

MANUFACTURING AND MATERIALS

RESEARCH LABORATORIES



Setting the bar

Bi-annual Inaugural Report (2023-25)

TABLE OF CONTENTS

| | |
|---|----|
| Director's letter | 1 |
| Our calling: Setting the bar | 2 |
| Foundation for Impact | 4 |
| MMRL Mission Statement | 7 |
| Highlights & Milestones | 8 |
| Bringing people together | 10 |
| Development & Delivery of advanced, Applied & Accessible Infrastructure | 12 |
| Innovation and Student Engagement | 13 |
| Research Funding and Collaboration | 14 |
| Events and Partnerships | 15 |
| Community of Partners, Collaborations & Sponsors | 16 |
| Global Engagement and Visibility | 17 |
| MMRL 2.0: Raising the Bar | 18 |

DIRECTOR'S LETTER

It is my privilege to share the inaugural Report of the Manufacturing and Materials Research Laboratories (MMRL). Established in Fall 2023, MMRL was created at a pivotal moment for Purdue and for the nation, when America's resilience through strength in advanced manufacturing is more vital than ever to economic competitiveness, security, and technological leadership, on Earth and in space.

Born from Purdue's eXcellence in Manufacturing and Operations (XMO) initiative, MMRL extends the University's long tradition of shared, world-class research environments such as Zucrow, Herrick, and Birck. Our mission is bold and clear: to enable discovery, accelerate innovation, advance applied and translational research, and educate the next generation of manufacturing leaders.

Guided by our foundational pillars, People, Place, Processes, and Products, MMRL is building an ecosystem where talent, technology, and purpose come together. We are cultivating a diverse community of researchers and learners, investing in a 30,000-square-foot collaborative laboratory, and establishing operational models that elevate creativity, safety, inclusion, and impact. These efforts are rooted in the Convergent Manufacturing thesis, where multi-material and multi-process innovation meets cyber-physical systems, robotics, data, and human-centered AI to unlock precision, agility, sustainability, and resilience at scale.

With Indiana as one of the nation's strongest manufacturing economies, and Purdue at its center, MMRL embraces its responsibility to lead. Through strategic partnerships with industry and government, we are ensuring that new knowledge, technologies, startups, and workforce pipelines move swiftly from the lab into practice to strengthen American manufacturing.

This inaugural report marks the beginning of a transformative journey, and the MMRL community is grateful to everyone helping shape it.

Special gratitude to President Chiang, Dean Raman, Prof. Groll, Head of the School of Mechanical Engineering, Prof. James Krogmeier, Associate Dean for Facilities & Planning, College of Engineering, related Heads of the units, and all of their respective leadership team members for their extraordinary support for the founding MMRL.

Ajay P. Malshe

R. Eugene and Susie E. Goodson Distinguished Professor of Mechanical Engineering

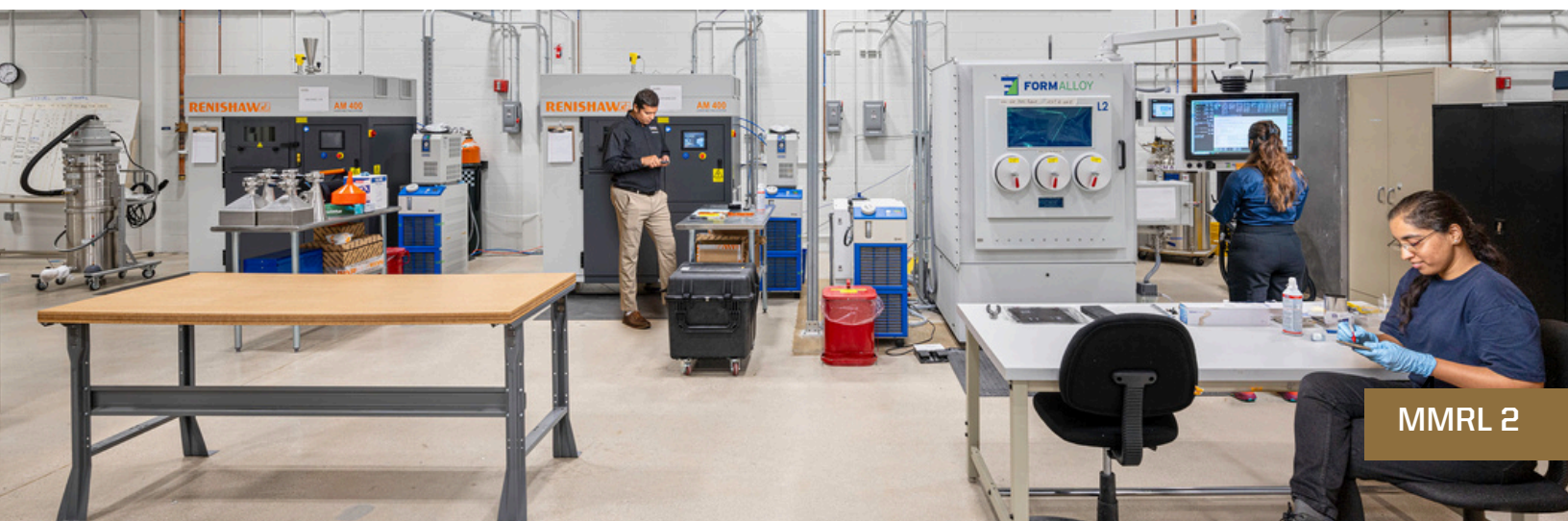
Inaugural Director, Manufacturing and Materials Research Laboratories (MMRL)

Co-Director, eXcellence in Manufacturing and Operations (XMO)

Our calling: *SETTING THE BAR*

MMRL was founded with the resolution that manufacturing is not just an industry but a strategic asset for the nation. At the Manufacturing and Materials Research Laboratories (MMRL), our calling is grounded in a simple but ambitious purpose: to accelerate the future of manufacturing through innovation, collaboration, and education. As a newly established shared-use laboratory, we are building the foundations that will allow MMRL to thrive for decades, foundations that include sustainable revenue streams, strong operational frameworks, and the ability to support faculty, key technical and administrative staff, students, and collaborators who make daily excellence possible.

Our mission extends well beyond basic research. Purdue has long been known for producing world-class engineering talent, and MMRL is expanding that legacy by shaping the next generation of manufacturing practitioners and leaders. We are developing laboratories for translational research and prototyping, interdisciplinary professional and industrial education pathways, executive education programs, and undergraduate education and certificates that tightly integrate theory with hands-on practice. These programs will cultivate professionals who can bridge design, materials, manufacturing processes, automation, data, AI/ML, and human-centered innovation, skills demanded by modern manufacturing and national competitiveness.





Through this integration of education, fundamental and translational research, and real-world engagement, MMRL aims to serve as an innovation and training ground for the workforce and leadership pipelines that industry and government urgently need.

Collaboration is the engine that drives our work. MMRL continues to deepen partnerships with companies, federal agencies, academia, professional societies, and foundations at regional, national, and global scales. By working alongside practitioners and decision-makers, we accelerate technology

commercialization, expand Purdue's intellectual property portfolio, and reduce the time from discovery to deployment.

Our commitment to a collaborative culture also extends inward: we are cultivating a vibrant, inclusive research environment that attracts world-class faculty, research staff, graduate and undergraduate students, and postdoctoral scholars to the Purdue College of Engineering.

Looking ahead, MMRL is positioning itself as a thought leader and competing for large-scale federal research initiatives and to expand sponsored programs in advanced manufacturing, materials, and cyber-physical systems. These opportunities will strengthen Purdue's role as a national leader while ensuring that new technologies, innovations, and workforce pipelines directly support America's commercial and defense resilience for social impact.



FOUNDATION FOR IMPACT

OUR FOUR PILLARS

To build the foundation for lasting impact, the MMRL is focused on four key pillars: **People, Place, Process, and Products**, each essential to our growth and long-term success.





PEOPLE

We are actively staffing the organization, developing technical and leadership talent, and preparing for future expansion. Equally important is cultivating a strong MMRL community of faculty, students, and staff, one that fosters collaboration, mentorship, and shared purpose across disciplines. By investing in people, we strengthen the engine that drives innovation.

PLACE

We are building a state-of-the-art, 30,000-square-foot shared laboratory environment designed

for convergence, collaboration, and rapid experimentation. This space brings together design, integrated manufacturing with multi-materials, robotics, precision instrumentation, including metrology, cyber-physical systems, and applied research capabilities under one roof. Our vision for Place extends beyond facilities. We are creating an accessible, welcoming hub serving Indiana and the nation, where faculty, students, industry partners, and government collaborators can work side-by-side. By shaping an environment that sparks creativity, ensures safety, and supports high-velocity innovation.

MMRL provides the physical and cultural foundation necessary for breakthroughs to flourish at scale for commerce and defense, on Earth and in space.

PROCESS

We are operationalizing MMRL by developing standardized procedures, digital systems, and governance frameworks to prepare us to open to all across Purdue, the state, and the nation as a recharge center. These processes ensure we can support research and education effectively while extending outreach to industry, professional societies, research foundations, and strategic partners. Clear and consistent processes enable us to scale impact without compromising creativity, quality, or safety.

PRODUCTS

We are developing tools, technologies, and research assets that will attract top talent and new opportunities to Purdue, while serving the nation. These innovations expand MMRL's capabilities and reinforce Purdue's role as a national leader in advanced manufacturing for resilience. From novel design, materials, and manufacturing methods to industries (start-ups, small, mid, and large), prototypes, and workforce and thought-leader pipelines, the Products pillar represents the tangible outcomes of our mission.



OUR MISSION

Impacting quality of life
through excellence in
manufacturing.

OUR VISION

In the pursuit of
becoming the most
consequential
manufacturing program.

OUR GOAL

Integrated scholarship,
fellowship, and
leadership at the
intersections of
manufacturing,
materials, and design.



HIGHLIGHTS & MILESTONES

Since its inception in Fall 2023, the Manufacturing and Materials Research Laboratories (MMRL) has advanced rapidly toward its mission of enabling convergent manufacturing research, innovation, and workforce development. In 2024–25, MMRL continued to expand its community, strengthen research capabilities, and lay the groundwork for long-term sustainability.

The organization now includes 26 faculty (core and affiliates), 8 professional staff (core and projects), and more than 70 graduate students, with various programs that have already impacted over 300 undergraduate students.

**Continued growth is
projected through 2026.**



MMRL has two operational laboratories across I-65, **the hard tech corridor**, between Purdue-in-Indianapolis and Purdue-in-West Lafayette.

These two connected locations are functional and grow with the integration of a common purpose driven by faculty, staff, students, and state-of-the-art facilities.



MMRL Indianapolis - 16 Tech



MMRL 9



BRINGING TALENT TOGETHER

As a result of the actions of the past five years, the Manufacturing and Materials Research Laboratories (MMRL) has been purposefully designed as a **faculty-, staff-, and student-focused lab** that values creativity, collaboration, and collegiality as core values.

As a shared resource for researchers from the **Schools of Mechanical Engineering, Materials Engineering, Industrial Engineering, Nuclear Engineering, and Chemical Engineering** within Purdue's College of Engineering, MMRL unites diverse expertise to address complex challenges in manufacturing, materials, and design.

We foster an environment where individuals feel supported, empowered, and encouraged to explore new ideas, an environment where interdisciplinary teams, particularly younger and mid-career faculty, can come together, innovate, and develop.



Through shared facilities, joint research initiatives, and a commitment to inclusive, community-driven engagement, MMRL acts as a unifying ecosystem that nurtures talent, accelerates discovery, and enhances Purdue's leadership in convergent manufacturing.

26


**Faculty
(Core and Affiliates)**

8

**Professional Staff
(Core and Projects)**

More

than
70 graduate students



DEVELOPMENT & DELIVERY OF ADVANCED, APPLIED & ACCESSIBLE INFRASTRUCTURE

From 2023–25, construction and operationalization of the MMRL high-bay facility progressed steadily and remain on schedule for full readiness in 2026. Phases 1a and 1b were completed on time, and Phases 2a and 2b are planned for completion in Q2 2026. The resulting 30,000-square-foot environment supports Convergent Manufacturing with an integrated suite of advanced equipment and supporting facilities, including:

- Two Matsuura Lumex hybrid additive–subtractive machines.

- Three Renishaw metal AM systems (*two in West Lafayette and one in Indianapolis*).

- The Markforged Metal X platform combines Fused Filament Fabrication (FFF) 3D printing and Metal Injection Molding (MIM) technologies.

- Electric discharge machining (EDM).

- Cold spray, shot peening (tabletop and industrial scale), vacuum furnace, and other surface engineering processes.

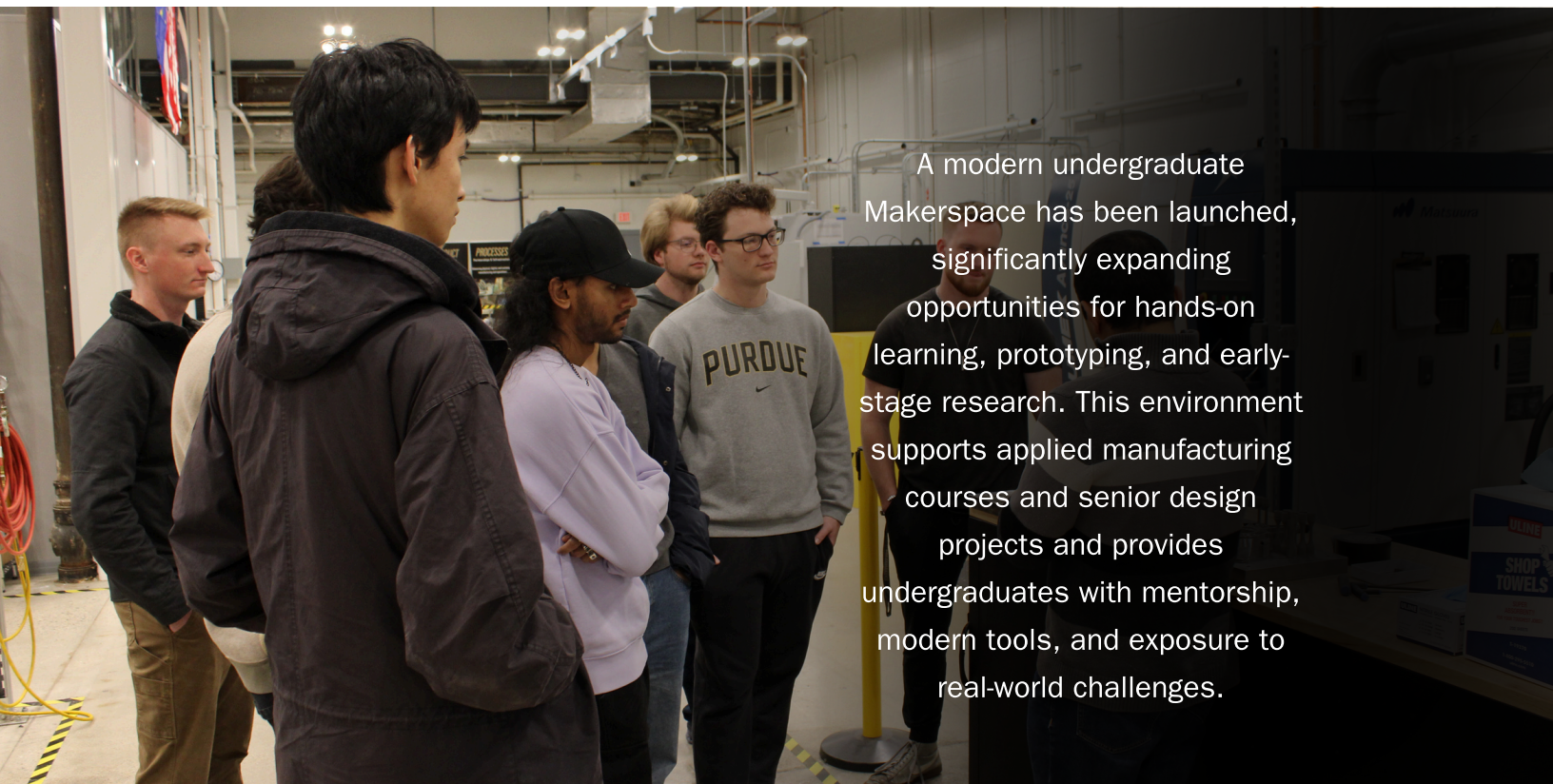
- Autonomous robotic manufacturing processes and integration platforms.

- Facilities for metal powder and feedstock preparation and powder characterization, including particle size, shape, and flowability.

- Comprehensive, destructive and non-destructive testing tools spanning nano- to macro-scale structural, microstructural, stress, and functional characterization.

MMRL's facilities are accessible through the iLab recharge system, supporting users across Purdue, the state of Indiana, and national partners. The laboratories are purpose-built to support basic research, applied and translational projects, prototyping, and industry-government-academia collaboration.

INNOVATION & STUDENT ENGAGEMENT



A modern undergraduate Makerspace has been launched, significantly expanding opportunities for hands-on learning, prototyping, and early-stage research. This environment supports applied manufacturing courses and senior design projects and provides undergraduates with mentorship, modern tools, and exposure to real-world challenges.

For the first time in Purdue's history, metal additive manufacturing is available to undergraduates as a user facility through MMRL, enhancing the competitiveness, creativity, and readiness of Purdue students entering the workforce.

RESEARCH & FUNDING COLLABORATION

MMRL's 15+ faculty hold more than \$20 million in active research funding from government agencies and industry partners. The laboratories have strengthened collaborations across federal organizations, corporate partners, and the Manufacturing USA network, creating pathways to tackle challenges of national significance and accelerate technology development both on Earth and in space.

MMRL now anchors two major research centers and one industrial consortium:

CISM | CENTER FOR
IN-SPACE
MANUFACTURING

The world's first center focused on manufacturing in space, supported by the U.S. Space Force, NASA, private industry, and the NSF.

CORIA THE CENTER OF OPERATION
AND RESEARCH FOR
INDUSTRY ADVANCEMENT

Advancing innovation in semiconductors, batteries, and future mobility through a strategic partnership with the Korea Institute for Advancement of Technology (KIAT) and MOTIE (South Korea).

**Shot Peening
Industrial
Consortium**

CSEE
Center for Surface Engineering
and Enhancement

Uniting industry partners with interests in shot peening to advance related surface engineering capabilities and applications.

EVENTS & PARTNERSHIPS

MMRL-XMO hosted several high-impact events, including the 2024 National Academy of Engineering (NAE) Regional Meeting, which brought together more than 55 leaders from Indiana, the Midwest, Washington, D.C., and beyond. Additional visits from the National Defense University, Army Research Laboratory, U.S. Space Force, Lockheed Martin, and numerous companies, ranging from large corporations to small and mid-sized manufacturers have advanced MMRL's national visibility and strengthened government-industry-university collaboration.

MMRL also hosted its first industrial training workshop focused on the operationalization of additive manufacturing in production environments, supporting workforce development and technology adoption.

Gallery



COMMUNITY OF PARTNERS COLLABORATIONS & SPONSORS

MMRL's community-building infrastructure is now fully active, expanding collaborations well beyond the physical laboratories. MMRL integrates activities of the Indiana Manufacturing Institute (IN-MaC), maintains formal partnerships with Conexus, and has received endorsements from the Society of Manufacturing Engineers (SME) for regional and national initiatives.

MMRL brings the mission of the Indiana Manufacturing Competitiveness Center (IN-MaC) to life by strengthening our state's manufacturing industry and making it more resilient. We accomplish this by transforming fundamental research into practical solutions through applied work, providing cutting-edge facilities to develop new product prototypes, collaborating with Indiana companies of all sizes, and engaging Indiana industries in national programs. Beyond technology, we are committed to supporting people: we offer training for industrial professionals, mentorship for entrepreneurs and new business owners, and leadership programs to cultivate the future workforce. With strong support from the State of Indiana, we are proud to keep Indiana at the forefront of American manufacturing.

Engagement with Manufacturing USA institutes, including America Makes and a growing relationship with NextFlex, underscores MMRL's commitment to applied, translational research and practical impact.





GLOBAL ENGAGEMENT & VISIBILITY

MMRL is solidifying its international presence through strategic partnerships, global thought leadership, and educational exchanges. The laboratories played a pivotal role in hosting the 2023 CIRPe Global Conference, the first time the event was held in the United States, strengthening connections among global academic and industrial communities.

Over the past two years, MMRL faculty have delivered research presentations at major international forums, including the General Assembly of the International Academy for Production Engineering (CIRP), and have hosted delegations from leading institutions in Belgium, France, Germany, India, Japan, and South Korea. These exchanges reinforce Purdue's position as a global hub for convergent manufacturing innovation.



MMRL

2.0 RAISING THE BAR

As we build on the momentum of MMRL 1.0, “**Our Calling: Setting the Bar,**” we now turn with purpose toward **MMRL 2.0**, where we will **Raise the Bar** with a sharper focus on being **savvy, smart, and sustainable** in our continued pursuit of excellence in manufacturing. MMRL was founded on a conviction that manufacturing is not merely an industry but a **strategic national asset**, vital to economic competitiveness, technological sovereignty, and defense resilience, on Earth and in Space. That conviction continues to guide us as we evolve from establishing foundational capabilities to shaping a nationally consequential enterprise.

In MMRL 2.0, we will accelerate our commitment to **innovation, collaboration, and education**, deepening our role as a shared-use, convergent manufacturing laboratory that empowers faculty, staff, students, and partners to do their best work. We will expand capabilities that enable fundamental discovery, translational research, rapid prototyping, and impactful deployment. Our laboratories and programs, spanning advanced manufacturing, materials, design, automation, cyber-physical systems, and AI/ML, will continue to prepare a new generation of practitioners and leaders who can bridge disciplines and deliver solutions at the speed and scale the nation demands.

Our future depends on the strength of our partnerships, and MMRL 2.0 will amplify them. We will continue to work alongside industry, federal agencies, academic collaborators, and professional societies to accelerate technology commercialization, strengthen intellectual property, and shorten the path from lab insight to real-world implementation. Just as importantly, we will sustain a culture that attracts and supports world-class researchers, fosters creativity and collegiality, and builds a community where individuals and teams thrive.

Looking ahead, MMRL will expand its pursuit of large-scale federal initiatives, multi-institutional collaborations, sponsored programs, and endowments that advance U.S. leadership in manufacturing. Through strategic investment, interdisciplinary education, and a commitment to operational excellence, we will elevate Purdue's role as a national hub for breakthrough manufacturing research and workforce development.

MMRL 2.0 is our next chapter, one defined by resilience, relevance, and responsibility. Together with our partners across Indiana, the nation, and the world, we are shaping the future of manufacturing and empowering the people who will lead it.



MMRL

Manufacturing and Materials
Research Laboratories

Address:

2550 Northwestern Ave
West Lafayette, IN 47906

Email us:

mmrl@purdue.edu

Website:

