WHERE IDEAS TAKE SHAPE:

VISION. PRECISION. MISSION.

CONCEPT DESIGN AND REALIZATION AT APL

JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

TABLE OF CONTENTS

INTRODUCTION

An engineering design and fabrication team has always been integral to the Johns Hopkins University Applied Physics Laboratory's (APL) operations. As the current enterprise design and fabrication capability of APL, the Concept Design and Realization (CDR) branch seeks to strategically enhance its multidisciplinary design, analysis, fabrication and integration capabilities to become an eminent leader in foundational engineering and bespoke manufacturing sciences and help drive the future of science and technology.

To continue to deliver innovative solutions across APL missions, CDR hosts our core competencies: depth of expertise in design, systems engineering, advanced manufacturing and physics-based modeling; responsiveness and agility while maintaining unparalleled quality; and rapid technology development, integration and prototyping.

BRANCH OVERVIEW

The CDR branch provides expertise spanning electrical and mechanical engineering, electronics design and fabrication, mechanical fabrication and emerging technologies including additive manufacturing, microfabrication and nanofabrication. Experimenting at scale, this branch designs, builds and deploys advanced prototypes and tactical innovations for mission areas across APL. With the ability to go from design to fabrication, including classified efforts, we provide a unique asset to the United States arsenal of capabilities.

OUR MISSION

We are committed to being national leaders in foundational engineering and bespoke manufacturing sciences, delivering next-generation, state-of-the-art systems, for any domain, on demand. Through multidisciplinary design, analysis, fabrication and integration, we support APL, our sponsors' missions and global initiatives. Our ultimate goal is to drive defining innovations that ensure our nation's technological preeminence in the 21st century, aligning our leadership with APL's Centennial Vision.

OUR VISION

BUILDING CONNECTIVITY *and* SHAPING THE FUTURE *from the* BENCHTOP *to the* FRONT LINES

CDR is the connecting link in APL's concept realization process, bridging early research to the creation of highly complex, operational prototypes for deployment to the front lines. Through our position as an enterprise resource for APL, we create opportunities to optimize the timeline for fielding new systems, decrease overall risk and ensure team continuity, from research, through engineering and fabrication, to mission deployment.

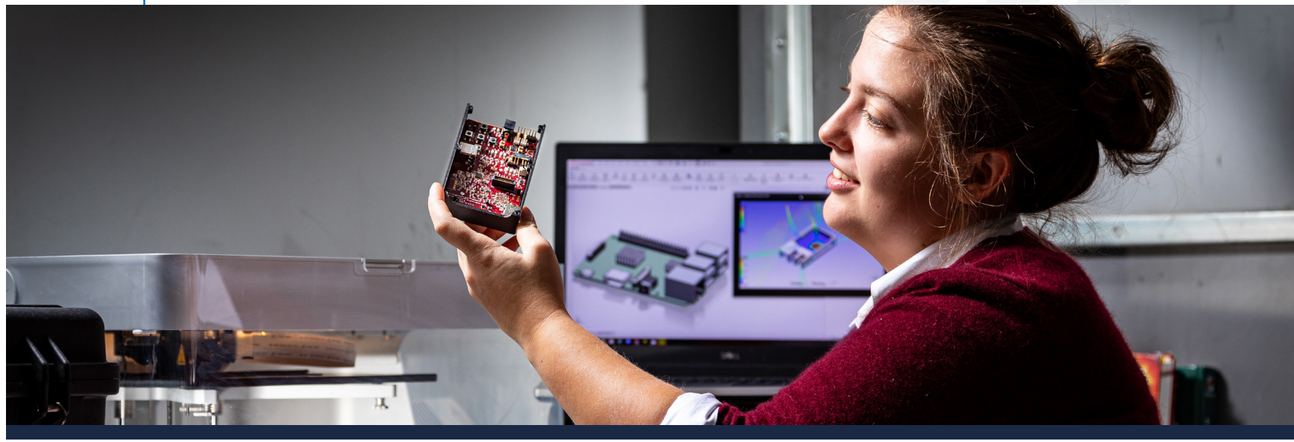
EXPERTISE AND IMPACT

The members of the CDR branch are creators of physical hardware as well as tacticians of technological solutions enabling excellence in the design, execution and delivery of exploratory and mission-ready products. CDR's excellence is built upon foundational core competencies and institutional resilience to tackle a broad range of emerging challenges with responsiveness and agility while maintaining unparalleled quality. Our approaches are rooted in depth of expertise in design, physics-based modeling, advanced manufacturing and systems engineering, along with classified workflows, advanced technology development and rapid prototyping capabilities. Every day, CDR uses advanced techniques in design, engineering and fabrication to ensure basic research is functional, feasible, survivable, scalable, sustainable and manufacturable. Ultimately, we work across, and at different points of, project life cycles to transform ideas into solutions that are realizable and imbued with smart design and packaging, foundational principles and novel approaches for manufacturing. Our key areas of expertise are foundational engineering and bespoke manufacturing sciences.

Our goal is to deploy systems of systems and ensure that each subsystem, component and assembly has undergone rigorous treatment as we lead APL in the demonstration and execution of best practices as a center of excellence for engineering design. Some processes and capabilities will endure the test of time. Our future depends on our ability to prepare for new challenges. This will require constant evaluation and adaptation (as needed) of emerging technologies and trends. To help achieve APL's Centennial Vision and achieve defining innovations that ensure our nation's preeminence in the 21st century, CDR aims to strategically expand our leadership in foundational engineering and bespoke manufacturing sciences. Looking forward, we aim to build on these core principles to continue delivering mission impact and critical contributions to critical challenges.

The CDR branch aims to support every APL mission, retain institutional resilience, evolve technologically and ensure a breadth and depth of expertise to produce high-quality work for both longstanding programs and rapid prototyping. And, as needed, we will ensure our ability to offer classified fabrication.

We anticipated challenges, including an ever-changing technological landscape, delivering ways to recruit, mentor and train our staff. We aim to set the standard for high-caliber and most passionate technicians, machinists, engineers and scientists working across manufacturing.



ELECTRICAL AND MECHANICAL ENGINEERING

APL's electrical and mechanical engineering teams form an agile, rapid-response capability that delivers innovative solutions to the Lab's most complex technical challenges. The highly creative and broadly skilled teams provide end-to-end support across every stage of development — from early concept exploration to deployed, field-ready systems. Their expertise spans electrical and mechanical design, systems integration, simulation, modeling and manufacturing-aware engineering. This interdisciplinary strength allows them to translate abstract ideas into tangible, high-performance results. Supporting more than 400 projects annually across all mission areas, sectors and departments at APL, their technical leadership has shaped efforts ranging from prototypes like BOLT for the Force Projection Sector (FPS) and electromechanical systems for the Asymmetric Operations Sector (AOS) to Dragonfly subsystem designs and multiscale modeling for the Air and Missile Defense Sector (AMDS), FPS and Space Exploration Sector (SES). Whether delivering automation systems for Special Operations, integrating augmented/virtual reality into Tactical Augmented Networked Gaming (TANG) or accelerating manufacturing solutions, the teams consistently drive impact through responsive, technically rigorous and mission-aligned engineering.

CAPABILITIES

- **Computer-Aided Mechanical Design and Engineering:** Computer-Aided Design (CAD) modeling, simulation, 3D scanning and model-based definition using tools like Creo, SolidWorks and Ansys.
- **Advanced Manufacturing (AM) and Prototyping:** AM, rapid prototyping, reverse engineering and optical layout support.
- **Mechanical and Electromechanical Systems:** Design mechanisms, radio frequency (RF) assemblies, flight structures, ground-support equipment and welded components.
- **Integration and Documentation:** Deliver wiring diagrams, harness drawings, interface documentation, basic thermal/structural analysis and complete data packages.

Electrical and Mechanical Engineering

MECHANICAL ENGINEERING

Our multidisciplinary Mechanical Engineering team delivers end-to-end solutions across the full product development life cycle — from concept and detailed CAD modeling to prototyping, fabrication coordination, assembly, integration and deployment.

The team supports critical aerospace, defense and research initiatives by combining advanced tools, industry best practices and deep mechanical systems expertise. They excel at producing high-precision designs that meet rigorous performance, environmental and operational standards. Through close collaboration with engineers, scientists and technicians, they drive the success of complex, mission-focused projects.

Electrical and Mechanical Engineering

ELECTRONICS PACKAGING

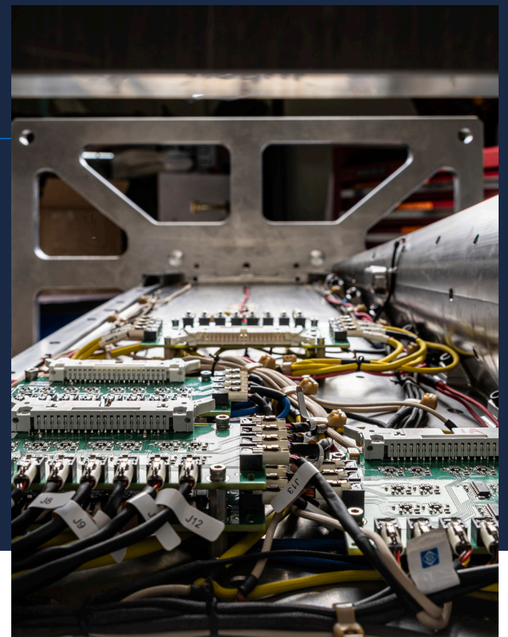
The Electronics Packaging team delivers efficient, high-quality design solutions for a wide range of challenges — from board layouts and cable harnessing to thermal and structural simulation, fabrication and integration. Every solution is crafted to meet the highest engineering standards while aligning with the technical needs of mission partners. The skills required for electronics packaging — including thermal analysis, structural analysis and mechanical design — are highly versatile and applicable across many engineering domains.

The team brings deep expertise in packaging, harnessing, mechanical design and system-level analysis. They support everything from prototyping and integration to hands-on assembly and testing. The team also explores emerging technologies like augmented/virtual reality to enhance design workflows and communication. With strong proficiency in CAD and simulation tools, engineers apply their knowledge of electromechanics, materials science and digital modeling to support a wide range of mission areas.

While its core focus is electronics packaging, the team's capabilities extend far beyond it. They offer flexible, end-to-end engineering support tailored to complex system needs across research, aerospace and defense applications. Their goal is to continuously evolve with sponsor needs by identifying strategic opportunities, expanding technical depth and leveraging innovative tools and methods. Through technical excellence and collaboration, the team ensures its solutions are robust, scalable and mission-ready.

Electrical and Mechanical Engineering

SYSTEMS INTEGRATION AND ANALYSIS



The Systems Integration and Analysis team comprises multidisciplinary engineers supporting end-to-end product development across space, air, ground and sea domains. Acting as the engineering glue between research and real-world deployment, the team ensures that systems — whether components or complex architectures — are functional, integration-ready and field-deployable.

Driven by the mission to transform ideas into mission-ready systems, the team brings expertise in technical leadership, project management, technology road-mapping and risk mitigation. Capabilities span concept visualization, tailored analysis, physical and digital prototyping, and test and evaluation. Engineers also support system feasibility assessments, traceability, integration planning and transitions to industry.

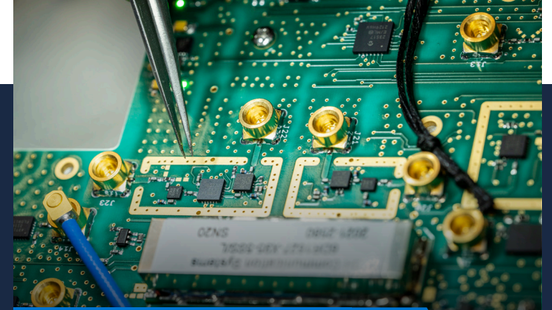
The team's work spans the full life cycle — from low technology readiness level (TRL) ideation and design exploration to detailed modeling, integration and deployment. Whether supporting space science missions or field-ready defense systems, the team contributes at every phase, ensuring technical rigor and alignment with mission objectives. Sponsor engagement remains central to delivering solutions that truly make an impact.

Electrical and Mechanical Engineering

ELECTRICAL ENGINEERING

REDD's Electrical Engineering team is a highly creative, skilled and committed group of problem solvers who leverage their expertise to tackle challenges across APL's sectors. Existing as an enterprise resource, we specialize in solving electrical and computer engineering problems under difficult technical, environmental or programmatic constraints. As part of the CDR branch, we apply our knowledge to build, test and deploy solutions, even if it necessitates long-term field work.

The team consists of agile learners, collaborating flexibly to meet project needs. With ample laboratory space and the capability to rapidly prototype and test electrical systems, we are well equipped to tackle challenges efficiently and effectively.



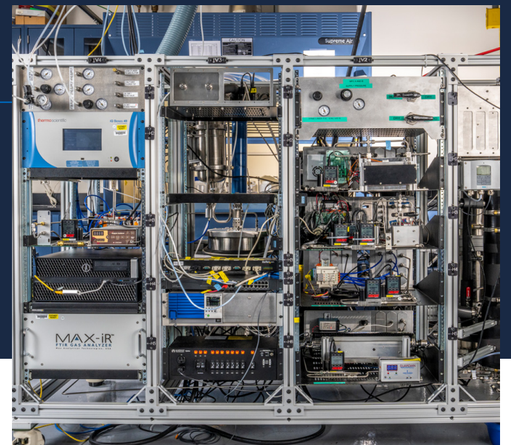
CAPABILITIES

- **Embedded Hardware/Firmware Design:** Develop embedded systems (e.g., circuit boards, firmware and task-specific software) from start to finish.
- **RF & Microwave Design:** Design and test high-frequency RF components like amplifiers, tuners, synthesizers and filters to specification.
- **Environmental & Subsystem Tests:** Perform environmental testing using thermal vacuum chambers to meet flight-level qualifications.
- **Power & Harness Systems:** Design power solutions and custom wiring for high-voltage, battery-powered and solar energy applications.
- **Digital Circuit Design:** Design digital circuits using field-programmable gate arrays (FPGAs), system on chips and microcontrollers for custom, embedded applications.
- **Electrical Systems Integration & Analysis:** Support full life-cycle product development and testing across space, air, ground and sea domains.

Electrical and Mechanical Engineering

MECHATRONICS AND ELECTROMECHANICAL SYSTEMS

The Mechatronics team is a multidisciplinary group of engineers focused on solving complex challenges through the integration of mechanical, electrical and software engineering. We specialize in transforming concepts into innovative, high-performance systems through cutting-edge design, prototyping and system realization. With expertise spanning mechanism design, electromechanical integration and precision manufacturing, we support projects in areas such as chemical processing, surveillance technology and advanced manufacturing. Our collaborative approach emphasizes hands-on prototyping, rigorous design and continuous knowledge-sharing to push the boundaries of automation, electromechanical systems and data-driven solutions.



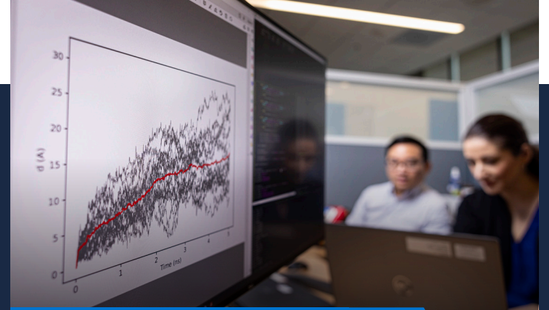
The team's core capabilities include mechanical and mechatronics design, covering everything from the design of additive manufacturing to complex surfacing and fixture/tooling design to robust mechanisms. They offer support for modeling and analysis through finite element analysis (FEA, thermal and structural) and data acquisition. The team's electrical design expertise includes sensor and actuator selection, system integration, cable harnessing and circuit-level design and analysis. We use software such as Python, MATLAB, and C++, and rely on industry-standard tools like SolidWorks, Creo, Altium, KiCAD and Ansys to deliver precise, reliable engineering outcomes.

These capabilities and skills enable the team to support everything from small prototypes to full-fledged deliverable systems incorporating industrial automation and data collection. From complex chemical process schematics to innovative MIL-SPEC-compliant mechanisms, our team seeks to grow our expertise to meet the rapidly changing needs of sponsors across the Laboratory.

Electrical and Mechanical Engineering

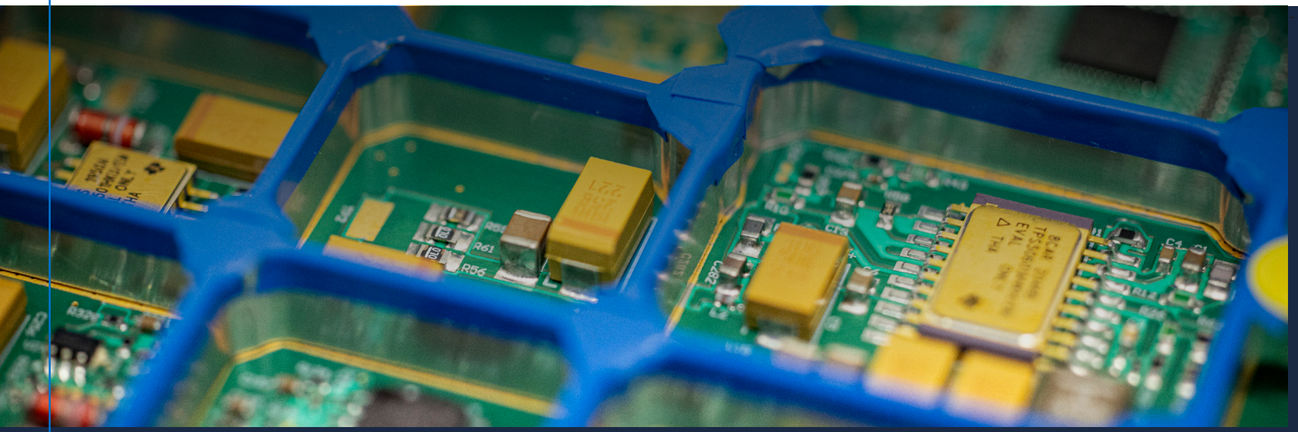
MULTISCALE MODELING AND SIMULATION

The Multiscale Modeling and Simulation team comprises a multidisciplinary group of engineers and scientists specializing in modeling and simulation across length and time scales. The team helps partners select the right computational tools for problems spanning subatomic interactions to large-scale mechanical and fluid systems. Using techniques like finite element analysis (FEA), computational fluid dynamics (CFD), hydrocode modeling, molecular dynamics (MD) and density functional theory (DFT), the team predicts material and system behavior under diverse conditions. They use commercial, government, open-source and custom-built software (e.g., Python and MATLAB) to deliver tailored solutions that advance scientific understanding, optimize designs and solve real-world challenges. They also integrate modeling across scales and with artificial intelligence (AI) to meet emerging sponsor needs.



CAPABILITIES

- **Finite Element Analysis:** Analyze structural mechanics and impact dynamics for standard/complex materials.
- **Hydrocode Analysis:** Simulate high-rate events like shock, blast, penetration and fragmentation.
- **Computational Fluid Dynamics:** Model airflow, heat and contamination from micro to building scale.
- **Multiphysics Simulation:** Capture interactions across fluids, structures, heat, mass transfer and chemistry.
- **Thermochemistry and Kinetics:** Predict pressure, temperature and chemical shifts from reactive processes.
- **Molecular Dynamics:** Simulate atomic-scale material behavior across microseconds and microns.
- **Density Functional Theory:** Model electronic properties influencing optics and thermomechanics.
- **Custom Analyses:** Deliver tailored modeling, optimization, automation and immersive visualization solutions.



ELECTRONICS DESIGN AND FABRICATION

The Electronics Design and Fabrication team brings together expert engineers, designers and technicians to create high-reliability hardware solutions — from one-of-a-kind rapid prototypes to Military Standard (MIL-STD), Institute for Printed Circuits (IPC) and NASA-certified assemblies. As a world-class capability within APL, this team develops customized tools, materials and processes to meet the most demanding technical requirements across the Lab's mission areas. Their expertise spans micro- and nanofabrication, advanced packaging and precision assembly using state-of-the-art equipment. Whether collaborating on bioengineering efforts with academic and industry partners or delivering heavy copper boards and rapid-turn solutions, this team consistently delivers innovative, high-performance results.

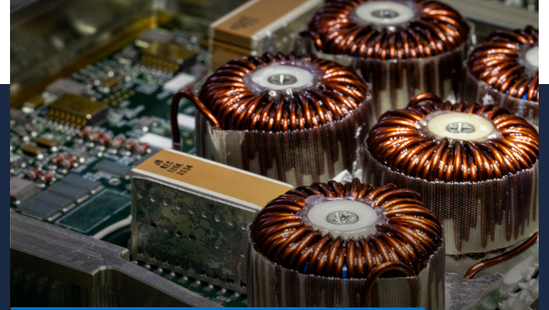
Electronics Design and Fabrication

PRINTED CIRCUIT BOARD FABRICATION

The Printed Circuit Board (PCB) Design and Fabrication team delivers advanced PCBs for a broad spectrum of applications — from rapid-turn prototypes to highly reliable boards used in space missions such as Parker Solar Probe, Dragonfly and DART. Supporting everything from single-layer to complex high-density interconnect (HDI), rigid-flex and sequential lamination designs, they provide complete solutions from concept through manufacturing validation. With in-house quality labs, additive manufacturing and AI-driven process development, they operate one of the only university affiliated research center (UARC)-secure PCB fabrication facilities in the nation, serving internal and external sponsors with precision and innovation.

CAPABILITIES

- **Design for Manufacture Reviews:** Comprehensive design reviews ensure the utmost quality and integrity of every board. Designing for manufacturability reduces costs and elevates quality and reliability.
- **Multilayer, Sequential:** Specialize in high-layer count and sequential lamination technologies, from single-layer boards to 24+ layer sequential boards.
- **Rigid-Flex PCBs:** Combine rigid PCBs with flexible sections for flexibility and tighter packaging.
- **High-Density Interconnect:** Provide minimal size, weight and power in a single package.



CAPABILITIES

- **Quick-Turn Prototyping:** Deliver fast, high-quality solutions tailored to customer specifications from initial concept to fully assembled prototypes.
- **Circuit Card Assembly:** Ensure flawless assembly at any scale, from simple to complex builds.
- **Cabling and Harnessing:** Cable and harness assembly for digital, RF and fiber-optic systems.
- **Polymeric Coatings and Staking:** Coating, bonding and staking applications, and encapsulation for high-reliability systems.
- **Assembly Rework:** Comprehensive rework for any assembly, including component replacement, trace repair, wiring and depopulation.
- **Magnetics Winding and Testing:** Custom bobbin and toroid winding as well as in-process testing.

Electronics Design and Fabrication

ELECTRONICS ASSEMBLY

The Electronics Assembly team provides end-to-end solutions for high-performance hardware — from early prototypes to spaceflight-certified assemblies. The team's International Standards Organization (ISO) Class 8 Cleanroom and electrostatic discharge (ESD)-compliant facility ensures precise, reliable builds, supported by automated environmental controls and dry storage for sensitive components.

The expert team delivers custom cabling and harnessing, PCB assembly and custom magnetics, with speed, accuracy and innovation. Early design-for-manufacturing integration enables flexible, scalable solutions for research, defense and space systems.

Whether fast-tracking a prototype or meeting rigorous requirements, the team combines precision engineering with streamlined workflows to exceed expectations.

Electronics Design and Fabrication

MANUFACTURING ENGINEERING AND OPERATIONS

The Manufacturing Engineering and Operations team bridges electrical design and fabrication, ensuring efficient, high-quality production. Experts in electronics assembly, testing and fabrication, the team delivers reliable hardware — from rapid prototypes to space-certified assemblies. They leverage advanced tools like Automated PCB assembly equipment, 2D X-ray, and optical and flying probe to meet rigorous standards and deliver PCB assembly, MIL-SPEC magnetics, custom cabling, polymeric coatings, precision rework, laser etching and high-resolution inspection.

From early design through delivery, the team focuses on design for manufacturability, scheduling, forecasting and cost analysis — enabling rapid, flexible support for mission-critical needs across APL, including national security and space programs.

CAPABILITIES

- **Electronics Manufacturing:** Precise, high-speed PCB fabrication using advanced automated assembly, solder-paste application and reflow technologies for prototypes and production.
- **Testing & Quality Assurance:** State-of-the-art inspection systems, (e.g., 3D optical and X-ray imaging) ensure quality verification and electrical validation for mission-critical hardware.
- **Design for Manufacturability:** Early collaboration between electrical design and manufacturing experts ensures manufacturability is considered upfront — reducing rework, optimizing designs and improving schedule accuracy.
- **Custom Fabrication Solutions:** Using 3D printing and laser cutting to create custom fixtures, enclosures and potting molds, and fabricate other hard-to-obtain parts to perfect assembly.
- **Complex Rework:** Ball grid array (BGA) reballing and BGA/ceramic column grid array (CCGA) replacement using specialized equipment like the ERSA Hybrid Rework 550 and AirVac DRS-24 hot-air station.

Electronics Design and Fabrication

MICROELECTRONICS

The multidisciplinary Microelectronics team focuses on high-mix, low-volume fabrication with capabilities in micro- and nanofabrication, microelectronics assembly and advanced plating techniques. Their expertise includes thin-film deposition, reverse engineering, dry/wet etching and 2.5D/3D packaging. Known for tackling cutting-edge research needs, the team supports quick-turn fieldable prototypes and novel material integration, with the ability to plate exotic substrates (e.g., AlBeMet and additively manufactured components).

Microelectronics
The team specializes in all areas of microelectronics manufacturing, including photolithography, thin-film deposition, etching, thermal oxidation and metrology. They work with both standard and unique materials to support fundamental research as well as high-TRL development (e.g., using gold for advanced applications). The team can fabricate features as small as 300 nm.

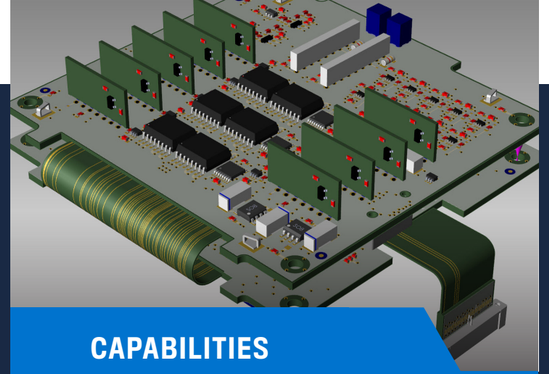
Microelectronics Assembly
APL's full-service microelectronics assembly facility supports wire bonding (ball and wedge), flip-chip bonding and other essential processes. This facility offers custom package design and fabrication tailored to specific needs. Package evaluation services are also available to ensure designs meet all specifications — whether for early-stage research or high-reliability fieldable packages.

Advanced Plating
In this area, we specialize in final finish plating, including Electroless Nickel Immersion Gold (ENIG) and Electroless Nickel Electroless Palladium Immersion Gold (ENIPIG). We can plate nickel and gold onto a wide variety of substrates, including those traditionally considered difficult or impossible to plate. We also provide specialized material preparation for bonding processes.

Electronics Design and Fabrication

ELECTRONICS DESIGN

The Electronics Design team offers complete life-cycle support — from initial concept and schematic layout to final manufacturing documentation. Each design is tailored to meet specific mission and performance requirements, with a strong focus on manufacturability. The team's proficiency in design is comprehensive — whether it is a substantial or modest project, encompassing single-layer, multilayer, sequential lamination, flex, or rigid-flex designs, the team ensures quality, consistency and rapid delivery. They have designers who are adept with industry-leading CAD tools, namely Xpedition and Altium. The team of seasoned and skilled designers plays a pivotal role in advancing customer product designs and improvements, ultimately benefiting clients by delivering superior and enhanced products.



CAPABILITIES

- **Library Management:** Create and maintain a centralized database of components, footprints, symbols and 3D models for consistency and accuracy in the design process.
- **High-Speed Interface Constraint Definition:** Define design constraints to ensure reliable performance of high-speed signals. These help guide layout and routing, minimizing crosstalk and signal degradation. Designs are verified to meet performance requirements using the defined constraints.
- **Manufacturing Validation:** Conduct design for manufacturability checks and collaborate with fabrication/assembly partners to ensure designs meet production capabilities and tolerances.
- **Product Life-Cycle Management Coordination:** Streamline sign-off of documents, track design revisions and ensure coordination between engineering, design and manufacturing teams.
- **Seamless Interface with Mechanical CAD:** Ensure accurate PCB layouts with enclosures and mechanical components.

MECHANICAL FABRICATION

APL's mechanical fabrication capability is powered by a dedicated team of engineers, fabrication specialists and project planners who create advanced prototype hardware systems to support projects across the Lab. As a science-based manufacturing and prototyping facility, it provides full-spectrum support — from conceptual research and development through configured hardware production — for mission-critical efforts in space, defense and national security. Nearly every hardware-related effort at APL involving composites additive manufacturing (AM, polymer and metal), welding and traditional subtractive processes is developed in-house. Our team strives to deliver the most professional and highest quality mechanical prototypes available, with an unwavering focus on precision, quality and responsiveness. Leveraging state-of-the-art equipment and deep cross-domain expertise, the team transforms novel concepts into flight- and field-qualified mechanical solutions — supporting programs from satellites to submarines with speed and reliability.

Mechanical Fabrication

ADDITIVE/HYBRID MANUFACTURING

The Additive/Hybrid Manufacturing team paves the way for AM at APL by delivering innovative, mission-ready solutions. The recently renovated lab houses various metal and polymer AM equipment to support the diverse array of sponsor applications we encounter.

The diverse team of engineers and technicians tackles a full spectrum of work, spanning from research topics such as novel material development, functionally graded materials, in situ sensor integration and process simulation to hardware fabrication including: flight-qualified parts, rapid prototyping, topology-optimized and lightweight structures, embedded components, and processing up to the secret level (classified builds).

The team blends design innovation with technical execution to deliver critical contributions to our nation's critical challenges.

CAPABILITIES

- **Rapid Material Development:** Accelerated creation and quick-turn fabrication of novel metal alloys tailored to specific applications.
- **AM Design:** Expert guidance on design principles and strategies to optimize parts for additive processes.
- **Hardware Fabrication:** End-to-end fabrication solutions, from early prototypes to fully qualified space-ready hardware.
- **Qualification of Additive Parts:** Comprehensive support navigating standards to deliver reliable, high-performance parts.
- **Metal AM:** Production of metal components using laser powder bed fusion and directed energy deposition.
- **Polymer AM:** Fused deposition modeling, stereolithography and selective laser sintering for prototypes, precision parts and durability.

CAPABILITIES

- **Computer Numerical Control (CNC) Milling:** A computer-controlled process that uses rotating cutting tools to remove material from a solid workpiece to create precise shapes and features.
- **CNC Turning:** A machining process where a computer-controlled lathe rotates the workpiece while a stationary cutting tool shapes it, typically used for cylindrical parts.
- **Electrostatic Discharge Machining (EDM):** A noncontact process that removes material from conductive materials using controlled electrical sparks to shape complex or hard-to-machine parts.

Mechanical Fabrication

SUBTRACTIVE MANUFACTURING

The Subtractive Manufacturing team specializes in high-mix, low-volume precision machining, delivering exceptional prototype fabrication through a wide array of advanced technologies and expert machinists. Leveraging capabilities such as 3-axis, 5-axis, turning, mill-turn, and EDM, the team produces complex, high-quality components in materials ranging from aluminum and titanium to more demanding alloys like molybdenum and tungsten. With deep experience and end-to-end expertise, these world-class fabricators deliver bespoke, reliable solutions for mission-critical applications — from space programs like Dragonfly to classified wind tunnel models — meeting the demands of innovation with speed and precision.

Mechanical Fabrication

WELDING

APL's welding experts deliver a broad spectrum of capabilities — from intricate precision welds to large-scale structural assemblies and vehicle modifications. Specializing in high-precision Metal Inert Gas (MIG), Tungsten Inert Gas (TIG), brazing and titanium welding, the team supports mission-critical hardware with unmatched accuracy and reliability. Their expertise spans additive postprocessing, space-qualified welds and complex assemblies for aerospace and defense systems. With extensive experience in exotic materials and tight-tolerance fabrication, they play a vital role in advancing APL's most demanding and innovative mechanical builds.

CAPABILITIES

- **MIG Welding:** Join metals quickly and efficiently using a wire electrode fed through a gun and shielding gas.
- **TIG Welding:** A precise method that uses a nonconsumable tungsten electrode and shielding gas to create high-quality welds, especially on thin or delicate metals.
- **Brazing:** A joining process where a filler metal is melted and flows into the joint between two close-fitting parts without melting the base metals.
- **Titanium Welding:** A specialized welding process that requires strict control of atmosphere and technique to prevent contamination when joining titanium components.

CAPABILITIES

- **Laser Cutting:** Uses a focused laser beam to cut or engrave materials with clean, accurate edges.
- **Waterjet Cutting:** A cold-cutting method that uses a high-pressure stream of water, often mixed with abrasive particles, to cut through a wide range of materials without heat.
- **Rolling:** A metal forming process where a sheet or plate is passed through rollers to create curved or cylindrical shapes.
- **Press Brake Bumping and Forming:** Uses a press brake machine to bend or shape metal sheets through a series of controlled, incremental bends.

Mechanical Fabrication

SHEET METAL FABRICATION

The Sheet Metal Fabrication team delivers high-precision metal shaping and assembly using laser cutting, waterjet cutting, rolling and forming. Their expertise supports classified, aerospace and custom applications alike, including fabrication of aeroshells for Europa Clipper and museum-grade replicas for the Smithsonian. With advanced capabilities and expert technicians, they ensure top-tier quality and fast turnaround for even the most complex metal components.

Mechanical Fabrication

MATERIALS AND PROCESS ENGINEERING

The Materials and Process Engineering team pushes innovation by transforming bold concepts into reality through cutting-edge polymeric and composite-based materials, advanced manufacturing and state-of-the-art equipment. With deep materials science expertise, the team realizes this vision through advanced composite fabrication, polymer molding, silicone processing and adhesive bonding.

From low-cost rapid tooling to biofidelic surrogates, they develop groundbreaking prototypes and fielded hardware, redefining performance, durability and quality. Leveraging in-house capabilities like 3D scanning, cleanroom layups, and soft goods integration, the team pioneers hybrid materials supporting APL's unique needs — enabling mission-specific solutions that challenge limitations and set new standards for advancement.

CAPABILITIES

- **Prepreg Hand Layup, Resin Infusion (VaRTM), Wet Layup:** Composite fabrication methods that layer fiber materials with resin — either preimpregnated, vacuum-infused or manually applied — to create strong, lightweight parts.
- **Sewing and Embroidering:** Techniques used to stitch or decorate textiles and composite reinforcements for structural shaping or branding purposes.
- **Silicone Processing:** The molding, casting or curing of silicone materials to create flexible, heat-resistant components for specialized applications.
- **Polymer Molding:** A process that shapes plastic or rubber materials into precise forms using heat and pressure in molds.
- **Adhesive Bonding:** A joining method that uses engineered adhesives to securely bond different materials, often in place of mechanical fasteners.

CAPABILITIES

- **Real-Time Manufacturing Insights:** Implement data visualization tools for real-time tracking of costs, schedules and resource usage.
- **Early Engagement with Manufacturing Experts:** Collaborate early with manufacturing subject matter experts (SMEs) to optimize designs, reduce rework and improve scheduling.
- **Streamlined Manufacturing Logistics:** Enhance scheduling, forecasting and cost estimation to improve planning, reduce delays and support efficient fabrication.

Mechanical Fabrication

MANUFACTURING ENGINEERING AND OPERATIONS

The Manufacturing Engineering and Operations team bridges design and fabrication, ensuring seamless manufacturing execution. The team manages manufacturing logistics, including scheduling, forecasting, cost estimation and resource allocation. They work directly with fabrication SMEs to align manufacturing capabilities with design intent, ensuring feasibility, quality and scalability. A key focus is design for manufacturability (DFM) at the part and system levels. By integrating DFM early, the team helps optimize designs and fabrication methods to reduce costs, minimize risk and improve overall efficiency. This collaborative approach enables reliable, scalable solutions that meet performance goals and streamline the transition from concept to production.

CONNECT WITH US

EMAIL
research@jhuapl.edu

Scan to learn more or visit
www.jhuapl.edu

JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

25-01829