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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.

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.

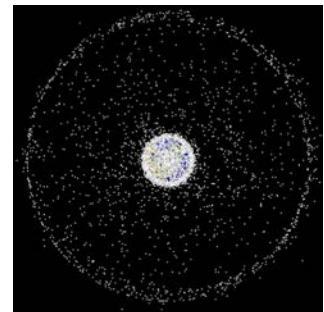
Noting the expansive opportunity in the new space economy, Jonas says, “A number of developments have increased the economic capacity and viability of the space economy. The biggest is satellite broadband, which improves access to the internet that otherwise would not be there. It can essentially turn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

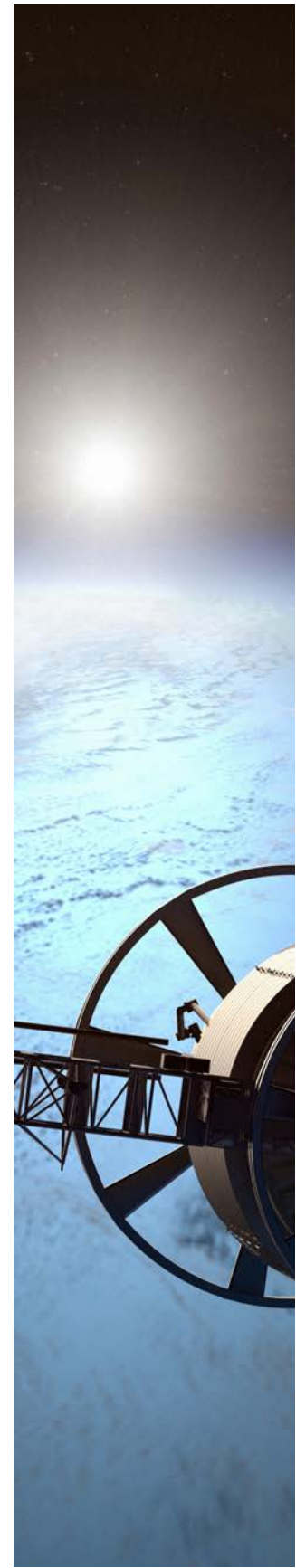


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Drivers of the New Space Economy

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

Satellite Launch Of growing importance, these players support primary satellite launches as well as maintenance and replacement missions. 	Telecommunications Satellite networks represent a growing global infrastructure that support optical communications, internet, broadband and monitoring activities in space and on earth. 	Lunar Missions 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. 
Space Exploration Truly the next frontier, activities in this sector are focused on missions to Mars and beyond and include transport of humans, cargo and infrastructure. 	Observation & Navigation Systems 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. 	Manufacturing These companies manufacture satellites, rockets, space stations, components, materials and related operational ground systems. 
Mining 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. 	Space Debris 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. 	Spaceports 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. 
Science & Discovery 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. 		



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 ...

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“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.

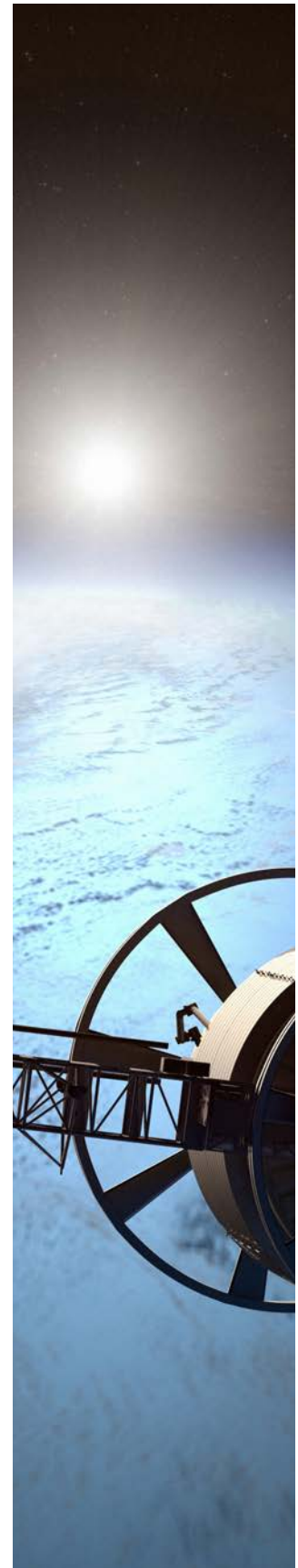
Advances in the new space economy are creating value for life on Earth, and promise to escalate innovation in manufacturing, technology, digital tools, and telecommunications. Science, education, business and human life will benefit. Supply chain industries will garner both direct and indirect value 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.

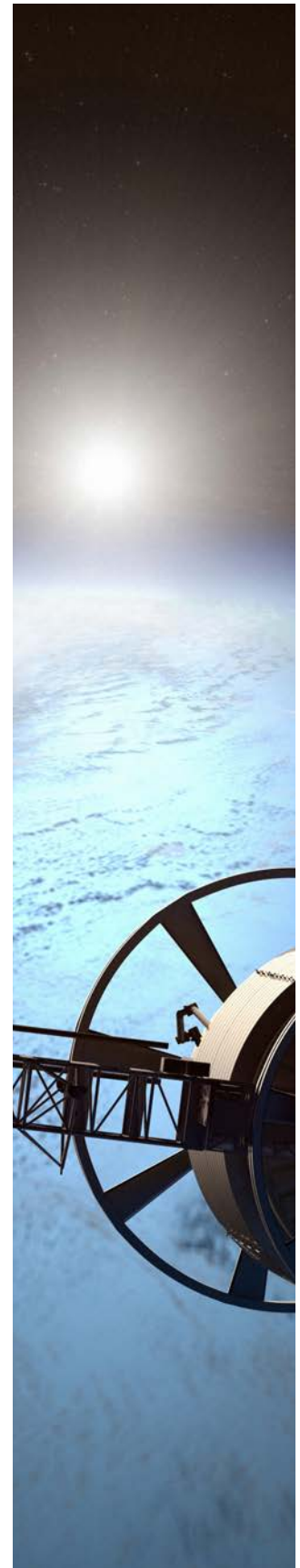
The new space economy represents a hopeful industry model, one with a positive bent, the embodiment of imagination, and a predisposition to evolve and collaborate that will serve mankind well as we move through the Transformation Age.



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Sources

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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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