

RETHINK EVERYTHING

MASTERING THE ART OF INNOVATION

Lockheed Martin Space Systems Company
P.O. Box 179
Denver, CO 80201-0179
www.lockheedmartin.com

Copyright 2015 Lockheed Martin Corporation. All rights reserved.

K1580700



RETHINK
EVERYTHING

THE
INNOVATION
IMPERATIVE

THINKING
AHEAD OF
THE CURVE

TECHNOLOGY
CRUCIBLE

WEAVING
A DIGITAL
TAPESTRY

TRANSFORMING
DESIGN

TRANSFORMING
MANUFACTURING

TRANSFORMING
PRODUCTION

INNOVATION
IN ACTION

DELIVERING
MISSION
SUCCESS

THE INNOVATION IMPERATIVE

Our customers have important missions:
A universe to explore. Citizens to protect. Freedoms to secure.

The importance of these pursuits is matched by an unprecedented demand to achieve higher levels of performance at a faster pace with fewer resources. The game has changed, and the pressure on our customers is enormous.

Is it possible to meet all of these demands at once?
How can it be done?

The answer is through innovation.

At Lockheed Martin Space Systems Company, we have spent more than 50 years delivering innovative solutions that help our customers meet their most challenging and critical missions.

To enable their success, we are fearless in our quest to make the "impossible" possible and rethink every aspect of our work to achieve new efficiencies, reduce costs, elevate performance and empower our customers, employees and partners to collaborate more closely than ever before.

As we deliver customer solutions, we know the challenges they face are always changing. We must lead that change, harnessing innovation to meet the emerging needs of nations and businesses, scientists and citizens, warfighters and peacekeepers.



Richard F. Ambrose

Richard F. Ambrose
Executive Vice President
Lockheed Martin Space Systems Company

Global economies are stressed. Mission demands are growing. Increasingly complex challenges require solutions in less time and with fewer resources. To deliver results in this environment, we need to rethink everything we do. We need to innovate in all areas.

Lockheed Martin Space Systems Company has a rich history of creative solutions. We have pioneered systems for submarine-based strategic deterrence, space-based surveillance and exploration of every planet in the solar system.

Now we're accelerating our efforts to seek out and implement new ideas across our business to deliver more capability at lower cost, in less time.



NO STONE UNTURNED

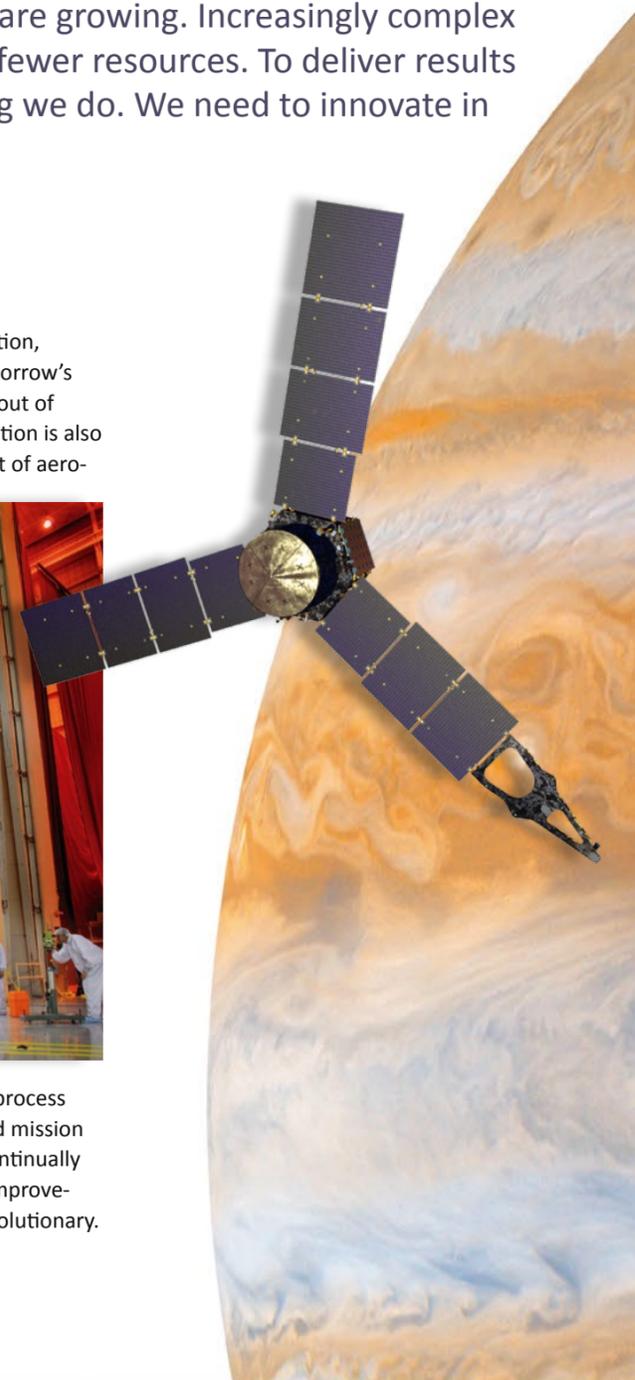
Finding innovative solutions starts with understanding the drivers of next-generation mission architectures. Armed with this insight, we collaborate with customer experts, universities and other companies to develop technologies that enable these architectures. Along the way, we explore and implement new methods to streamline design, manufacturing and production processes to deliver greater value.

CHANGE AS A CONSTANT

Innovation never stops. By definition, today's breakthrough will be tomorrow's standard, and the need to break out of familiar patterns endures. Innovation is also a balancing act. The development of aero-



space systems requires rigorous process discipline to ensure reliability and mission success. At the same time, we continually look for opportunities to insert improvements, both incremental and revolutionary.



RETHINK
EVERYTHING

THE
INNOVATION
IMPERATIVE

THINKING
AHEAD OF
THE CURVE

TECHNOLOGY
CRUCIBLE

WEAVING
A DIGITAL
TAPESTRY

TRANSFORMING
DESIGN

TRANSFORMING
MANUFACTURING

TRANSFORMING
PRODUCTION

INNOVATION
IN ACTION

DELIVERING
MISSION
SUCCESS

THINKING AHEAD OF THE CURVE

NEXT-GENERATION MISSION SOLUTIONS

To innovate effectively, we must fully understand customer missions and anticipate future challenges and threats. We invest significant time, effort and resources analyzing their needs, assessing the utility of our systems and crafting innovative mission solutions.

To fully understand where our customers want to go, we collaborate. We work shoulder to shoulder with them to test and analyze potential solutions and provide insight into the drivers for next-generation mission architectures.

DEEP MISSION EXPERTISE

To achieve this, we leverage a comprehensive, multi-domain knowledge of our customers' mission space. This unique asset stems from our experience supplying world-class space architectures that support missions around the globe.

For near-term challenges, we apply advanced simulation and visualization systems to run scenarios that test the mission utility of different space and missile assets – either alone or in combination – to support a given mission requirement.

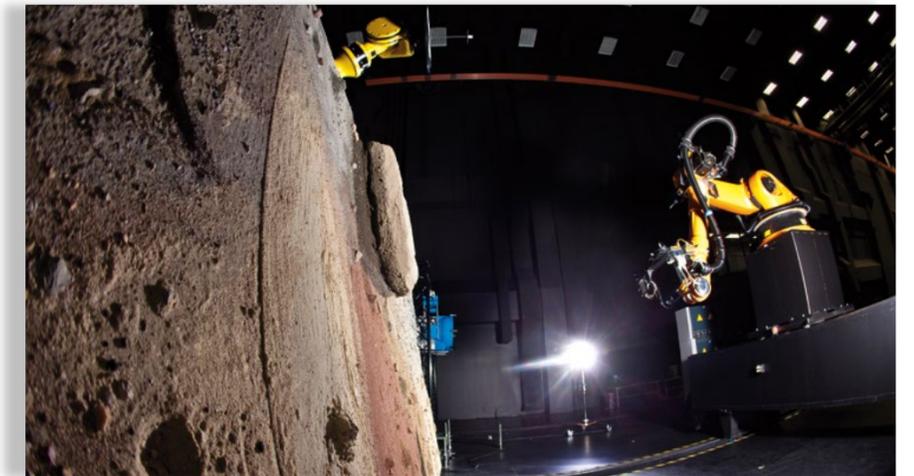
FORESIGHT AND INSIGHT

Future operational environments will differ in many ways from today's, with more dynamic needs spread across new areas of interest coupled with emerging challenges and threats that must be met with increased speed and capacity.

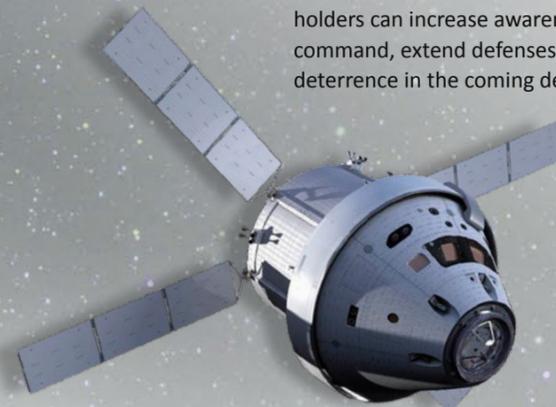
Through simulation and analysis, we assess how to evolve or change out space architectures so that our military stakeholders can increase awareness, enhance command, extend defenses and maintain deterrence in the coming decades.



Wargaming – The DoD has expressed renewed interest in using wargaming to “think critically” about U.S. capabilities. In response, we model and analyze how multiple systems – from command-and-control and communications to Intelligence, surveillance and reconnaissance – enable warfighter missions. For existing architectures such as GPS III, Advanced Extremely High Frequency (AEHF) and the Defense Meteorological Satellite Program (DMSP), we evaluate alternative operating environments and scenarios to enhance mission effectiveness.



Simulating Exploration – Using the Space Operations Simulation Center (SOSC), mission planners evaluate the flight hardware necessary for safe, affordable and sustainable exploration – both human and robotic. Their simulations encompass navigation, ranging, rendezvous, docking, proximity operations, imaging, and descent and landing operations.



Stepping Stones – Space Systems Company mission architects work closely with NASA's Orion team to help plan the future of human exploration. The Stepping Stones concept they developed is a series of exploration missions that build incrementally toward the long-term goal of sending astronauts to Mars.

TURNING UP THE HEAT ADVANCING LASER TECHNOLOGY

At Lockheed Martin, we have anticipated the need for military forces and key infrastructure to counter emerging threats with improved defenses. One promising technology is directed energy, which can deliver advantages of speed, flexibility, precision and low cost per engagement.

We are fulfilling this potential by advancing the development of practical and precise laser weapon systems. Recently we conducted the first successful field test of a 30-kilowatt, single-mode fiber laser, disabling the engine of a small truck from more than a mile away. This followed a series of demonstrations in which the system used a 10-kilowatt commercial laser to successfully engage small rockets and unmanned aerial vehicles in flight and small boats operating in the ocean.



Our 30-kilowatt fiber laser uses a technique called spectral beam combining. In this approach, multiple fiber laser modules form a single, powerful, high-quality beam that provides greater efficiency and lethality than multiple individual 10-kilowatt lasers used in other systems.

RETHINK
EVERYTHING

THE
INNOVATION
IMPERATIVE

THINKING
AHEAD OF
THE CURVE

TECHNOLOGY
CRUCIBLE

WEAVING
A DIGITAL
TAPESTRY

TRANSFORMING
DESIGN

TRANSFORMING
MANUFACTURING

TRANSFORMING
PRODUCTION

INNOVATION
IN ACTIONION

DELIVERING
MISSION
SUCCESS

TECHNOLOGY CRUCIBLE

GOING BEYOND THE KNOWN

Technology is at the heart of what we do. Through research and development, we're delivering new options that meet our customers' current and emerging needs. Our scientists and engineers revel in challenging the status quo and building pathways to the future.

INNOVATION WITH PURPOSE

Our Advanced Technology Center is where many of our new ideas are born and where we develop key discoveries into game-changing solutions. This work helps lower the cost of existing products and processes, injects new capabilities into ongoing programs, and develops foundational technologies that enable breakthroughs in space exploration, defense, environmental monitoring and more.

TODAY, NEXT-GEN AND GEN-AFTER-NEXT

Informed by a deep understanding of customer missions, we improve current products and accelerate the arrival of next-generation solutions. First, we invest in technology that makes an immediate impact, even on programs already in production. Second, our ground-breaking research matures technology to retire risk, turning

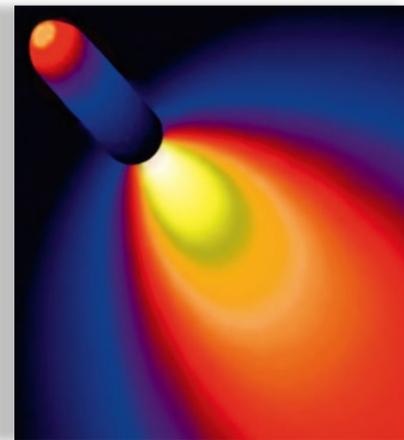
emerging technical concepts into practical solutions. And looking far ahead, we're inventing new approaches to our customers' challenges in the next 50 years. These "gen-after-next" technologies are already in work so that options will be available when the need arises.

SPECIALIZATION AND COLLABORATION

We maintain expertise in a broad array of technologies, investing in advanced materials, innovative sensing systems, electro-optical systems and other disruptive technologies that promise to extend or transform our customers' mission effectiveness. When our specialists share knowledge across disciplines, new ideas multiply. Our

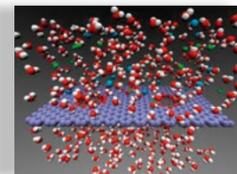
science and engineering teams also create synergistic partnerships with universities, small businesses and government research labs to create breakthrough technologies, applications and capabilities.

Interface Region Imaging Spectrograph (IRIS) is one of many ground-breaking spacecraft that we have built for NASA to understand how the sun generates "space weather" that affects human activity on Earth.



Phenomenology and Sensors

Phenomenology research helps us understand what we can detect in nature and then use it to our fullest advantage. Our work in this area enables sensor development for applications such as environmental monitoring, scientific research and military surveillance.



Advanced Materials & Manufacturing

Materials research is a fundamental enabler of breakthrough technology. We're working at the nano scale to develop new solutions that impact everything from electronics to water purification. We're also tackling materials-by-design, which mixes metals, polymers and composites to make parts "on the fly," perfectly tailored to each custom use.

Invention, Innovation and Technology



Ground-Based Space Situational Awareness

We're revolutionizing deep-space and near-Earth imaging with ground-based observatories that use optical data to identify threats in space. Using an innovative approach to providing that information, customers can subscribe to our international network of partner observatories.



Protected Communications

We are improving how we protect the most important communication transmissions of our nation and its allies. Our developers are creating new algorithms and waveforms that add a new level of security, preventing transmissions from being detected, jammed or intercepted.



Hypersonic Flight

In hypersonics, our experts in materials, phenomenology, adaptive control and propulsion collaborate to create out-of-the-box solutions. This work has great potential in missile defense and space and aircraft design.



Photonics

By using commercial fiber-optic technology in different ways, we're able to deliver approximately 50 percent savings in weight and size while lowering power needs for communication payloads. We do this by simplifying the design and using common architecture, producing an easily reconfigurable payload that can be used across product lines.



Optics

We're taking new approaches to collecting and focusing light more effectively. For a true leap in capability, we're developing the Segmented Planar Imaging Detector for EO Reconnaissance (SPIDER). It consists of millions of light detectors densely packed onto photonics integrated circuits, decreasing the size and mass of the imager by 10- to 20-fold.

RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

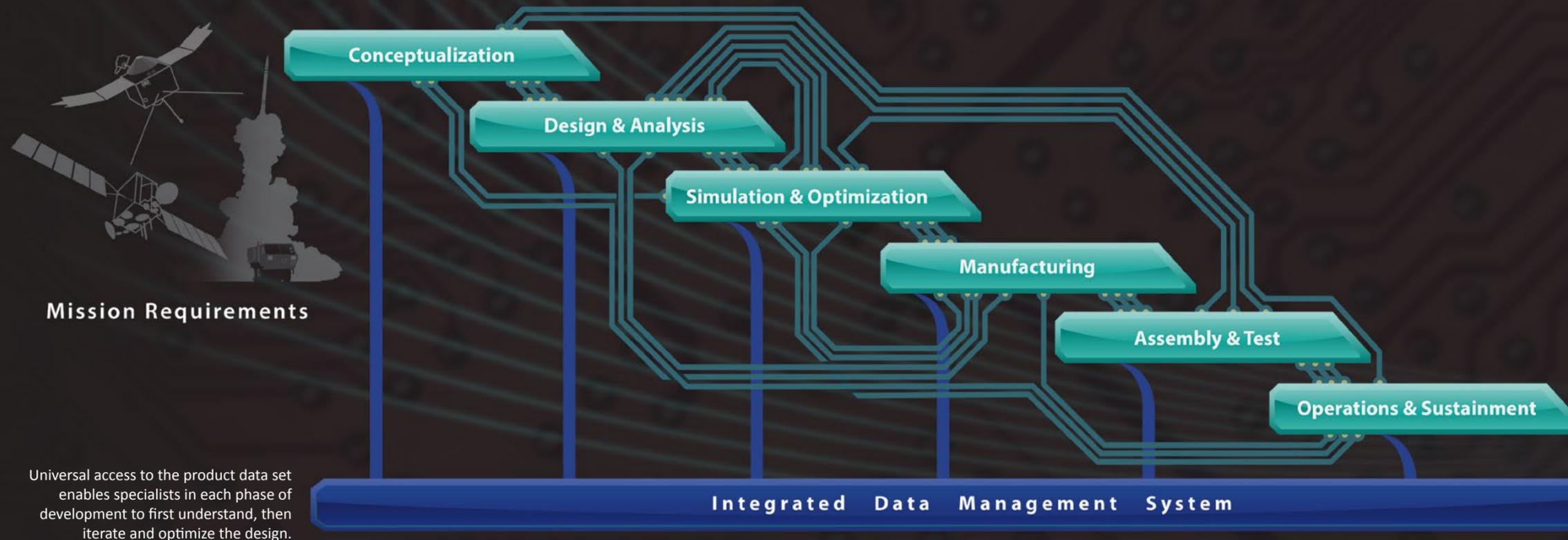
INNOVATION IN ACTION

DELIVERING MISSION SUCCESS

WEAVING A DIGITAL TAPESTRY

CREATING AN INTEGRATED MODEL-BASED ENTERPRISE

Building complex systems requires development teams working across all engineering disciplines and phases of development. When we enhance the team's ability to share information and move seamlessly from one step to another in this process, we transform the enterprise.



Universal access to the product data set enables specialists in each phase of development to first understand, then iterate and optimize the design.

For centuries, the printed page has ruled the world. No longer. Now we're exploiting the power of a fully integrated electronic domain – an end-to-end tapestry that weaves together all aspects of system development into a seamless digital environment. Our Digital Tapestry fully leverages modeling and simulation data sets and powerful computer tools, enabling us to optimize the design and predict the performance of even complex systems before they are built.

With common access to this virtual resource, collaboration flourishes. By developing this end-to-end virtual environment, our technical teams are making dramatic gains in system performance and the speed and cost of development. The result: more capable, less expensive systems delivered faster to our customers.

CONCEPTUALIZATION

We begin with a deep understanding of customer missions. Next, the Digital Tapestry enables rapid trades and analysis to converge on a system architecture that meets all requirements, accelerating transition to detailed design.



DESIGN & ANALYSIS

Powerful visualization tools allow hardware and software designers to better understand, analyze and refine the product data set at multiple levels. Capturing product designs in complete, integrated data sets also enables the standardization of common products across our systems.



SIMULATION & OPTIMIZATION

We simulate everything from the performance of a prototype missile to the producibility of a component or planned assembly sequence. This allows us to detect and eliminate defects in design or process that would otherwise not be discovered until manufacturing or assembly and test, thus avoiding costly redesign.



MANUFACTURING

The marriage of the Digital Tapestry and new manufacturing technologies is dramatically reducing production time and cost. Examples are automated tube-bending and blanket-cutting machines as well as additive manufacturing machines that can "print" a component in less time than traditional methods.



ASSEMBLY & TEST

From assembly to launch, we streamline processes with innovations such as standard core test equipment and safer, simpler ways to transport space vehicles to launch sites. We also optimize factory layouts and adapt product visuals into intuitive assembly instructions.



OPERATIONS & SUSTAINMENT

When the Digital Tapestry extends to the end of the product life cycle, the product data set can generate visual, intuitive operating and maintenance manuals for end users superior to text-based instructions. End users also feed operations-based improvements seamlessly back to the design team to enhance block upgrades.



RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

INNOVATION IN ACTIONION

DELIVERING MISSION SUCCESS

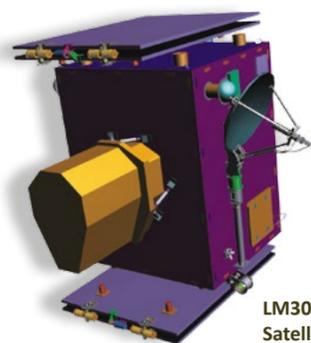
TRANSFORMING DESIGN

NEW WAYS TO CREATE AND OPTIMIZE COMPLEX SYSTEMS

At Space Systems Company, our Digital Tapestry includes hardware and software models that enable our teams to test designs before they are built. This approach allows us to refine designs virtually to reduce costs and improve performance before manufacturing begins.

A DIGITAL FOUNDATION

Using digital tools, designers define a system architecture that responds to mission requirements. Engineers then construct, simulate and test various product design concepts in the digital environment. Working with an integrated digital product data set, engineers spend less time searching for and coordinating data and more time creating and optimizing the design to satisfy performance, cost and schedule requirements.



LM300 Common Satellite Bus

REUSING COMMON COMPONENTS

Our Digital Tapestry facilitates reuse of standard, flight-proven elements. Designers can choose from a virtual catalog of standard subsystems, components and software modules and instantly plug them into the appropriate model to see if they fit or, alternatively, see if a slight change in design will accommodate them. Leveraging proven software and hardware is another path to increased affordability and agility.

QUALITY THROUGH COLLABORATION

The Digital Tapestry's common design environment enables rapid collaboration to optimize the product design. More designers work simultaneously with greater system insight. Because the comprehensive product data set is available to the entire team, production and operations specialists who play important roles during later phases of development can now influence the producibility and product performance earlier in the cycle.



SPEED AND AFFORDABILITY

This new ability to eliminate design flaws up front avoids the time and expense of re-work that would be required in the production phase. With universal availability of the product data set, analysts perform verification and validation checks, conduct trades, ensure requirements are being met, and perform virtual thermal, launch stress and other types of analyses. Early and thorough troubleshooting informs and streamlines actual hardware testing.



OneView – To exploit cross-discipline data, we have developed OneView, a software visualization tool that allows one-stop analysis of model-based systems engineering data so that our engineers and customers can understand and assess designs in less time and with less effort than traditional methods.



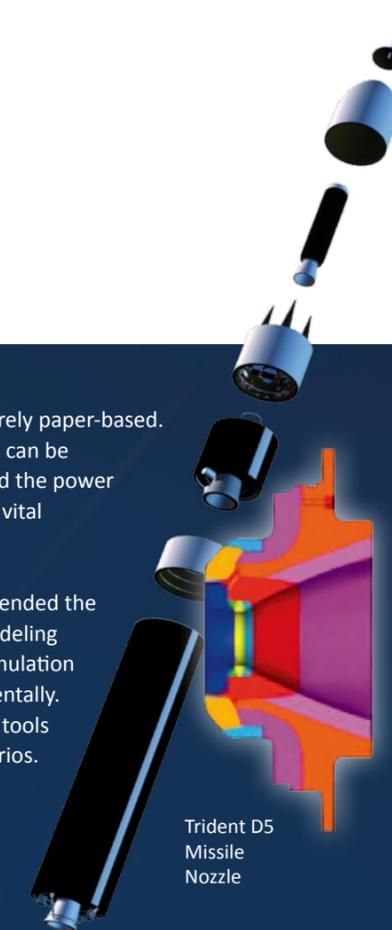
CoreSim – Our CoreSim development environment significantly reduces the time required to develop and test complex guidance, navigation and control software. This tool suite uses modern graphical programming languages and autocoding from models to produce high-quality source code ready for integration into real-time simulations and flight software.

PIONEERS IN DIGITAL PROTOTYPING

When the Fleet Ballistic Missile program began in the 1960s, it was entirely paper-based. Despite rigorous program management discipline, paper-based systems can be cumbersome and prone to error. In this century, the team has harnessed the power of 3-D visualization tools to refine and streamline improvements to this vital strategic deterrent.

Using model-based virtual prototyping technology, the program has extended the frontiers of rocket science – performing fundamental-physics-based modeling of thermal design, analytical tool development, transport processes, simulation and system performance evaluation, and verifying the models experimentally. The team is now developing a complete suite of user-friendly analytical tools that can be easily modified for anomalous conditions and what-if scenarios.

This effort has set the standard for maintaining and improving heritage products using virtual advanced modeling capability while enhancing knowledge transfer in long-term programs between veteran employees and new hires.



Trident D5 Missile Nozzle

RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

INNOVATION IN ACTIONION

DELIVERING MISSION SUCCESS

TRANSFORMING MANUFACTURING

LEVERAGING THE DIGITAL DOMAIN TO AUTOMATE WORK

When it comes to building the products we've designed, our Digital Tapestry raises the bar. Early in the product life cycle, the computer models we develop are analyzed for producibility and later translated directly into manufacturing systems that automatically build, inspect and test the physical article.

OPTIMIZING THE FLOW

Manufacturing first-time products can be challenging. Unforeseen production problems occasionally emerge, requiring costly redesign to resolve the issue.

With the Digital Tapestry, this paradigm is changing. Working together, design and production experts conduct detailed simulation and analysis of the design. They simulate the movements of the production technicians assembling the product's components to ensure the proposed manufacturing sequence is efficient and ergonomic. These insights enable the product developers to "design out" flaws even before the first part is ordered.

PRINTING THE FUTURE

Additive manufacturing, or 3-D printing, has a disruptive potential for the aerospace industry. Additive manufacturing is a process of making three-dimensional objects directly from a computer model.



Additive Manufacturing – We now fabricate large items such as propellant tanks more rapidly and economically.

Traditional subtractive manufacturing depends on turning, milling and cutting parts from blocks of material. In contrast, 3-D printing is achieved using an additive process. A material such as powdered titanium is heated and then applied in successive layers to create almost any shape. When a product is printed using additive manufacturing, waste is minimized and cycle times drastically reduced. Additive manufacturing also streamlines the supply chain by enabling the manufacture of many parts in house.



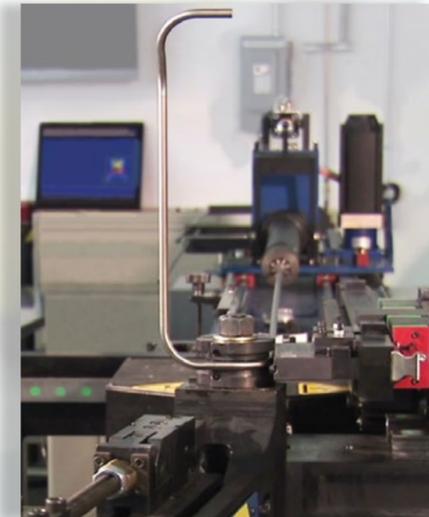
Applying Advanced Materials – APEX is a thermoplastic nanocomposite that can be processed using injection molding, extrusion, compression molding and additive manufacturing. The bracket above, an important THAAD missile component, was manufactured from APEX, resulting in a product that is 30% lower in weight and significantly less costly than its predecessor.



Virtual Pathfinding – Powerful simulation aids such as the Collaborative Human Immersive Laboratory (CHIL) enable cross-functional collaboration and mistake-proofing prior to touching flight hardware.

AUTOMATING TIME-CONSUMING TASKS

One advantage of operating in the digital domain is that manufacturing processes that used to take significant time to execute can now be automated. Precision processes like bending and inspecting spacecraft propulsion lines once took many hours of manual work. Now the systems that form and inspect these products operate automatically using data input directly from digital models. Results of this automation include higher product quality, higher productivity levels, reduced costs, shorter cycle times, reduced waste and a smaller factory footprint.



Automated Tube Bending



Automated Tube Inspection

MERGING 3D MANUFACTURING WITH ROBOTICS

Lockheed Martin has taken the concepts of the Digital Tapestry and additive manufacturing one step further: we have built the world's first multi-robot additive cluster. This innovation consists of two robots working in tandem to accomplish a variety of manufacturing operations.

In a recent demonstration, one robot in the cluster used a carbon-fiber-reinforced ABS composite material to create a hexagonal structure that represented a satellite bus. Meanwhile, a second robot machined the completed end of the structure to a final finish. The cluster will enable increasingly large and complex structures to be manufactured more rapidly and at lower cost.

Built by Lockheed Martin, the world's first multi-robot additive cluster debuted at a recent Defense Manufacturing Conference.



RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

INNOVATION IN ACTION

DELIVERING MISSION SUCCESS

TRANSFORMING PRODUCTION

STREAMLINING THE PROCESS

We continually pursue new ways to build our systems more efficiently. We rethink workflows, eliminate steps, leverage common products, standardize processes and restructure our sourcing practices to deliver greater customer value.

NEW APPROACHES TO ASSEMBLY, TEST AND LAUNCH OPERATIONS

At Lockheed Martin, we are implementing a wide range of innovative approaches to reduce the time it takes to flow a satellite through the factory and deliver it to the launch site.

COMMONALITY AND PRODUCTION

The Digital Tapestry facilitates greater use of standard components in product designs. This approach also streamlines production, expanding the use of consistent and well-understood processes, reducing learning curves, and improving the efficiency of manufacturing and assembly.



Ground Support – Our common up-ender design will be shared across the enterprise. Results include a reduced number of lifts for a safer and more streamlined production flow.

INTUITIVE ASSEMBLY INSTRUCTIONS

In production, new digital technology is transforming the legacy paper-based enterprise. This evolution extends to the factory floor, where intuitive 3-D visual instructions are replacing detailed text-based assembly instructions.

FACTORIES OF THE FUTURE

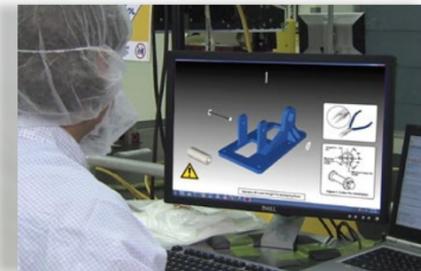
A well-designed factory allows teams to work together more efficiently and safely. By redesigning our factories to optimize production flow, eliminate unnecessary steps, and enhance productivity and safety, we have achieved significant improvements in cost and schedule.



Core Transportation – This new resource has, in most cases, eliminated the need for a separate shipping container, reducing cost and minimizing risk to space vehicles.



Aerospace Common Equipment – This approach standardizes the user interface and reduces cost through common ground support system design, commodity buys and reduced sustainment.



Complex Assembly Manufacturing Solution – CAMS leverages the 3-D model-based data set to provide clear work instructions that result in fewer errors, less rework and reduced cycle time.

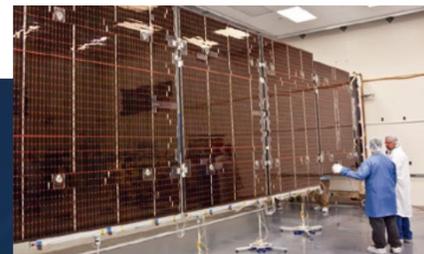


Virtual Collaboration – Video teleconferencing on the factory floor enables quicker status of hardware builds and resolution of production concerns.

RETHINKING STRATEGIC SOURCING

We are restructuring our relationships with suppliers to find opportunities to improve quality and capture cost savings. For example, we are driving common design and testing requirements and coupling cross-program bulk buys to maximize our company's buying power. These efforts also include streamlining requirements, restructuring work and increasing competition, all with the goal of driving down cost and driving up quality to deliver greater returns for our customers.

Our evolving product strategy includes rethinking how we decide to either build or buy specific parts, components and subsystems. By vertically integrating our operations to manufacture key components in house, we are able to exercise greater direct control over quality, efficiency and performance while reducing the risk of program delays.



Solar Array Manufacturing



Propulsion Manufacturing

RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

INNOVATION IN ACTION

DELIVERING MISSION SUCCESS

INNOVATION IN ACTION

APPLYING NEW TECHNOLOGIES AND TECHNIQUES

Applied innovations are dramatically impacting the cost, performance and capability of the products we build. We are continually developing new approaches to designing and building the platforms and payloads our customers rely on to meet their mission requirements.

THE MODERNIZED A2100 SPACECRAFT

Innovating for Affordability. For the next-generation A2100, we have re-examined all aspects of how we develop satellites for our customers:

- Redesigning the product architecture
- Reducing the number of parts
- Streamlining our design and production approach
- Adopting flexible financing options and business models to deliver best value.

The result of this across-the-board transformation is a spacecraft that can be built at a lower cost and with a shorter cycle time.

Additionally, we've applied innovations that increase power, extend on-orbit life and

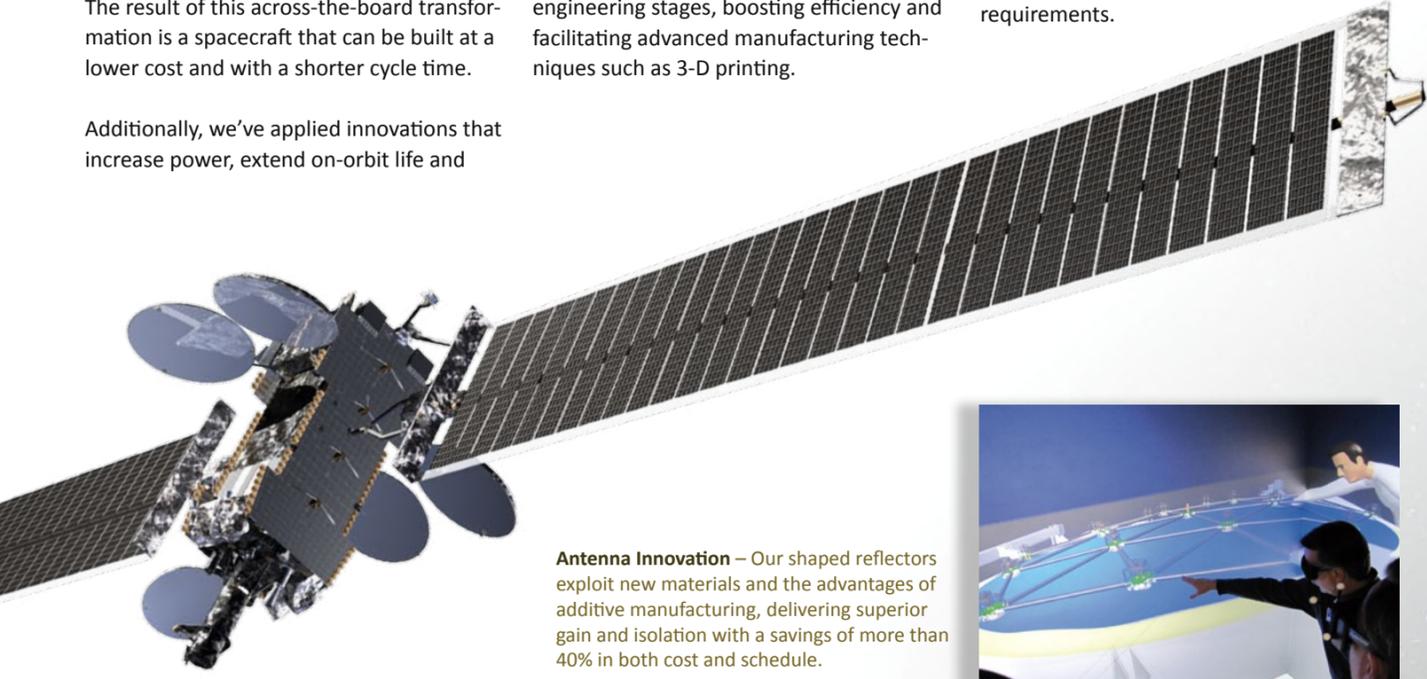
improve platform flexibility, all of which add value for both commercial and government customers.

Commonality and Flexibility. Our company's common bus framework offers a modular A2100 platform using common parts, subsystems and components, enabling catalog-to-order spacecraft systems.

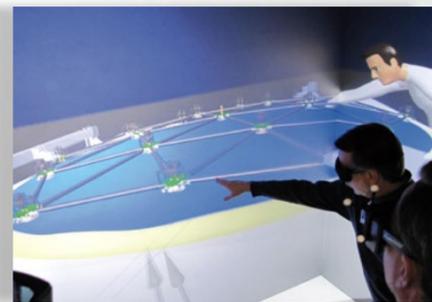
In support, our Digital Tapestry enables a virtual development process linking all engineering stages, boosting efficiency and facilitating advanced manufacturing techniques such as 3-D printing.

This strategy yields a high degree of configurability. For example, the A2100 offers the industry's greatest flexibility in satellite propulsion – from all-chemical, to hybrid, to all-electric. Once on orbit, a fully reprogrammable onboard mission processor enables changes to satellite configuration to adjust to changing business needs.

This flexibility gives our customers powerful options for optimizing systems to meet their cost, schedule and performance requirements.



Antenna Innovation – Our shaped reflectors exploit new materials and the advantages of additive manufacturing, delivering superior gain and isolation with a savings of more than 40% in both cost and schedule.



WORLD-CLASS PAYLOAD TECHNOLOGIES

Lockheed Martin is taking a new approach to how we develop payload technologies. Our Payload Centers of Excellence are rooted in a deep mission understanding derived from our work over the last 50 years producing space payloads for science, exploration and defense. These centers, which comprise multi-site, future-focused teams, are now taking advantage of our Digital Tapestry, using virtual worlds and additive manufacturing to rapidly develop new concepts for our customers.

These teams include a broad network of experts from Lockheed Martin, our industry partners and leading research universities. Through these networks, we remove cost and development time while infusing new capability.



Radio Frequency – Our RF Payload Center of Excellence in Denver, Colorado, is shaping the future of space-based communications. This center combines a proven, integrated team with new talent and facilities – collocating design, manufacturing and testing of all types of RF systems, products and antennas.

Optical – Our Optical Payload Center of Excellence is defining the future of imaging in space. Headquartered in Palo Alto, California, this center is advancing Lockheed Martin's capability, efficiency and agility in optical technologies and products.



THE DUAL-LAUNCH ADVANTAGE

When it comes to increasing affordability, launch costs are fair game. One way to cut these costs is for two satellites to share launch vehicle and insurance costs. As part of our A2100 modernization effort, we have developed a unique satellite configuration that enables two spacecraft to be mounted side by side on a single launch vehicle.

New features such as our compact solar arrays enable this side-by-side arrangement, which eliminates the requirement of pairing a smaller satellite on top of a large satellite in a stacked dual-launch configuration. This side-by-side design also allows both spacecraft to be equipped with large-aperture side-mounted and Earth-deck-mounted antennas. Our side-by-side adapter structure is compatible with standard launch vehicle fairings and can be used on multiple launch vehicles.



RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

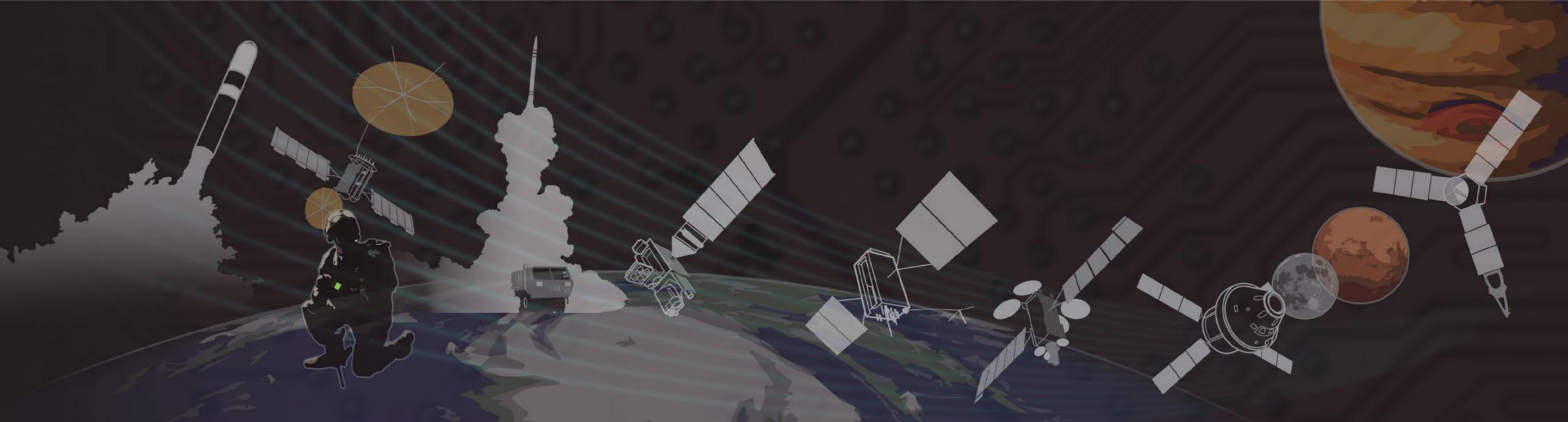
INNOVATION IN ACTION

DELIVERING MISSION SUCCESS

DELIVERING MISSION SUCCESS

BETTER, SOONER, MORE AFFORDABLY

At Lockheed Martin, innovations in technology, engineering and business processes help our customers achieve critical missions or business objectives sooner and more affordably.



STRATEGIC DETERRENCE

Fleet Ballistic Missiles: 3-D model-based engineering has enabled digital prototyping of the system, streamlining development and adoption of system improvements.

ICBM: Our unmatched mission expertise enables us to refurbish Minuteman III reentry vehicle fuzes, helping extend the life of the U.S land-based strategic deterrent.

MILITARY SATELLITE COMMUNICATIONS

MUOS and AEHF: Production innovations enable MUOS “comms on the move” more affordably, cutting build times for multi-beam antennas by 60% and payload system modules by nearly 70%; and streamline the Air Force’s most secure SATCOM system, AEHF, cutting costs by 35% for the next block buy.

MISSILE DEFENSE

THAAD: Using advanced analysis and simulation tools, we run realistic test-like-you-fly scenarios, enabling low-cost verification of missile interceptor performance against multiple threats.

ATHENA: New technology development has resulted in successful demonstration of a fiber-optic laser against simulated targets.

ENVIRONMENTAL MONITORING

GOES-R: New technology development enables a space-based lightning mapper that improves detection and warning of tornados and other severe weather.

WindTracer®: Repurposing proven technology extends the use of lidar from airline safety to the development of wind energy resources.

NAVIGATION

GPS III: Our Digital Tapestry has enabled virtual testing of proposed factory layout and assembly sequences, enabling more efficient manufacturing. We also are pioneering use of a full-scale satellite prototype to resolve development issues in advance of full-scale production of the GPS III constellation.

COMMERCIAL SATELLITE COMMUNICATIONS

A2100 Spacecraft: Our modernized A2100 offers powerful new options to commercial and government customers, including a fully reprogrammable mission processor and side-by-side dual launch.

HUMAN SPACE EXPLORATION

Orion: Orion achieved an important milestone with the success of Exploration Flight Test-1. Meanwhile, our deep mission expertise has helped NASA develop a stepping-stone mission approach that adapts to current funding levels.

SPACE SCIENCE

Juno: The first 3-D printed components in space enable Jupiter exploration at lower cost.
OSIRIS-REx: By repurposing proven technology from Mars spacecraft, we have cut cost, risk and schedule for NASA’s first asteroid-sample-return mission.

RETHINK EVERYTHING

THE INNOVATION IMPERATIVE

THINKING AHEAD OF THE CURVE

TECHNOLOGY CRUCIBLE

WEAVING A DIGITAL TAPESTRY

TRANSFORMING DESIGN

TRANSFORMING MANUFACTURING

TRANSFORMING PRODUCTION

INNOVATION IN ACTION

DELIVERING MISSION SUCCESS