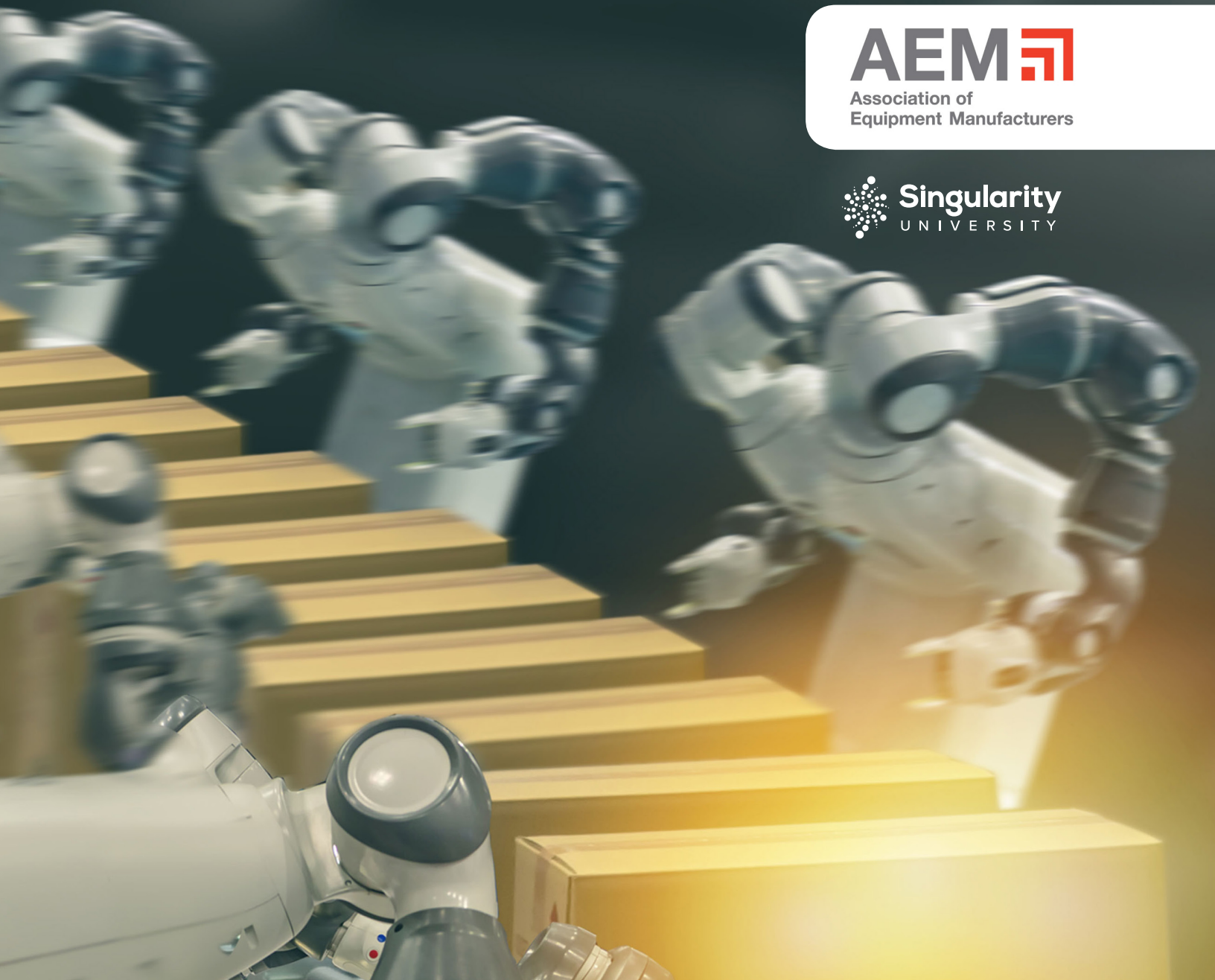
EXPONENTIAL POSSIBILITIES

Insights on the Potential Future of the Equipment Manufacturing Industry



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It's hard to think of an exponential technology that doesn't feed into the manufacturing sector.

Ray Kurzweil, *Co-Founder and Chancellor of Singularity University*

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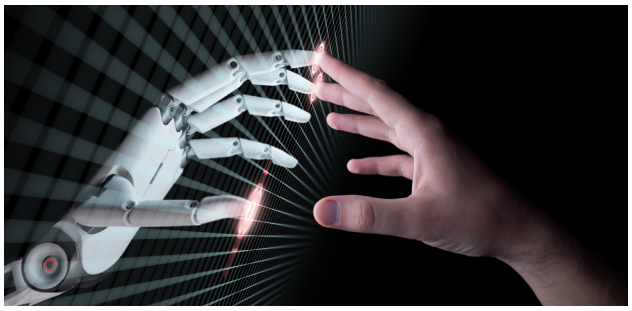
Introduction

It's no exaggeration to say that the industrial revolution of the late 19th and early 20th centuries dramatically changed every aspect of the world's economy, society, and our daily lives. Today, an even more sweeping transformation is in the works. There's no doubt we're entering a new era of global business in which the manufacturing sector is on the cutting edge of innovation.

Exponential and emerging technologies are transforming the world of manufacturing before our eyes, more rapidly and radically than we could have expected. Imagine a world where heavy equipment is:

- No longer purchased by our current customers, but contracted by project owners
- Designed without manual controls
- Guided by remote operators from half a world away
- Equipped with sensors that generate precise billing data for each job



In September 2018, the Association of Equipment Manufacturers (AEM) Futures Council joined with Singularity University (SU) for a workshop to discuss the ramifications of various trends that could reshape our industry. Together, we explored how AEM members can better understand the challenges and opportunities of exponential technologies and their enormous impact on construction, agriculture, and other equipment manufacturing sectors.

In this report, we'll recap the key takeaways from the workshop and explore major industry technology trends that reveal just how quickly manufacturing paradigms are shifting.

- First, we will examine the **impact of the exponential technologies** fueling these shifts, and some of the people and organizations leading the charge.
- Then, we'll explore what it means to be an **exponential enterprise**—something every manufacturing organization must become.
- Next, we'll share some **insights on industry disruption** from AEM Futures Council members.
- Finally, we'll list some helpful **resources and next steps** you can take on your journey to becoming an exponential manufacturing organization that can survive and thrive far into the future.

"A lot of the value that we currently provide in what we bring to the marketplace is going to become commoditized, and it's not going to be of any value anymore."

Brian Bloczynski
Vice President of Manufacturing, Kondex Corporation

SESSION RECAP

The impact of exponential technologies

Jonathan Knowles, SU Faculty, Technology, Innovation, and Exploration

According to the Singularity University Exponential Primer, exponential technologies are those which are rapidly accelerating and shaping major industries and all aspects of our lives. Exponential technologies include artificial intelligence (AI), augmented and virtual reality (AR, VR), Internet of Things (IoT), data science, digital biology, medicine, nanotech and digital fabrication, networks and computing systems, robotics, and autonomous vehicles.

One of the best things you, as AEM members, can do for your organizations is to get them to really understand the exponential growth, and the rapid acceleration to a lot of these technologies.

There is nothing any of us can do to keep the accelerating rate of change driven by exponential technologies from happening. It's already happening. But before you change the value you provide, you have to change your mind. You can go out and buy tools. You can go out and learn the skills. But the change of mindset needs to come first.

Something we all know by now is that tomorrow will be nothing like today. This happens over and over again, that our lives are dramatically impacted by technology. And sometimes the speed of change is overwhelming. Think of Nokia. It had 47% of the global mobile hand-held telephone market in 2007. Now, Nokia really doesn't exist, except as a brand name.

Stewart Brand said that "today used to be yesterday's unimaginable future." On December 16, 1903—the day before Orville and Wilbur Wright got their odd-looking invention off the ground—humans couldn't fly. So many people thought it just wasn't meant to be. Yet, less than 70 years later, we sent people to the moon and back again. In that moment, we again achieved the impossible. This happens over and over again.

The Raspberry Pi Zero—a fully functional computer, the size of a business card—now costs five dollars. That means that for the price of a Starbucks Caffè Latte, today you can purchase processing power similar to that of a 1988 Cray Supercomputer that cost about $12 million in today's dollars.

And then someone recognized that the NVIDIA graphic processor units being used primarily for gaming could be used for neural networks, machine learning, and deep learning applications. Because of the realization that graphic processor units can do massive parallel computing, we now create deep learning algorithms that simulate the way humans think. The exponential future has already arrived, and it's happening faster than ever.

SESSION RECAP

The exponential enterprise—and why your company must become one

Renu Kulkarni, SU Principal Faculty, Corporate Innovation

An **exponential enterprise** is an organization that, over the years, consistently delivers disproportionate results relative to its peers. In this case, the disproportionate results we have in mind are 10x greater than industry norms, as measured in profit or impact. These enterprises are built around more innovative technologies, using **exponential business models** to achieve 10x growth.

That is a bold statement, but we have seen organizations leap from 10% gains to 10x growth by leveraging exponential thinking and exponential technologies. In fact, there are many examples of organizations experiencing this type of accelerated growth by employing savvy business models and smart applications of exponential tech.

A clear example of the need for organizations to embrace innovation—to disrupt themselves before someone else does—can be found in the S&P 500. In 1965, the average lifespan of an organization listed on the S&P 500 was 33 years. Today it's in the 20s, and by 2027, the average lifespan is forecasted to be just 12 years. That means today's enterprises should already be building the capabilities that will enable them to become exponential organizations and make the leap from 10% improvements to 10x outcomes.

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Five capabilities exponential enterprises must build:

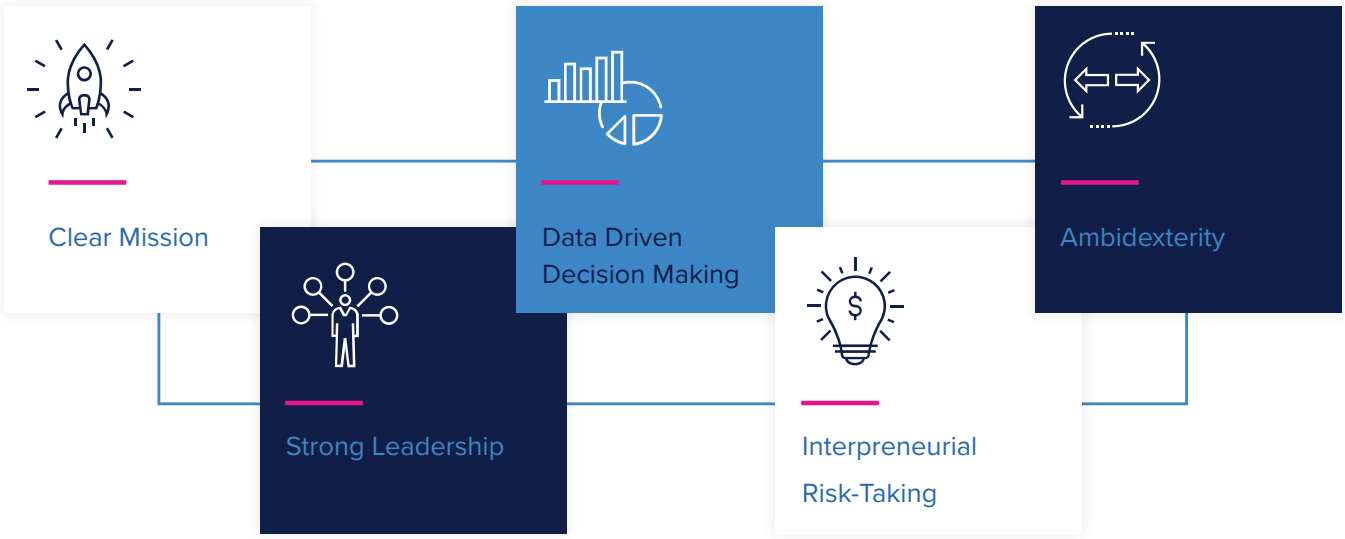


Image courtesy of Renu Kulkarni, SU Principal Faculty and Managing Director, 10x Strategy

1. A **clear mission** for your organization includes having a purpose beyond making a profit. A classic example of a clear mission is when, in 1961, President John F. Kennedy announced that the U.S. would go to the moon by the end of the decade. This bold mission statement changed the course of history.

2. **Strong leadership** means connecting with the clear mission that you've articulated, strategically and consistently. A key requirement for strong leadership is agility. Organizations should be as flat as possible in terms of hierarchy, with reduced focus on org charts—or no org charts at all.

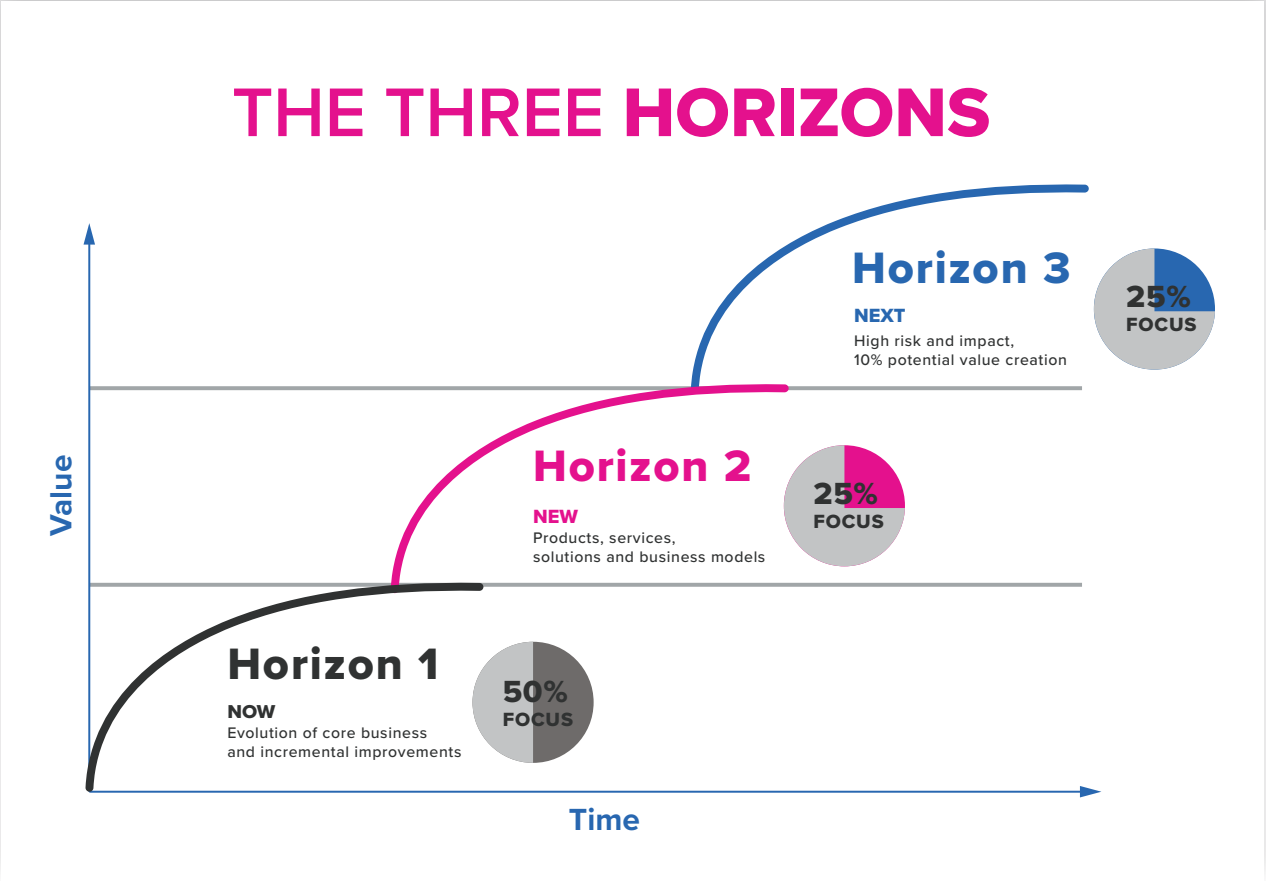
3. **Data-driven decision making** involves developing a culture informed by data analytics, and increasingly, predictive analytics. Relevant metrics should inform decision-making in every dimension of the business.

4. **Intrapreneurial risk-taking** is characterized by an experimental mindset and continuous learning. These organizations have accelerators, incubators, and ambitious experiments that often fail—but failure that drives fast learning and consistent improvement.

5. **Ambidexterity** is the ability to successfully do seemingly opposing things at the same time. Ambidexterity is displayed by balancing organizational objectives and focus between the present and the future. This is sometimes called Horizon 1, 2, and 3 thinking. For more on the 3 Horizons, see the Innovation Leader's Checklist.

Planning across the Three Horizons

One planning tool that can be useful for all types of organizations is to map growth across the Three Horizons. The original version of this framework first appeared in a book called *The Alchemy of Growth*. This framework can be immensely helpful to clarify that for optimal results, organizations must focus on innovation efforts in all three horizons concurrently, as shown below. Learn more about the Three Horizons framework.



Insights on Industry Disruption

Pressure-testing the status quo

During the workshop, Singularity and the AEM Futures Council took part in an exercise in which Council members were asked to consider these questions:

- **How do you define your business? What customers do you serve? Who are your suppliers and partners? Who are your competitors?**
- **What assumptions do you hold today that allow for this business model to be successful?**
- **Based on everything you've heard about exponential technologies and organizations, what NEW assumptions may hold true 10-15 years from now?**
- **Which assumptions from today may no longer apply?**

Approaching these questions simply from the speculative standpoint of what is possible, the Futures Council pondered the potential impact of trends and technologies that could disrupt our industry.

For the purposes of the exercise, no idea could be ruled out as too "far-fetched." We share below some of the important insights about the potential future of equipment manufacturing that emerged from this discussion.

Looking at tomorrow, we may not be actually fabricating the equipment anymore, but we're providing a solution for a job to be done.

Bob Martin
Market and Business Insights Manager, Vermeer Corporation

Equipment-as-a-service

What if the paradigm shifts:

> ***From** a business model where AEM members build equipment and sell it to contractors and farmers . . .*
>
> ***To** a business model where AEM members sell construction and agriculture solutions?*

In other words, customers don't purchase the means to complete a job, they purchase the completion of a job and pay by cubic yards of dirt moved, miles of road paved, or bushels of corn harvested. Council members felt that such a shift could be leveraged to the industry's benefit.

Our current customers may not be doing the actual work anymore, because it is likely that work could be done more efficiently by those

of us who are now manufacturers. The project owners would be the ones contracting with the OEMs as primary partners. Software companies will enable the customers themselves to get input and feedback on what needs to happen.

Today, we're making machines out of iron. Typically, bigger is better. The bigger it is, the more it can get done. We've got an established distribution network—for the most part, a traditional distribution network. We rely heavily on skilled operators, and on our suppliers. Today's equipment, for the most part, is highly specialized. It's designed to do one job very well. We can assume in the future that some of these business models and practices will no longer be applicable. In fact, every one of these practices could potentially no longer be valid.

"Narrow AI seems highly applicable to our industry. The first step might be that we don't need an operator on site. They could be in India working at night, and maybe an AI will enable a twelve-year-old to run equipment from home. Then AI evolves to enable the machine to teach itself until, over time, it can operate on its own."

Autumn Steinert

Partner, Circle S Sprinkler and Steinert Farms

Remote and AI-operated equipment

What happens if the job market and financial pressures combine to create a demand for equipment that is operated remotely by operators at sites all over the world? What would that mean for equipment design? Such a shift

would also force individual brands to collaborate more heavily on equipment interoperability.

In all likelihood, remote equipment operators are a key part of the future, so equipment will be operated by people from all around the world, as opposed to having someone sit on a machine.

That means that AEM members would potentially have to collaborate with other manufacturers to create a construction site ecosystem of connected equipment that is communicating together, even if we aren't manufacturing all of the equipment that's existing in the ecosystem. The development of shared standards would be necessary for the ecosystem approach to function.

The growing role IoT systems play in equipment will enable the eventual development of an AI platform to run the equipment without any operator—onboard or remote. A self-teaching AI could study telematics data from equipment in the field, analyze successes and failures, and eventually replace human operators.

"To move forward, it's often beneficial to take a couple steps back. Sometimes, it's not whether we can create a different or improved way to dig a hole, but can we create a solution that doesn't require the hole to be dug?"

Bob Martin
Market and Business Insights Manager,
Vermeer Corporation

Smaller, modular equipment

If equipment could be operated autonomously, that means that it would no longer need to accommodate a human operator or provide for human comfort and safety. This could challenge the current notion that "bigger is better" in equipment.

In an equipment-as-a-service business model, there will be a demand for less-specialized equipment as well. Modular products could be produced to connect with standardized subframes and various attachments, depending on the solution that's needed. This would simplify the logistics network needed to provide solutions, enabling solutions providers to ship smaller components instead of entire pieces of heavy equipment.

Outside disruptors moving into the industry

As equipment comes to rely more heavily on software, members feel it opens the industry up to competition from traditional technology companies. While the specialized nature of the industry presents a barrier to outside disruptors, these disruptors will grow bolder as technology advances, especially if traditional manufacturers fail to innovate rapidly.

And what about future competitors? Software developers and potentially AI itself could be big competitors to our business model if they can provide better solutions than we can.

Looking 10 or 15 years into the future, customers and competitors are going to look very different than they do today. We're in an industry in which we all recognize that consolidation is happening. We will have different groups of people we're dealing with. We may deal with some of the same people, but there are going be new people and organizations in our industry—and some who won't be around anymore, and we need to address that.

There was an interesting point made that a lot of the value that we currently provide in what we bring to the marketplace will become

commoditized and won't be valuable anymore. We now have to think about the next value chain and the next value proposition. And the customer experience is going to be even more paramount than it is today, because of all this constant feedback and choice that customers have.

"Technology is disrupting every facet of traditional manufacturing and industrial processes across the board and throughout the supply chain—hardware, software, economics and infrastructure. They are all changing rapidly, and they're never going back."

Guru Bandekar
Vice President, Global Engineering & Program Management, JLG Industries

Next-generation repair and maintenance solutions

Predictive maintenance could reduce downtime. Augmented reality could revolutionize training, repair, and maintenance processes. It's likely that replacement parts could be 3D-printed onsite in the future, rather than obtained through a traditional supply chain.

Learn more about how exponential technologies will power the future. Download SU's free ebook, *Manufacturing on the Cutting Edge*.

In the future, equipment maintenance and customer care become paramount. Competitive advantage will be all about keeping service levels up. Here is a potential disruption that changes the labor force: instead of an operator or repair tech, you become the manager of the technology, or the manager of an equipment-as-a-service offering. And as manager, you are the interface with the technology and the hardware—whether you're remotely operating it or you're sending technicians in with augmented reality platforms that are instructing them how to make repairs in real-time.

A declining need for heavy equipment?

As more technologies become wireless, it stands to reason that the need for underground utility projects will wane, impacting the demand for equipment. If car ownership continues to decrease, will this in turn reduce the need for road-building? As new food-growing and waste elimination technologies come online, will this also impact equipment sales?

Today people make machines—but in the future, machines will make machines. Today, we just assume that we have to make the hardware. In the future, maybe we don't have to make the hardware; maybe we can just skip that step and make software.

We make current decisions based on the fact that roads are hardscape. Maybe those roads will evolve into something else or be built with something else. In the future, will we actually need to move earth and build roads as we do today? Maybe there's a different assumption to be made in the future about that.

"The most fascinating thing about the whole city-of-the-future concept is the preconceived notions that automatically get applied to it. You can think about the Jetsons. They fly around in personal spaceships, but George Jetson still works for a sprocket company."

Jim Colvin
President and Chief Executive Officer, Serious Labs

Funding models

Currently, road construction is tied to public policy. Could a new funding model come into play that would create increased demand for infrastructure improvements? For another example, consider how large projects are funded. Today we're tied to public policy as a funding model for a lot of things, but maybe in the future there will be alternative forms of funding that make it easier to sell your hardware or software.

Today, equipment is really considered an asset or an investment. In the future, maybe the equipment, the metal it's made from, is disposable in some way, shape, or form. The hardware may become less important, and perhaps it will be the software that becomes most highly valued.

Today, the assumption is that we are paid for hardware, not software. In the future, we could be looking at the opposite situation, where we are paid for software. Today we have traditional building, where people come on-site and build something. In the future, maybe the model becomes that the people are off-site, with machines building on-site.

"We really challenged the whole idea around roads and infrastructure. If things are flying and they are not driving and rolling, do we need roads? Houses could be on stilts, then we would fly from one house to the next. All of that changes the entire problem at hand, actually."

Jason Hallett
Vice President of Global Software, Topcon Positioning Systems, Inc.

Traditional manufacturers are at a crossroads

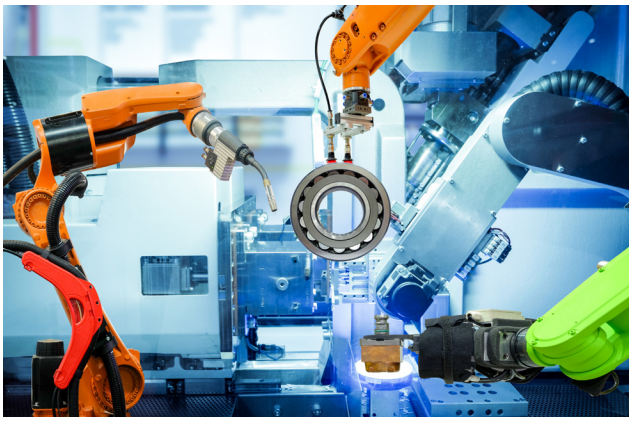
In order to thrive, exponential manufacturers are those who understand:

- What business they are in
- The exponential technologies driving change
- 10% improvement vs 10x outcomes
- How to become an exponential enterprise
- Future skills, tools, and resources

A final component to becoming an exponential manufacturer is an active and supportive network—an innovation ecosystem to help you reach your goals. AEM members have a built-in advantage because they have member companies, the Futures Council, and SU's resources to help jump-start and accelerate their innovation journeys.

Next Steps on the Exponential Journey

1. Create a portfolio of new strategic choices to drive your initiatives
2. Cross-disciplinary working teams to break down silos
3. Lower risk of failure/fail fast/often
4. Celebrate learning, not an outcome
5. Form partnerships with incubators, accelerators, hackerspaces
6. Integrate your technology strategy into your corporate strategy



What's next?

Where you go from here will depend on several factors, including your current situation, your organization's goals, and the amount of resources dedicated to your innovation journey. In addition, since exponential technology trends are a fundamental driver and accelerator of change, it's important to have a solid understanding of the technologies that affect your business and the manufacturing industry.

We hope you found these examples and insights thought-provoking. Visit aem.org/think to learn more about AEM's Thinking Forward initiative.

Thoughts? Share your own insights at thinkingforward@aem.org.

Is your innovation strategy moving your organization in the right direction? This five-minute assessment offers actionable insights and relevant best practices to help you optimize your approach to innovation and better prepare your organization for the future. Check out Singularity University's Exponential Innovation Assessment at su.org/quiz.

Resources

Books

The Singularity is Near by Ray Kurzweil

Abundance: The Future is Better Than You Think by Peter Diamandis, Steven Kotler

Bold: How to Go Big, Create Wealth and Impact the World by Peter Diamandis, Steven Kotler

Exponential Organizations by Salim Ismail with Michael S. Malone and Yuri Van Geest

Fit for Growth: A Guide to Strategic Cost Cutting, Restructuring, and Renewal by Vinay Couto, John Plansky and Deniz Caglar

Measure What Matters by John Doerr

Online

AEM website: aem.org/think

AEM Thinking Forward Podcast: https://www.aem.org/about-aem/podcast/

Singularity University website: https://su.org/

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Singularity University Resources: https://su.org/resources/

Manufacturing on the Cutting Edge: https://su.org/resources/ebook/manufacturing-on-the-cutting-edge/

Exponential Technologies in Manufacturing Report (produced with Deloitte and the Council on Competitiveness): https://su.org/resources/report/exponential-technologies-in-manufacturing-report/

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