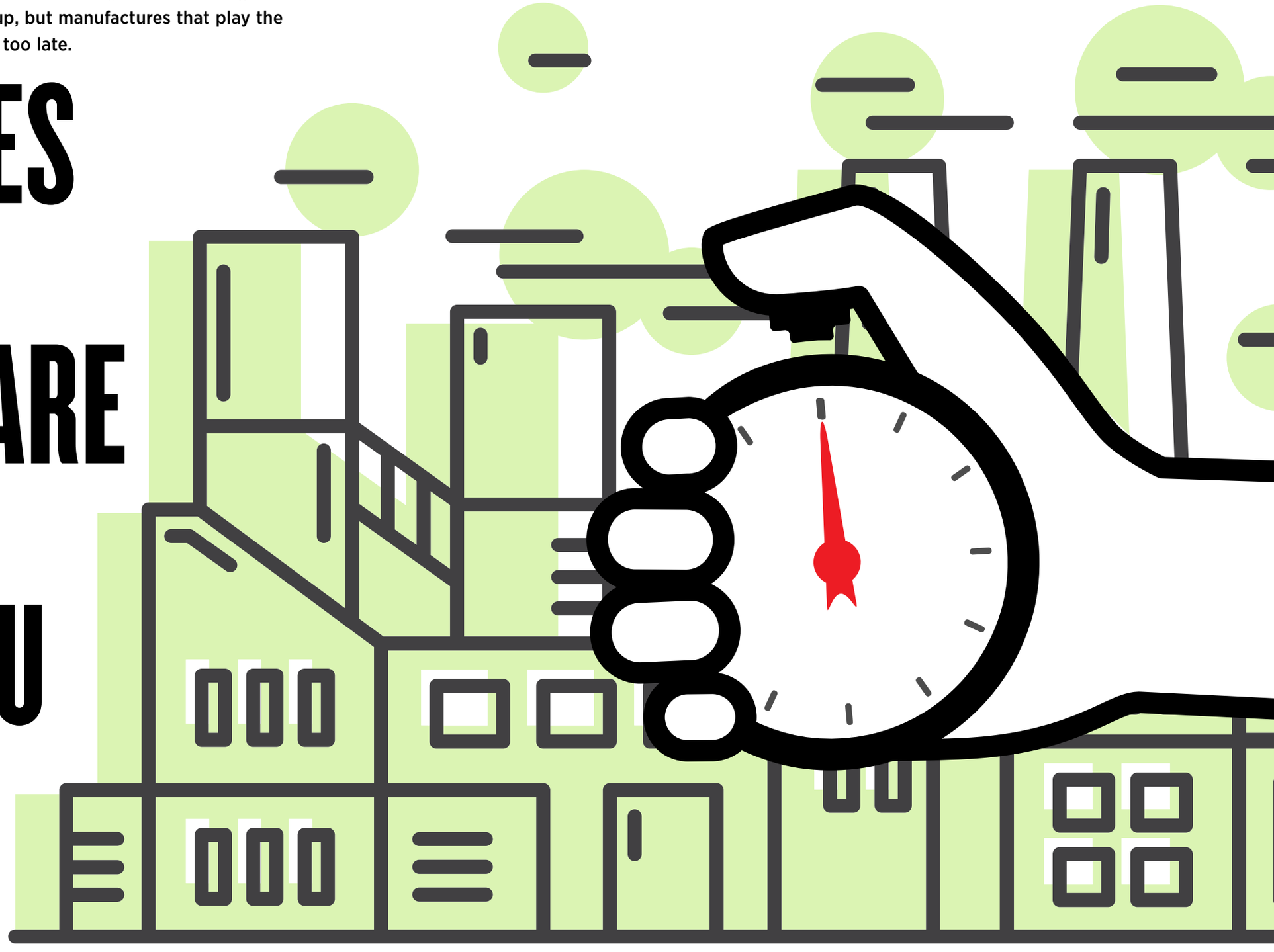
MANUFACTURING LEADERSHIP JOURNAL

Future factories are fast becoming a competitive imperative as the adoption of advanced Manufacturing 4.0 technologies continues to drive efficiency, flexibility, customization, autonomy, and product innovation. Early adopters will gain advantage, fast followers will play catch-up, but manufactures that play the wait and see game may find it's suddenly too late.

FACTORIES OF THE FUTURE ARE CLOSER THAN YOU THINK

By Scott Renner



Scott Renner is Global Director of industrial Manufacturing at Oracle Corp. and has helped to guide industrial manufacturing companies through major operational and management system transformations for more than two decades. A former independent manufacturing and supply chain consultant, Renner holds a degree in management information systems from the University of Cincinnati, and an M.B.A. from the Xavier University's School of Business Administration.

THE CHANGING NATURE OF PRODUCTS AND CUSTOMER ENgagement in today's evolving world is creating new industry segments and reinventing, sometimes even eliminating, others. In this fluid environment, manufacturers have become acutely aware of the risks of being left behind if they do not master emerging technologies on their plant floors.

But manufactures don't acquire and implement technologies just because they are cool. There has to be a compelling reason based in business gains and/or competitive pressures in their markets. Many of the advanced technologies often cited as part of the new digital transformation have in fact been around for a long time. Now, however, they have matured and the barriers to adoption have been lowered, or simply removed. These emerging technologies, combined with the slow but steady drumbeat of socioeconomics, are colliding to create both the ability and necessity of new Manufacturing 4.0 approaches.

Manufacturing's agility has sometimes been likened to that of the Titanic – slow, expensive to change, and disastrous when things go wrong. Factory infrastructure has historically required large investments with long capitalization periods. With so much at stake, why should companies start steering production towards the modern 'factory of the future' that capitalizes on cutting edge technology?

It's the socioeconomic changes that in the end will cause the most dramatic shift in how our factories operate, where they operate, and the kinds of technologies that will drive them. Without the changes in economies and customer's needs and expectations, many of the new technologies would be destined to adoption on a use-by-use basis. Understanding the underlying drivers from customers, product innovations, geo-political, and competitive pressures is pivotal to understanding the factory of the future.

Customers Want To Get Personal

Not since the baby boom has the customer had such an impact on the factory. With a scale so large it's often difficult to discern, the customer is changing what it is that he or she wants from products, how they want to consume them, and what relationship they have with the manufacturers who produce them.

The need for instant gratification, personalization, and rising expectations of individualistic product attributes, are pushing product engineering and manufacturing to new levels of customized complexity. Manufacturers are responding with shorter product life cycles, and more product options, resulting in lower lot sizes and higher product mixes.

To maintain costs and product quality, manufactures must increase their effectiveness, yet socioeconomic forces are now giving rise to the need for more factory automation combined with more flexibility, which have not historically been paired together. In the factory of the future, conversion processes need to go beyond automation and become autonomous. This march to autonomous production will not be driven by technological capability primarily, but by the need to profitably convert materials into products that have many customized characteristics.

Manufacturers have traditionally reacted to the need for greater efficiency with automation, more sophisticated decision systems, and robotics to eliminate high cost labor. But the factory of the future pushes past the simple replace labor with a machine scheme. To convert materials to products more efficiently in the future, machines will need to make decisions in more flexible, unstructured ways.

The Evolution of Factory Intelligence

Many emerging technologies will be deployed to help create these enhanced capabilities. Artificial intelligence will develop so that it not only directs physical operations, but also transforms our current understanding of product configuration, production scheduling, and real-time decision making for optimized profitability.

Digital twin capabilities will evolve as the ultimate factory management tool, where the physicality of the factory is combined with past and current data attributes of product and process to assess impacts on throughput, quality, or product/machine changeover. The sophistication of the digital twin becomes the instant-replay of production sequences for analysis.

IIoT will be combined with 5G cellular connectivity to go beyond creating a central repository into data lakes for analysis. Networked machines will communicate critical data to other machines in what is destined to be defined as a state of awareness. In reality, this real time communication within the physical material conversion network becomes the ultimate lean manufacturing control mechanism. Data shared amongst the machines turns into intelligence that ensures that manufacturing assets operate as a balanced system.

The need for manufacturing flexibility, responsiveness, and efficiency will also change the physicality of workspaces. Machines are now learning to work alongside human labor where human intelligence and flexibility of movement are required to maintain the integration of sub-systems within the factory. However, the evolution of machines will continue. Production assets will no longer need to be dedicated to a small set of conversion tasks. Their enhanced capabilities will be the foundation of the modular production facility, where manufacturing processes can be configured on an order by order basis.

Ultimately, these dynamics and technical capabilities may create factories that can autonomously recognize demand, configure a production plan, assemble the necessary assets for the conversion of material, and react to real-time feedback within the factory ecosystem.

Product Innovation Will Depend on Advanced Environments

The digitization of the economy is also changing the nature of products. Data will no longer be a by-product of the manufacturing process, but will become a co-product that delivers increasing economic value to both the customer and manufacturer. As a product's

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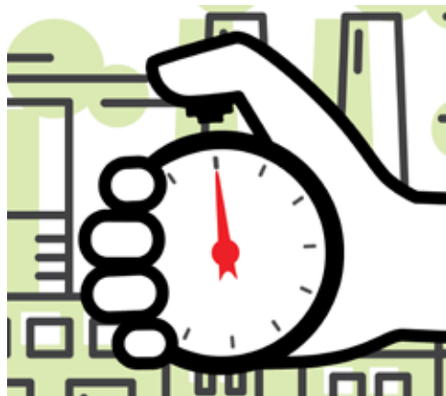

physical attributes become commoditized by competition and higher quality, manufactures will compete in non-traditional areas. Factories will produce goods that have converged attributes which are important to the customer. Physical, digital, and social capabilities become parts of the same product, inevitably increasing the complexity of product design, builds, new systems, and collaboration with eco-system partners.

New methods and materials have always been central to the evolution of manufacturing conversion processes. But pending breakthroughs in material technology do not fit the old mode of incrementally enhancing existing products for traditional machining, fabrication, and assembly processes. Technical and economic breakthroughs in new materials will revolutionize product design and application, and whole new industries will rise up to support them.

The advanced digital nature of future products is a given, but their changing physical characteristics may have even more of a transformational impact on the manufacturing industry as digital technologies are having today. These advancements will come from an array of potential game changers, such as advanced polymers, graphene, nanotechnologies, electrification, etc. While the adoption of new materials will be driven by the traditional need for product enhancements, environmental, and energy efficiency forces, these new materials will not fit into traditional conversion methods so will force existing manufactures to adopt to new approaches, and they will also create new market spaces for competitive entrants.

This is currently happening most acutely with additive manufacturing where the potential to revolutionize manufacturing is just beginning to be realized. Finding initial applications in prototyping, 3D printing will continue to migrate toward the center of production facilities. Perhaps at first for producing low volume parts, or repair/replacement parts, but eventually deployed in the heart of a manufacturing line where multiple parts are simultaneously produced and consumed into higher level assemblies, creating the most efficient just-in-time delivery possible and a key enabler for product individualization.

Globalization Favors the Tech-savvy

Globalization has been an economic dynamic that has affected manufacturing since WWII. Historically, globalization was mostly about international trade agreements, standardizing methods and terms, and ensuring financial liquidity between states. This had a direct effect on the factories of developed economies as it opened up foreign markets to increased sales.

However global access to lower labor rates since the 1970s has also meant that factory assets and jobs have shifted to developing countries such as Latin America, and then to Asia, and then back to Latin America, and so on.

But today's manufacturing environment is rapidly evolving from the goal of minimizing direct labor costs and maximizing the economies of scale, to the potential elimination of many direct labor costs and the maximizing of market-driven product customization. This evolution is perhaps, a natural progression, driven by both changes in the global labor pool and advancements in production capabilities. It is happening now because the economic constraints that have previously made these changes impractical have also changed. Much like the way cheap oil stymies the adoption of alternate energy sources, cheap labor has for decades stymied the investment in production capability. The business proposition for investment in new facilities simply wasn't able to overcome the low cost of labor in developing countries, until now.

While the labor component costs of products shrink, the need to be closer to markets is also becoming a prominent driving factor. The flexible capabilities of advanced manufacturing will slowly cause the migration away from large centralized factories, towards smaller, more agile, networked production assets that are located closer to the markets they serve. This is particularly compelling for products that have localization requirements in product and political attributes, or where a reduction in transportation costs creates a competitive advantage. All economies may benefit in some ways from this trend. The shrinking and redistribution of factory assets will simultaneously create repatriation of manufacturing to developed economies, and maintain/expand satellite facilities for markets abroad.

A Hyper-Connected Business

The exponential adoption of advanced technologies presents a dizzy array of potential changes and investment demands for manufacturing in the years ahead. It is clear that the manufacturing business is changing into a hyper-connected endeavor, both within and without the four walls of the factory.

Huge datasets, AI, and autonomous production will combine to execute complexity that extends beyond the human capacity to manage in real time. A virtual facsimile of the physical factory will become the interface to production as physical execution becomes increasingly removed from direct human management decisions and intervention.

But not all technology will be adopted at the same scale and pace. It's certain that some technologies will find their most effective applications in individual industries, while the same technologies may have little penetration in others.

The Future is Closer Than You Think

Many technologies of the future are already in place. The difference will be the scale of deployment. IIoT will continue to expand to everything imaginable; AI will be ubiquitous and extend to every transaction; the compute infrastructure will be split between the cloud and edge networks; while technologies such as virtual and augmented reality will be more application specific, enhancing human tasks with data and expert knowledge.

The advanced factories of the near future have already begun their digital transformation and early adopters are beginning to create competitive advantage. By investing in emerging technologies today, many leading companies are now well on their way to creating the technical expertise and the critical digital transformation culture they need to succeed and thrive in the years ahead. That's the competitive imperative now facing all the world's manufacturing companies.

The future may look far off, but it will be here before we know it. M

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