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TRANSFORMATION AGE

SHAPING YOUR FUTURE

MHI Roadmap Series

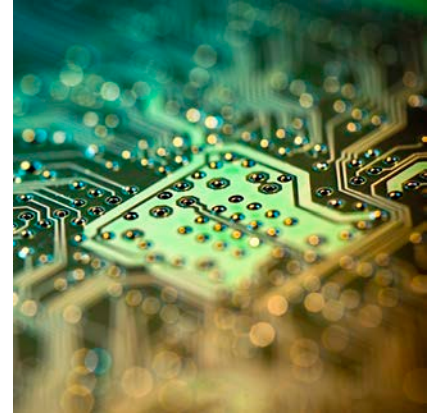
Transformation Age: Shaping Your Future, the third publication in the MHI Roadmap Series, is intended to provide material handling, logistics and supply chain industry professionals insights into trends impacting success in the next 10 to 20 years.



SHAPING YOUR FUTURE



FIRM OF THE FUTURE



TOOLS



MARKET INFLUENCERS



GLOBAL MARKETPLACE



NEW SPACE ECONOMY

TRANSFORMATION AGE

SHAPING YOUR FUTURE

An evolution in business models is already underway, with early adopters moving to a collaborative, integrated and transparent ecosystem. Success will require multiple engines for growth and profitability with flexibility to adapt quickly to changing conditions.



SHAPING YOUR FUTURE

It came sooner than many thought.

The Transformation Age is in full swing and with it comes a heightened environment of change, uncertainty and complexity.

In 2020, the material handling and logistics industry is experiencing rapid change, diverse opinions on the sure path to success, and shifting demographic profiles and skills sets of industry leaders. All sectors are beset with unending announcements of new technologies and equipment upgrades, as well as growing customer demands for immediacy and customization.

Industry leaders are accustomed to change and good at adapting to new market requirements. But the magnitude of the shifts underway are exceeding even the expectations of the largest companies and the most experienced integrators.

The Transformation Age brings great change, but also tremendous opportunity.

Key questions include how will this environment shape the industry going forward and what strategies will enable companies to survive and succeed.

What factors will distinguish market leaders from average players and leave some players lagging behind?

Which trends will emerge as long-term factors and which ones will fade from the headlines?

A single transformative technology shift can spark innovations, discovery and new capabilities. Those developments, in turn, lead to multiple advancements in design, manufacturing and delivery that move the needle significantly for the evolution, and, indeed, transformation of industries.

And the time is ripe for such opportunity in the Transformation Age.

When taken individually, key industry trends are forces around which business strategies should be built and executed. When they occur as an integrated set of factors, each morphing with a different velocity and timing, the call to action is something larger, requiring new business models and shifts in skills sets and expertise.

Leadership

Leadership is key. Transformation of companies must be owned at the top.

One thing is clear. Leaders must fully own shaping their company's future. This is not a task for delegation. It is one to be owned at the top and developed with thoughtful, deliberate collaboration.

Go first with new behaviors and practices to signal meaningful shifts in expectations and culture.

Shaping a company's future requires vision, planning, an appetite for change, and above all, communication with the board of directors, the executive team, the broader workforce, suppliers, customers and other key stakeholders.

INSIGHTS

- LEADERSHIP IS KEY.
- FLEXIBILITY AND ADAPTABILITY ARE IMPORTANT.
- TEST. LEARN. ADAPT. REPEAT.
- NEW BUSINESS MODELS ARE REQUIRED.
- DELIVER CUSTOMER VALUE.
- GET IN THE GAME.

George Prest
CEO, MHI



Leadership vision and planning are critical elements in shaping a company's future. Market information and insights play a key role in strategy development. The Transformation Age: Shaping Your Future report paints a picture of market and industry trends that will present opportunities and challenges to companies in the material handling, logistics and supply chain industry over the next two decades.

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SHAPING YOUR FUTURE

Vision and change management are two critical leadership requirements in this environment. Courage, collaboration, flexibility and resilience are vital attributes.

Thought leadership must evolve to a new, flexible and dynamic process.

Success in this environment requires an evolutionary shift in thinking...

Success in this environment requires an evolutionary shift in thinking, one that moves from a focus on doing more of the same, or even using better approaches for traditional processes, to one that encompasses options for accomplishing goals in new and different ways. This transformation in thought leads to evolution of approaches and development of new ideas and solutions.

Leaders must prepare and engage their organizations for these shifts. Fear is the most pervasive emotion expressed by employees facing significant change in the workplace. Lack of understanding, buy-in and execution of new goals, approaches and processes will derail even the most effective plans.

Engagement and collaborative planning are essential. One-off initiatives don't work for broad and deep lasting change. Engagement of the board of directors and alignment across the senior leadership team are critical first steps in implementing transformative change. Education on trends, opportunities and barriers coupled with scenario planning to address multiple strategic and tactical options engages both groups in the initial exploration of ideas. Without the understanding and a consensus buy-in by these two groups, the organization will falter in implementing strategic initiatives.

Operating Models

To win in this era, a new game plan is required. One that includes a new business structure, in both literal and conceptual terms.

Companies with siloed operations will not be well positioned to reap the benefits of the highly digital and integrated environment of the next two decades. An evolution in business models is already underway, with early adopters moving to a collaborative, integrated and transparent ecosystem that incorporates multiple engines for growth and profitability while allowing flexibility to adapt quickly to changing conditions.

A new game plan is required to succeed in the Transformation Age.

An effective ecosystem includes transparency across the core business as well as visibility of key partners throughout the entire value chain, including sourcing, manufacturing, warehousing, distribution, customer delivery and final disposition of product assets.

Flexibility and adaptability will be critical components of successful businesses, allowing leaders, their boards and their business units to respond quickly and effectively to changes in market conditions. Companies with the ability to shape shift will be best positioned to take advantage of new and sometimes fleeting opportunities and to protect themselves from negative impacts.

Emmy Lou J. Burchette
President & CEO, Burchette & Associates



The Transformation Age: Shaping Your Future report represents an evolution in the approach to the MHI Roadmap Series. For this edition, we combined insights from in-depth personal interviews with industry leaders and trend experts with findings from secondary market research to provide perspectives on ways material handling and logistics companies should prepare and take action to be successful in the coming decade.

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Given that rapid change will be the characteristic feature of this time frame, creating an operating model that incorporates multiple options for market engagement is key. The capability to adapt and move among those options quickly is the competitive differentiation of winners in the coming decade.

“Your business approach and philosophy over-ride trends,” says Jim Tompkins, CEO of the supply chain consulting firm Tompkins International. “In this era of volatile change, optionality is optimal. We urge our clients to use business strategies that incorporate rapid learning, flexibility and above all, options. You can’t be brittle and succeed in this environment.”

Tompkins International Business Strategies for Success

- Utilize a network of connected teams that operate with rapid learning and fast decision cycles
- Reconfigure quickly and efficiently as you learn
- Be flexible. Conditions change, so should you
- Approach new capabilities as modular initiatives
- Be portable – share ideas across your enterprise
- Utilize agile tenets and processes
- Focus on scalable ideas
- Experiment: when you make mistakes move from failure to success quickly
- Approach new things with a no regrets decision process: operate well by evolving over a series of options that morph into what is needed over time
- Use an ongoing evolution of options – no steady state

1

A business model that accommodates multiple earnings engines works well in this environment, allowing capital allocation and resources to be shifted according to market conditions. Clear distinctions among B2B, B2C and B2e business units, as well as between product lines within those units, will provide valuable insights into lanes of opportunity, risk parameters and competitive factors.

Customer experience must be aligned and unified across internal business units, but the business propositions, functions and measurements of each business should yield a clear picture of separate and distinct earnings streams, risk parameters, market activities and competitive positioning.

Jim Tompkins
Ph.D., CEO, Tompkins International



SHAPING YOUR FUTURE

The emerging business model is one that serves multiple stakeholder groups not just corporate shareholders. Interest and appeal is growing for investments in projects and initiatives versus whole companies. Following venture capital scenarios, these investors will fuel new and innovative products and processes.

Winning Business Strategies

Success in the Transformation Age will come to those companies that are willing to think differently about opportunity and risk, and to engage the marketplace in new ways.

Focus on problem-solving and providing value for customers. A customer-centric, outward-facing culture begins with the way business goals are expressed and incentives are awarded.

Find and deliver customer value in all aspects of product delivery, from components, features, packaging, delivery modes and sales channels to service and after-use disposition. View products and services from customer perspectives of problem solving, preferences and benefits.

Incorporate sustainability into corporate culture and all processes.

Broaden risk management perspectives and leverage enhanced decision-making tools that allow improved and timely insights into upside and outside risks.

Shift innovation to a core competency and process. Capture, encourage and share enterprise-wide ideas, activities and results.

Get in the game. Act on commercially viable solutions today within a flexible environment that can be modified quickly as future enhancements and capabilities become available. Don't delay participation in smart automation and digital tools. The coming decade will be characterized by waves of innovation and enhancements.

Pilot and succeed or fail quickly. Learn. Adapt. Repeat.

Plan for alternative market scenarios using data decisioning tools to assess different strategies.

Be resilient. Adapt quickly to changing conditions.

Collaborate. Companies and their leaders do not have to win this race alone. Leverage outside partners and peers to collaborate, learn and implement new solutions faster and further than your organization can achieve alone.

Scale, broaden scope and invest in differentiating capabilities. Market boundaries will broaden in this decade, bringing disruptive competition to every geographic market and industry sector.

Leverage the new environment. Advances in the internet and digital tools, as well as evolving practices such as shared physical assets and freight delivery, allow even small and medium-size companies to leverage capabilities and information in ways previously only in the purview of larger organizations.

Forty years ago, financial services organizations collaborated to build regional and national electronic exchange networks to support ATM transactions across the United States and eventually the world. Similar opportunities in material handling and logistics will underly sharing of assets from satellite constellations to EV charging infrastructure.

SHAPING YOUR FUTURE

Mergers and Acquisitions

The pace of industry consolidation will increase over the next decade. Firms will utilize mergers and acquisitions to increase scale, broaden scope and strengthen infrastructure positions in the market. These approaches can be utilized successfully by large, medium and small-size enterprises.

Lessons learned in other industries such as telecommunications and financial services that have been reshaped significantly by consolidation offer insights into key success factors: 2

There is no such thing as a merger of equals. Apparent equality changes after the transaction. There is always a single clear winner.

Over-communicate. Keep board members, employees and customers informed of changes and timelines.

Focus on integration not just conversion of systems and processes.

Shape post merger integration for long-term future state rather than post transaction status.

Distinguish between goals of increasing market share and productivity versus leveraging infrastructure and processes.

Ensure acquisitions are aligned with longer-term corporate goals.

Invest time and resources in a deep due diligence process prior to execution of the deal to ensure a smooth transition. Surprises come at a cost.

Fill leadership team positions with those who have the skills needed for the resulting company size and future growth goals.

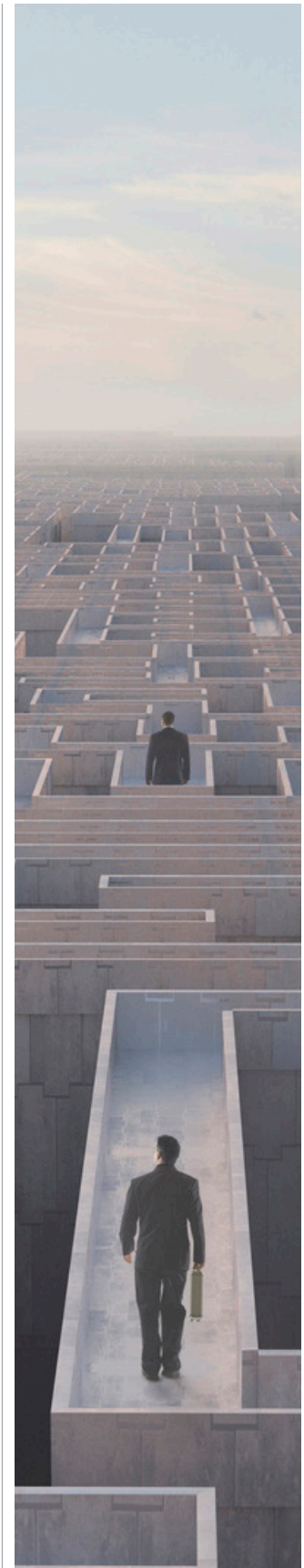
Be deliberate in selecting the resulting company culture. Choose one and select a leadership team that will champion that culture.

Implement tight controls and processes, including board oversight.

Engage all financial business tools including tax and legal entity status early in the planning process to benefit from savings and other financial opportunities.

Expect a different regulatory environment as the company size increases. Increased scrutiny and controls and a different style of interaction with regulators should be expected as size increases.

Don't overpay. Save money to use funds for other opportunities post merger or to pursue other acquisitions.



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Specialty Plays

Growth and expansion of technology and engineering capabilities will spur some firms to diversify and invest in infrastructure, digital expertise or an emerging technology as a separate business. Other firms will divest operating businesses and focus on these singular capabilities as their new core.

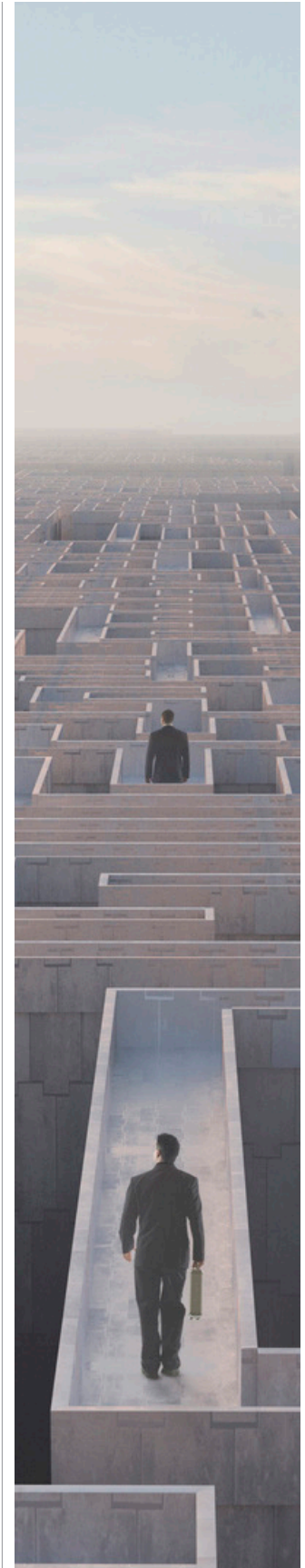
Entrepreneurial activity will increase over the coming decade. Innovation and discovery will occur in stand-alone ventures as well as in company funded specialty business units established to leverage opportunity while protecting the established entity from risk.

Increased activity in all of these approaches will contribute to the re-engineering and transformation of the material handling and logistics industry over the next twenty years.

Timing

As smart automation and digital tools improve and adoption increases, pressure will mount on production, and timelines for delivery of equipment will lengthen.

The process of planning and scheduling the purchase, installation, training and implementation of new technologies is best done collaboratively, involving both outside suppliers and internal managers, to achieve desired outcomes for a successful and timely transition.



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Opportunity

A convergence of technological and engineering advances, environmental issues, global and domestic policies, demographic changes and evolving consumer trends promises a challenging but exciting time in the material handling and logistics industry between 2020 and 2040 and beyond.

Long-awaited opportunities for dramatic increases in productivity, lower capital requirements for new equipment acquisitions, enhancements in portability of equipment, greater flexibility in manufacturing and distribution facility design, and evolutionary strides in transportation and freight delivery make the Transformation Age a time of memorable excitement and change.

Industry leaders must now heed strategic imperatives that have been under discussion for some time. Action in the near term is required for success and survival over the coming decade.

The path to 2030 is clear and the road beyond to 2040 is coming into focus.

Transformation requires change. But with a new course comes opportunity.

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Sources

- 1 Tompkins International, "Tompkins International Business Strategies for Success," 2020, tompkinsinc.com
- 2 Burchette & Associates, Inc. 2020, "M&A Success Factors"

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Success in the coming decade will be marked by significant changes in the workforce, workplace and business approaches. Change will be iterative, abounding with opportunities for entrepreneurial initiatives.

A NEW LOOK

WORKFORCE

WORKPLACE

BUSINESS APPROACHES



FIRM OF THE FUTURE

A NEW LOOK

Looking out ten years, the vision for the firm of the future is clear. There is no doubt: the environment will be much different than what we experience today.

Leaders and their teams will be younger and steeped in technology. The workforce will be diverse, dispersed and highly skilled.

Warehouses and factory floors at leading companies will be highly automated and flexible to accommodate shifting priorities and demands.

The technology focus will embody human needs, making the shift to man + machine rather than emphasis on one to the exclusion of the other.

Education and training will be a career-long activity with both education institutions and companies utilizing advanced technology to speed and enhance the effectiveness of the learning process.

Collaboration and partnerships will bring together competitors and peers to leverage industry opportunities in new and exciting ways.

Industry consolidation will create new powerhouses, while entrepreneurial activity will abound in specialty areas.

Beyond 2030, change will not slow.

Continued commercialization of new technologies and enhancements of tools will emerge in waves of development throughout the following decade out to 2040.

INSIGHTS

- LEADERS AND TEAMS WILL BE YOUNGER AND STEEPED IN TECHNOLOGY.
- THE WORKFORCE WILL BE DIVERSE, DISPERSED AND HIGHLY SKILLED.
- UTILIZE A FLEXIBLE BUSINESS MODEL.
- MOVE TO AN INTEGRATED, COLLABORATIVE ECOSYSTEM.
- USE SMART AUTOMATION, DIGITAL TOOLS AND FLEXIBLE WORK ENVIRONMENTS TO ACCOMMODATE DYNAMIC PRIORITIES.
- SHIFT TECHNOLOGY FOCUS TO MAN + MACHINE.
- ENHANCE STRATEGIES FOR MANAGING RISK, SUSTAINABILITY, BRAND, MARKETING AND SALES.

FIRM OF THE FUTURE

WORKFORCE

Leadership Transition

Today, top executives of most material handling and logistics companies are over 55. Many are over 60 and a fair number are approaching 70. The mix at the executive team table reflects experience, success and a good bit of gray hair.

The next decade promises to see a significant number of leadership positions transition to younger executives. The demographic shifts from older Baby Boomers to younger Baby Boomers, mixed with emerging Gen X and Millennial executives will bring new skills, perspectives and approaches to the industry.

Aging Demographic Groups by Decade

Demographic Groups	2020	2030	2040
Gen Alpha*	1-10	5-20	15-30
Generation Z	8-23	18-33	28-43
Millennial	24-39	34-49	44-59
Generation X	40-55	50-65	60-75
Baby Boomer	56-74	66-84	76-94

*Gen Alpha includes births from 2010 - 2025

Source: U.S. Census Bureau data. Graphic by Burchette & Associates.

These demographic shifts bring more than just age changes to the top ranks. Decision-making styles, risk tolerances, technology knowledge, global perspectives and comfort levels with change differ in this group from their predecessors. Members of the emerging group are comfortable with a higher degree of uncertainty, an environment most have experienced throughout their lives.

While some senior leaders will continue to lead through the next decade, others will elect retirement. Across the board, a lot of change at the top will happen throughout the industry. With that change comes loss of legacy knowledge, experience and valuable peer networks.

A concern commonly voiced among a number of younger executives is the potential loss of legacy information and expertise held by those retiring – information that is not widely known or well documented in some companies. Younger executives recognize the Importance of this key and sometimes proprietary knowledge and are seeking ways to capture these intangible assets as older executives retire. Companies would fare well by focusing greater attention on this information transfer.

Kevin O'Neill
President, Steele Solutions



“We need to pair younger executives with senior leaders to retain valuable knowledge and expertise as transitions occur.”

FIRM OF THE FUTURE

These emerging leaders enjoy learning from their company's executives and look forward to contributing to the future success of the organization. Their perspectives reflect a strategic view that will continue the strengths of their predecessors's approaches and build on those with new technologies and processes. The combined result will arm their companies with knowledge and expertise vital in the Transformation Age.

Living with Change

In recent in-depth interviews with seasoned supply chain industry leaders, top executives describe the industry as undergoing significant and rapid change. They are focused on making needed investments in facilities, equipment, processes, technology and workforce skills. Their view of the next 10-20 years is unanimous: the pace of change will accelerate as innovation and technology drive new approaches and capabilities.

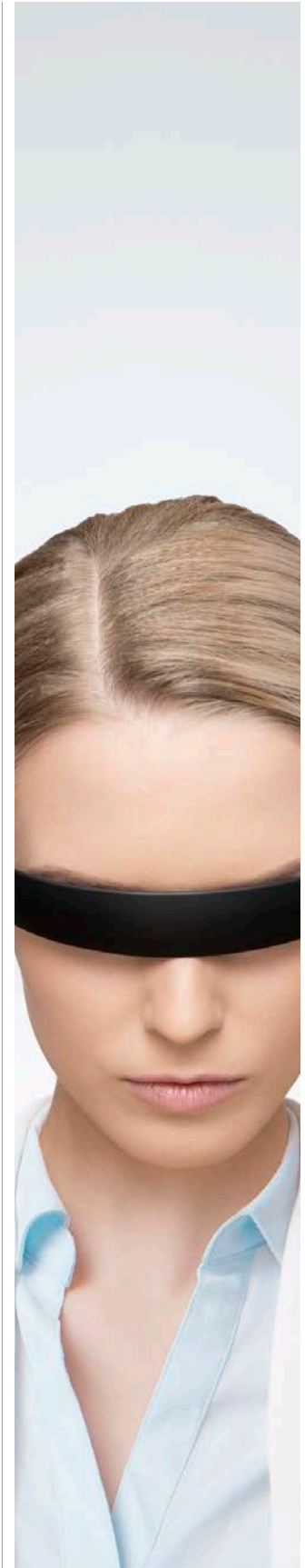
Many have strategically positioned younger executives throughout their company to bring new ideas and skills to key operations. Technology knowledge is often cited by top executives as the area they look to younger executives to understand, navigate and lead.

Today's leaders acknowledge the pace of change will increase throughout the next two decades, but they remain uncertain about the timing and scope of impact various trends may exert. Many view this uncertainty as unsettling while others are invigorated by the excitement of new frontiers.

Younger executives view change as a ubiquitous marketplace and competitive factor, and see technology as a valuable enabler of new levels of efficiency, speed-to-market and profitability. Technology is also viewed as the means for meeting increasing customer demands for customization.

Those under 50 are familiar with a wide range of digital, automation and engineering technologies. But just as their senior executives do, they rely on technology and engineering specialists in their company, integrators, and service and product partners to select and execute new platforms, equipment and processes. As a group, they tend to have a higher level of comfort than their predecessors in guiding their company directionally without having mastery knowledge of the technical tools required for successful execution.

In viewing the future, both groups believe advances in technological, engineering and data decisioning tools will drive continued improvements in safety, efficiency, time to market, and business partnerships and collaboration. They also share beliefs that consumer demand for customization and immediacy of delivery will continue to shape material handling and logistics in the future.



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Industry Networking

As a time-honored tradition, industry leaders actively pursue networking opportunities to examine and share ideas related to industry trends and changes. For many, their long-held friendships with company and industry colleagues represent important ties enabling productive collaborations and partnerships.

Younger executives are seeking meaningful industry networking opportunities. They view these opportunities as one of the most vital ways they can learn from other industry executives as well as global trend experts. They highly value inclusion in industry and association meetings and events, describing these opportunities as key to their continued professional growth and development.

Generation Z Workers

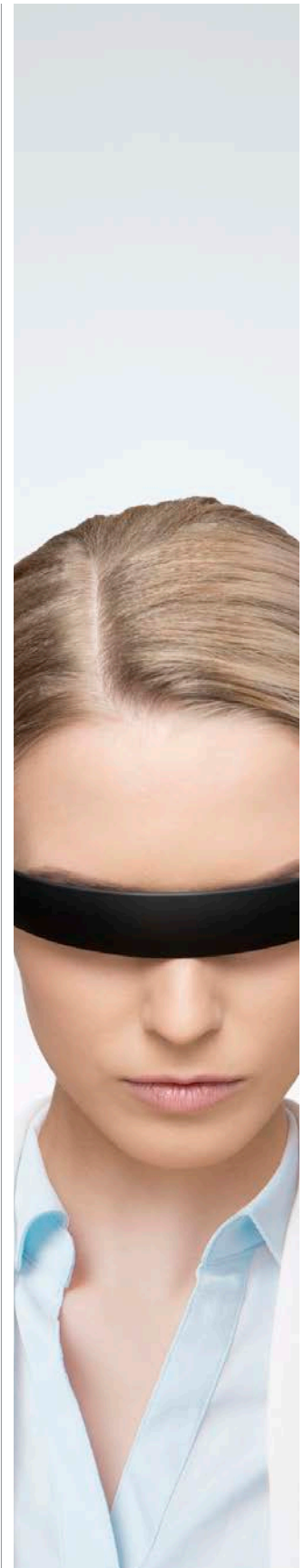
By 2030, the younger Gen Z employee group will bring another wave of new work styles, skills, preferences and expectations to the workforce. Their leadership styles will be impacted by the Gen X and Millennial group they encounter in their first decade of working, but they will equally impact corporate cultures and leadership models by the sheer size of their generation and their strong convictions and belief systems.

While a lot of attention is focused on meeting the needs of Millennial workers in 2020, companies need to prepare now for this next influx into the workforce. Representing a group larger in size than Millennials, numbering roughly 65 million in the U.S. and 2.47 billion worldwide, this generation will impact the industry from both within as employees and without as customers. ¹

By 2030, older members of this group will be emerging as young professionals. This group is already known for high expectations for workplace diversity, inclusiveness and technological savvy. ²

Due to their lifelong exposure and use of technology, this group actively uses a variety of technological tools in their personal and work lives. ³ They look to technology rather than people as the first stop for information, whether that is to learn something new such as a game or a process, or to communicate among peers and co-workers.

The timing of Gen Z emergence in the workplace aligns well with the increasing prevalence of smart technologies, data decisioning tools, and geographically dispersed workplace locations.



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Gen Alpha

The youngest generation emerged in 2010. The children of Millennials and GenZ will be entering the workforce by 2030, bringing with them a new reality of the world. Theirs is truly a viewpoint shaped by a technology lens and a global perspective.

Growing up with digital platforms, this group is already influencing families and institutions. 4 In the workplace, this generation promises to be the one that is skilled and prepared for innovation of thought and execution of new ideas. The grandchildren of Baby Boomers and Gen X , Gen Alpha employees will realize the dreams of industry leaders who are pioneering change in the dawning years of The Transformation Age.

The grandchildren of Baby Boomers and Gen X, Gen Alpha employees will realize the dreams of industry leaders who are pioneering change in the dawning years of The Transformation Age.

Gen Alpha are growing up with technology and digital platforms shaping their life experiences. Artificial Intelligence will power many of their choices and decisions, from clothing to careers. Augmented reality and virtual reality games and tools will prepare them for a workplace that manifests an environment of change measured in seconds not days or years.

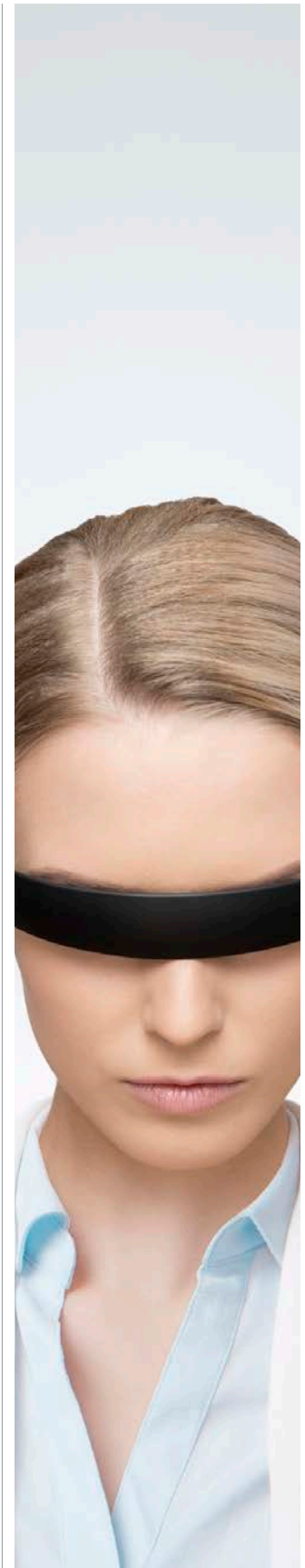
Raised in environments customized and personalized for family and individual preferences, employers will have to deliver workplaces that mirror the context of individual uses.

It is not too early for the industry to address how this generation is educated and trained. Courses, content and delivery channels beginning with toddler toys can impact adult workforce readiness skills.

Diversity

The Gen X and Millennial groups will bring greater diversity to leadership and broader workforce participation in the industry in the coming decade. Today's industry leaders welcome greater participation by these groups evidenced by their support of industry and company initiatives to recruit and hire qualified candidates across the board. Global diversity initiatives in STEM education over the last decade are reaping an increasing number of diverse candidates for the industry.

In recent interviews, industry executives voice beliefs that having more women and members of various ethnic groups in leadership positions will help evolve industry practices related to Human Resources and contribute to greater understanding and improved relationships across supply chain participants.



FIRM OF THE FUTURE

Industry executives' recognition of the need and their willingness to pursue greater diversity in the workforce are already helping the material handling, logistics and supply chain industry attract more women and more people from varied ethnic groups. Many industry firms participate in local education collaboratives to attract high school students in all demographic groups to careers in the field. A number are now advocating for more involvement with schools and students in primary grades to ensure skills are developed and interests nurtured well before secondary education courses and degrees are selected.

In the 2030-2040 timeframe, greater diversity in the industry will be shaped strongly by the Generation Z group that demands inclusiveness in real terms, not just numbers. Their collaborative nature will impact the development of work groups and shared accountability systems that will increasingly drive integrated processes throughout the Transformation Age. One can expect the same impact from Gen Alpha. Age, gender, sexual identity, religious preferences, and even national citizenship will become less important than workplace credentials, with expertise and skills becoming the true differentiators. The proverbial "A Team" will become a respected, highly diverse group of individuals who work collaboratively across corporate ecosystems of employees, suppliers, and customers.

New technologies such as smart automation, robotics and augmented reality will enable older men, women and physically challenged individuals of all ages to participate in job classes previously less attractive to them due to physical labor requirements. As these technologies replace physical labor, and job requirements shift to intellectual capital, more individuals will qualify and be attracted to a larger field of jobs. This growing diversity will be present throughout the supply chain and have attendant impacts on related company cultures, policies and procedures.

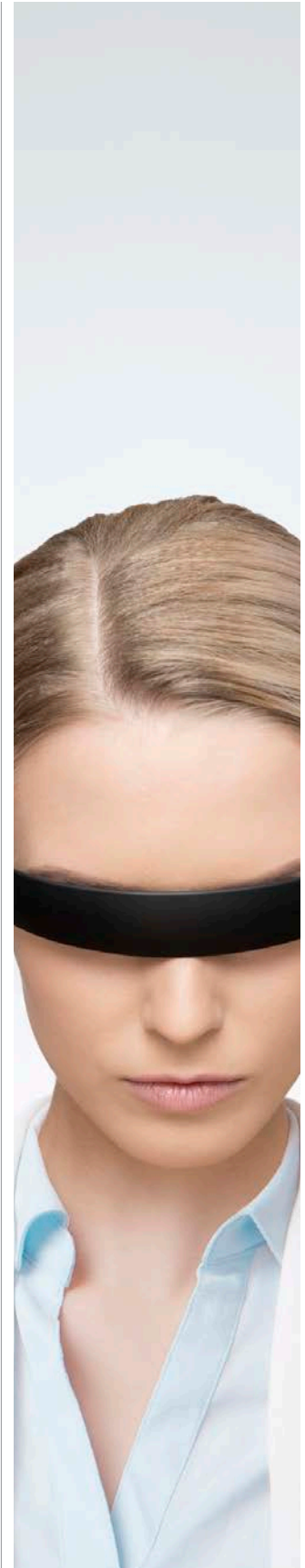
Organizational Culture

Shifts in the organizational culture within supply chain industry companies began in earnest in the last five years. Success in the coming decade warrants a more significant evolution, one that literally transforms the Human Resources department's functional scope to encompass all facets of Employee Experience (EX), and builds a climate supportive of innovation and discovery, collaboration and integration of functions, and career-long learning.

This dynamic requires attention now as expertise in these areas becomes as important as investments in smart automation and digital technologies.

Companies will need to increase funding for human resource initiatives over the next five to ten years in order to prepare, create and sustain the environment required for success in the Transformation Age. These investments are in addition to those needed for technical training. Additionally, existing management and leadership curricula will need to be retooled or developed anew to support the evolving environment.

While younger workers may come aboard with more finely honed technical expertise, communication skills for successful collaboration across the enterprise will be an area of increased need.



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Industry firms need to become learning institutions and employees need to become active learners. A culture of career-long learning will differentiate leading companies and characterize industry champions.

Labor Force Shortages

Coming into 2020, the single greatest labor force challenge reported across the industry is finding and retaining qualified skilled workers. The outlook for the next decade and beyond brings no relief to that situation absent significant changes in the utilization of smart automation equipment and processes. Hence the evolving scenario, where the situation is not solved but rather changed by new approaches.

Both seasonal and permanent labor shortages abound. This situation already demands changes in recruiting, salaries, training and retention practices. Enhanced strategies in these areas will serve companies well in the future, as shortages and churn in the labor force are expected to continue. Projected demographic, education and training trends do not support an adequate solution to this labor shortage in the coming decade. Automation of jobs is viewed as the single greatest opportunity for relief.

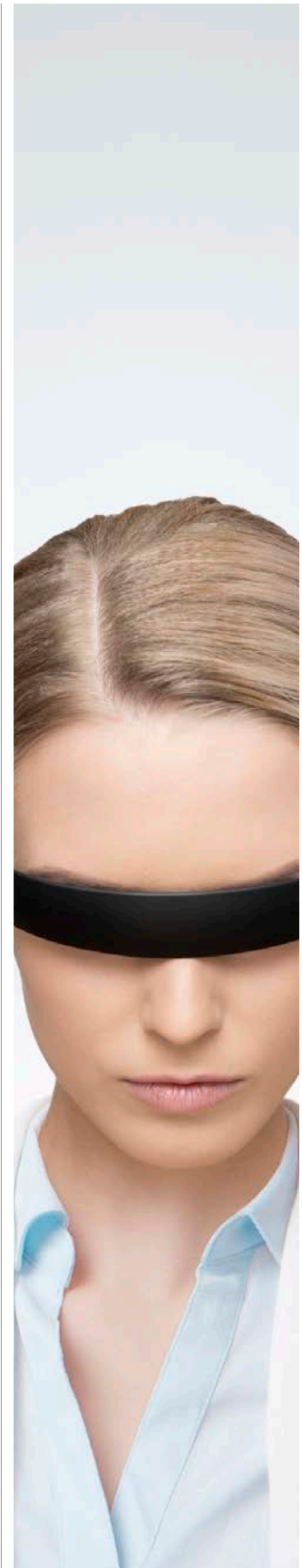
The race to solve this issue is moving quickly. Companies that are able to marshal the financial resources to address their labor shortage through smart automation as soon as possible will reap significant financial benefits over the next 20 years while enhancing their speed to market and competitive positioning. Those who cannot make such investments in the next five years may lag behind at best or cease to operate or be acquired by larger organizations by the end of the decade.

Automation of Jobs

Industry leaders expect continued growth in automation of jobs, resulting in significant loss of people in some job categories. With this view comes the positive expectation for an increase in safety, efficiency, time to market, customization capabilities and competitive positioning.

Executives who have invested in new smart automation technologies and processes in the last 24 months report a good experience, a positive ROI for most investments in fewer than 12 months, and a belief that continued automation will benefit their company over the next decade. Some are accelerating their plans for additional investments in transforming their equipment and processes, which will result in increased job losses over the coming decade. The ripple effect of these job losses across the industry will in turn create economic market impacts over the next two decades.

While equipment and technical investments increased in late 2018 and early 2019, some slowing occurred in the latter half of 2019. Economists differ in their forecasts for 2020 through 2025, but industry business owners and leaders indicate a desire to continue investments in smart automation and emerging technologies in the coming years. The pace of the investment remains the question.



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Current struggles with finding and retaining people with specialized skills fuel the belief that when those jobs are automated in the future, companies will experience less risk and lower costs related to the labor force.

Most companies that have moved forward with smart automation believe the challenge is one of skilling-up and leveraging the potential of Man + Machine.

Some industry integrators report their clients are uncomfortable with reducing their labor force headcount even as they implement new automation. The concept of hiring fewer people, especially during peak periods, creates concern for those who are not yet fully automated. This represents a short-term challenge in adapting to change.

Bottom line, executives at all levels share a view of the future that includes fewer employees and increased use of automation. There is no debate about the result, just differing time frames based on the size of the company and the financial resources available to implement new processes.

A New Mix of Workers

The vision for the workforce in 2030 and beyond is one that looks very different from what exists today. The relative number of physical labor jobs will decrease significantly, being replaced by automation, robotics and innovative processes.

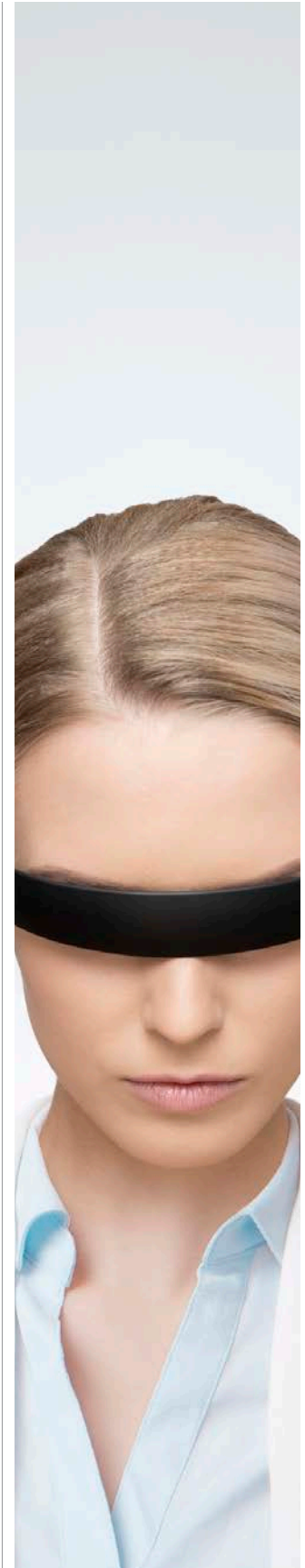
Jobs requiring technical expertise in data management, data analytics, sensors, robotics, artificial intelligence (AI), and augmented reality (AR) will increase. Management jobs will place greater value on critical thinking, problem solving, creativity, and risk management. Technology skills will become a ubiquitous element of leadership and management resumes.

Leadership positions will require a working knowledge of a variety of digital software and hardware platforms and data decisioning tools in order to develop, execute and effectively measure operational models and business strategies.

The demographics and psychographics of the labor force will shift significantly by 2030 and continue to evolve through 2040. These changes, combined with shifts in job roles, will provide a work fabric and culture that is fluid, collaborative, diverse and smart.

Some but not all companies will increase the number of outsourced employees used for specific jobs, including “gig workers.” Those who elect this route will be challenged in managing company, brand and technical value belief systems across an employee base that is not fully engaged within a single corporate structure.

A growing element of human-automation interfaces will increase productivity while changing the very nature of the work environment, especially in manufacturing and distribution facilities. By 2030 advances in robotics, AI, AR, sensors and telematics will allow industry players to leverage workforce capabilities well beyond today's operating levels.



FIRM OF THE FUTURE

Education and Training

Corporate needs for a skilled workforce are expected to increase over the next 20 years, requiring added focus on this topic, investment in at least collaborative solutions if not in-house delivery, and expectations for continued training of employees throughout their careers.

The skill sets required for success in the material handling and logistics industry in the Transformation Age fall into two large categories: (1) highly technical skills related to smart automation, data decisioning tools, and new technologies, and (2) cognitive skills related to critical thinking, innovation, problem solving and business process management. A significant overlap between the two areas involves knowledge and use of technology.

In 2020, company leaders report that education institutions and private training programs are not filling their need for qualified employees in either category, and are especially lacking in the area of technical skills. In some part, the lack of people interested in the skilled job categories is to blame.

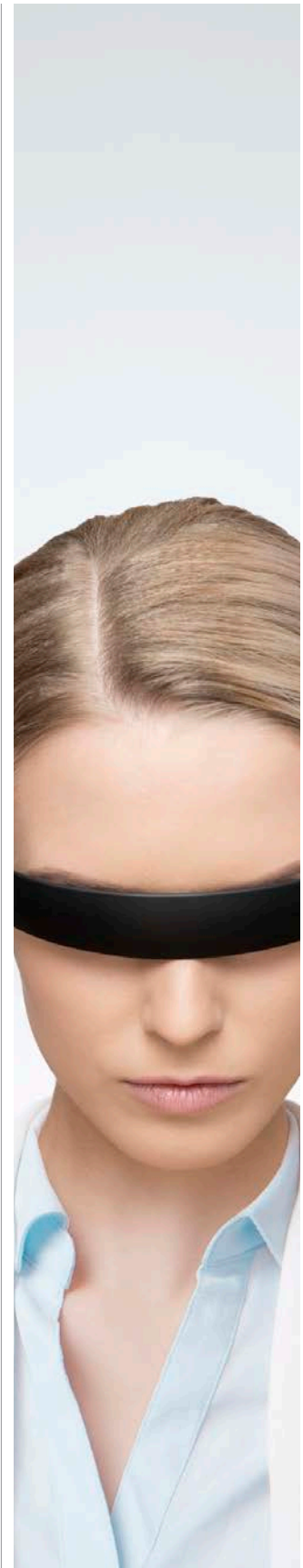
Some companies are expanding their in-house training capabilities or partnering with universities to develop customized offerings to enhance employees' knowledge and skills. The projected trend calling for life-long learning and skills enhancement is adding cost stresses to company budgets, a reality not expected to be abated in the coming decade.

Promising approaches include augmented reality enhanced training and customized programs developed and delivered collaboratively by employers, universities, community colleges, private training/education companies and equipment manufacturers. The mix of online and in-person curricula to deliver training has become well accepted and increasingly adopted. Remote, digitally delivered training is rapidly becoming the norm.

Industry initiatives for collaborative and networked training on topics of noncompetitive skills and issues represent an opportunity for cost savings and development time efficiency. Other industries such as financial services and legal and accounting professions have successfully leveraged pooled resources for education and training as they have undergone significant and continuing growth and transformation.

The concept of incremental academic or training courses leading to a degree or certification coupled with work experience, or "experiential education" as it is sometimes known, represents a path forward for many students who otherwise could not bridge the gap between education and a career in material handling and logistics. Companies benefit from this approach as well, as employers have the opportunity to work with students during internships and apprenticeships. 6

A growing cost factor for industry players is the need to invest in training to support the use of new technologies and digital tools across their workforce. This training is vital for the successful execution of an integrated information-based culture and for collaborative initiatives reaching across an enterprise and beyond to industry suppliers, partners, and customers. Increasing training budgets to support this growing workforce requirement is imperative for success over the coming decade. Without this ongoing education and training, the full benefits of investments in new smart automation and digital processes will not be realized.



FIRM OF THE FUTURE

Managers and leaders in the industry would benefit from programs addressing cognitive skills related to critical thinking, problem solving, creativity, innovation and discovery. Expertise in these areas as well as management approaches to risk management, flexibility, and resilience will be market differentiators in the years to come.

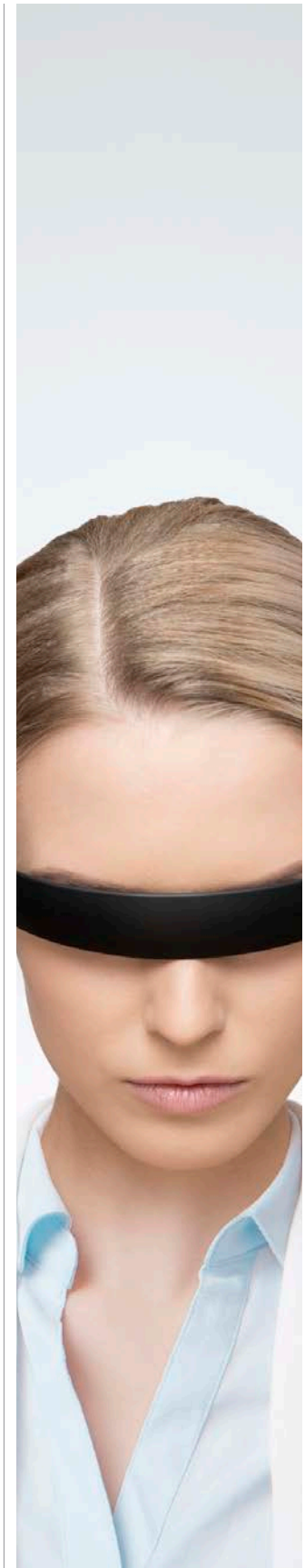
Training to prepare companies to deal with change management is something every industry player should be utilizing given the rapid change environment that exists today. From the board room to the factory floor, openness to change, mindset and skills for adapting to new approaches, mental flexibility and resilience are critical success factors that need to be taught, practiced, modeled and nurtured.

Another growing need in industry training is programs to address new types and styles of communication and management practices across an increasingly dispersed workforce. Cultural business values and expectations will have to be conveyed and practiced by individuals and work groups who often may not be in the same physical location. Remote working is expected to expand significantly by 2030, requiring tools and training to support this new work culture to be developed and launched within the next two years.

Expectations for continued consolidation in the industry bring with it the need for training to facilitate rapid integration of people and processes post mergers and acquisitions. The financial services industry learned quickly during the massive bank merger spree in the 1980s that financial benefits expected from mergers were impacted significantly by not just systems integration but the degree to which company cultures, brand promises and customer experiences were integrated and aligned. In fact, banks often found that systems integration could be delayed but people alignment could not.

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FIRM OF THE FUTURE

WORKPLACE

Just as today, one size will not fit all operations in 2030. But by that time, the leading and even average performing industry players will have changed their environments to accommodate and leverage new processes, equipment and technology. By 2040, these environments will be further enhanced with developments not even under discussion today.

Industry experts paint a picture of 2030 and beyond that is a highly automated, productive, scalable and flexible environment. Technologies commercialized in the last decade will be further enhanced by 2025 and new innovations and capabilities will be in use by 2030. By 2040 the landscape will be truly transformed.

A critical key for success will be having the right environment in place to optimize performance. Leadership vision, a flexible, collaborative operating model, and supporting business strategies and processes will be required to inform and leverage workplace automation and digital tools in a highly integrated ecosystem. Without that approach, companies will miss opportunities to optimize earnings and competitive positioning.

Facilities

Manufacturing plants will range from those with a small number of human workers to facilities that are truly “dark factories” running 24/7 and managed through digital interfaces with technical managers located onsite or hundreds of miles away.

Flexible “pop-up” mobile facilities and equipment will be utilized to enable rapid deployment of processes to meet seasonal or special market demands. Everything from mobile conveyer belts to packaging equipment will be modular and enabled to plug and play with permanent resources. Key design challenges will need to be addressed to achieve the speed and efficiency of today’s embedded equipment.

Distribution centers will range in size from large structures suited to service Panamax ships to small and geographically dispersed facilities located close to customer delivery points in urban settings. Loading platforms will be automated for robotic loading onto electric delivery vehicles

Retrofitting old plants with new equipment may become a significant challenge for some companies. Many of today’s manufacturing facilities cannot easily incorporate robotics and other innovative equipment solutions due to space constraints. Equipment manufacturers are addressing these issues today with plans for hybrid and smaller-sized solutions in the works. Over the coming decade, companies will have more choices from which to select as they implement new or additional equipment.

Urban designers and transportation experts predict a growing number of parking facilities, once overflowing with cars in urban areas, will be underutilized by 2030 and vacant by 2040. These spaces will be retooled to house manufacturing and distribution companies in major cities.

George Prest
CEO, MHI



“The physical environment for material handling will transform over the coming decade. Smart technologies will improve operating efficiencies and advanced digital decisioning tools will enable scenario planning for adapting to dynamic market conditions. “

FIRM OF THE FUTURE

Malls and large retail box facilities will be converted and used as distribution centers. Some retail space will be retained for consumers to experience products such as large home furnishings, automobiles, music and TV systems. Studio experiences will showcase and teach skills ranging from gardening and cooking to sports. The lines between product sales, personal experience and experimentation, and art will be blurred.

Rural areas with good access to transportation networks will become attractive for some highly automated manufacturing sites and regional distribution facilities due to lower land costs, lack of need for a large labor force, and good access to other rural customer delivery centers. Improvements in broadband infrastructure in rural areas will be critical as an economic development asset required for entry to industry participation.

As in homes, **ambient computing** will be located throughout industrial and commercial facilities. Virtual assistants will facilitate tasks. Architectural surfaces will double as touch screens and other environmental features will include sense-sensitive technology – making “with the wave of a hand” a meaningful gesture.

Investments in data security and corporate and personal privacy within the workplace will increase as these issues gain more focus with the proliferation of digital tools and platforms.

Onsite solar and wind generation will be used to replace or augment public utility electric generation, reducing or eliminating the power bill and thereby freeing up cash for other facility expenses.

Electric vehicle fleets, made up of a mixture of autonomous and human-driven models, will ferry materials between facilities.

Autonomous vehicles will be incorporated into a variety of freight and passenger uses. Enhancements in visual and spatial capabilities will enable safety and speed. These vehicles will operate in the same space as human-driven vehicles, requiring more sophisticated vision and anti-collision systems than the robots and forklifts operating inside facilities.

Drones will monitor inside and outside environments, structures, people and processes. 1 Light-weight supplies, components and goods will be moved between facilities and inside facilities with specialized robotic drones. By 2040, passenger drones will be part of the Urban Air Mobility system ferrying people among facilities and short-distance stops. 2

Smart Automation and Digital Tools

Supply chain business facilities will be characterized by high levels of smart automation, digital tools and environments that facilitate and protect those tools.

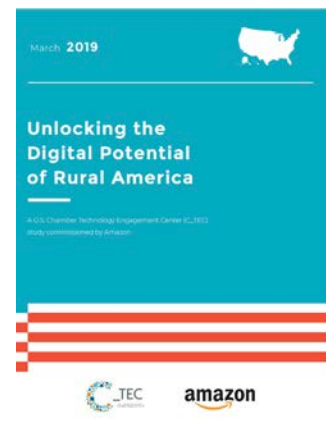
Edge computing will be prevalent, leveraging proximity to data collection, cloud computing capacity and 5G or higher bandwidth. These digital capabilities will optimize functions ranging from product design, inventory control, and scenario planning, to production cycle management and freight delivery. This digital strategy will also allow large sectors of the supply chain, and more functions within each, to be simultaneously optimized.

Daniel R. Alexander
Director of Operations, Anovotek®



Digital Tools Help Rural
Business Fight ‘Retail
Apocalypse’

Unlocking the Digital Potential of Rural America



FIRM OF THE FUTURE

A **quantum computing** capability, accessed on a shared network platform, will provide Individual companies digital speed and capacity well beyond their infrastructure and allow businesses of all sizes to compete with powerful data and analyses. Companies will be able to solve a variety of supply chain functional challenges, synthesizing solutions into a deployable enterprise strategy.

Technology requirements will be enabled by **new telecommunication networks and satellite constellations**, locally located edge devices, cloud computing, 5G and higher broadband capacity, innovative screens, wearables and ubiquitous computing devices and terminals. New configurations for office and operational areas to accommodate these technologies will be achieved without significant new construction requirements, but may require new HVAC considerations for temperature and humidity control.

Standardized industrial software will enable digital connections and collaboration throughout the manufacturing and distribution processes and the broader supply chain components. Increased open architecture and standardization of software will facilitate installation of equipment and speed investments across functions and facilities.

Industrial software and specialized apps will multiply over the coming decade, increasing customizable options for specialty manufacturing and packaging.

Satellite constellations coupled with 5G and later broadband will increase digital speeds, reduce latency, open new markets and expand access to new customers.

Artificial Intelligence will empower most digital functions and many management processes. AI becomes a predominant feature by 2025 and ubiquitous by 2030.

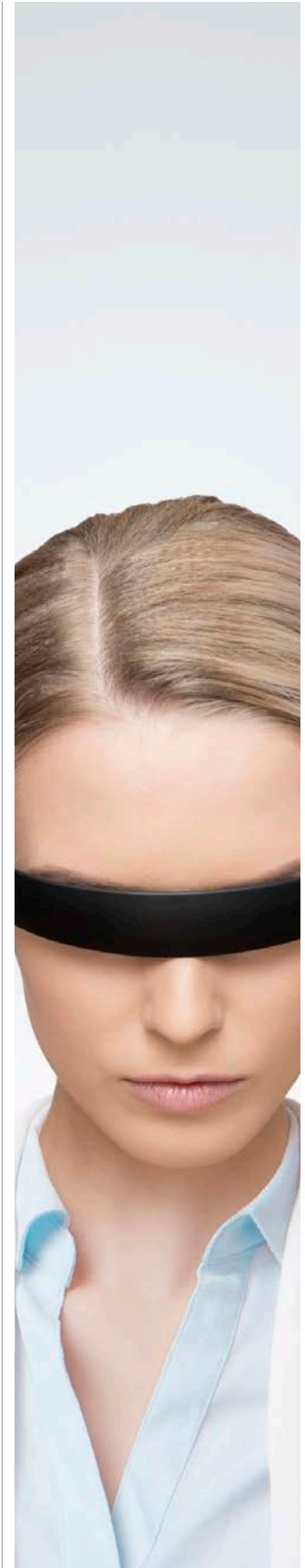
Augmented reality platforms will enable new forms of collaboration and engagement across physical space and time. AR technology will be incorporated into many functions, from equipment operators to delivery workers. Virtual reality platforms will be utilized for training and sales and marketing initiatives. Consumer uses will speed development and use of industrial applications. Both AR and VR applications will multiply in 2020 and continue to spread throughout the next ten years. By 2030 these technologies will be embedded in a broad variety of operating devices as standard features.

Autonomous mobile robots and smart telematic forklifts will be ubiquitous. Early struggles in adapting the workforce and workplace for robotics will be resolved by 2030, facilitating a more rapid and pervasive adoption over the following decade.

For more on workplace tools, go to TOOLS section of this report.

People at Work

Geographic disbursement of employees, a trend gaining ground in 2020, will continue to grow over the next two decades. Companies in all parts of the supply chain will employ workers at all levels who work from home, from satellite offices or shared public work spaces. Digital interaction among workers will increase versus face-to-face interactions.



FIRM OF THE FUTURE

As use of gig and full-service contract workers increases between 2020 and 2030, facility requirements for touch-down work space and secure guest digital access will increase.

People will work collaboratively in teams more than ever before, and that team work will be conducted face to face and over digital interfaces. Job descriptions will not speak to command and control as much as to skill sets, with more communication occurring across multiple levels of seniority. The need for collaborative work environments will change the look of factory, warehouse and office spaces to support group and individual tasks as well as communication across the room and across the globe.

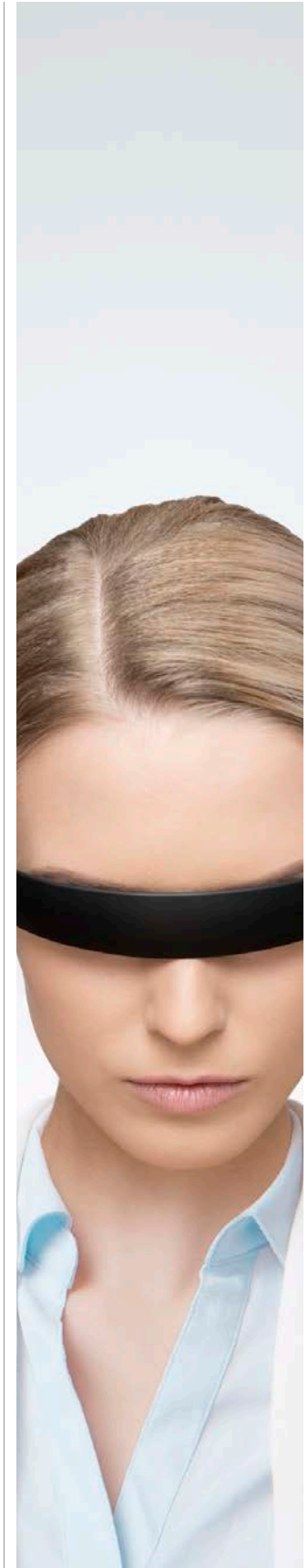
Wearable, wired clothing and devices will be ubiquitous by 2030. Some of the technology will be personal devices, while others will be corporate assets used by team members while at work.

Recurring investments in facility and equipment upgrades will be required to provide cybersecurity as well as privacy and security of the workforce.

Go to [WORKFORCE](#) section of this report for more in-depth discussion on workforce topics.

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FIRM OF THE FUTURE

BUSINESS APPROACHES

Risk Management

Risk management and the resilience to adapt quickly to changing conditions and needs will be key market differentiators in the next 10 years. Both require planning, revised business approaches and new tools.

Good news for industry businesses is the significant increase in AI and digital modeling capabilities that have emerged in recent years. These scenario planning tools enable risk taking with guard rails. Multiple options can be tested, including changes in competitive positioning, market conditions and significant events and opportunities. Different risk tolerances can be set, guiding tactical execution as events unfold.

The more difficult challenge may be to align mindsets of leadership teams, board of directors, investors and other key stakeholders.

Taking steps now to create a consensus around adaptability and agree on actions to be taken under a variety of scenarios will serve leaders well in this dynamic environment. The pace of industry and market changes is only going to increase, making this competency a vital success factor in the years ahead.

“Moving forward, more emphasis will need to be placed on a variety of factors such as human capital risk, third-party management risk and cybersecurity,” says Shawn King, senior vice president of strategic execution and operations at Wells Fargo and a former chief executive of an industrial manufacturing firm.

King cautions that planning for change needs to include risk assessment and prevention for initiatives such as implementation of new equipment and technologies. “New factors such as workers operating new equipment but using old equipment knowledge and experience can lead to errors and failure to reap the full benefits of new technologies.”

Another risk analysis need King expects to grow in the future is assessment of third-party contracts.

“As outsourced services increase, the number and types of risks introduced through third-party personnel, systems and processes will grow.”

Shawn King, SVP, Strategic Execution and Operations, Wells Fargo

King agrees with supply chain leaders' expectation that cybersecurity will continue to be a significant risk factor in the future. But she believes cybersecurity specialty firms are better positioned to assess company risk than internal teams in many cases. “A cybersecurity risk audit is best performed by professionals outside of the firm, bringing specialized tools and threat information that most internal staffs would not have.”

The coming decade will bring traditional business and industry risks, as well as a number of new risk factors. King and other risk management experts recommend plans that incorporate a broad variety of topics:

Shawn King

Sr. V.P., Strategic Execution and Operations, Wells Fargo



Trend Expert

“Risk management should be a key factor in managing any business at any time. But the pace of change is accelerating and I expect risks will multiply and take on different profiles. A key will be to identify the sources of potential risks and then develop a plan to manage those issues within acceptable tolerances.”

[Read More](#)

FIRM OF THE FUTURE

Brand, Marketing and Sales Management

Organizations approach brand management, marketing and sales in a myriad of ways. For the coming decade, a number of principles and practices are critical for success.

Strategy is key: Strategic thinking and problem solving will be key assets in these functions. Much like in operational areas, scenario planning will be needed to underpin resilience to changing competitive forces.

Scenario planning will be needed to underpin resilience to changing competitive forces.

Market segmentation, research and measurement will be critical strategic tools and data analytics will fuel tactical execution.

User Experience Rules: The outlook for the decade promises a strong focus on customer experience – also known as user experience (UX) – beginning with purchase needs and considerations and extending through shipping, usage and disposal or re-use.

This concept describes all aspects of interaction between a customer and a brand or company, including all of the organization's services and products. User experience is a broad concept, one that incorporates experiences across the spectrum from word-of-mouth references to social media commentary and personal use of products.

When someone calls for a replacement part, they have a user experience. When they operate equipment, open a shipping box, or visit a website, that's user experience.

All forms of interaction – real and virtual – will be critical in customer purchase decisions, sales transactions, usage, service delivery and brand loyalty. Even a customer's anticipation of what something like a robotic process might be can come into play.

In support of this perspective, brand managers must champion a customer-centric environment throughout the company. Everything from product design to delivery channels should be driven from a user experience point of view.

User Experience is broader than the more familiar concept of customer service or the digital reference to User Interface (UI).

UX is at the core of customer expectations for brands, companies, product and services. It reflects the customer's valuation of many factors, from access, ease of use, and friction of return processes to navigation of a website and brick and mortar shopping. It can include sensory experiences such as the fragrance in the air of a retail shop or a brand sound element in an advertisement. It's the whole spectrum of experience.

UX is the essence of what the firm of the future should be built around to meet customer expectations, to drive value and to reap profits in the Transformation Age.

Ashish Shah
Senior Director, User Experience, GEP



Trend Expert

User Experience: Providing Customer Value Nets Big Rewards

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FIRM OF THE FUTURE

Omni-Channel Marketing: Omni-channel marketing approaches will be needed to address all facets of user experience.

This approach provides customers with seamless and integrated shopping with a unified message, voice and brand value proposition.

The number and type of communication channels will increase and the interrelationships among them will be complex.

Voice search and controls, video on new smart surfaces, holograms and true three-dimensional images – technically referred to as “3d free-space volumetric images”-- will be added to the marketing communications. This spectrum was broadened significantly in the last decade with the power of social media and alternative media formats.

Brand and marketing elements will need to be refined. How should your brand “voice” sound; how should your brand be personified? How many seconds will you have to engage a prospect with your message before they move on to something else? How will you incorporate the voice of the customer and convert voice search to sales?

To be successful, omni-channel marketing requires significant collaboration and information sharing across the business enterprise, as well as integrated customer information systems that yield actionable, timely information.

This decade will see the art and science of marketing become merged more than ever before.

Digital Approach: Increases in smart automation will produce corresponding increases in data on market conditions, customer profiles, product usage and competitive factors. The key will be to create meaningful, actionable information to drive business processes and meet customer expectations.

How should you utilize equipment maintenance data to manage customer relationships or create sales opportunities? Are your edge systems in manufacturing plants or distribution centers interfacing with marketing systems to capture opportunities? Are your customers reacting differently to robotic processes than human interactions?

Investments in new data management, analytics and system interfaces will be needed to leverage new computing capabilities and create greater value for marketing and sales purposes and for the enterprise overall.

In many cases, investments in new systems will be more cost effective than trying to tie together legacy systems. For example, legacy systems may require an inordinate amount of time for retrieving and cleaning data by analytics staff. Newer systems and approaches will free these experts to spend time on creating actionable strategies from information gleaned across multiple systems. Outside providers should be considered as they may provide significant leverage and cost efficiencies to the processes required for updating marketing information systems and capabilities.

Brand managers must champion a customer-centric environment throughout the company.

Scenario planning will be needed to underpin resilience to changing competitive forces.

Brand managers must champion a customer-centric environment throughout the company.

The number and type of communication channels will increase and the interrelationships among them will be complex.

FIRM OF THE FUTURE

Collaboration: Leaders in brand, marketing and sales management will need to collaborate with each other and with other functional departments across the enterprise. Never before has such collaboration been more important to the success of business. The collaboration needs to be active and supported with transparent, shared information systems and decision-making processes.

Finance, risk management, product design, information technology, manufacturing, warehousing and distribution are all key marketing and sales partners who have critical information and who drive processes that impact customers in some way. Shared insights can lead to innovation and even small improvements that benefit the customer and ultimately the bottom line.

Relationship Management: While data and digital tools will be critical information sources, personal relationship management of key prospects and customers will continue to bring added value. In this highly digital world, people crave personal interactions for what they view as key purchases and significant service issues.

The same is true for transactional touch points for all customers. Employees need to be empowered with information and processes that allow them to provide customers with quick, expedient solutions, whether online, on the phone or in a retail store. To this end all business functions must work together to support first line employees' customer interactions.

Leading with Vision

The decade ahead requires vision, leadership and innovation from brand, marketing and sales leaders. Success in retaining customers and winning new business depends on a unified corporate vision with flexible means to accommodate a rapid pace of change.

Market and customer insights must be embedded in the corporate strategy and risk management scenarios.

Brand positioning should be defined and managed for the user experience across every element of the company, including the employee experience.

Rapid change strategies for branding, marketing and sales must be developed to address dynamic market and competitive conditions.

The art of communication must be amped and adjusted with the science of data analytics.

Graphic design will need to accommodate diverse and new delivery channels and devices.

Collaboration with other company leaders can lead to shared insights and discovery.

Brand, marketing and sales functions will have a critical role to play in the coming decade as leaders of change, creators of customer value and contributors to corporate financial success.

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FIRM OF THE FUTURE

Sustainability

In 2020, sustainability is no longer viewed by most companies or people as a special initiative, but rather as a critical responsibility and accountability. This perspective will prevail throughout the decade.

Pressure from investors, employees and customers will not abate on this topic in the coming years. Expectations will remain high and stakeholders will expect to be able to confirm brands, companies and their supply chains are fulfilling their promises. Transparent views of compliance with sustainable practices will be a requirement.

A heightened interest in health and ecology by consumers along with companies' deep sustainability commitments will drive purchase choices and usage behaviors on both consumer and commercial fronts.

Products and processes that support sustainable practices will be marketed for differentiated positioning. All features and benefits of products, from packaging and component parts to end-uses, can be promoted around sustainable value.

End-use of products and packaging will rise in importance, supporting growth of new businesses for disposal, recycling, and secondary markets.

Government policies and regulations related to sustainability will continue to shift, driven by political motivations and scientific debates. Industry leaders note compliance is growing as a cost of business, with variable impacts as regulations change.

Reverse logistics will gain increasing attention and added risk over the decade, says David Franchina, head of the environmental practice at McGuire Woods.

“As interest builds around sustainability in the supply chain, added risk points related to compliance are emerging.”

Franchina notes that some products considered safe for shipping to retail outlets or direct to consumers can be reclassified as hazardous waste when put into the supply chain for returns. Examples include items with ingredients such as nicotine, pesticides and pharmaceuticals. “Once classified as hazardous, these products must be stored, labeled and shipped in specific ways, Franchina says. “Hefty penalties are already being meted out and will mount for this issue. Companies need to retool their supply chain practices to account for these types of regulations.”

On a broader front, Franchina points out consumers are now recognizing more contaminants in every day life – from straws to Styrofoam – and making purchasing decisions based in part on companies' sustainability practices, or the lack thereof. “These impacts will drive product development and supply chain practices in multiple industries, with billions of dollars at stake.”

David Franchina
Partner, McGuire Woods



Trend Expert

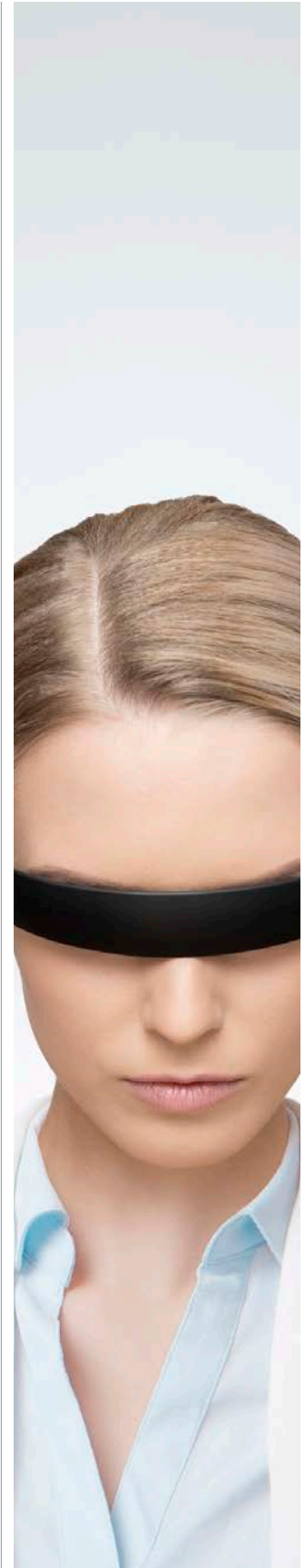
Technology Advances and Business Trends Combine To Create Positive Environmental Impacts in The Transformation Age

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FIRM OF THE FUTURE

Success in the Future

The industry landscape will continue to change and material handling, logistics and supply chain firms will be different in many ways in 2030 and 2040 than they are today. Making those differences the elements of a successful, prosperous business requires vision, planning and action today.



TRANSFORMATION AGE

TOOLS

The world needs new vocabulary to convey the continuous state of change characterized by multiple factors morphing at differing, rapid rates. The key is to distinguish among the factors that should be acted on today versus ones to watch for future commercialization and impact.

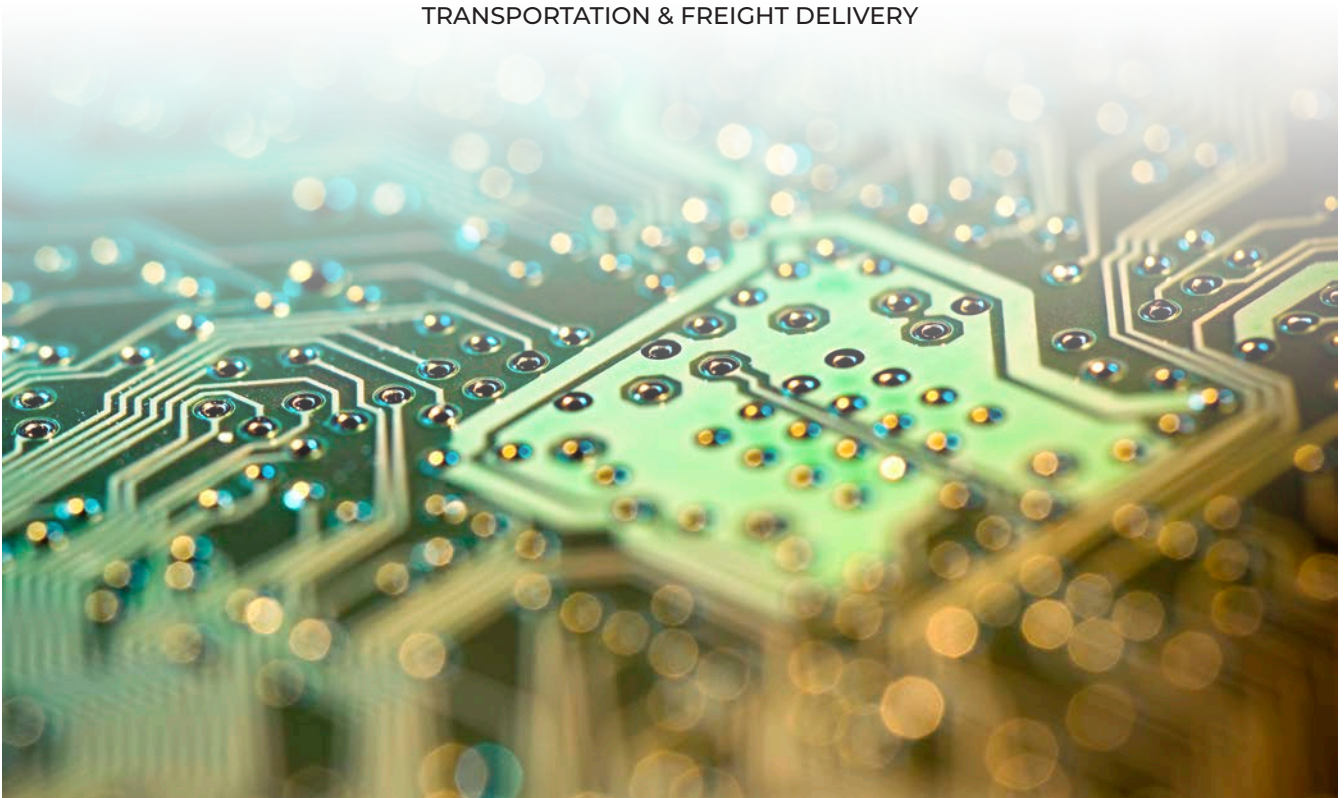
INNOVATION

SMART AUTOMATION & TECHNOLOGY

DATA & DIGITAL DECISIONING TOOLS

PACKAGING & LABELING

TRANSPORTATION & FREIGHT DELIVERY



TOOLS

INNOVATION

The convergence of advances in computing power, technology, digital decisioning tools and change mindsets brings unprecedented opportunity to the material handling and logistics industry. And to our world.

What are you going to do with it?

The world needs new vocabulary to convey the continuous state of change of multiple factors that morph at differing, rapid rates. Even quantum physics doesn't quite capture the conundrum that many are experiencing in this new era.

Success in the Transformation Age requires innovation and transformation for every industry player in some fashion or another. Clarion calls for new and improved manufacturing capabilities, integrated information flows, enhanced delivery channels and accelerated product design headline the list of needs for advanced approaches and tools.

This phase is messy for the material handling and logistics industry and will continue to be so, especially for the next five years. The promotional promises of new concepts outnumber announcements of solutions truly ready for commercialization and impact. Companies trying to embark on an evolutionary path are constrained by facility issues, cultural bias and even their own past success. So why change? Why invest in new tools?

If material handling companies and logistics companies want to be in the race, much less win it over the next five to ten years, investments in new, advanced approaches, mindsets and tools are required. Those that lag might not be around by 2030.

Industry leaders and process managers must gauge the timing and impact of new capabilities both for immediate use as well as for longer-term consideration. Some will have many shades of possibility. Others will morph in utility and effectiveness as customers implement solutions in live applications. Just as multiple versions of consumer products such as the Apple iPhone have been launched over the last decade, so too will various robotics and IoT capabilities emerge over time.

The key is to not be distracted by "hype locusts" as Jason Schenker, Chairman of The Futurist Institute cautions, but rather to distinguish among the factors that should be acted on today versus ones to watch for future commercialization and impact.

Innovation typically occurs in an iterative fashion. Waves of success and failure characterize the process, whether discovery is taking place throughout the industry, across an enterprise, or in a functional department.

INSIGHTS

- DEFINE STRATEGY, THEN TOOLS.
- TEST AND LEARN.
- STRUCTURE PILOTS CAREFULLY.
- CREATE LIFT WITH COMBO OF SMART AUTOMATION, TECHNOLOGY AND DIGITAL TOOLS.
- ADD VALUE WITH PACKAGING INNOVATIONS.
- LEVERAGE ADVANCES IN TRANSPORT AND FREIGHT DELIVERY.

Jason Schenker
Chairman, The Futurist Institute



"The key is to not be distracted by 'hype locusts'..."

TOOLS

Desired Outcomes

The change environment characterizing the Transformation Age dictates a need for clarification of corporate purpose and a definition of desired outcomes in order to choose how to best move forward with innovation and change related to equipment, tools and processes.

Companies should explore and define which outcomes they are pursuing and what action are tied to each. This strategic planning process helps clarify and direct tactical decisions and execution, and ties those decisions to longer-term corporate objectives.

Desired outcomes for transformation generally fall into three large buckets:

- Improve Operating Efficiency and Productivity
- Develop New Capabilities
- Meet Customer and Market Demands

Actions required to deliver value for each outcome are different and at times overlap. Key to the execution is matching technology, processes, and people to strategies and outcomes. Without such clarity, leaders may be frustrated with the gap between innovative steps and value goal achievement.

This process also helps companies wrestle with strategic change in more manageable steps. For example, purchase of automated sorting equipment with updated maintenance sensors can meet immediate needs for efficiency and productivity improvements and improve scheduling of down-time for maintenance. This use of smart automation checks the box for moving toward strategic improvement without overhauling workforce mindsets and workplace environments. The key is to make sure that investment aligns with the longer term vision for the process and facility.

Implementation of new capabilities for packaging or information flow, usually requiring significant investment of time and resources, provides opportunities for market differentiation and growth. Who knew the refrigerator box would sell more soft drinks? Again, this type of investment should be analyzed in the context of the long-term strategic view of the firm and be compatible with the vision for the broader equipment and technology platforms.

Customer demands will drive the industry in many more ways in the future than in the past. A key question for strategy consideration is whether the demand represents a differentiating opportunity or one that can be satisfied with a collaborative industry approach with no loss of market position for contributing players.

Global Lighthouse Project



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44 of the most advanced manufacturing factories in the world are lighting the way as learning beacons

TOOLS

Test and Learn

The evolutionary nature of the Transformation Age calls for companies – from CEOs to design professionals to factory floor operators – to ask and answer questions about adapting processes and tools to achieve goals for growth, profitability and sustainability. Creating a culture around this approach is a key success factor in fostering innovation and change.

The scientific process of testing and learning, a journey proven to reap rewards for those with patience and vision, is a practice encouraged by industry leaders contemplating strategic initiatives for this decade.

While testing is widely practiced in design activities, the process also reaps benefits in equipment purchases, installation, and implementation, as well as helping improve training and maintenance. Customer touch points can also provide environments for learning by testing messaging, pricing, packaging and promotions.

A powerful benefit of the invest + test + learn strategy is that it can reset the mindset across the workforce – establishing a collaborative culture, and accelerating the acceptance and deployment of new tools and decisioning systems. In the best scenarios, change represents steps toward opportunity.

Pilot Programs

Much has been discussed about the value of pilot programs in transforming company processes and approaches. Consensus among industry experts points to the importance of how such programs are led, structured, measured and monitored.

Companies with experience in utilizing pilots as part of their innovation and transformation initiatives point to a number of key success factors:

- Own and demonstrate innovation and transformation at the top.
- Create a corporate culture of innovation that rewards new ideas.
- Clearly define the desired transformation outcomes of the innovation pilot in terms directly tied to the company's long-term strategy.
- Educate your board of directors and other key stakeholders about the purpose and use of pilot programs.
- Create pilots that involve more than one department or division. Cross-department collaboration results in more ideas and solutions, and increased probability of success.
- Structure pilots to provide rapid success or failure. Learn quickly and adapt.
- Reward employee efforts in the process, not just the results.
- Share learnings broadly within the company to accelerate new ideas and future pilots.
- Fund pilot initiatives adequately.
- Commit to a long-term pilot framework: pilot, learn, adapt, repeat.

Brett Wood
President and CEO, Toyota Material
Handling North America



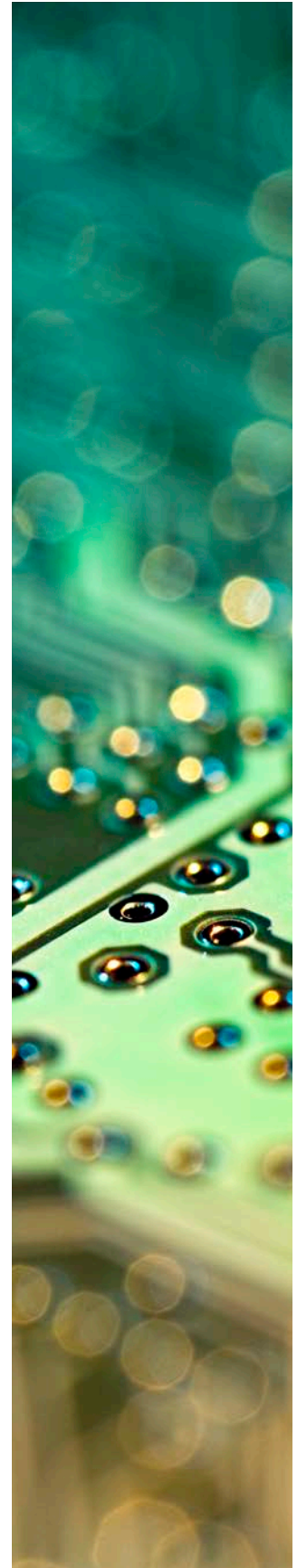
"The key is to invest and test. That philosophy drives our product development."

TOOLS

Keys to Success

Did you ever wish you had known something before you began a new initiative? Industry leaders and experts have a general consensus on ways to increase the probability of success. Keep these critical success factors in mind as you plan and execute new tools:

- Determine long-term strategy, then tools. For what purpose are you implementing smart automation and digital tools?
- Build for flexibility, scalability, and modular enhancements.
- Identify a long-term software platform: The biggest threat to effective implementation is using multiple devices with different vendor software.
- Invest time in getting everyone on board.
- Talk to others who have implemented solutions you are considering: what lessons did they learn? For example, the pattern of adoption can make a difference.
- Budget for training costs and allocate training time for everyone from equipment operators to information users.
- Acknowledge implementation may be messy at times, with a learning curve for combining machinery + people + environment.



TOOLS

SMART AUTOMATION & TECHNOLOGY

Opportunities abound for new, smart automation and technology in the material handling and logistics industry.

The next twenty years will see dramatic changes in equipment and processes. Many of the changes will be enhancements to initial product releases, while others will represent step-change technology innovations.

Stepping away from specific equipment and technology choices, innovation in engineering capabilities available today and those expected to be viable over the coming decade will provide new avenues for cost efficiencies, product design, equipment training and customer solutions.

A key factor in identifying the value of new capabilities is to evaluate both their singular contribution as well as the value found at the intersection with multiple other factors.

As an example, new material handling or manufacturing equipment may yield greater volume and precision. But the pairing of that equipment with sensors that feed AI and analytics platforms provides opportunities for information to inform and enable scheduling, maintenance, training, sales and marketing. Adding edge computing resources paired with cloud broadband power creates near real-time information for management decisions. Utilizing AR tools that pair human work with machine intelligence reduces time and improves performance for operations, maintenance and repairs.

The combined lift becomes exponential in benefits and payback.

John Paxton
COO, MHI



“The next decade will see great strides in commercialization of new and advanced tools in the material handling and logistics industry. Every sector, from manufacturing to retail stores will see transformations in the way materials are produced, stored, transported, tracked and sold.”

TOOLS

Quick Overview of Smart Technologies

A transformative view of industry tools includes a number of known categories, with expectations that the benefits offered within each will expand over time.

SMART TECHNOLOGIES



Cognitive Engineering: Cognitive engineering is a multidisciplinary approach to analysis and design of complex systems and equipment utilizing human factors, psychology, cognitive science, human-technology interaction, and systems engineering. The desired outcome is to provide a wholistic experience enabling a faster, more productive, safer, and at times, more meaningful work environment.



IoT: Incorporation of digital measurement devices with traditional and new equipment provides one of the greatest enhancements to long-standing and emerging companies, allowing rapid capture and transfer of information. Devices incorporated into wearables and mobile devices leverage man + machine information and enable work environments.



5 Senses and More: Many new technologies will emerge with variations based on use of one or more of the 5 human senses- See, Sound, Smell, Touch, and Taste. Human behaviors such as gesturing are being added to man+ machine interfaces.



Neurotechnology Ecosystems: Neurotechnology is where man+ machine meet, interact, and enhance the performance of both.



Augmented Reality and Virtual Reality: Already appearing in both industrial and civic settings, forecasts for the expansion of Augmented Reality (AR) and Virtual Reality (VR) applications suggest these technologies will be prevalent by 2030 and pervasive by 2040.



Robotics: Still in its infancy, robotics is expected to become far more sophisticated in the coming decade, moving from replacement of simple, repetitive human activities to activities humans cannot conduct or even imagine today.



Drones: Great strides have been made in drone equipment, technology, regulation and uses in the last decade, and especially in the timeframe 2018-2020. The coming decade will see much greater use of drones and a wider range of industry applications.

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TOOLS

Cognitive Engineering

Cognitive engineering is a multidisciplinary approach to analysis and design of complex systems and equipment utilizing human factors, psychology, cognitive science, human-technology interaction, and systems engineering. The desired outcome is to provide a wholistic experience enabling a faster, more productive, safer, and at times, more meaningful work environment. This approach characterizes much of the innovative design work underway in the industry, with a growing emphasis on the human-technology interface expected over the coming decade.

Cognitive engineering enables positive man + machine interfaces and process improvements which lead to easier adoption, and safer and more productive equipment and technology uses.

Applications for the workplace include improvements in equipment operation, maintenance, and safety for both human and autonomous operators. Today, cognitive engineering applications paired with telematics (telecommunications + informatics), abound in vehicles, from highway transportation to fork lifts. Advanced features and benefits will continue to multiply.

Wider range applications include shifts in workplace environments to accommodate temperature, lighting, sound and ambiance preferences.

IoT

Incorporation of digital measurement devices with traditional and new equipment provides one of the greatest enhancements to long-standing and emerging companies, allowing rapid capture and transfer of information. Devices incorporated into wearables and mobile devices leverage man + machine information and enable work environments.

Sensor capabilities have grown significantly in recent years, adding a broad range of human senses to engineering-based measurements. Smart wearables that utilize IoT, video, text and visualization capabilities are becoming commonplace in the industry. These IoT tools are leveraging the man + machine interface and creating real financial value. Growth in the use of these tools is expected to rise sharply over the next five years, with continued growth for the remainder of the decade as cost decreases and uses multiply.

Ease of entry makes IoT technology one that companies of all sizes can begin to implement now. Applications for use of IoT are expected to expand dramatically over the next five years, becoming a best practice standard by the end of the decade. IoT interfaces along the supply chain will multiply, feeding accounting, safety, sales, marketing and regulatory information systems. Volume will drive the cost down, enabling more companies to utilize this technology.

Bill Ferrell

Ph.D, PE Fluor Professor of Industrial Engineering Associate Dean of the Graduate School Clemson University



“The variety of ways that humans will interact with the internet as well as the number of implementations are going to increase dramatically and bring efficiencies and new capabilities to the supply chain. Wearables, equipment sensors, smart robotics and more will be useful for operations, maintenance and safety.”

TOOLS

Innovation in use of sensors comes with friction from debate over privacy, bias, data ownership, legal and regulatory compliance, and security. These issues will garner significant attention over the next ten years.

5 Senses and More

Many new technologies will emerge with variations based on use of one or more of the 5 human senses – See, Sound, Smell, Touch, and Taste. Human behaviors such as gesturing are being added to man + machine interfaces.

Vision and voice recognition capabilities are expanding for robotics and worker-centric facilities. Touch and gesture commands are being incorporated into digital screens, assistants and equipment. Sight is key in the AR and VR worlds and smell and taste are already a part of retail experiential strategies.

The primary message here is that smart automation and digital technologies are improving in part because of advancements that humanize the user experience. This trend will continue, in turn creating greater adoption by companies, facilitating higher performance levels and increasing acceptance by workers.

Neurotechnology Ecosystems

Neurotechnology is where man + machine meet, interact, and enhance the performance of both.

Advancements in this brain technology will be an important driver of innovation in intelligent manufacturing and material handling systems over the next 10 years, with significant commercial impact in the decade to follow.

A variety of technologies measure cognitive and affective brain functions and translate the data into meaningful insights and actions for personal, commercial and industrial uses. Hardware and software tools are used to monitor, analyze, visualize and understand brain data for analytical purposes, behavior modulation and modification, or for interfaces with smart devices.

Advances in wearables and other portable devices, telecommunications, AI and computing are converging to provide greater uses and utility for this technology. Other technologies such as Augmented Reality and Virtual Reality will grow as a response to advances in neurotechnology.

Benefits for material handling and logistics environments include workplace wellness, safety, learning and productivity. Neurofeedback on employees' levels of stress and attention can inform workplace management, leading to healthier employees and a safer and more productive workplace.

“Many companies are already leveraging this technology,” says Olivier Oullier, president of EMOTIV a leading provider of portable wireless brain-sensing solutions.

Olivier Oullier
President, Emotiv



Trend Expert

“Technology coupled with responsive, adaptive work environments provides the best working conditions and delivers great workplace wellness, safety, learning and productivity.”

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TOOLS

“These solutions allow a company to measure in real-time some of people’s affective and cognitive states such as stress, attention, and distraction. This information is then used to provide work assistance such as additional training or changes in schedules.

These neuro-tech based solutions also enable someone to mind-control connected objects, software or robotic workstations.”

Controls stemming from brain function, facial expressions and motion enabled machine operation, environmental control and human behavior modulation and modification. These science-based solutions leverage personalized neuroinformatics and machine learning.

In commercial use today, neurotech devices and machine learning algorithms are combined to convert brain waves into digital signals that operate a wide variety of smart equipment. This type of user interface can be used to control virtual and real objects just by thinking, replacing traditional input devices such as keyboards and keypads.

“Use of these technologies provides benefits to both employers and workers,” says Oullier. “We need to stop asking employees to adapt to a fixed work environment and start offering work environments that dynamically adapt to the employees. The end result is a safer and more productive facility and a happier, healthier employee.”

“We need to stop asking employees to adapt to a fixed work environment and start adjusting the work environment to the employee.”

Olivier Oullier, President, Emotiv

An area of great promise for this technology is the provision of useful applications for physically impaired individuals. Through the use of this technology, those traditionally unable to participate in the workforce will find new avenues for employment. Everyday life abilities will also be enhanced, supporting greater independent living, enhanced functionality and a broader scope of activities.

Augmented Reality and Virtual Reality

Already appearing in both industrial and civic settings, forecasts for the expansion of Augmented Reality (AR) and Virtual Reality (VR) applications suggest these technologies will be prevalent by 2030 and pervasive by 2040. 1

Both of these technologies enable collaborative work in real time and experiences beyond present time and location.

Augmented Reality is gaining popularity in material handling equipment operation and maintenance. Glasses enabled with AR informatics and links to service experts reduce time for equipment maintenance. Similar benefits accrue for training.



TOOLS

Applications include: 3

- Visualizing digital twin images and data within a real-world environment context. This application helps with equipment design, customization, training and operation.
- Quality and performance monitoring, utilizing past and present images for comparison.
- Remote assistance allowing the technician and expert to work collaboratively, sharing a view of the live equipment as well as maintenance and repair data and instructions.
- Monitoring real-time health of equipment or products from close range or distance without having to traverse the factory or distribution center floor.

With acceptance growing and equipment costs dropping, use of these technologies will greatly expand over the decade. 2

Growth in Smart Cities that incorporate AR technology tools will in turn spur industrial and retail applications.

The integration of AR and VR technologies with neurotechnology systems represents a next step advance that will emerge in this decade. This integration will spur the use of both AR, VR and neurotechnology systems.

Robotics

Still in its infancy, robotics is expected to become far more sophisticated in the coming decade, moving from replacement of simple, repetitive human activities to activities humans cannot conduct or even imagine today.

A key to imagining the future of this field is to remember that advancements in AI, Edge computing, quantum computing, semiconductors, material components, batteries, electric vehicles, industrial and urban infrastructure, and telecommunications will impact the pace of change and the breadth of applications.

Industry experience with robotics over the past five years varies dramatically. At the same time, the field has moved forward with innovations, making practical applications more effective, flexible and varied.

Robotics provides stationary and mobile capabilities for transforming material handling work environments. Improvements in flexibility, safety and guidance systems promise broader adoption in the next five years.

Melonee Wise
CEO, Fetch Robotics



Trend Expert

“Robots have very different applications. For example, there are robots that weld cars, some go under the ocean, others are used to deliver toothpaste inside a hotel. It’s not one thing.”

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TOOLS

Nuances in robotic applications now include on-demand automation of activities and data collection, providing enhanced flexibility and safety of implementation and ongoing usage. Without the need for fixed guidance infrastructure, installation is quicker and uses are more flexible in industrial environments. This change has the potential to spur adoption significantly.

Robotics for material handling are not reserved for industrial settings. Innovation in commercial and home environments will incorporate AMRs and other robotics in the coming decade. 4 Needs for moving heavy loads, from office supplies to groceries and gardening mulch will be addressed with small-scale, portable robotic equipment and devices.

Key success factors related to implementation of robotics include (1) mapping out detailed process steps to be performed with robotics prior to purchase, (2) reaching buy-in and support of the workforce, (3) investing in time and resources for operator training as well as training for others working in the shared environment, (4) investing in programming resources to ensure robotics benefits are fully realized.

Drones

Great strides have been made in drone equipment, technology, regulation and uses in the last decade, and especially in the timeframe 2018-2020. The coming decade will see much greater use of drones and a wider range of industry applications.

Competitive differentiation opportunities exist along the supply chain for movement of goods and people, monitoring, mapping, surveillance, and other services utilizing proprietary drones as well as drone services.

The 2019 drone market forecast by Drone Industry Insights calls for the drone market to hit \$43 billion by 2024, representing a compound growth rate of 20.5% and tripling the market value compared to 2018. 5 The forecast anticipates Services to continue as the leading segment in the drone industry with Software growing at the fastest rate.

End-to-end solution providers are expected to continue to lead market R&D and growth.

The Energy industry leads in use of drones and the forecast states that leadership position is expected to continue through at least 2024. Agriculture and construction follow, but Transportation and Warehousing companies are the fastest growing users and are expected to take over the second rank by 2025. Most notably, Kay Wackwitz, CEO and founder of Drone Industry Insights, says "...the drone market will grow much larger than initially expected and predicted..." 6

While a lot of growth and innovation will occur in this industry, with short-term benefits accruing to the material handling and logistics industry as well as others, much work remains to address issues pertaining to public acceptance, regulations, safety and infrastructure. Progress will be rapid, but mitigated by these factors.

The drone industry is now bifurcated into two categories of drones: those with existing commercial use, and others with great promise, such as eVTOLs, but require significant investment in R&D before broad adoption and usage is expected. The material handling and logistics industry will benefit from both types by 2030.

Kay Wackwitz
CEO and Founder, Drone Industry Insights



"The drone market will continue to grow much larger than initially expected and predicted."

TOOLS

Understanding the various types and uses of drones will be important in building competitive transport strategies for the next several decades. Each type is built for a specific purpose, including flight length, load weight, and environmental factors such as whether or not a runway is available.

Purpose

Counter Drones

Used for surveillance, detection and deterrence.

Delivery Drones

Commercial, industrial and private/public partnership drones used for transporting goods.

Passenger Drones

Commercial and private drones used for human transport.

Styles

Piloting

Piloted/manned and unpiloted/unmanned

Energy

- Electric
- Hydrogen/Fuel Cell
- Gasoline or Kerosene/Combustion Engine/Turbine and Generator

Configuration

Vertical Takeoff and Landing (VTOL)
Conventional Takeoff and Landing (CTOL)

Automation and Autonomy

Partial Automation to Fully Autonomous



Millie Radovic
Market Analyst
Drone Industry Insights



“The disruptive power of delivery and passenger drones is the first step in the radical reshaping of both the aviation industry and the way we move in urban environments.”

Data: Drone Industry Insights. Graphic by Burchette & Associates

Development and growth in drones will be dependent and intertwined with the evolution of the broader topic of [Urban Air Mobility](#). National infrastructure, Smart Cities, transportation technologies, regulations, public acceptance and smart automation will all play a role in the future of drones.

Sources

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TOOLS

DATA & DIGITAL DECISIONING TOOLS

Data and digital decisioning tools are bringing step-change advancements to material handling and logistics. In the next five years, digital technologies could well produce the greatest changes to the industry – and to the world – ever experienced and ever imagined.

The enormity of the impact will be evolutionary, creating lasting changes to the way data is obtained, stored, analyzed and used. In turn, the resulting informatics capabilities will impact everything from material and product design to marketing and logistics scheduling.

Advancements in these technologies will continue throughout this decade and well into the next. Every aspect of material handling and logistics will be impacted and every industry sector can benefit.

Quick Overview of Data and Digital Decisioning Tools



Infonomics: Infonomics - or the economics of information - is the discipline of managing and accounting for information. Approached with the same rigor as other business assets, companies have the opportunity to derive and optimize the value of their proprietary information.



Digital Twins: The digital virtual world can mirror reality in actionable ways.



Standardized Platforms and Protocols: Adaptation of smart technology and digital tools by material handling and logistics companies would be greatly enhanced by greater standardization of industry technology protocols and software platforms. Many firms cite this issue as an obstacle in their transformation initiatives.



Computing Power: By 2030, innovations in compute technology and processes will greatly enable speed, memory and capacity of computers and machines. Capabilities announced in the last two decades will gain traction and existing solutions will be enhanced far beyond current state offerings.



Quantum Computing: Up until now, mankind has been constrained in using technology to solve problems by the limits of computing power, memory and speed of computers and machines. With advances in quantum computing, and growing opportunities for commercially available applications, the challenge becomes one of imagining the issues to solve.



5G Broadband and Beyond: Coming into 2020, fewer than 30 cities in the United States have 5G broadband service, and even those do not have complete coverage across their city limits. Customers who do have the service will experience faster speeds and lower latency, translating to improved abilities for data capture and use.



Blockchain: It's all about truth and certainty - and having the information to certify that truth.



AI: By 2030, innovations in compute technology and processes will greatly enable speed, memory and capacity of computers and machines. Capabilities announced in the last two decades will gain traction and existing solutions will be enhanced far beyond current state offerings.

“5 Reasons Not to Delay Your Digital Transformation,” by Lawrence While for World Economic Forum



A worker on a Audi assembly line in Hungary.
image: REUTERS/Laszlo Balogh

TOOLS

Infonomics

Infonomics – or the economics of information – is the discipline of managing and accounting for information. Approached with the same rigor as other business assets, companies have the opportunity to derive and optimize the value of their proprietary information.

This process examines the production and consumption of data and the transfer of money to produce, sell or obtain information.

Data and information will drive the next two decades as never before. Sales cycles, inventory controls, marketing initiatives, risk management, production cycles, transportation schedules... every facet of the supply chain... will be data driven. By 2030, leaders in material handling and logistics will be those who generate business value from their data.

Beyond immediate important internal uses, industry players will have myriad opportunities to leverage their proprietary data for financial gain. Debates surrounding data and information ownership and privacy will increase, signaling the need for greater clarification in communication surrounding data privileges and underscoring the value of secure digital information technologies such as Block Chain.

Accounting practices do not yet recognize data as a formal company asset, but that too may change as more companies and brands find financial value in leveraging information about products, markets and customers.

Digital Twins

The digital virtual world can mirror reality in actionable ways.

Other definitions extend the concept to include processes and people. ²

Gartner defines a digital twin as a software design pattern that represents a physical object with the objective of understanding the asset's state, responding to changes, improving business operations and adding value. ¹

A screen displaying graphic representations and data on the unique and integrated operations of equipment in a manufacturing facility provides a digital twin of the actual equipment operation. This type of digital twin is useful because it allows a facility operator to see the information in an aggregated form that is actionable. The same application is useful in a distribution center to view products and environmental conditions.

Training via internet screens or AR technology can utilize digital twins to provide the workforce with realistic simulations.

Uses of digital twinning also includes predictive twins, which model the future state and behavior of a device based on historical data from other devices. ² This predictive tool promises to further extend the value of twinning and IoT.

Use of digital twinning is expected to expand in the coming decade as more and more of life on Earth is conducted via digital means.

Naras Eechambadi,
President and Founder, Quaero



Trend Expert

**Data is Great, but What You Do with
it is Where the Value Lies.**

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TOOLS

Standardized Platforms and Protocols vs. Equipment Based Software

Industrial Platforms and Protocols

Adaptation of smart technology and digital tools by material handling and logistics companies would be greatly enhanced by greater standardization of industry technology protocols and software platforms. Many firms cite this issue as an obstacle in their transformation initiatives.

This issue often inhibits companies' ability to integrate processes across equipment manufacturers and impedes valuable data flow.

Much talk about the need for standardized industrial software platforms has yet to produce a meaningful breakthrough to resolve this issue. The firm or venture that cracks this design will become the enabler of rapid transformation for many industry companies.

Home Product Platforms and Protocols

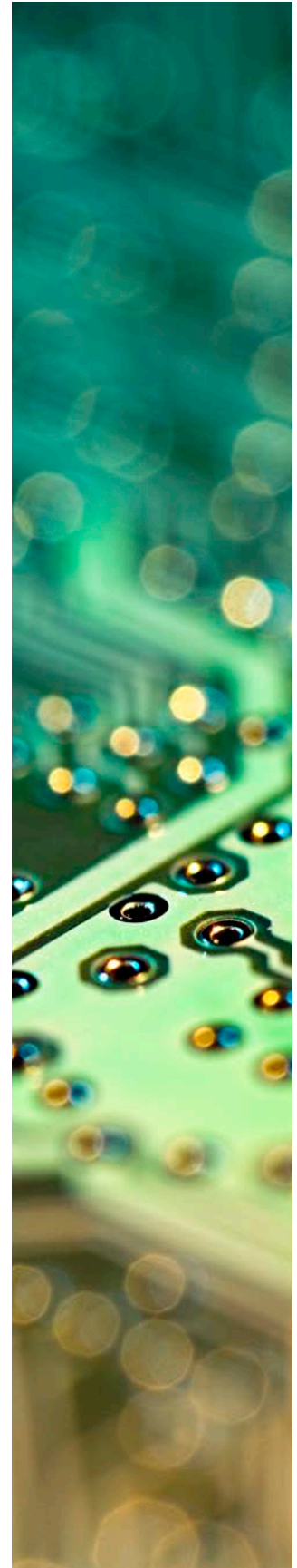
In the consumer products world, a new working group was announced in December 2019 by Amazon, Apple, Google and the Zigbee Alliance to “develop and promote the adoption of a new, royalty-free connectivity standard to increase compatibility among smart home products, with security as a fundamental design tenet.”³

This collaborative venture aims to tackle the challenge of standardizing in-home protocols.

Apple notes in the project announcement, “The goal of the Connected Home over IP project is to simplify development for manufacturers and increase compatibility for consumers. The project is built around a shared belief that smart home devices should be secure, reliable, and seamless to use. By building upon Internet Protocol (IP), the project aims to enable communication across smart home devices, mobile apps, and cloud services and to define a specific set of IP-based networking technologies for device certification.”

This industry working group, dubbed “Project Connected Home over IP,” already includes a variety of Zigbee Alliance board member companies and welcomes other device manufacturers, silicon providers, and other developers from across the smart home industry to participate in and contribute to the standard.

If you'd like to get involved or receive updates visit connectedhomeip.com.



TOOLS

AI

The use and effectiveness of AI has increased significantly in the past 3-5 years. The impact will grow exponentially in the coming decade, affecting every industry, business, and nation. Most individuals will be impacted in some way, whether they are aware of it or not.

Ponder these stats from the “AI Index 2019 Annual Report”: 4

- In a year and a half, the time required to train a large image classification system on cloud infrastructure has fallen from about three hours in October 2017 to about 88 seconds in July, 2019. During the same period, the cost to train such a system has fallen similarly.
- Prior to 2012, AI results closely tracked Moore's Law, with compute doubling every two years. Post-2012, compute has been doubling every 3.4 months.
- In the five months since being launched in May 2019, the T5 Team at Google almost reached human baseline in the language-based AI SuperGLUE competition with a score of 88.9. Human baseline is 89.8. Industry bets are the team will exceed a score of 90 by May 2020.

The combination of AI and smart technology is the brain behind the use of IoT smart sensors, edge computing, cloud technology, 5G and next generation broadband, satellite communication systems, and more.

Best practices around AI uses will evolve over the next decade. The most frequently identified societal considerations relative to AI, as reported in the “AI Index Annual Report 2019,” include fairness, interpretability and explainability. Standards around ownership and usage of data will continue to be key points of discussion and debate within the industry as this technology evolves and more uses and users are added.

Key areas of AI usage today include data analytics, semantic segmentation, image classification, image generation and temporal activity localization. Development of production and activity benchmarks and innovative machine learning algorithms continue to advance the technology in each of these areas.

Material handling and logistics fields of robotics, IoT, product design, packaging and transportation will continue to benefit from AI embedded solutions. Improvements in computing capabilities will enable larger data sets to be used, which in turn will improve machine learning and machine teaching capabilities.

Next steps in advancing this technology depend on improvements in algorithms used to serve specific needs. For example, to improve AI applications in robotics, improvements are needed across cognitive functions of vision, natural language, spatial relationships and task-specific knowledge.

“AI in Shipping: Areas to watch in 2020,” by Alexander Love for Ship Technology



TOOLS

Computing Power

By 2030, innovations in compute technology and processes will greatly enable speed, memory and capacity of computers and machines. Capabilities announced in the last two decades will gain traction and existing solutions will be enhanced far beyond current state offerings.

Integration across platforms, devices and processes will enable AI and IoT in commercial, industrial, consumer and military applications. Compute processes will be integrated in new ways for technology underpinning a wide array of capabilities from EV guidance systems and Smart Cities to those in complex industrial manufacturing.

“Computers were the fundamental driver of digital progress until now. Going forward, machine learning will be the fundamental driver,” says Pablos Holman, inventor and founder of Komposite. 5

He cautions, “But we need to always keep in mind, technology is just a tool, and like a hammer we can use it to smash a head or build a house. We need to become possibilistists and think about how the future could be better.”

Going forward machine learning will be the fundamental driver.

Pablos Holman, Inventor and Founder, Komposite

Technology advances as well as greater integration across the computing spectrum will allow meaningful collaboration among people and processes and enable faster decision cycles, while at the same time dictating greater requirements for information sharing throughout supply chains and business and personal processes.

Compute Technologies to Watch

3D Computing

MIT researchers announced a 3D chip fabrication method in 2017 that uses carbon nanotubes and resistive random access memory (RRAM) cells. 6 Commercialization followed when Intel launched a 3D silicon chip in 2018. Scaling chip production has already begun, impacting product design across many industry sectors.

The advancement from 2D to 3D is significant, allowing far more chips to be placed on a motherboard, and notably, enabling greater integrated chip functions and an increase in information pathways. The resulting increase in power and speed in a small space promises to advance infinite IoT applications powering large equipment, modular systems, portable devices and wearables.

Pablos Holman
Inventor and Founder, Komposite



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TOOLS

DNA Computing

DNA computing is a branch of biomolecular computing that uses DNA as a carrier of information for arithmetic and logic operations. Still in its early stages, DNA computing is being explored by leading technology companies such as Microsoft and attracting attention from a world community of scientists.

“As incredible as it sounds, DNA can be used for computing, says Stephen McBride, editor of RiskHedge Report and contributing author to Forbes. “One pound of DNA has the capacity to store more information than all the computers ever built.” 7

This approach has important implications for information recording and archival data storage in molecular form.

In their nature.com article on digital data storage using DNA, Luis Ceze, Jeff Navala and Karin Strauss note, “Molecular data storage is an attractive alternative for dense and durable information storage, which is sorely needed to deal with the growing gap between information production and the ability to store data. DNA is a clear example of effective archival data storage in molecular form.” 8

The researchers point out a number of benefits of this data storage tool. High density storage in the magnitude of six times that of other approaches available today will become increasingly important as more and more data is generated through a variety of smart technologies. This high density characteristic promotes long-term preservation of data in molecules at low energy costs. The ease of replicating DNA enables copying large amounts of data faster and at lower costs.

DNA also offers advantages for long-term archival storage. As the researchers note, “DNA is time tested by nature, with DNA sequences having been read from fossils thousand of years old.”

When kept away from lights and humidity and at reasonable temperatures, DNA can last for centuries to millenia. An interesting point made by the researchers is that DNA has been time tested by nature, with DNA sequences having been read from fossils thousands of years old.

Researchers and data scientists agree that this digital tool is one to watch over the coming decade. Not only will storage capabilities be improved, but other technologies that feed and use the data will be advanced as well.

Edge Computing

Answers lie at the edge. Costs savings and digital efficiencies are to be found there too.

There is much to discover at the edge, onsite or near an industrial or commercial activity. Smart Cities will benefit as well. So will consumer experience.

While cloud computing brings great memory and bandwidth for managing large amounts of data, there is great distance between most cloud platforms and their data sources. This distance introduces latencies that reduce the timeliness, and at times the usefulness, of information gleaned from algorithms in the cloud.

Edge computing provides the geographic proximity to functional IoT sensors, and, more importantly, proximity to decision makers who may need to act expediently to the information gleaned from monitors and analytics.

“Molecular Digital Data Storage Using DNA,” by Luis Ceze, Jeff Navala and Karin Strauss



“Cisco Alums Reunite: Prem Jain’s Pensando Spins into the Edge-Computing Conversation,” by Mark Albertson for Silicon Angle



TOOLS

Already in commercial use, edge computing is providing impact on data security, speed, reliability, and scalability. Powerful, timely data collection is driving data analytics, developed and honed in cloud environments, that provide in-the-moment actionable results.

Many of the benefits of edge computing are achieved when paired with the power of cloud computing. For example, algorithms in the cloud can be used to analyze and test data streams to optimize manufacturing production or inventory controls. The updated analytics can be delivered to the edge on a daily or hourly basis to modify operations. The same approach can be used to optimize vehicle traffic management or local weather forecasting.

Consumer experiences can also be modified with edge computing – in this case sometimes referred to as “ambient computing.” Suggestions for additional items or recipes can be served up to a shopper in a grocery store, a blouse suggestion for a shopper buying slacks, or athletic socks to someone purchasing running shoes. The suggestions are based on algorithms developed and enhanced in the cloud, with the application to specific shopping experiences enhanced at the edge.

Much of the impact of IoT and AI will be delivered through edge technology. Over the next several years, edge computing will quickly become ubiquitous, with tremendous impact over the decade.

Exascale Computing

Think big. Think fast. Really fast. 10¹⁸ fast. Quintillion calculations per second.

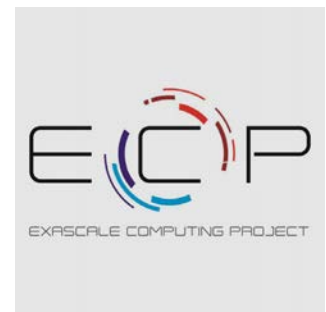
That’s 5 times faster than the world’s largest supercomputer can deliver today.

And the U.S. is on it.

The United States embarked on a 7-year project in 2016, known as the “Exascale Computing Project,” to develop the hardware, software and protocols to bring this capability to reality by 2021. The project promises to have a “profound impact on life in the coming decades.”⁹

The project is being conducted as a collaborative effort of two US Department of Energy (DOE) organizations the Office of Science (DOE-SC) and the National Nuclear Security Administration (NNSA), to advance the country’s efforts in scientific discovery, energy assurance, economic competitiveness, and national security.

The mission of this strategic initiative is to deliver applications, system software, hardware technologies and architectures to establish “an enduring national HPC (High Performance Computing) ecosystem along with HPC workforce development.”



“...Exascale super computers will more realistically simulate the processes involved in precision medicine, regional climate, additive manufacturing, the conversion of plants to biofuels, the relationship between energy and water use, the unseen physics in materials discovery and design, the fundamental forces of the universe, and much more.”

exascaleproject.org

TOOLS

World-wide competition for development of exascale technologies pits the U.S. project against initiatives in China, Taiwan, European Union, Japan and India.

Along the way to reaching their end goal, Exascale Computing Project teams are developing capabilities that in and of themselves bring added value to improving current computing applications. Announcements are posted frequently on exascaleproject.org.

A 2020 Research and Markets report cites MindCommerce as seeing the advent of hybrid systems that will utilize both quantum and classical CPUs on the same computing platform. 10

Research and Markets is high on this technology, writing in their report, "These next generation computing systems will provide the best of both worlds – high speed general purpose computing combined with use case specific ultra-performance for certain tasks that will remain outside the range of binary computation for the foreseeable future." 10

Quantum Computing

If only we could imagine...

Up until now, mankind has been constrained in using technology to solve problems by the limits of computing power, memory and speed of computers and machines. With advances in quantum computing, and growing opportunities for commercially available applications, the challenge becomes one of imagining the issues to solve.

Quantum computing is based on quantum bits referred to as qubits. Each qubit doubles the computing power of a linear bit. That increase in computing power represents enormous potential.

In a sense, quantum computing isn't better than traditional methods – it's different. The class of problems it can solve is different from those served well by approaches broadly embraced today.

The nature of quantum computing isn't just about speed. Quantum computers enable complex modeling and simulation functions of large data sets. These capabilities are escalating AI, molecular modeling, cryptography, financial modeling, weather forecasting and particle physics.

On the flip side, cybersecurity experts warn that encryption strategies must be adapted to counter quantum-based attacks. 11

Already in use in well-funded scientific and technology design environments, quantum computing is being developed, tested and used by hundreds of organizations worldwide. 12

Implications for the material handling and logistics industry include escalation of development of autonomous vehicles and robotics, development of new materials for use in industrial environments, and advances in augmented reality and virtual reality applications.



TOOLS

Over the next decade, discovery and innovation in quantum computing, programming and problem solving will lead to novel creations and solutions for commercialization and impact.

If we can only imagine....

5G Broadband and Beyond

Coming into 2020, fewer than 30 cities in the United States have 5G broadband service, and even those do not have complete coverage across their city limits. Customers who do have the service will experience faster speeds and lower latency, translating to improved abilities for data capture and use.

Seemingly instant downloads and connections will improve manufacturing processes, business interactions, and customer experiences, whether virtual or real. Collaborative product design, freight transportation and delivery, Smart Cities, equipment maintenance, machine learning, virtual education and training tools, autonomous vehicle management, robotics execution and drone surveillance will become more powerful, customizable and effective.

While 5G is being rolled out, the next generation – 6G, or by whatever name the next iteration is known – is already being researched and developed by engineers and labs around the world. This next generation network is predicted to be available by 2030, but may be a reality even sooner.^{13, 14} The key expectations are for even greater bandwidth, and that any issues encountered with 5G will be addressed with this next network technology. During this decade, advances in other areas of technology may provide new avenues for communication technology that enhance 6G in ways not even imagined today.

An issue getting attention in the telecom industry today is the state of current fixed infrastructure – the cables, fibers and switches – and the gap between the fixed side and the quickly evolving mobile side. Most of the advancements in recent years have been on the mobile side. Fixed networks don't have the capacity to handle the larger and faster data sets of 5G, much less what comes beyond that. The result will be delayed signals at switches and routers.

Work on future infrastructure capabilities is necessary, according to Richard Li, chief scientist of future networks at Huawei and the chairman of the United Nations' International Telecommunication Union (ITU) 2030 focus group. He offered that assessment in, "Now's the Time to Think About What Comes After 5G," an article in the IEEE Signal Processing newsletter.¹⁵

Article author, Yang Li, cites Li's opinion that "The next generation, 6G, will likely bring applications with even higher throughput requirements. Li says autonomous vehicles, massive machine-type communications, tactile Internet, and holographic communications are all on the table for the coming years. But the current fixed side won't be able to withstand the coming surge."

"Fixed networks that will be able to support the 6G networks. That is the key," says Li



TOOLS

Blockchain

It's all about truth and certainty – and having the information to certify that truth.

Blockchain is a distributed ledger technology that provides a way to create a secure and permanent digital record of an asset's origin, characteristics, and ownership as well as its pathway across the supply chain.

The technology provides a digital framework through which information is documented, verified and shared.

This digital tool enables public information sharing in support of verifiable sourcing, security, safety, financial transactions and compliance. The benefits to individuals and businesses promise to drive a whole new standard for transactional relationships over this decade

The benefits to individuals and businesses promise to drive a whole new standard for transactional relationships over this decade.

The potential is enormous and the benefits will accrue to companies of all sizes as well as consumers and members of the workforce.

Leanne Kemp, CEO and founder of Everledger, one of the world's leaders in blockchain technology, says blockchain "fosters trust, transparency and accountability throughout the network." She notes, "These are important factors in building relationships among businesses and their stakeholders, no matter their size or location."

Kemp points to parallels with the growth of other technologies, including the evolution of the world wide web, now connecting businesses and people all over the world via the http protocol, and the emergence of a standard secure platform using the smtp protocol. She sees the adoption of blockchain as the next step in advancing technology protocols for transactions and relationships whether the participants are down the block or around the world from each other.

Kemp's vision for blockchain is that the technology will become the global standard for securely sharing data. "This tool has the potential to become the worldwide distributed technology that brings value to every participant in the supply chain, from the origin of a raw material to the end consumer," notes Kemp.

"60% of CIOs expect some level of adoption of blockchain technologies in the next three years."

"This tool has the potential to become the worldwide distributed technology that brings value to every participant in the supply chain, from the origin of a raw material to the end consumer."

Leanne Kemp, CEO, Everledger

Others agree. A September 2019 Gartner publication reports the "business impact of blockchain will be transformational across most industries within five to ten years." David Furlonger, distinguished research vice-president at Gartner, says "60% of CIOs expect some level of adoption of blockchain technologies in the next three years." 16

Leanne Kemp
CEO and Founder, Everledger



Trend Expert

Blockchain Fosters Greater Transparency and Stronger Worldwide Relationships

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More from Leanne Kemp:

How the OECD can release the power of blockchain

TOOLS

A key to gaining full value from adoption of blockchain is to understand its components.

In an October 2019 article, "[The Four Phases of the Gartner Blockchain Spectrum](#)," Gartner contributor Kasey Panetta describes blockchain as containing five elements: distribution, encryption, immutability, tokenization and decentralization. She writes, "When combined, these elements enable organizations to take advantage of the true benefit of blockchain, which is allowing two or more parties who don't know each other to safely interact in a digital environment and exchange new forms of value and assets." 17

Blockchain industry experts agree that convergence of advancements in multiple technologies such as AI, IoT and self-sovereign identity (SSI) will fuel blockchain adoption and expand its use exponentially over the next 10 years.

The strategic signals here point to something even bigger – to evolution in business models, not just technology adoption.

The strategic signals here point to something even bigger – to evolution in business models, not just technology adoption.

As Panetta notes, "Blockchain-enhanced solutions will lead to business model changes as autonomous agents gain the ability to commercially interact and operate independently of a human."

The time is right to begin exploring and evaluating blockchain solutions. Adoption of key aspects now will prepare businesses for more widespread adoption and help identify future break-out opportunities for market success.

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TOOLS

PACKAGING & LABELING

Over the last decade, packaging and labeling have shifted from being commodity elements to value-added products and solutions that serve key expectations from industrial, commercial and consumer customers.

The experience of package shipping, unloading, opening and disposal are now differentiators in product and service delivery.

Innovation and growth in these solutions will escalate over the next 10 years. This growth will come with added pressures to meet demands related to shipping characteristics, smart automation, competitive costs, customer preferences and product value.

A number of factors are driving this growth and shaping sector innovation, including e-commerce, digitization, sustainability, margin pressures and customer preferences for convenience, customization, safety and security.

Packaging and labeling have the potential to provide value to customers in many ways, especially cost savings, preventing waste and adding value.

New technologies in automation, AI and blockchain are creating opportunities for the packaging sector, which in turn are serving myriad needs of customers and logistics partners.

Whether you are in the packaging business or a user of packaging and labeling, these solutions can be leveraged for brand building, customer satisfaction and loyalty, safety, security, logistics, tracking, sustainability and convenience.

[In an interview with McKinsey consultant Shekhar Varanasi](#), Ted Doheny, CEO of Sealed Air, describes packaging as being at the convergence of disruptive technologies. ¹

“That’s because everything is put in a package,” Doheny says. How does a package communicate with people who want to know what is inside, when it was filled, how much it weighs, whether it was stolen, and whether the contents are nearing their expiration.”

He encourages companies to think about the interface between packaging and technologies such as blockchain. “Packaging companies can use digital tools that note exactly when something went into a package. We can own that information and share it with customers, so they can trace the inputs and track the package. By providing that information, blockchain helps us add value.”

Smart automation dictates the need for packaging to be addressed in different ways than those used in the past with a human workforce. Doheny says, “A robot hand might not be as soft as a human hand. So what packaging is required? We may have to design for both robots and humans.”

More retail packaged goods brands will emerge as leaders in sustainability, responding to customer demands and driving packaging and labeling innovations. Greater integration of this philosophy into design, sourcing, production, shipping and merchandising practices will mark this decade for significant progress in positive supply chain value.



TOOLS

One such brand, General Mills, published their strategic imperative in 2019, pledging to reduce greenhouse gas emissions, sustainably source fiber packaging, utilize 100% recyclable packaging by design and achieve zero waste landfill impact, all before or by 2030. 2

Their efforts include active research, sourcing, development, and use of new materials that are from renewable sources and are recyclable. Both in-house and collaborative initiatives contribute to this ongoing commitment.

These types of efforts, whether pursued in-house or collaboratively with industry partners, represent significant corporate focus, resources and commitment, and a shift from a project mentality to a long-term strategic business model.

Future Trends in Packaging and Labeling

A broad variety of market demands, material innovations and business factors will impact and enable packaging and labeling over the coming decade.

<p>Primary Packaging</p> <p>Packaging for direct shipments of products without a secondary protective outer layer will grow. This solution reduces weight, eliminates unboxing and dealing with packing materials, and reduces waste.</p> 	<p>Safety and Security</p> <p>Information on date and time of shipment, temperature and moisture while in route and locations of shipping points will become standard information.</p> 	<p>Delivery Coding</p> <p>New delivery modes will need enhanced labeling to support autonomous freight delivery.</p> 
<p>Customer Unboxing</p> <p>The customer experience in unboxing the contents and either disposing or reusing the packaging will be a growing and critical user experience factor.</p> 	<p>Sustainability</p> <p>Greater adoption of sustainable materials and practices will reduce use of plastics, reduce landfill impact and increase recycling of materials. Sustainability will become a must have and not a trade-off option.</p> 	<p>Reusable Packaging</p> <p>Costs savings and sustainability with repetitive use.</p> 
<p>Freshness</p> <p>Food delivery is growing and so is the demand for keeping food fresh and appealing. Innovations in materials, material coatings and packaging design will emerge.</p> 	<p>E-Commerce Packaging</p> <p>Increased requirements for strength and flexibility, improvements in consumer's unboxing experience, and facilitation of easy, efficient returns.</p> 	<p>Materials</p> <p>Light-weight, flexible, protective materials. Able to withstand rough handling along supply chain. Edible materials. Additive features to package contents. Sustainable materials will grow in importance.</p> 









General Mills Sustainability Pledge



As responsible stewards of natural resources, we aim to reduce our environmental impact across each product's full life cycle. Several key strategies drive our work to reduce the impact of packaging production and waste.

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<p>Easy to Pack</p> <p>Time and cost savings; ease of workforce training and machine programming and handling.</p> 	<p>Simplify Returns</p> <p>Packaging reusable for returns provides value in the customer experience and increases likelihood of accurate and safe return delivery.</p> 	<p>Integrated Production</p> <p>Solutions will become more localized, close to or integrated in-house at brand owners.</p> 
<p>Increase in Convenience</p> <p>Easy open and resealable closures, portability, one-hand use, and single-portion packs will grow in consumer and commercial goods.</p> 	<p>Sustainable Convenience</p> <p>Consumers have strong preferences for sustainable solutions in convenience options. These are no longer trade-offs.</p> 	<p>Personalization/Customization</p> <p>This goes well beyond monograms and names. Personalization relates to size, repeat shipping cycles, color, texture and shape.</p> 
<p>Price Pressure</p> <p>Margins will continue to be under pressure even as greater value is delivered.</p> 		

Graphic: Burchette & Associates

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TOOLS

TRANSPORTATION & FREIGHT DELIVERY

Movement of materials is one of the key aspects of logistics, and one that represents a significant cost factor. Significant shifts in transportation and freight delivery occurred in the first decade of this century, paving the road for further progress in the future. From electric delivery trucks to warehouse drones and many modes in between, transport will be transformed through technology and engineering to optimize capabilities throughout the supply chain.

In looking ahead to 2030, transportation experts believe 4 factors will drive changes in commercial transportation and freight delivery:

The first is a tipping point for electric vehicles (EVs), with improved battery capabilities and expanded domestic charging infrastructure.

Second is the use of drones to facilitate short-distance ferrying of light-weight goods in and around manufacturing, warehouse and distribution facilities and for specialized freight delivery to consumers and businesses.

Third is the emergence of new, integrated urban freight delivery strategies to execute the last mile with special focus on the last fifty feet of delivery.

Fourth is technology and material advances in marine vessels and associated freight handling and storage capabilities.

A look at each of these factors reveals the potential impact of each as well as some opportunities for multi-modal approaches.

Electric Vehicles (EVs)

Industry leaders and transportation experts forecast strong adoption of EVs in multiple commercial classes over this decade, paralleling growth in consumer-driven EVs. 1 Adoption timeframes and cost impacts will differ among light, medium and heavy-weight commercial vehicles.

Municipal and private bus fleets will continue EV adoption as part of cost savings and sustainability initiatives.

Electric van and truck sales are expected to accelerate over the decade with growth continuing out to 2040.

Long-haul heavy-duty trucks will be more difficult to electrify, thereby utilizing more natural gas and hydrogen fuel cells.

The move to smaller freight vehicles will accommodate growing urbanization, e-commerce and city restrictions, further fueling the rapid rise in EVs.



TOOLS

EVs with autonomous capabilities will grow in adoption for on-premise use during this decade. Expect to see them shuttling people and cargo around large facilities, such as manufacturing plants, distribution centers and office parks. Important strides are being made in autonomous vehicles, but wide-spread use of this technology for freight delivery on public roads is not expected before the 2030s. 2

Improvements in battery capabilities and domestic charging infrastructure will allow vehicles to cover longer distances and improve safety and longevity of equipment. But costs will be an important factor in the switch from internal combustion vehicles, impacting the level and pace of adoption rates over the decade.

Lithium-ion battery costs are expected to drop as demand for EVs rises. Global forecasts call for lithium supplies to become strained by the mid 2020s, creating new demand for batteries utilizing nickel, cobalt and other minerals. 3

Much greater charging infrastructure will be needed across the U.S. to support the growing demand in EVs for both commercial and consumer use. Companies and consumers will need to evaluate private facility and home charging capabilities versus public infrastructure for cost and convenience. Opportunity exists now for oil and gas companies, private providers, utilities and automakers to build out this infrastructure, with the 2030s being the timeframe when mass adoption will be realized.

Package Delivery and Cargo Drones

Unmanned aerial vehicles (UAVs) are defined as remotely piloted aerial vehicles. Operating over land and sea and inside facilities, drones are becoming familiar assets in the material handling and logistics sectors.

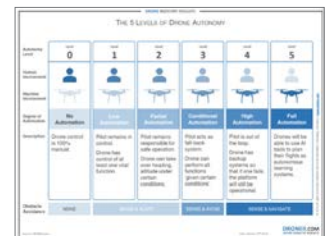
Research on drones by Research and Markets forecasts the drone logistics and transportation market to grow from USD 11.20 billion in 2022 to USD 29.06 billion by 2027 at a compound annual growth rate of 21.01%. 4

For commercial freight, UAVs are typically segmented into delivery drones (<10kg) and cargo drones (>10kg). Research and Markets expects increasing investments by large retail companies such as Amazon, Google, Wal-Mart, FedEx and UPS to grow the delivery drone sector at a higher rate than cargo drones. 4

Research and Markets notes that trends driving drone package delivery include demands for faster delivery to consumers and businesses, amended regulatory frameworks to allow and facilitate drone package delivery, and increased use of low-cost and light payload drones for product delivery by start-ups. 5 The short duration (< 30 minutes) segment is estimated to account for a larger share of the overall market in 2023, however the longer duration segment is projected to grow at a higher rate through 2030 due to demand for immediate, low cost package delivery.

Drones Industry Insights sees the adoption of Remote ID planned for 2020 in the United States as an important milestone in Unmanned Traffic Management (UTM). 6 The proposal requires all drones over 250 kg in weight to provide identification information that can be received by requesting parties. A key question remains about how other nations' remote ID standards will compare.

“Drones in Cities: the Future of Urban Air Mobility,” Drone Industry Insights



TOOLS

Increased adoption of drones will be driven by advances in automation for data processing and mission execution, reports Millie Radovic, industry analyst at Drone Industry Insights. 6 Radovic notes, “Actionable data is next to a powerful and reliable drone probably the most important driver of the drone industry...the faster, the more accurate, and the easier the images can be evaluated, the better.” Additionally, she notes AI technologies will allow processing of thousands of images without a human in the loop.

Key trends in packaging, such as eliminating secondary packaging, and use of lower-weight materials will converge with advances in drone equipment and standards and further facilitate innovation in deliveries. Sensors will add capabilities and useful information as well.

Today, commercial drone deliveries are handled by both outsourced specialty firms and in-house staff. Drone Industry Insights expects the use of full service end-to-end solution providers to grow, providing rapid competition to non-drone approaches. 7

For more information on drones, go to the [Smart Automation & Technology](#) section of the Tools chapter or the [Market Influencers](#) chapter of this report.

Urban Freight Delivery

Much academic and private research is underway to address the realities of freight delivery. The questions are not easy to answer; new technologies and capabilities, converging with an explosion in delivery demand, require new thinking and approaches to optimize freight delivery strategies and leverage innovations in industry equipment.

In the U.S., as in much of the world, progress in material handling and logistics finds itself at odds with current infrastructure settings in urban areas. Throughout the last century, cities have removed alleys meant as delivery corridors; most remaining alleys are limited by narrow space dimensions. Developers have built out commercial districts and work-stay-play venues without adequate delivery parking and dock access. Skyscrapers, condos and apartment buildings have added miles of floors for deliveries.

Research by the University of Washington’s Urban Freight Lab (UFL), an innovative partnership of private industry, academic researchers and public transportation practitioners, indicates “if cities do not redesign the way they manage increasing numbers of commercial vehicles unloading goods in streets and alleys and into buildings, we will reach total gridlock.” 8

This “final 50 feet,” a term coined by UFL researchers and described by the lab as a key to customer satisfaction, is “both the most expensive and most time-consuming part of the delivery process,” they say. 8

Anne Goodchild, director of the UW Supply Chain, Transportation & Logistics Center and founder of the UFL, cites 4 areas of great potential for optimizing the final 50 feet. She stresses the need for public-private collaboration to effectively address these urban freight delivery needs:

“Global Drone Outlook 2020,” Drone Industry Insights



Anne Goodchild

Director, UW Supply Chain, Transportation & Logistics Center, Founder, UFL



University of Washington, Urban Freight Lab

The University of Washington’s Supply Chain, Transportation & Logistics Center houses the vibrant Urban Freight Lab (UFL), an innovative partnership that brings together private industry, academic researchers and public transportation practitioners to solve freight problems common to private and public spaces.

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TOOLS

Industry professionals and city staffs need to work together to address delivery-related parking. For example digital platforms can provide delivery trucks with an automated way to locate parking spots for designated times, and one day even reserve spaces as needed.

Public policy can impact new development, ensuring curb parking space and transportation lanes are not hijacked for delivery activities, and delivery and loading docks are located where delivery vehicles will not obstruct other traffic.

Multi-tenant buildings can include innovative delivery mechanisms such as commercial and personal locker systems so deliveries can be made and picked up from a central location. While this is easier to implement in new construction, existing facilities can be modified to support this strategy.

Utilization of emerging technologies for robots and drones can provide new avenues for time and cost-efficient delivery strategies while also providing methods that reduce the toll on human labor.

Goodchild notes that, historically, the transportation and freight industry used to think of transport approaches as common solutions that needed to be implemented in the same or similar manner across the board. “Not so today,” she says. “We are increasingly seeing that we must have highly differentiated approaches that match specific environments, especially in the last mile.” She adds, “What works in New York City doesn’t work in Kansas City, and what works in dense urban spaces isn’t applicable in rural areas.”

In addition to geographic differences, various delivery sectors have specific needs as well. Goodchild says, “Think of delivery vehicles for small packages versus vans with heavier cargo that require equipment like a hand truck or jack to assist the delivery person. How does that cargo get lifted up a flight of stairs? That is the type of question we have to solve for the last mile and the last fifty feet of delivery.

“In solving for these different environments, we will see a lot of experimentation with different types of solutions from electric cargo bikes to bots like the Amazon Scout that moves along sidewalks at a walking pace,” notes Goodchild. “We will also see more mixed mode approaches such as a truck delivery using a drone to transport goods to a landing area on top of a building.”

Delivery services are also growing in type and complexity for suburban residential settings. Food and gift delivery tops the list of what comes to mind for most people, but a growing affinity for home delivery of everything from toothpaste to dog food is occurring across all age groups.

Michael Kay, associate professor of industrial engineering at North Carolina State University, believes consumer trends favoring home delivery services for food as well as house and garden supplies will drive adoption of new delivery equipment systems.

“Home delivery stations will provide secure receipt and pick-up of everything from dinner to garden mulch.”

Michael Kay, Associate Professor of Industrial Engineering, North Carolina State University

“Home delivery stations will provide secure receipt and pick-up of everything from dinner to garden mulch,” says Kay. He expects these systems will create new demand in the coming decade for innovative new construction as well as home renovations. “Consumer garage space, less relevant as consumers reduce vehicle ownership, will be prime locations for home locker systems,” says Kay.

Urban Freight Lab Members

Boeing HorizonX
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 US Pack
 UPS
 United States Postal Service (USPS)

Michael Kay

Associate Professor of Industrial Engineering, Interim Director of Operations Research Graduate Program, Associate Director of Graduate Programs in ISE Department, North Carolina State University



Home Delivery Logistics using Driverless Delivery Vehicles

TOOLS



7 Hot Trends That Will Change the Future of the Food Delivery Industry

The Final 50 Feet Research Program: Optimizing the Last Leg of the Urban Goods Delivery System



Maritime Shipping

Maritime shipping is experiencing significant transformation, driven principally by the expansion of world trade, changing customer needs, the pursuit of operational efficiencies and a desire to protect the environment. Advancements in technology, engineering and business solutions are rapidly enhancing and enabling commerce at sea.

Over the last decade, significant investments have been made to upgrade ports on every coast of the United States. These enhancements are continuing and will provide greater channel depth, improved navigability and enhanced freight management.

Automation of loading and cargo discharge processes, channel deepening, widening of port access, expansion of berth slots, and improvements to drayage will allow American ports to receive larger ships and speed processing times and length of stays in port.

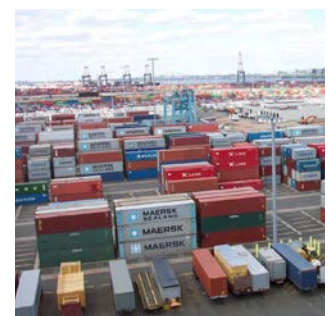
These investments appear to be paying off. Gary Frantz reports in DC Velocity that “many U.S. ports processed record or near-record freight volumes through the first part of 2019, building on a 2018 that set a high-water mark for import and export ocean cargo.”⁹

Competition for bigger vessels and larger cargo discharges is fueling hundreds of millions of dollars in investments by multiple ports, especially those on the East Coast. These improvements will enable simultaneous entry by multiple big vessels and faster cargo handling between ships and trucks or rail. That’s good news for supply chain players everywhere.

Enhancements in related infrastructure will include road and rail line improvements and construction of inter-modal facilities to support extended supply chain transport and logistics. Container yard expansions, construction of specialized storage facilities, smart automation, digital capabilities, and upgrades in cranes and robotic equipment are planned as well.

Significant economic development opportunities are tied to these enhancements, promising lucrative benefits to port states and other markets along connecting transportation corridors.

ARO 2020: US East Coast ports vie for rising cargo volumes



TOOLS

Strategic Imperatives

A subsequent report, Global Marine Technology Trends 2030 (GMTT 2030) by Lloyd's Register, QinetiQ and the University of Southampton, examines how technologies will impact maritime shipping, naval operations and the ocean space sector out to 2030. 10

The stage is set for continued growth and modernization of U.S. ports out to 2030. But is the vision for these improvements transformational and setting the stage for use of future smart technologies?

And what about capabilities to interface with new and planned maritime communication networks and smart ship systems?

Will the U.S. workforce be prepared for the new digital capabilities required for port operations in the future?

The Global Marine Trends 2030 report places maritime shipping in a global supply chain context: "The ocean is the highway for international trade, with 90% being seaborne." 10 This statistic underscores the importance of vision, strategy and investment in the future of this critical pathway in the supply chain.

As in other areas of the supply chain, avenues for progress stem from advances in smart automation, technology, digital tools, new materials, communication systems and sustainable processes. Innovation in marine environments, logistics and operations will contribute to improvements of shore-based activities, and the combination of advances in both realms will lead to transformative change that will benefit life around the globe. Positive impacts on the new space economy are possible as well.

Challenges and Opportunities

The commercial shipping industry has hurdles to clear in navigating this evolutionary phase.

A report focused on marine technologies, The Global Marine Technology Trends Report 2030 (GMTT 2030), 11 paints a picture of great need and opportunity in maritime shipping around the world. The report points out that today the shipping industry is in its infancy in technology applications compared with automotive, aerospace and consumer electronics industries – so the scope of the opportunity is huge.

The report examines how technologies will impact maritime shipping, naval operations and the ocean space sector out to 2030.

For the commercial shipping sector, the report identifies two technology arenas that will shape operations in 2030.

- The first arena includes technologies for propulsion and powering, ship building and smart ship – their term for ships with enhanced digital technology
- The second includes sensors, robotics, big data analytics, advanced materials and communications.

The researchers point out these technologies are not isolated, but rather are connected to each other to create advanced capabilities and benefits.

TechnoMax Ships

Ships incorporating these technologies will be known as TechnoMax Ships. Others that have only some improvements will be known as Pre-TechnoMax Ships. These two classes of ships will be important distinctions in the marine industry for chartering, contracting, bonuses and cargo handling.

Global Marine Technology Trends 2030

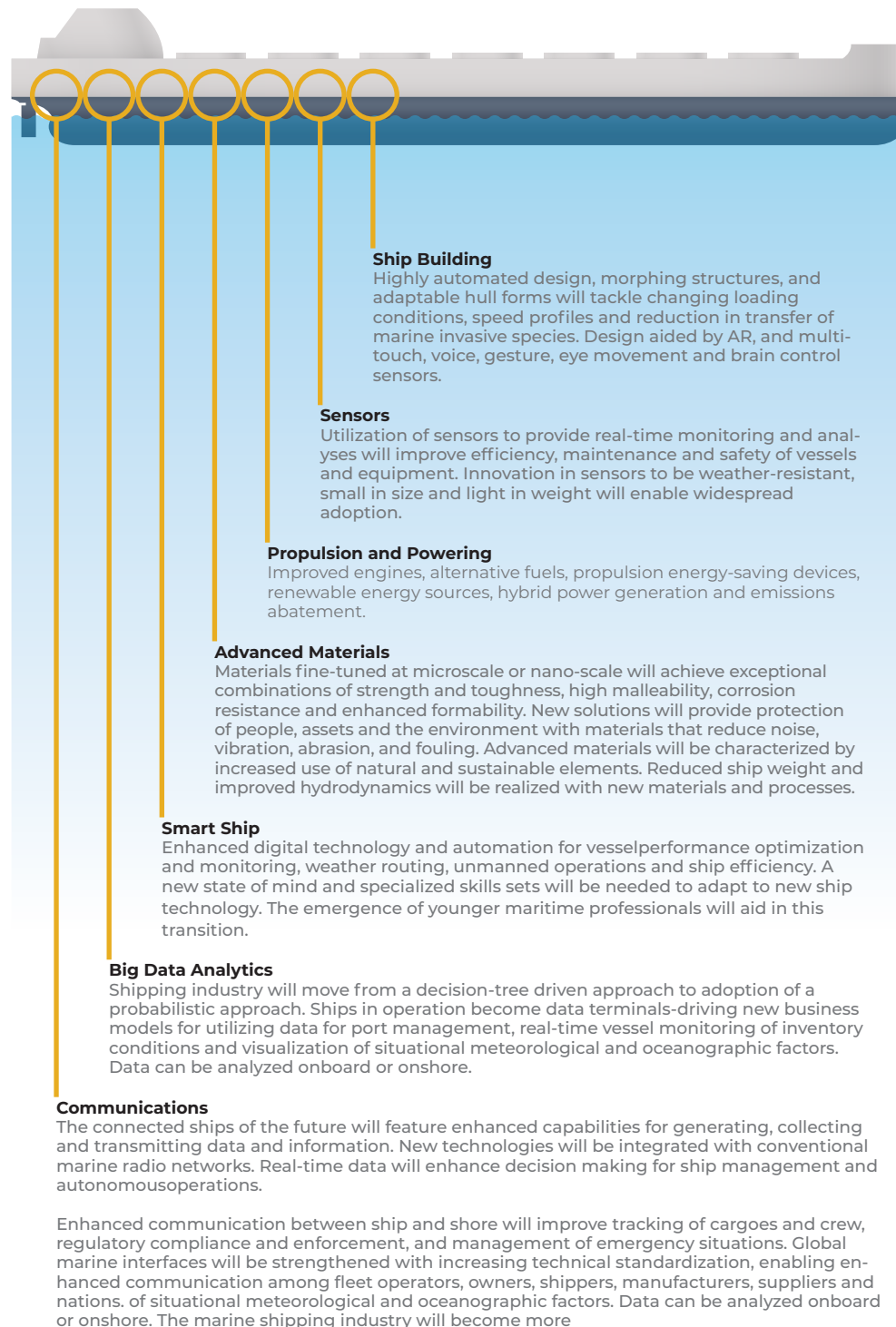


"These ships will be smarter, data driven, greener, with flexible powering options, fully connected wirelessly onboard, digitally connected through global satellites." GMTT 2030

TOOLS

Beyond operational advancements, perhaps the greatest value gains from TechnoMax Ships will come from enhancements to communications networks and the actionable data that will be available on a real-time basis.

Smart Shipping



TOOLS

The challenges involved in successful implementation of these technologies are not small. Success depends on a favorable regulatory framework, technical standardization on a worldwide scale, cooperation among marine stakeholders and significant re-skilling and training of crew and management.

As with much of the material handling industry, a shortage of skilled workers is a continuing challenge. The GMTT 2030 report sizes the hurdle: “There are over 104,000 ocean-going merchant ships. The shortage of highly-qualified sea-going staff is an increasing concern, especially as ships become more complex due to environmental requirements.”

The report casts a long-term vision for the man + machine relationship in maritime shipping that is centered around critical thinking and technical skills: “Smart shipping is not necessarily about removing people from ships, but about better connecting ships and their crews with specialized onshore resources.”

“Smart shipping is not necessarily about removing people from ships, but about better connecting ships and their crews with specialized onshore resources.”

Commercial shipping and the workforce that powers the industry will change significantly and benefit greatly over the decade as technology, digital tools and innovative processes are embraced and incorporated into many aspects of the sector.

2030 and Beyond

Overall, marine shipping will look very different in 2030 than it does today. Operations will be smarter, digitally enabled and data-driven. Ships and their processes will be greener and more flexible to accommodate dynamic conditions. Onshore resources and onboard management will be transparent and improved for the safety of crew, cargo and the environment.

Tools for the Future

The future is bright.

The material handling, logistics and supply chain industry will gain tremendous opportunity in the coming decade with the realization and commercialization of innovations in smart automation, technology, digital decisioning tools, packaging and transportation solutions.

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MARKET INFLUENCERS

Many factors will fuel the emergence, growth and impact of trends in the coming decade. Some will gain singular attention while others will attain only subtle note as part of a larger sweep of change.



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Many factors will fuel the emergence, growth and impact of trends in the coming decade. Some will gain singular attention while others will attain only subtle note as part of a larger sweep of change.

In recent interviews with industry leaders, trend experts and practitioners, these ten factors stand out as those that will make a significant mark during this decade and impact our lives, our work and our planet in lasting fashion.

Human Factors

The convergence of technology trends with consumer and industrial customer preferences, interest in human betterment and a new sense of individual empowerment will shape the world significantly over the next forty years.



Being Better: Everyone from Baby Boomers to Gen Alpha will be focused on “being better” with health, wellness, fitness and nutrition for themselves and their families.



Convenience: Time, Usage and Access: A perennial driver of consumer trends since WWI, the concept of time convenience will be measured in seconds and minutes rather than hours or days. This trend will apply broadly, from on line purchases and package delivery to time required for food preparation and work commuting.



Individual Empowerment: A growing belief in one's personal worth, empowerment and responsibility will blossom and reward the efforts of decades of diversity debates and struggles. Women, Men, African Americans, American Indians, Gay and Straight, Transgender, Youth, Elderly, Citizens and Immigrants will live, work and collaborate with acceptance of one another to a higher degree than in past decades.



Life-Long Learning: A better label will probably emerge in common parlance for continual learning throughout human life and work stages. This need will become an imperative as well as an empowering choice in the new decade.



Personalization and Customization: A prior decade of rising sentiment and experimentation around this topic brings a tipping point to consumer and labor force influence in the 2020-2030 period. Personal choice becomes ubiquitous.



Aging Gracefully: Human life will be lengthened and the quality of life improved in this decade. Advances in biotechnology will bring new meaning to cliches of “70 is the new 50,” and other claims to youth. Older generations will hope to work longer while also adapting schedules and lifestyles to mature preferences.



Privacy and Retreat: A clarion call for information privacy and protection rises over the decade, forcing brands to implement greater measures to respond to this demand. Blockchain usage increases as an information security measure for commercial and industrial customers.

INSIGHTS

- HUMAN FACTORS CREATE NEW DEMANDS.
- TECHNOLOGY AND DIGITAL TIPPING POINTS BRING PERVASIVE CHANGE.
- STRESSES ON NATURAL RESOURCES MUST BE ADDRESSED.
- ENERGY AND TRANSPORTATION ADVANCES BRING SWEEPING CHANGE TO LIFE AND WORK.
- AMERICA'S GLOBAL POSITIONING EVOLVES.
- ART, FASHION AND DESIGN REFLECT SIGNIFICANT CHANGES IN LIFESTYLES, BELIEFS AND WORK ENVIRONMENTS.
- BRANDS THAT FAIL AT SUSTAINABILITY WILL NOT SURVIVE.
- MANUFACTURING PROCESSES MAY ACE BRAND LOYALTY.
- LIFE ON EARTH BENEFITS FROM RENEWED INTEREST IN SPACE.

MARKET INFLUENCERS

Being Better: Health, Wellness, Fitness and Nutrition

Everyone from Baby Boomers to Gen Alpha will be focused on “being better” with health, wellness, fitness and nutrition for themselves and their families. 1

This notion will extend to a wide array of applications from fitness equipment and digital apps for tracking personal activities to food purchasing habits.

New scientific discovery and commercial applications will redefine availability of fresh produce. Fabrics that protect people from temperature and sunlight as well as those that promote wellness by warning wearers of environmental hazards such as air contaminants will be incorporated into personal fashion and home furnishings. Fitness and wellness will be incorporated into institutional, commercial, industrial and home architecture and design.

While each of the health, wellness, fitness and nutrition categories has been growing in recent years, the convergence and focus will increase and create powerful influences on personal and business choices in brands, products and services.

The convergence and focus on wellness, fitness, and nutrition will impact everything from personal choices in healthcare services to business facility environments and home design, employee benefit programs, restaurant and grocery offerings, home fitness equipment and personal digital tracking services.

Convenience: Time, Usage and Access

A perennial driver of consumer trends since WWII, the concept of time convenience will be measured in seconds and minutes rather than hours or days. This trend will apply broadly, from online purchases and package delivery to time required for food preparation and work commuting. 2

The desire for ease of operation and use will drive design of commercial, industrial and home equipment, vehicles, packaging of foods and beverages, lawn and gardening tools and personal digital devices. Want to sell baby food? Those single servings better come in pourable containers that can be opened and sealed with one hand.

Convenience will drive the growth and expansion of easy access concepts such as transportation services, ride sharing and vehicle sharing for cars and bikes. The concept of “one stop” will expand to blended service offerings such as co-working facilities that also provide daycare and yoga in the same building, and nursery schools with hair cuts and laundry pick-up services.

The desire for personal convenience is being driven by two factors: (1) the world is moving faster, so people feel as if commodity tasks are leeching time from their day, and convenience factors allow them to recover some small slivers of time for work or play; and (2) because we can – life is difficult, so if in some small measure we can make things easier for ourselves or others, why not?

John Goodman
Vice Chairman, CCMC



Trend Expert

“Don’t underestimate the role of customer experience in B2B.”

[Read More](#)

MARKET INFLUENCERS

Individual Empowerment

A growing belief in one's personal worth, empowerment and responsibility will blossom and reward the efforts of decades of diversity debates and struggles. Women, Men, African Americans, American Indians, Gay and Straight, Transgender, Youth, Elderly, Citizens and Immigrants will live, work and collaborate with acceptance of one another to a higher degree than in past decades. 3

This trend does not mean the end of discourse, but rather a move toward individual confidence in unique or minority characteristics and a growing acceptance of diversity.

Gender neutrality will be visible in new ways such as the design of children's toys and adults' clothing. Toys will reflect greater ethnic diversity and encourage boys and girls to pursue all kinds of career interests. Tailoring and clothing designs will be driven by personal size, shape and preference more than by gender. 4

Personal profiles will be viewed based on skills and personal contributions rather than on positions of power or rank. Traditional barriers to diversity will ease and acceptance broaden. The resulting human landscape will change in neighborhoods, workplaces, schools, places of worship, shopping venues, entertainment casts, and social organizations.

The growing sense of individual responsibility will mean that individuals will be more prone to take action on behalf of themselves, their families, their jobs, and their beliefs and causes.

Life-Long Learning

A better label will probably emerge in common parlance for continual learning throughout human life and work stages. This need will become an imperative as well as an empowering choice in the new decade. 5

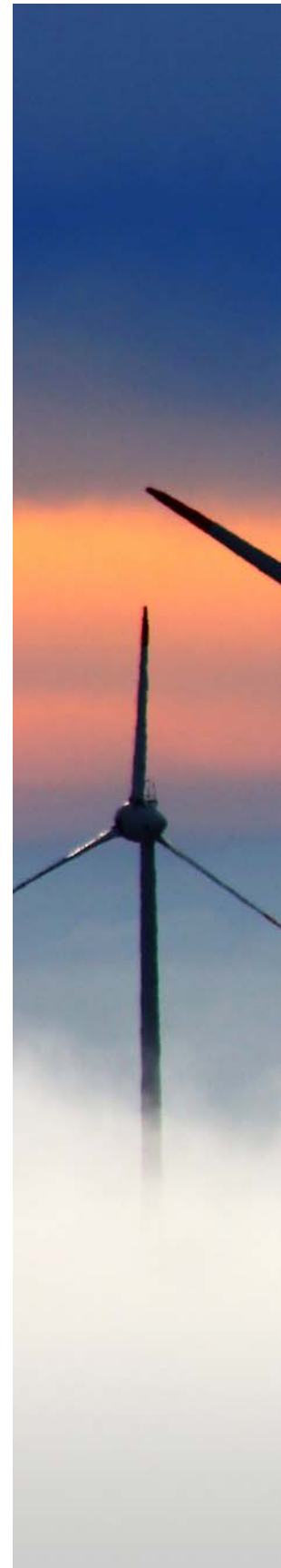
The rate and scope of change in the world will be such that individuals must continue to learn and adapt in order to successfully pursue their lives, their work and even their entertainment. Coupled with a rising interest in pursuing new ideas, new hobbies and new job skills, this trend aligns with the Being Better trend.

A large impact will be felt in the 2020-2025 timeframe by the existing labor force as individuals work to adjust to smart automation and technology and digital tools. Adaptation around these capabilities will continue as new advances emerge.

As part of this trend, credentials will shift to reflect the importance of both academic degrees and skills attainment. In the workplace, progression through a series of technical skills levels will be an important career component.

Education institutions will broaden and shift their offerings to support this trend. Skills certifications will take on greater recognition alongside academic credentialing. 6

Companies and industries will invest in training programs to meet a growing need for workforce skills in specific technical areas. Opportunities for industry collaboration in these efforts will abound.



MARKET INFLUENCERS

Personalization/Customization

McDonald's was way ahead of its time with the "have it my way" campaign. The slogan serves this decade well in describing the ways consumers will make transactional, work and lifestyle decisions in the future.

Since the beginning of the 21st century, we've seen a rising desire for personalization. The coming decade will see a tipping point of influence emanating from that trend. Personal choice will become ubiquitous, not only among consumers but in the labor force as well.

This perspective will drive consumer and workforce choices in the ways people want to get information, what services they use, and how they approach their daily schedules. Impacts will be felt in personal decisions about what time of day they want to work and play, what entertainment programming they prefer, and how they want to interact with health care providers, schools, employers and retailers.

Personal preferences will drive transaction decisions in far-flung ways, from selection of purchase channels to decisions on how and when package deliveries will be received. 7

Aging Gracefully

Human life will be lengthened and the quality of life improved in this decade. 8 Advances in biotechnology will bring new meaning to cliches of "70 is the new 50," and other claims to youth.

Older generations will hope to work longer while also adapting schedules and lifestyles to mature preferences.

Pressures will mount on families and healthcare facilities to care for older members of the population. Legacy wealth will be consumed as healthcare costs escalate to cover needs and longer timeframes.

Technological advances will support physical frailties in new ways, enabling longer work lives, independent living, and safer mobility and physical activities.

Privacy and Retreat

A clarion call for information privacy and protection rises over the decade, forcing brands to implement greater measures to respond to this demand. Blockchain usage increases as an information security measure for commercial and industrial customers. 9

As the pace of life increases in work and personal environments, people want greater personal privacy, including spaces and experiences that offer retreat. 10 Office environments built around open space concepts will need to add privacy areas for focused, quiet work or periodic personal escape.

The home and hospitality design industries will reflect these preferences, offering retreat environments to complement fitness, sports and adventure activities at the opposite end of the spectrum.

"Fast-Fashion's future of sustainability," Focusing Future



MARKET INFLUENCERS

Technology

Smart automation and digital tools will be pervasive and will enable improvements in quality of life, industry, science and commerce. 11

Man + Machine: The man + machine relationship will become accepted in work and life environments. Practical applications will multiply, coming to bear with appreciable value after a decade of trials, resistance and doomsday predictions.

Convergence: A tipping point of engineering and digital capabilities, consumer preferences, industrial needs and scientific interests will spur use, adoption, and further advancement of technology.

Artificial Intelligence, IoT and Advanced Computing: These three technologies will rule the decade, fueling equipment development, product design, smart automation, telecommunications, robotics, transportation innovations, and environmental design.

Satellite Communications and Broadband: Enablers in the best of senses, these two technologies will open markets, speed innovation and connect people in new ways around the globe.

Moving from single structures to constellations, while shrinking in size and cost, satellites will provide increasing value in a variety of fields, from climate monitoring, communications, and digital network capabilities to vehicle navigation services and medical collaboration.

Broadband will continue to progress over the decade, both in coverage and capability. The emergence of true 5G offerings in a handful of cities at the beginning of the decade will spread to national coverage of large and medium-sized urban markets. The hope for greater rural access to broadband capabilities will be realized, at least for locations able to support some commercial and industrial activities.

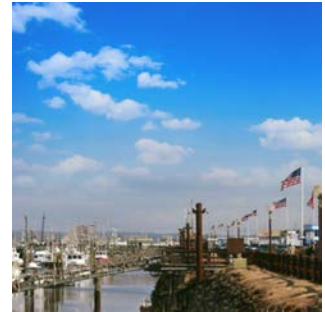
Robotics: The field of robotics will achieve new levels of acceptance with the advance of commercial capabilities, greater flexibility in installation parameters, and improved knowledge and training of the workforce.

Augmented Reality, Virtual Reality and Neurotechnology: Advances in AR, VR and neurotechnology will create significant changes in communication among people at work and in the world at large. These emerging technologies have the potential for significant impact in collaborative processes in manufacturing and logistics by the end of the decade.

Emerging today in industries such as healthcare, entertainment, education and transportation, these capabilities will enable collaboration, learning and training, navigation and digital competition among people in close proximity as well as those separated by global geography.

Devices: Connectivity will rise over the decade through new and innovative wearables, surfaces, screens, textiles and other materials. Device costs will drop as sales increase. Portable devices will enable rapid adoption of technology in emerging economies.

Case Study: “Meylah brings Smart City Tourism IoT solution to Grays Harbor with help from Microsoft, HPE, and other partners,” Microsoft



MARKET INFLUENCERS

Natural Resources

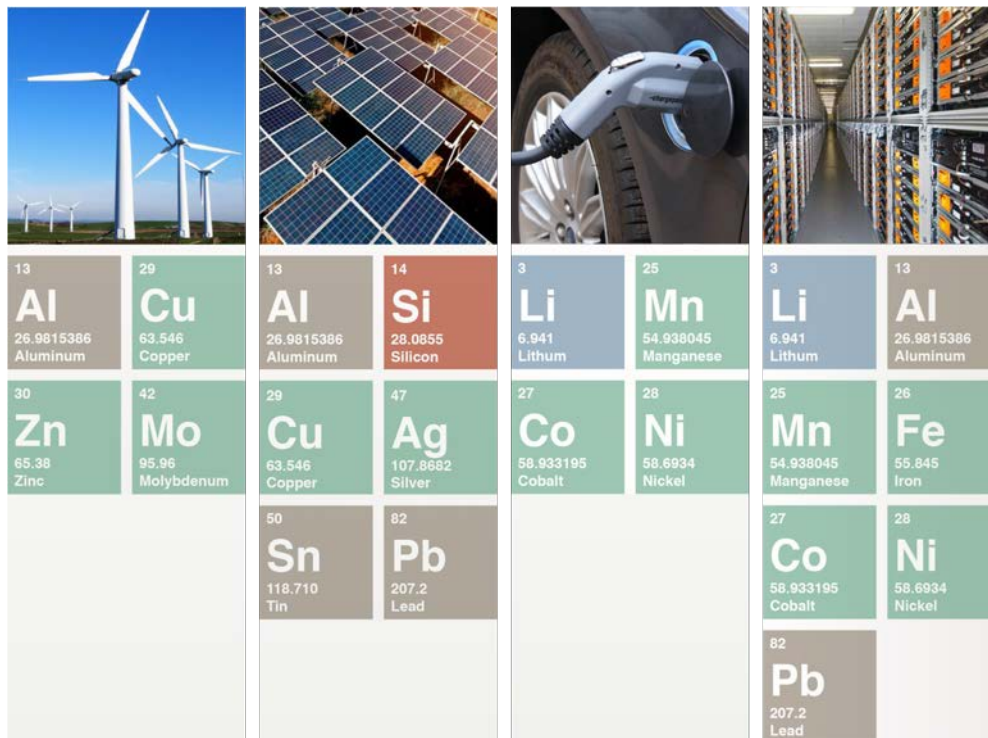
Stress on natural resources will increase, especially on water, critical minerals, forested lands and green space.

Growth and Migration: Global population growth will bring new demands for water filtration, land development, water, sewer, road and power infrastructure, and transportation systems, all of which impact natural resources. 12

Urban migration will require added housing and commercial infrastructure, further reducing green space and forested lands. Water resources and energy sources will be further taxed as a result. 12

Critical Minerals: Critical minerals are needed for core technologies for solar and wind energy generations, energy storage and batteries for electric vehicles (EVs). 13

Minerals Used by Technology Type



Source: Data from CSIS, Graphic by Burchette & Associates

Center for Strategic & International Studies (CSIS)

CSIS Brief: Critical Minerals and the Role of U.S. Mining in a Low-Carbon Future

MARKET INFLUENCERS

Demand for these minerals is expected to increase sharply during this decade. The Center for Strategic & International Studies (CSIS) predicts that under a 2-degree climate warming scenario, demand for all of the relevant minerals in electric storage batteries is expected to increase by over 1,000 percent.

The CSIS also notes that in 2020 the United States is absent from many of the global supply chains for these critical minerals, making it imperative for the country to identify new ways to secure needed domestic supply to fuel needs of the future.

Recycling: Recycling can contribute to resource availability in the U.S. but critical mass hurdles must be resolved. As new technologies reach scale such as lithium-ion batteries for EVs, end-use processes will be developed to leverage the components and materials. 14

Energy

Trends surrounding energy will have profound effects on life in the coming decade. Progression from age-old generation capabilities coupled with advances in newer technologies will transform energy usage and create positive impacts on world climate and sustainability in a variety of ways. 15

“In the future electricity system, having to buy fuel will be a disadvantage.”

New Energy Outlook 2019, BloombergNEF

Wind and Solar: Decarbonization of world economies is progressing at a promising rate. Solar, wind and batteries will be the new drivers of the electricity sector over the next 30 years.

America will have continued growth in renewables and gas over the decade with these becoming the country's primary source of power generation. (Bloomberg NEF)

Batteries and Photovoltaic Systems: Growth in adoption of electric vehicles (EVs) for consumer, commercial and government use will lead to a rapid rise in battery usage and advancement of battery technologies over the decade. Demand for batteries for EVs will drive down the costs of batteries for other applications.

Businesses and households will invest significantly in behind-the-meter photovoltaic (PV) and battery systems. BloombergNEF estimates the payback period for a PV plus battery system will halve over the next twenty years, from 13 years today to 6 years in 2040.

Electricity: Population growth coupled with development of emerging economies will increase demands for air conditioning. Electric vehicles (EVs) will add significant electric demand in the U.S. by 2050.

Technology: Sensors and improved machine efficiencies from AI will drive down commercial energy usage and improve costs.

Infrastructure: Construction of infrastructure for solar and wind generation and storage will increase, bringing new hardscape to urban and rural areas.

BloombergNEF

BloombergNEF predicts: “By 2032 there is more wind and solar electricity in the world than coal-fired electricity.”

BloombergNEF: New Energy Outlook 2019

MARKET INFLUENCERS

Transportation

Already in transition, the transportation industry will undergo massive transformation and restructuring over the next twenty years. 16



Consumer Vehicles: Personal vehicles will reduce in number, due to the rise in passenger transportation services overall and improvements in public transit systems in urban areas.



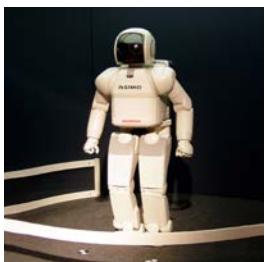
Electric Vehicles: Expect to see a dramatic rise in EVs in all sectors. Households, businesses and public transit systems will transition to EVs with a rapid adoption curve between 2020 and 2040. Charging station infrastructure will multiply to support longer distance travel and convenience. 17



Delivery Services: Delivery of retail packages and commercial freight will continue by road vehicles, but a rise in use of delivery drones in some sectors will segment the market. 18 A significant rise in food delivery services will come from supermarkets as well as food preparation companies. 19



Drones: Urban Air Mobility (UAM) comes of age in this decade with a dramatic increase in use of drones. Delivery and surveillance drones will have the greatest growth. Passenger drones, sometime referred to as “flying cars,” will gain acceptance but will be limited for some time by weight, energy sources and distance barriers. 20



The Last Fifty Feet: Much research, trial and effort will continue over the decade to determine the best approaches and develop the most effective technologies to support the last fifty feet of freight delivery. Autonomous vehicles, robotics, public and private parcel systems, digital and dynamic delivery scheduling and other tools will be honed in the process.



“High-speed rail can serve as an alternative to short-distance air travel, and conventional and freight rail can complement other transport modes to provide efficient mobility.”

The Future of Rail, IEA

MARKET INFLUENCERS



Infrastructure: Many roads, bridges and tunnels in the U.S. need attention and will require public investment over the decade.



Maritime Shipping: Port authorities on all U.S. coasts will continue investing in deeper channels, robotic stevedoring and specialized warehousing facilities to expand capabilities for global and domestic trade. The move toward automation will continue the reduction in manual labor at ports that began with the shift to containerization in the 1960s. 21



Spaceports: Spaceport development will increase in support of the rise in launch, recovery and related space industry activities. 22



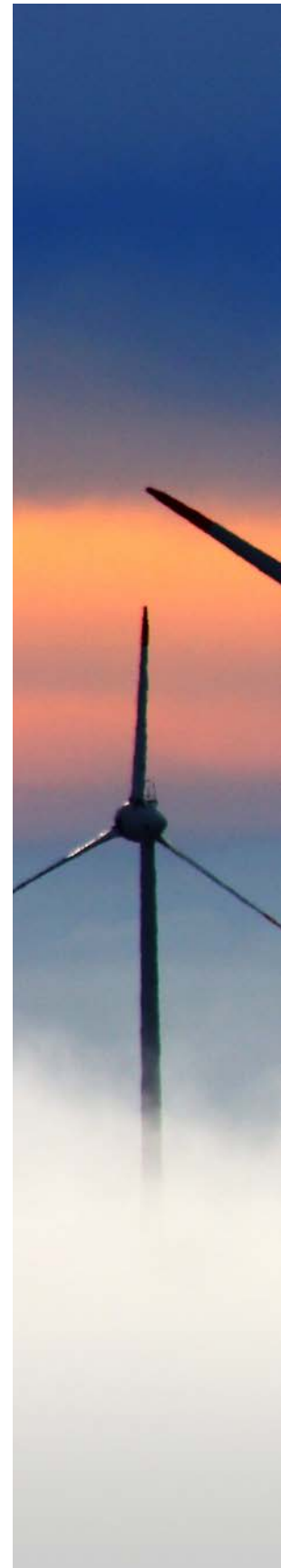
Rail: Investments in rail infrastructure in the U.S. will support growing passenger and freight needs as well as address increased interest in lowering CO2 emissions. 23

USA

The evolving positioning of the United States on the global stage will both propel and limit the domestic economy. 24

A return to domestic manufacturing in some sectors warrants close tracking as reduced costs and shorter supply chains to domestic customers promises increases in profitability and greater control over supply chain logistics.

Made in the USA will always be popular at home, but the acceptance of products manufactured around the globe will continue to grow as those products fuel demand, improve in quality and provide unique benefits.



MARKET INFLUENCERS

Increased economic strength across Asia represents a potential for loss of U.S. market share and profitability in international trade.

A polarized media will continue to fuel domestic conflicts over race, religion and ethnicity. The impact of this diversity of opinion will be mitigated in part by more inclusive Gen Alpha youth emerging into adulthood toward the end of the decade.

Art, Fashion and Design

Art is the reflection of life. In that realm the world will see itself in an age of rapid change, with a dichotomy of old and new opinions and approaches.

As art and design are age-old mediums for engaging discussion and creating debate, artists and designers will bring a clarion call for thinking about the present and the future via various mediums. The evolving environment will be well suited for those so talented to take on roles as instigators, mediators and facilitators of change.

Fashion design will reflect a greater adoption of gender-neutrality and diversity. New materials and protective finishes will appeal to consumers' interest in health and well-being.

Clothing will incorporate technology with accommodations for wearables and embedded smart fibers.

Industrial wearables for technologies such as AR and neurotechnology will become lighter weight, more comfortable, less obtrusive and allow greater integration with other processes.

Convergence of art and technology will bring exciting new experiences through new applications of augmented reality, virtual reality and digital surfaces.

Architecture and home and office design will reflect a global influence, with a local focus. Preferences for personal privacy and retreat will dictate new layouts in space usage and materials that convey quiet ambiance.

Gudy Herder, founder of Eclectic Trends and an international trend expert, says "Silence has become the new luxury in many cities." She expects noise-reduction pods/booths for offices to be implemented in public spaces. Herder believes future design preferences will include a focus on acoustic collections. "3D woven fabrics absorb and reflect sound waves much better than flat textiles contributing to a more muted environment," she says. 25

Technology will be a driver of design in many settings. 26 Richard Petersheim, partner and landscape architect at LandDesign says, "By 2030, a lot of technology will be incorporated into designed spaces. Augmented reality, advanced conferencing, digital walls, embedded sensors and other types of communication devices will be in use. New materials will allow walls to display information. AR will let you overlay information on real settings and new types of small wearable devices will facilitate communication." 27

Augmented Reality App: MariposaAR: Code the Dream for Google Fiber



"What Will Fashion Be Like 20 Years from Now?" by Bel Jacobs for BBC



What will fashion be like 20 years from now?

Richard Petersheim, Partner and Landscape Architect, LandDesign



"Design is driven by how people want to live and work.... We have to design for today and the future.... It is important for design professionals and their clients to be looking at future trends and how people will want to use spaces for the long-term."

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Petersheim advises firms to think strategically about their technology plans and how changes may require adaptation of the work environment. “A big part of the job in designing industrial spaces in the future will be to map out the technology and the communications.”

Across all design topics, trend experts are aligned on the concept of greater integration of technology into life and work spaces. A futuristic example is the “woven city” project announced by Toyota and Bjarke Ingels (BIG) that imagines new forms of urban life. Bjarke Ingels, founder and creative director at BIG says, “A swarm of different technologies are beginning to radically change how we inhabit and navigate our cities.” He views this as an exciting design opportunity. “Connected, autonomous, emission-free and shared mobility solutions are bound to unleash a world of opportunities for new forms of urban life,” he says. 28



“Toyota to Build Bjarke Ingels-designed ‘City of the Future’ at the Base of Mount Fuji,” designboom

Sustainability

No longer viewed as optional, proactive efforts to use sustainable practices in business will be a powerful driver of choice in this decade. Brands that fail at sustainability will not survive.

Consumers' participation in supporting sustainability will increase, demanding similar practices by public entities and businesses.

Consumers and companies will consider the level of sustainable materials in products when making purchasing decisions. The environmental impact of using products and services will also be important. Brands will be held responsible for their extended supply chain impacts, not simply end-product features.

Gen Alpha children will grow up with sustainability practices such as recycling and use of biodegradable materials being a part of everyday life at home, school and even on the playground. This engrained perspective will fuel this generation's focus on sustainability as they enter the workforce at the end of the decade.

We have 10 years to save Earth's biodiversity as mass extinction caused by humans takes hold, UN warns



By Jessie Yeund, CNN

MARKET INFLUENCERS

Recent research indicates an increase in the number of major global and U.S. companies that are more aware, engaged, and committed to addressing sustainability throughout their business processes. 29 So says Richard Mattison, CEO of Trucost, a research and publication partner with Green Biz Group for the State of Green Business 2020 report.

“These companies have never been more focused on sustainable business,” Mattison says. He finds an increasing number of senior executives are engaged around this issue and more companies are making their commitment goals public.

Financial markets are paying attention as well. Mattison notes that \$30.7 trillion in assets under management are run according to sustainability objectives and financial market regulators are showing significant interest in aligning capital flows with sustainability outcomes.

In the report, Jerry Makowitz, chairman and executive editor at Green Biz Group also casts a positive light on business trends for addressing sustainability in the future. He writes that “nature’s feedback loops and other indicators are worrisome....What gives us hope is that companies around the world are moving more quickly than ever to reduce the business risk that comes with these threats to natural capital and human well-being.”

Manufacturing Process as a Brand

Smart automation brings a new twist to the manufacturing process.

Today, a growing number of consumers view “made by” processes as more important than the geography of origin or the brand that manufactures the goods. A component made by a specific smart automated process is becoming a commodity in the eyes of the buyer. 30

How will brands compete when “Made By RoboticBlue” supersedes “Made by the Acme brand”? The combination of the manufacturing process with other factors such as sustainability, packaging, convenience and cost will be key differentiators.

Race to Space

Renewed interest, investment and commercialization of the race to space will fuel significant progress in a myriad of space-related activities. Life on earth will benefit from new knowledge, new processes, new materials and new capabilities.

Commercial and government-funded initiatives in space will increase throughout the decade, attracting participation from countries around the globe in launch, recovery and associated manufacturing, mining, research and support activities.

Maybe we’ll even get something as fun as Tang and space blankets this go around.

For more on this topic, go to [New Space Economy](#).

Joel Makower
Chairman and Executive Editor,
GreenBiz Group



“The trends reflect the potential of sustainable business: to create value for all society, balancing people, profits and the planet.”

State of Green Business 2020



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“Supply chains to infinity and beyond: interview with Mark Wiese,” by David Maloney for DC Velocity



MARKET INFLUENCERS

Convergence

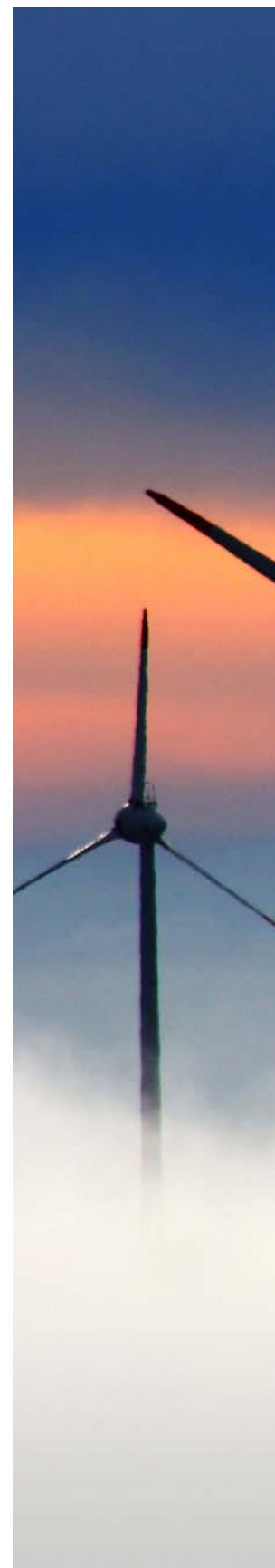
The convergence of market forces, trends and innovations will drive progress over the next two decades.

Business trends, consumer preferences and global needs will impact life and commerce.

Our connected world will allow material handling, logistics and supply chain players to rapidly address challenges and opportunities and learn from one another to achieve sector success.

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TRANSFORMATION AGE

GLOBAL MARKETPLACE

People around the globe share responsibility for progress. How we utilize our strengths, our resources, our gifts and our knowledge will tip the scales of impact that mega trends bring our way.



GLOBAL MARKETPLACE

The world enters 2020 with the greatest promise and the greatest uncertainty of our time.

Mega trends and game-changing events will converge to create a pathway for opportunity, molded by choices made by individuals, organizations and nations.

Technology has already made the world a smaller place and altered the pace of life to one of dizzying change.

The return to a focus on space reminds us that there is much beyond our world to explore, discover and learn.

Citizens of all countries share needs and battles for natural resources, individual rights and freedom.

What's next is largely dependent on how humankind chooses to use technology, innovation and discovery, and how to relate and to care for one another.

It's a small small world

Disney had it right, many years ago. The world is small and... "there is just one moon and one golden sun." 1

People around the globe share responsibility for progress. How we utilize our strengths, our resources, our gifts and our knowledge will tip the scales of impact that mega trends bring our way.

The National Intelligence Council's latest Global Trends report, "Paradox of Progress," provides a view of the world out to 2035 where "The achievements of the industrial and information ages are shaping a world to come that is both more dangerous and richer with opportunity than ever before." 2

The report makes the case that, "Although material strength will remain essential to geopolitical and state power, the most powerful actors of the future will draw on networks, relationships, and information to compete and cooperate."

People and nations are interconnected as never before. With that bond comes responsibility for international cooperation and collaboration. A critical question for the future is how well that cooperation materializes and enables positive progress.

America

Interviews with supply chain industry leaders reveal general agreement with the NIC's view: within the world context, the United States' dominance draws to a close in the next five years and is replaced by emerging networks of nations, organizations and individuals. 2 The U.S. will wield significant power and be viewed as a leader of progress in many fields, but must learn to navigate in a different role in the coming decade.

This shift has implications for the entire planet, as the world enters 2020 with the greatest upheaval in international relationships since WWII.

INSIGHTS

- THE U.S. MUST LEARN TO NAVIGATE A DIFFERENT ROLE.
- ASIA WILL GAIN ECONOMIC POWER AND SHAPE GLOBAL TRADE.
- ADVANCEMENTS IN TECHNOLOGIES AND DIGITAL PLATFORMS WILL ENABLE GLOBAL COLLABORATION.
- EVOLUTIONARY ENHANCEMENTS IN ENERGY GENERATION AND STORAGE WILL ENABLE CHEAPER, CLEANER SOLUTIONS.
- THE NEW SPACE RACE OFFERS AN OPPORTUNITY FOR SHARED DISCOVERY AND INNOVATION AROUND THE WORLD.



"Look again at that dot. That's here. That's home. That's us."

Carl Sagan
The Pale Blue Dot, 1994 17

GLOBAL MARKETPLACE

This rebalancing brings opportunity for material handling and logistics as market trends generate increased demand for both domestic and international supply chain enhancements and innovative, new materials, processes and technology. A key driver will be the replacement of market share loss to emerging capabilities in Asia.

The wars of domestic and international politics will become increasingly important to the pace and impact of regulations, tariffs, and legislation in the U.S. and abroad.

Most economists agree that with the pain of the recession in 2018 still on the minds of industry leaders, investments are expected to be moderate throughout the first half of the decade. Sales driven by consumer demand and returns yielded from smart automation will be key drivers of investment.

Industry leaders point to a number of factors that need to be addressed to enable American companies to compete successfully in global markets. Foremost in their minds is the protection of intellectual capital, equitable treatment of imports and exports, and legal protections for business structures and funding. 3

Workforce preparation is a priority for global competition. Strengthening education and training resources in the United States will be vital to competing effectively in the global market. Investments at federal, state and local levels are needed to prepare the workforce for 2030 as well as 2040 and beyond. More private company investments in these fields will be required to serve industry and company needs.

The United States is strongly positioned to become energy independent, which would represent an historic shift and provide critical leverage with other nations. Already the world's largest natural gas producer, the U.S. has the potential to dramatically increase crude oil production as well. 4 Outcomes from debates over the environmental impacts of drilling may stall or derail progress in this field..

The Rise of Asia

The rise of Asia is driving a significant shift in economic power and prowess across the globe.

In many Asian countries, China in particular, government policies and growing infrastructure are driving domestic manufacturing and logistics to serve an increasing number of people and domestic markets. Less dependence on the West for goods and services will increasingly dampen imports from the U.S. and other countries.

The McKinsey Global Institute adds perspective; "The question is no longer how quickly Asia will rise; it is how Asia will lead." 5

The institute portrays Asia as "increasingly the center of the world economy. By 2040, the region could account for more than half of global GDP and about 40 percent of global consumption." 6

Bryan Jensen
Chairman & EVP, St. Onge Company



"Supply chain infrastructure and market conditions are changing around the globe. It is important to monitor these dynamics and adjust plans as changes occur."

McKinsey
Global Institute

"The Asian Century has begun. Asia is the world's largest regional economy and, as its economies integrate further, it has the potential to fuel and shape the next phase of globalization." 18

GLOBAL MARKETPLACE

McKinsey's research groups regions of Asia into four economic categories, based on scale, economic development, interactions with one another and connectedness to the world. 7



Source: Category groups from McKinsey Global Institute. Graphic by Burchette & Associates.

The World of Politics

Shifts in political leadership will have a tremendous impact on the coming decade. The combination of ruling party beliefs and personal leadership styles will color international relationships and the progress toward peace, health and prosperity for all nations.

The decade is beginning with a rough start.

Trade tariffs being used as political weapons in 2020 will further strain relationships among nations. Boundary disputes, weapons development and economic sanctions will heighten tensions.

Social and religious beliefs and differences will drive elections and either increase discourse or lead to greater harmony among political allies and enemies, which in turn will impact global commerce and supply chains.

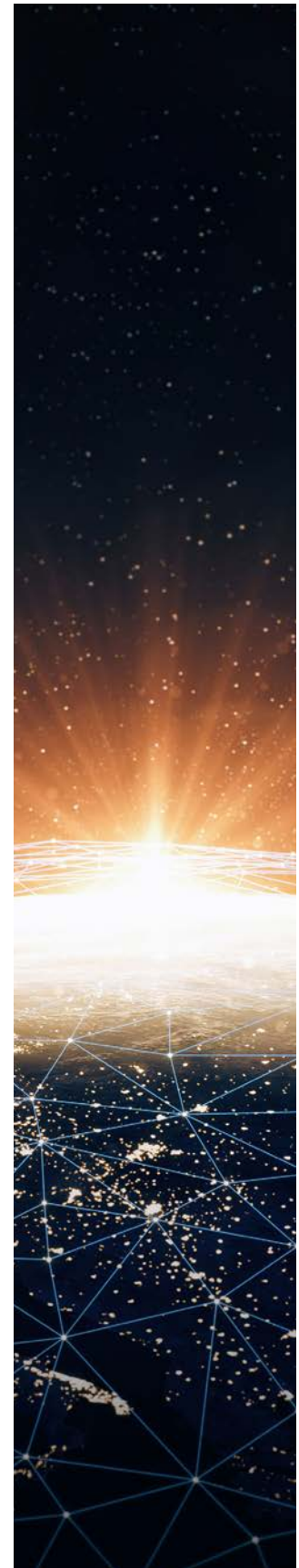
Resilience

Business strategies for dealing with uncertainty and change will be critical for managing successfully in the global market during the Transformation Age.

Dr. Suzanne Fry, a political analyst at the Central Intelligence Agency and former director, NIC Strategic Futures Group, says the key factor for a positive future is "resilience – in infrastructure, knowledge and relationships – for managing surprise and discontinuity." 8

The NIC draws a key conclusion about the importance of resilience to success in the future in the "Global Trends, Paradox of Progress," report:

"...The very same trends heightening risks in the near term can enable better outcomes over the longer term if the proliferation of power and players builds resilience to manage greater disruptions and uncertainty. In a world where surprises hit harder and more frequently, the most successful actors will be those that are resilient, enabling them to better adapt to changing conditions, persevere in the face of adversity, and act quickly to recover after mistakes." 8



GLOBAL MARKETPLACE

“...the most successful actors will be those that are resilient, enabling them to better adapt to changing conditions, persevere in the face of adversity, and act quickly to recover after mistakes.”

NIC, Global Trends, Paradox of Progress

Global Demographic Trends

Humankind. There will be more of us. We will be older as a group and more diverse.

The United Nations predicts the world's population will increase by 2 billion people in the next 30 years. 9 Population trends will be varied around the world, but a number of key themes prevail: 10

Population Growth.

More people will inhabit the Earth, but with uneven growth and distribution around the globe. Africa will lead and Europe will suffer declines absent migration from other countries. The U.S. population will increase from 330 million in 2020 to approximately 350 million people by 2030. (US Census/PBS). China and India will continue to lead the world in population size, neck and neck with populations around 1.4 billion.

Older Demographics.

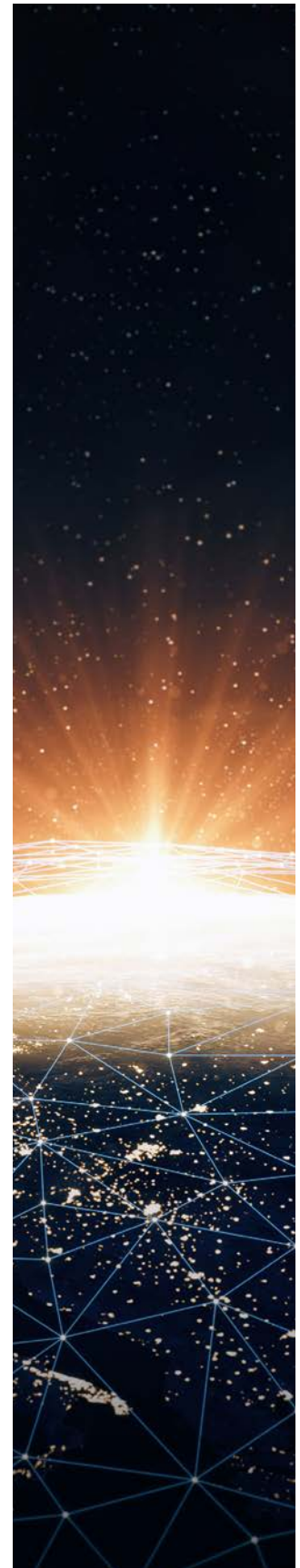
World population continues to skew to older ages, impacting consumer preferences, needs and demands. Workforce profile shifts continue, underscoring needs for career-long training and technology-enabled processes to lessen tasks requiring physical labor.

Urbanization.

Migration to urban centers continues worldwide, drive by those seeking work and adding infrastructure stresses and potential scarcities of food, water and energy.

Gender Imbalance.

Global trends continue with males outnumbering females due to birth selection and other factors.



GLOBAL MARKETPLACE

Minority Growth.

In the U.S., racial minorities, mainly Hispanics, are projected by demographers to grow the most, making them the primary driver of demographic change for the next 10 years and beyond. Whites under the age of 18 are already a minority in the U.S.

Human Health.

Advances in biotechnology will contribute to longevity and improved quality of health. Dudley Poston, writing for PBS, reports the number of centenarians in the U.S. will reach 130,000 by 2030. He calculates that in the year 2046, the first surviving Baby Boomers will reach 100, boosting category growth. U.S. Census data projections show the number of U.S. centenarians growing to 603,000 by 2060. 11

Graphic by Burchette & Associates

The Renewed Space Race

Growing interest and investment in space exploration and related industries will create opportunities for collaboration, competition, innovation and discovery across the globe.

Could this be the field that fuels common interests and helps countries act in concert?

Early initiatives show good progress in collaboration, with engineers, astronauts and other experts from different countries working together on initiatives related to the International Space Station. NASA reports the space station program “brings together international flight crews, multiple launch vehicles, globally distributed launch, operations, training, engineering, and development facilities; communications networks, and the international scientific research community.” 12

Development of new materials and processes in the pursuit of interstellar travel and commerce will enable technological advances in other fields such as satellite manufacturing, broadband technology, mining, textile fabrication and healthcare – all of which have impacts on Earth and create benefits for the material handling and logistics industry.

Growth in demand for technologies such as GPS in vehicles and drones, weather forecasts delivered to customized online maps, and low latency augmented reality (AR) healthcare procedures will fuel proliferation of stronger and better satellites. The supply chain will benefit from these advances as well.

NASA



Launched in 1998 and involving the U.S., Russia, Canada, Japan, and the participating countries of the European Space Agency, the International Space Station is one of the most ambitious international collaborations ever attempted. The largest space station ever constructed, the ISS continues to be assembled in orbit. It has been visited by astronauts from 18 countries- and counting. 19

GLOBAL MARKETPLACE

There are limits to the space we have to utilize for satellites in orbit around Earth, and those spots are filling up. More and more space debris is accumulating from man-made sources. Different nations will reach various planets and asteroids independently and collaboratively, gaining first looks and discoveries. How will nations work together to define space law and space policy around such issues? How will supply chain companies access new technologies and processes from various international sources? These and other questions reflect new frontiers in this field.

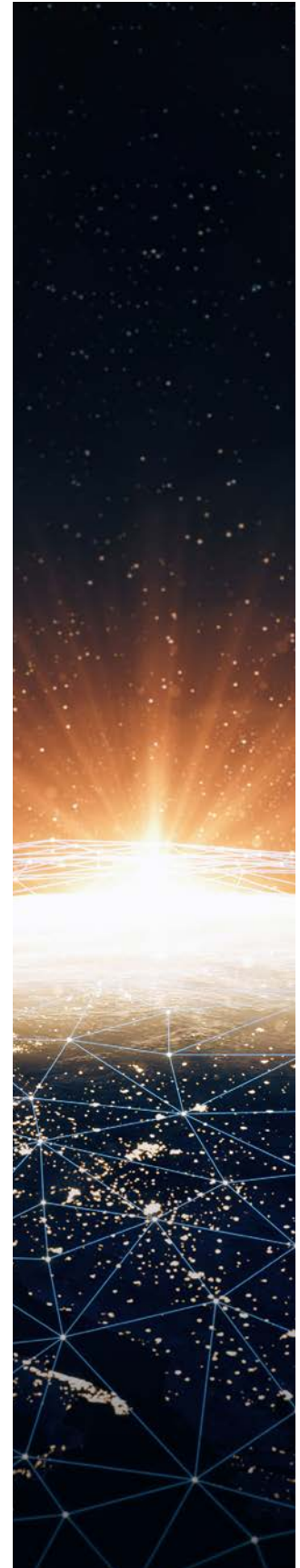
For more information on this topic, go to the section on the [New Space Economy](#).

Global Technology

Every nation stands to benefit from advancements in satellite systems, remote sensors, broadband capabilities, drones, AI and other technologies. Opportunities for collaboration – across a greater number of faster and increasingly less expensive platforms – will grow. Manufacturing and associated logistics will be optimized across markets, cities, countries and global supply chains as never before.

Industry leaders voice optimism at the opportunities technology will afford for entering new markets and improving supply chain logistics in territories where they operate today. Expectations run high for the progress to come in emerging economies that may skip over legacy approaches and jump to newer technologies as they become commercial realities over the decade. 13

Industry leaders also expect privacy and data security concerns to be dominant topics in discussions and initiatives involving global partners. Information sharing technologies, surveillance techniques, satellite tracking capabilities, and industrial and personal information sensors will all bring valuable information to companies, governments and their partners, while at the same time, creating doubts and conflicts over privacy, security and data ownership. 13



GLOBAL MARKETPLACE

Energy

The pursuit of ways to generate and harness energy is a common goal of all nations. The fuel of life, energy drives our factories, our homes, our businesses and our supply chains.

Vaclav Smil reminds us in his examination of energy and its impact on the world in *Energy and Civilization, A History* that “Energy is the only universal currency: one of its many forms must be transformed to get anything done.” 14

But the energy supply on Earth is not unlimited. Different forms of generation come with various consequences and trade-offs, limiting the realization of improved quality of life as energy sources and processes fuel progress.

To that point, Smil also reminds us, “Life’s two cardinal characteristics have been expansion and increasing complexity,” and asks, “Can we revise these trends by adopting the technically feasible and environmentally desirable shift to moderated energy use?” 15

Answers to that question will emerge over the decade.

Multiple direct and indirect factors will drive energy trends for the future. Increasing global demand to meet population, commercial and industrial needs comes at a time when planetary aspirations to meet a 2 degree climate goal bring pressure on sustainability impacts.

Advances in wind and solar generation will propel usage of those sources and battery technology will be widely used to support extended storage capacity and peak demands. The convergence of these factors will drive significant global changes in the way energy is generated, transmitted, stored and used. The resulting mega trend will create a rapid increase in the use of renewable sources that provide both cost effective energy solutions and a decline in carbon emissions.

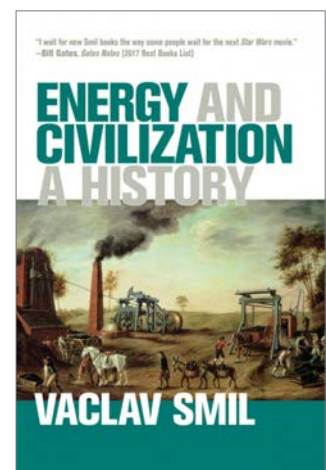
Supply chain leaders expect battery technology improvements to enhance factory and transportation equipment such as forklifts, electric delivery vehicles and drones. Expectations for future lower energy costs driven by solar and wind generation are moderated by concerns about expensive infrastructure requirements for both public and private sources over the decade.

Projections by BloombergNEF call for wind and solar to make up almost 50% of world electricity in 2050, with Europe “decarbonizing furthest, fastest.” The United States and China are predicted to follow this trend as well. 16

New energy technologies bring the need for domestic and international standards to ensure safety and compatibility of approaches. For example, common standards are needed for public infrastructure such as EV charging stations to support long-distance deployment of consumer and commercial electric vehicles.

The availability of minerals and Earth elements used in the manufacture of batteries and other energy technologies will be an important factor to all nations in the pursuit of enhanced energy infrastructure. The scarcity of some minerals will spur innovations in technology to utilize new, more plentiful sources.

Vaclav Smil
Author and Distinguished Professor
Emeritus, University of Manitoba



GLOBAL MARKETPLACE

Our Opportunity

The great promise of this decade is for global players and small town businesses and citizens alike to collaborate where possible and act independently when called to achieve life on our planet that is peaceful, prosperous and sustainable.

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TRANSFORMATION AGE

NEW SPACE ECONOMY

Discovery, innovation and information transfer from space industry initiatives will benefit the material handling and logistics industry as well as other aspects of commerce and life on Earth.



NEW SPACE ECONOMY

The 21st century is starting off with activity, hope and promise of a rebirth – more so an evolutionary leap – into space.

Fifty years after the Apollo 11 mission put man on the moon, there is renewed interest and investment in a variety of space-related activities. That interest is spurred by recent advances in technology that were lacking following the progress made in the last century.

Those who believe the space race is too much in its infancy to impact manufacturing, logistics and commerce in the coming decade, or even the next twenty years, may be missing signals that tell the story of more immediate impact and opportunity.

Two decades of early trials, failures and successes have positioned the space industry to make significant strides in not only the return to the moon and exploration of Mars, but the development of new capabilities in everything from telecommunications to manufacturing and healthcare. The potential impact is broad, impacting sustainability and the advancement of civilization and technology beyond incremental efforts in any other field.

The new space economy brings excitement and vision to the Transformation Age. The pursuit of space brings a unique perspective to the environment of rapid change and challenge. Somehow humans of all ages find space interesting and even fun, rather than daunting and frightening.

The year 2018 reflects a renewed appetite for progress and economic growth for the space industry. During those twelve months, the world learned from 114 space launches from 25 sites involving 13 countries. 1

A significant shift for the space industry is the move away from concentrated public funding as private investment has grown significantly. The world is benefitting from the wealth of a handful of billionaires who view space as new ground for creating fundamental change on Earth.

Adam Jonas, managing director of Equity Research at Morgan Stanley and a clarion voice in research into the impact of this industry, sized the new space economy at \$350 billion in 2019 with a forecast for the market to grow to between \$1.1 and \$1.7 trillion by 2040. 2 That growth represents a tremendous amount of capital investment and an unprecedented opportunity for discovery and knowledge transfer in the years to come.

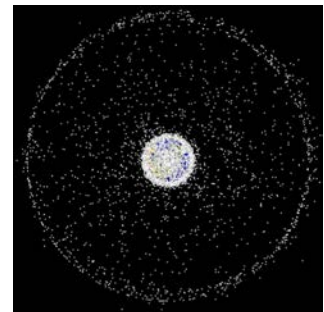
Noting the expansive opportunity in the new space economy, Jonas says, “A number of developments have increased the economic capacity and viability of the space economy. The biggest is satellite broadband, which improves access to the internet that otherwise would not be there. It can essentially turn on a continent.” 2

“In our lifetimes we’ll see significant advancements in space as a domain for exploration, commerce, internet, and scientific study that can make the earth something our children and grandchildren can inherit.” 2

INSIGHTS

- IMMEDIATE OPPORTUNITIES EXIST FOR MANUFACTURING, LOGISTICS AND COMMERCE.
- EXPECT SIGNIFICANT GROWTH IN THIS SECTOR.
- DISCOVERY, INNOVATION AND INFORMATION TRANSFER WILL BENEFIT PEOPLE AND INDUSTRY.
- OPPORTUNITIES ABOUND FOR GLOBAL COLLABORATION.

Space Debris



More than 500,000 pieces of space debris are currently tracked as they orbit the Earth, some traveling as fast as 17,500 mph. Many millions of pieces are too small to be tracked but could be hazardous to critical satellites or other spacecraft. International action may soon be necessary to identify and fund the removal of debris most threatening to an expanding global space presence.

Source: “Global Trends, Paradox of Progress” National Intelligence Council, January 2017

NEW SPACE ECONOMY

Many of the trends impacting the material handling and logistics industry play an important role in the rise of space activities. Shelli Brunswick, Chief Operating Officer for the Space Foundation notes, "That upward climb coincides with the explosive use of smartphones, the creation of the app economy, the evolution of small sats (satellites), the unfolding data revolution, the development of smaller, cheaper, and more reliable sensors as well as an array of launch vehicles and payload specializations that have delivered growing choice and lower costs. Add to those technology revolutions the rise of a new generation of space entrepreneurs willing to put capital and reputations into one of the world's most disruptive marketplaces, and you have the ideal environment for expanding economic growth and opportunity." 3

The potential for discovery, innovation and information transfer will benefit the material handling and logistics industry as well as other aspects of commerce and life on Earth.

Access to new markets will be enabled through expanded telecommunication capabilities. Announcements in 2019 for new satellite constellations promise the first of many such investments over the coming decade. 4

New materials and processes will be discovered and developed, leading to improved design and manufacturing capabilities. 4

Sustainable energy generation, storage and usage technologies for space travel and space station activities will enable transportation and infrastructure innovations on Earth. 4

Mining technologies developed for asteroids will be translated to exploration and use of Earth's resources. 4

Advances in digital hardware and software will translate to a myriad of commercial, industrial and consumer uses. Edge computing coupled with the power of the Cloud will be further leveraged, and in turn, will provide industrial solutions not yet imagined. 4

Quantum computing will be used to tackle problems encountered in space discovery, netting improvements on Earth in everything from business solutions to healthcare and education. 4

Surveillance and sousveillance capabilities will be improved, empowering individuals and nations alike to record, protect and predict experiential moments-in-time for life-improving purposes. 4

Technology transfer and tech insertion will occur, yielding singular and collaborative benefits among industries, entrepreneurs, scientists, engineers and universities. 4

Shelli Brunswick says, "Health care, transportation, public safety, environmental protection, machine learning, manufacturing, energy production, and many other business sectors will be first-tier benefactors of ongoing space technology innovations. Every consumer in this country and around the planet will find their lives improved by space-enabled breakthroughs in these and other areas." 5

Shelli Brunswick,
COO Space Foundation



Op-Ed: Growth is great but innovation is the real investment











spacefoundation.org

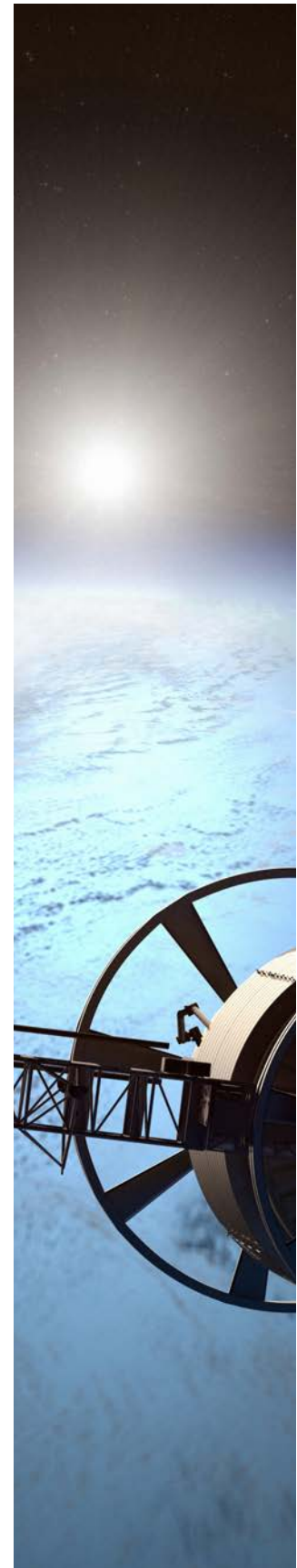


NEW SPACE ECONOMY

Drivers of the New Space Economy

It is important to note the breadth of activities in this sector. Definitions differ among industry experts, but all forecast growth for the decade. 6

<p>Satellite Launch</p> <p>Of growing importance, these players support primary satellite launches as well as maintenance and replacement missions.</p> 	<p>Telecommunications</p> <p>Satellite networks represent a growing global infrastructure that support optical communications, internet, broadband and monitoring activities in space and on earth.</p> 	<p>Lunar Missions</p> <p>Returning to the moon is a high priority for entrepreneurs, governments and military forces. These organizations develop and build vehicles and infrastructure to support lunar travel and exploration.</p> 
<p>Space Exploration</p> <p>Truly the next frontier, activities in this sector are focused on missions to Mars and beyond and include transport of humans, cargo and infrastructure.</p> 	<p>Observation & Navigation Systems</p> <p>This sector includes development and operation of systems to monitor weather, climate, and natural resources and to support mapping and navigational capabilities. Satellites, constellations and ground-based sensors are included in this ecosystem.</p> 	<p>Manufacturing</p> <p>These companies manufacture satellites, rockets, space stations, components, materials and related operational ground systems.</p> 
<p>Mining</p> <p>These companies are focused on mining on asteroids and the moon to net critical resources and prepare for mining on planets. This sector includes development of lunar and planetary propellant depots.</p> 	<p>Space Debris</p> <p>Millions of pieces of man-made debris are becoming hazardous to expanding space traffic. Companies tracking and analyzing human made objects will soon be called on to guide debris removal.</p> 	<p>Spaceports</p> <p>Facilities to support launch and recovery activities are increasing in number. These sites also serve as economic development magnets for R&D, manufacturing and tourism.</p> 
<p>Science & Discovery</p> <p>These organizations focus on R&D and discovery of materials, processes and impacts of space activities. Realms span engineering, manufacturing, earth and planetary sciences, biology, botany, sustainability, telecommunications and digital tools.</p> 		



NEW SPACE ECONOMY

Spaceports

Spaceports – sites for launching or receiving spacecraft – represent a new opportunity in domestic infrastructure that has a broadening interest by industrial players in aerospace and related fields.

Spaceport development is expanding, led by efforts in the United States. The 2020 decade began with 40 active launch sites around the world with 10 more in development in the United States, Sweden, Australia and Canada, and 13 more proposed in eight countries. ⁷

Development is occurring by both private sector and government entities. The Space Report cites lower spacecraft and launch vehicle manufacturing costs as spurring the building boom. “As launch costs have lowered, satellites have shrunk in size and cost and grown in capabilities, making it possible for more countries and more businesses to take their place in space. The turnaround time for lightweight rockets with small satellite launch capacity also is decreasing. Smaller rocket launches can be conducted at lower costs and launched more frequently.”

Spaceport characteristics will evolve over the decade, with some including primarily launch facilities and others incorporating business hubs of office buildings and labs for related businesses and scientific discovery. Areas that are home to these facilities will enjoy population growth and economic benefits. Tourism dollars can also be accrued.

Space Review, in conjunction with SpaceNews, reports that Houston Spaceport is putting in roads and other infrastructure to support companies such as Flight Safety International which plans to set up an aviation safety training center there, as well as Intuitive Machines, a commercial lunar lander developer. Other locations identified in the report include Colorado Air and Space Port, which is attracting companies such as Reaction Engines, a British company testing their SABRE engine at the former Front Range Airport. ⁸

These facilities can't be located just anywhere.

Spaceports are best located in areas close to the equator to take advantage of the spin of the Earth as an accelerant, saving significant fuel costs. Location is relative, and doesn't rule out areas further north or south as evidenced by many existing sites, but the fact remains – the closer to the equator the better.

Characteristics of surrounding areas are important too. Drop zone locations, technically known as Azimuth limitations, are measured in degrees and describe the limit of direction and width of airspace a rocket has available to reach orbit. These drop zone locations are important in site selection for the safety and environmental protection of surrounding areas.

Weather patterns is a third factor in site selection. Cloud cover, high altitude winds, lightning and thunderstorms are key environmental considerations.

Evolution in design of spaceports will continue throughout the decade, leveraging new technologies to meet the needs of growing space initiatives in the United States and around the globe.

New Mexico Spaceport Authority



Images: Spaceport America

NEW SPACE ECONOMY

The United States Space Force

In December 2019, President Trump authorized the formation of the U.S. Space Force as a military branch under the Department of the Air Force, operating alongside of the United States Air Force.

The mission of the U.S. Space Force is to “organize, train, and equip space forces in order to protect U.S. and allied interests in space and to provide space capabilities to the joint force.

Its responsibilities include developing military space professionals, acquiring military space systems, maturing the military doctrine for space power, and organizing space forces to present to the Combatant Commands.”

Over the coming decade, this new military service branch will need to determine new strategies and protocols for national security and warfare in the Space domain. Innovation of technologies and processes will evolve as part of this process. Opportunities will increase for private sector participation in design and implementation of these new and enhanced capabilities.

Technologies such as IoT, robotics, drones, satellite telecommunications, augmented reality and virtual reality, as well as myriad digital capabilities from AI to quantum computing will be part of the military solution set.

Intellectual capital and expertise in areas of manufacturing, distribution, packaging, product design, engineering, research telecommunications, transportation, and computing will be in demand to help serve the needs of this promising new branch of the military.

Innovation and Growth

TechCrunch author, Devin Coldewey, describes innovation and growth in the industry in the context of four key components: launch, craft, ground infrastructure and data.

Launch

In the launch category, Coldewey distinguishes between what he refers to as “brute force” initiatives from those with “smart positioning” and “novelty” approaches. He puts the current efforts of companies such as SpaceX and Blue Origin in the brute force bucket where he views the billions in investments by billionaires as a unique proposition from which we all reap benefits.

Noting the newness of smart positioning efforts, he points to the work by Rocket Lab on small payloads delivered with short turnaround time. The company’s founder, Peter Beck, is betting big on the ongoing need for maintenance and replacement of satellites.

Coldewey quotes Beck as a harbinger of future trends.



Devin Coldewey, TechCrunch: The four corners of the new space economy

It's gotten to the point now where a handful of angel investors can put a space company on the map. But the same changes that have made the industry accessible have made it increasingly complex to track its trends. By default, all space startups are exciting, but companies vary widely in risk, capital intensity and ...

NEW SPACE ECONOMY

“Responsive space, or launch on demand, is going to be increasingly important,” Beck said. “All satellites are vulnerable, be it from natural, accidental, or deliberate actions. As we see the growth and aging of small sat constellations, the need for replenishment will increase, leading to demand for single spacecraft to unique orbits. The ability to deploy new satellites to precise orbits in a matter of hours, not months or years, is critical to government and commercial satellite operators alike.”

Craft

Coldewey describes a number of trends in manufacturing of space craft, from miniaturization to flexibility of operation. Citing parallels to the smartphone revolution, he paints spacecraft design as a field enabled by advances in miniaturization of electronics and falling costs.

He also notes Beck’s belief that spacecraft hardware expertise will become a speciality niche, allowing businesses like satellite operators to focus on their operations and research rather than building their own spacecraft.

Ground Infrastructure

Construction of base station infrastructure, automation of operations, and development of supporting telecommunication capabilities are essential to the advancement of the space industry.

Coldewey points out that means construction of new infrastructure as well as merging legacy systems with newer, advanced ones. Cloud-based technologies, artificial intelligence applications, IoT sensors, cybersecurity systems and other digital tools will all be in the mix..

Data

Enormous amounts of data and information are being captured and transmitted from satellites and other spacecraft. What is done to process this information and how it is used are the keys to value in this sector.

Entry into this sector is open to data and digital tool companies with a myriad of opportunities for analysis and application to scientific research and business.

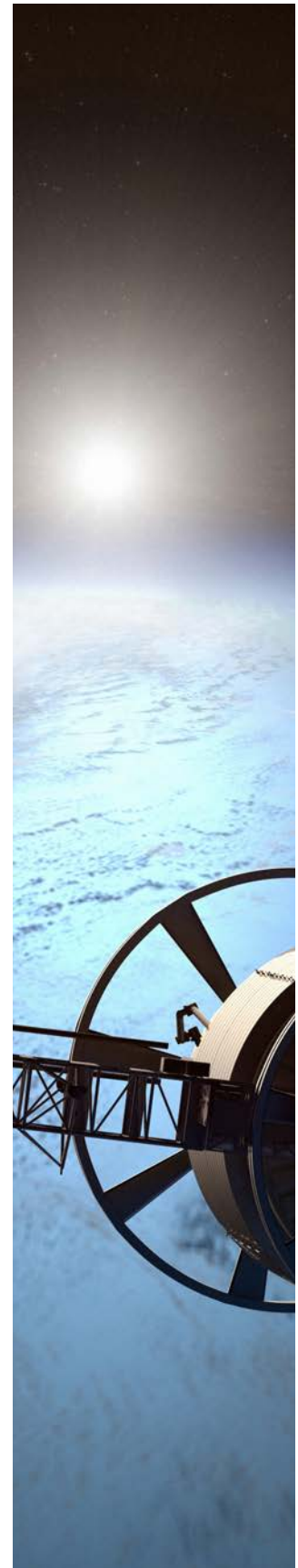
Advances in the new space economy are creating value for life on Earth, and promise to escalate innovation in manufacturing, technology, digital tools, and telecommunications. Science, education, business and human life will benefit. Supply chain industries will garner both direct and indirect value from space-related endeavors.

A Decade of Promise

The convergence of advances in technology, need, and human interest promises to propel the growth of the new space economy over this decade.

Many of the sectors in this economy provide opportunities for world leaders, scientists and industry professionals to work together and collaborate on discovery and execution of new ideas, processes and technologies.

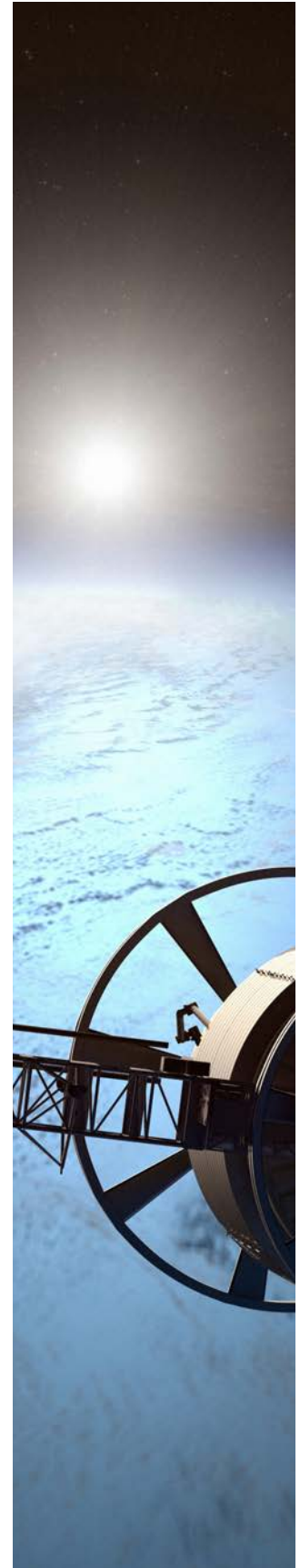
The new space economy represents a hopeful industry model, one with a positive bent, the embodiment of imagination, and a predisposition to evolve and collaborate that will serve mankind well as we move through the Transformation Age.



NEW SPACE ECONOMY

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Report Credits

The “Transformation Age, Shaping Your Future” report site offers information and dialogue on long-term industry trends for the material handling and logistics industry. As such, the information contained within serves as an invitation to engage in thought and discussion about key factors that are expected to drive, fuel and impact various aspects of life, commerce and industry in the coming decade.

Much of this information was gleaned from in-depth interviews with industry leaders and trend experts. Other data was obtained from secondary research of published material on specific topics. The combination provides insights into those forces that will impact the industry and, more importantly, the implications for action needed now and in the future by company leaders and their teams.

We wish to express thanks to all who gave their time and shared their experience, expertise and opinions for this report.

The report and website were developed by Burchette & Associates, Inc. for MHI.

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