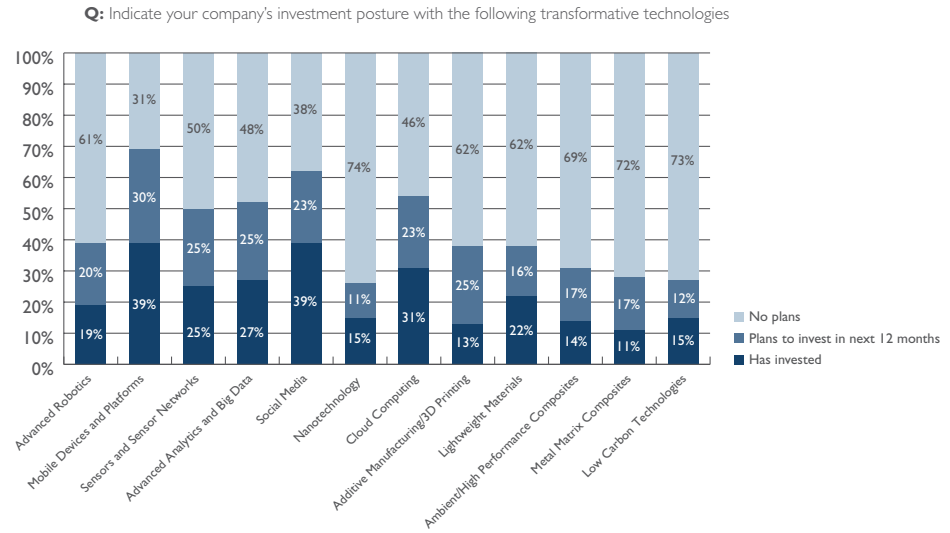


Source: *Manufacturing Executive - Transformative Technologies Survey*

And manufacturers expect the same set of transformative technologies to deliver the highest levels of competitive impact five years from now. An impressive 47% of respondents expect mobile devices and platforms to deliver a high impact on competitiveness in five years. That was followed by sensors and sensor networks (34.6%), advanced analytics and big data applications (34.3%), and advanced robotics (32.6%). Meanwhile, rising up the list of transformative technologies expected to deliver high competitive impact in five years were cloud computing applications and platforms (30.8%), as well as nanotechnology and other new materials (28.8%).

Interestingly, two emerging technologies that regularly receive high levels of media attention—additive manufacturing/3D printing and social media—received relatively low scores from manufacturing executives in terms of their current and future impacts. Perhaps manufacturing executives still question the bottom-line business benefit that social media can bring, while viewing 3D printing as primarily a prototyping tool rather than a platform for a new manufacturing model.

Figure 12: Mobility, Sensors, Analytics Investments Planned



Source: *Manufacturing Executive - Transformative Technologies Survey*

As might be expected, manufacturers plan to invest in those transformative technologies that they see improving their companies' competitiveness now and in the future. More than one-third of respondents, 38.9%, said they have already invested in mobile devices and platforms, and 30.3% said they plan to do so within the next 12 months. Just over one-quarter said they plan to invest in advanced analytics and big data tools in the next 12 months, the same percentage that plans to invest in sensors and sensor networks in the coming year.

Manufacturers demonstrated divergent plans regarding future additive manufacturing investments. While 24.5% of respondents said they have plans to invest in 3D printing and other additive technologies within the next 12 months, a hefty 62.2% said they have no plans to invest in the technology.

Meanwhile, the survey results reflected manufacturers' plans to invest in several technology-enabled process improvement initiatives. Over the next 12 months, 23.9% said they will invest in enabling the rapid configuration of production set-ups, while 29.7% said they have already done so.

And 15.6% said that, over the next 12 months, they will invest in technologies and processes that enable distributed manufacturing. An impressive 29.7% said they have already done so.

CONCLUSIONS AND RECOMMENDATIONS

As manufacturing is increasingly seen as a driver of strategic value, and as the manufacturing function becomes more fully integrated with the broader enterprise and with society, manufacturing leaders are accelerating their evaluation and adoption of a wide range of transformative technologies, including mobile devices and platforms, advanced analytics and big data tools, sensors and sensor networks, and advanced robotics. Manufacturers believe

this wave of emerging technologies has the potential to reduce costs, improve efficiencies and, ultimately, drive competitive advantage.

Moreover, it is clear that manufacturing executives view the evaluation, selection, and successful adoption of these transformative technologies as core to the achievement of their strategic objectives, rather than simply tools for achieving incremental operational improvements. More than ever, manufacturing CEOs and other C-level executives are directly engaging in and leading the assessment and adoption of transformative technologies. As a result, many manufacturing leaders surveyed said they will increase their tolerance for risk when evaluating transformative technologies. And most said they will increase their investments in transformative technologies over the next two years, a significant percentage (19.9%) by more than 25%.

At the same time, however, it is clear that the maturity of the processes many manufacturers use to evaluate, prioritize, and plan transformative technology investments have not kept pace with the growing interest in these technologies. Many have not yet adopted consistent, coordinated processes for assessing the potential of transformative technologies and linking investments to business strategy. For many, primary responsibility for evaluating and selecting transformative technology investments appears to be scattered across the enterprise, with little coordination between groups and business units taking on this task.

In order to realize the full potential of these transformative technologies to deliver competitive advantage and to advance their strategic objectives, manufacturers will need to invest not only in the technologies themselves, but also in improving and coordinating assessment and implementation processes.

To do so successfully, manufacturers should:

- Develop a framework for the coordination of transformative technology evaluation and investment. Manufacturers should consider a corporate office or committee of executives with the authority to develop best practices for the evaluation of and investment in potentially transformative technologies. This office should also create a portfolio of transformative technology investments made or under review in order to avoid duplicate investments.
- Invest in internal resources capable of independently discovering and investigating technologies that could transform or threaten the business. Such an internal expert resource could afford manufacturers the option of first-mover advantage.
- Include information about potentially transformative technologies in all strategic planning efforts.
- Create processes and resources for pilot testing potentially transformative technologies before they are rolled out on a large scale.

CASE STUDIES

Flextronics: Transforming the Supply Chain

In the fast-moving electronics manufacturing business, margins are tight and global competition is fierce. Using transformative technologies to help streamline operations, collaborate with partners, and identify future business opportunities is becoming increasingly essential.

Flextronics is the largest global end-to-end supply chain solutions company with more than 125 manufacturing operations in 30 countries, 200,000 employees, and revenues of about \$24 billion. The company provides a broad range of services from design, manufacturing, logistics and supply chain services for companies ranging from Motorola/Google and Microsoft, to Cisco and the Ford Motor Company.

So how significant are transformative technologies to the Flextronics business? Ron Tarter is senior vice president and general manager of East Coast operations at the company: “If you’d asked me this a year ago, they wouldn’t have been nearly as important,” says Tarter. “I think we are now at an important juncture. Over the last year there has been much more awareness about how technology can transform our business.

“We’re a supply chain solutions company, not a product company,” he adds, “so most of our technology investments are around innovation and process. We’re now investing much more in automation, especially in the design of the supply chain. We’re looking at how we can keep our cost structure down by completely automating the process from when a customer first has an idea or places an order, right through to final delivery and all the information that has to flow to make that happen. It’s all those things in the chain you can’t see that are important here.”

Speed and visibility across the entire supply chain are among the top business drivers for how Flextronics identifies, assesses and invests in transformative new technologies. “What we’ve discovered,” adds Tarter, “is that when everyone in the supply chain can see what’s going on, we can manage our inventory better, we can service working capital better, and we can reduce lead times and increase the speed of the entire supply chain, which is exactly what our customers desire. Any new technology that helps us achieve this is important to us.”

Flextronics has a strong tradition of harnessing transformative new technologies across many of its operations. It was an early adopter of cloud technology and has now transferred many of its core business systems into the cloud. The company also uses cloud platforms to support its own innovative applications. These include a Facebook-like application called Whisper Enterprise Collaboration to help foster greater collaboration and interaction between its 30,000-plus global suppliers, and an internal YouTube-type video sharing app for engineers to share problems and solutions with their peers around the world.

At a production level, Flextronics has invested extensively in plant floor automation systems and advanced robotics. It has also developed its own Web-based quality control system that everyone in its supply chain can access.

The company has developed its own Flextronics Supplier Portal Program (FSP), a next-generation supply chain collaboration solution used to manage supplier communications, transactions, and processes. An e-sourcing tool uses the SAP E-Auction software to provide an online collaborative environment between Flextronics and its numerous suppliers around the world. Its new Product Innovation Centers also house design labs, 3D printing systems, and new product introduction capabilities that rapidly prototype new products across a wide-range of industries.

Next on Flextronics' transformative technology horizon is big data analytics. "We are still at an early stage in this endeavor, but we're beginning to use big data tools to help us decide where we want to take the company, where our customers' markets are going, what kind of areas we can succeed in, and what technologies are available," says Tarter. Much of this activity is focused on understanding what is trending in different global market environments that are in flux, allowing the company to provide and suggest new solutions for its customers.

"What's going to be really transformative for Flextronics," concludes Tarter, "is to get the supply chain design fully automated, including all the things you can't see, and to become more predictive. Then we can build a much more regional supply model to allow our customers to respond faster and be closer to their customers. We think that will help us be far more competitive in higher-cost regions like Europe and the US. That's what's getting us all excited right now. How do we use technology to get more speed and visibility, not just from low-cost locations, but in a much more regional way across the world in the future?"

L'Oréal Embraces the Cloud, Social Tools

L'Oréal, one of the world's most iconic consumer products companies, operates in a market that always seems to be moving faster and changing rapidly. Across its 27 international brands – among which are L'Oréal Paris, Garnier, Maybelline New York, Lancôme, Giorgio Armani, and Yves Saint Laurent – the company produces more than 5.8 million products annually, of which 87% are manufactured in-house at the company's 42 factories.

For L'Oréal, fast is never fast enough in the highly competitive beauty industry. Products must satisfy a broad range of consumer tastes and requirements, be made according to the highest standards of quality and efficiency, and brought to market quickly. That's why the company is embracing a set of cloud, social and mobile technologies to improve its operations as well as its engagement with consumers.

Morris Lenczicki, vice president of industrial systems applications at L'Oréal USA and a survey respondent, said L'Oréal is looking for technologies to improve supply chain efficiencies as well as social and mobile tools to better share ideas and information throughout the company, which includes opportunities that Cloud can potentially offer. He said he expects L'Oréal's investments in these technologies to increase in the next few years.

"The total cost of ownership of cloud may not be advantageous in the end, but we do believe firmly that it brings speed to implementations, and this brings business value sooner," Lenczicki said, noting that these transformative technologies are evolving so rapidly that it is hard to

understand their effect on the company's structure and on how people work. "We will need to establish partnerships with providers and at the same time invest in our internal resources to better understand their impact."

And even though there are relentless demands for greater speed and efficiency, Lenczicki said L'Oréal takes a measured, rational approach to adopting and using new technologies. "We cannot change everything at once," he said. "We have to assess where best to take advantage of new technologies while still benefitting from our existing structure."

RESEARCH AND WRITING TEAM

David R. Brousell, *Global Vice President, Research, and Editorial Director*

Jeffrey R. Moad, *Research Director and Executive Editor*

Paul Tate, *Research Director and Executive Editor*

Silicon Valley

331 E. Evelyn Ave. Suite 100
 Mountain View, CA 94041
 Tel 650.475.4500
 Fax 650.475.1570

San Antonio

7550 West Interstate 10, Suite 400,
 San Antonio, Texas 78229-5616
 Tel 210.348.1000
 Fax 210.348.1003

London

4 Grosvenor Gardens
 London SW1W 0DH
 Tel +44 (0)20 7343 8383
 Fax +44 (0)20 7730 3343

877.GoFrost • myfrost@frost.com
<http://www.frost.com>

ABOUT THE MANUFACTURING LEADERSHIP COMMUNITY

The Manufacturing Leadership Community, part of Frost & Sullivan, is the world's first member-driven, global business leadership network dedicated to senior executives in the manufacturing industry. The community's mission is to help senior executives define and shape a better future for themselves, their organizations, and the manufacturing industry at large. It produces an extensive portfolio of leadership networking, information and professional development products, programs, and services, including the [Manufacturing Leadership Community Web portal](#), an online global business network with more than 5,800 members around the world; the [Manufacturing Leadership Council](#), an invitation-only executive organization of more than 100 members; the prestigious annual [Manufacturing Leadership Summit](#) in Palm Beach, Florida (June 3-5 2014); the [Manufacturing Leadership 100 Awards](#) program celebrating industry achievement; and the thought-leading Manufacturing Leadership Journal publication.

ABOUT FROST & SULLIVAN

Frost & Sullivan, the Growth Partnership Company, works in collaboration with clients to leverage visionary innovation that addresses the global challenges and related growth opportunities that will make or break today's market participants. For more than 50 years, we have been developing growth strategies for the Global 1000, emerging businesses, the public sector and the investment community. Is your organization prepared for the next profound wave of industry convergence, disruptive technologies, increasing competitive intensity, Mega Trends, breakthrough best practices, changing customer dynamics and emerging economies? Contact Us: Start the Discussion

For information regarding permission, write:

Frost & Sullivan
 331 E. Evelyn Ave. Suite 100
 Mountain View, CA 94041

Auckland

Bahrain

Bangkok

Beijing

Bengaluru

Bogotá

Buenos Aires

Cape Town

Chennai

Colombo

Dubai

Frankfurt

Iskander Malaysia/Johor Bahru

Istanbul

Jakarta

Kolkata

Kuala Lumpur

London

Manhattan

Mexico City

Mumbai

Moscow

Oxford

Paris

Pune

Rockville Centre

San Antonio

São Paulo

Seoul

Shanghai

Singapore

Sophia Antipolis

Sydney

Taipei

Tel Aviv

Tokyo

Toronto

Warsaw

Washington, DC