Technology Transition through Collaborative R&D

Metals Affordability Initiative: A Government-Industry Technical Program

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Department of Defense leadership has challenged the acquisition community to deliver quality technology rapidly and efficiently. In September 2001, then Secretary of Defense Donald Rumsfeld said, "We must recognize … the revolution in management, technology, and business practices … reward innovation and … share information. [Business enterprises] have to be nimble in the face of rapid change or they die. … but governments can't die, so we need to find other incentives for bureaucracy to adapt and improve."

The key thoughts in the above challenge center upon embracing innovation, sharing information, and adapting in order to enable constant improvement. Those same thoughts have been the main tenets of the Metals Affordability Initiative (MAI), a collaborative research and development initiative between the Materials and Manufacturing Directorate of the Air Force Research Laboratory (AFRL/ML) and the metallic materials and product sector of the United States aerospace supply chain. Since its inception in 1999, the MAI consortium has worked dozens of technical projects in a collaborative research environment, enabling an impressive number of technology transitions to impact a wide variety of aerospace systems.

What is the Metals Affordability Initiative?

Metals are a mature but still vital and robust technology area for defense aerospace systems. For example, metals comprise almost three-fourths of turbine engine components and two-thirds of the weight of a typical airframe. Thus, improving the performance of metals and their alloys and addressing cost issues of both in-service and in-acquisition metallic components will have a major impact for a wide array of defense systems. With both cost and performance objectives in mind, AFRL/ML has teamed with a large cross-section of the complete aerospace metals supply chain, including primary metals producers (mills), component manufacturers (forge and casting shops), and original equipment manufacturers (airframe and system integrators and aero-engine manufacturers). The following 17 companies formally joined as the MAI

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Consortium: Boeing, GE, Honeywell, Lockheed Martin, Northrop Grumman, Pratt and Whitney, Rolls-Royce Corporation (OEMs); Brush Wellman, Alcoa Howmet Castings, Ladish Company, PCC Structurals (metallic component manufacturers); and Allegheny Technologies, Carpenter Technologies, Crucible, RMI, Special Metals, Timet (mills/metals suppliers). They work with AFRL/ML to spur technology development that is aimed at improving the performance of metallic components, lowering materials costs, maturing and transitioning innovative computational and manufacturing methods, and refreshing in-service components through the introduction of a wide array of new technologies. Each project tackled by the MAI team requires focused technical plans, defined implementation targets and milestones, and realistic and supportable business cases. The enumeration of these three project features is required at the proposal stage and at every periodic project review.

To date, the consortium has been awarded approximately $40 million of funding and has matched it with about $14 million of cost share, as required under the technology investment agreements that the consortium signed with AFRL. This shared risk stimulates projects that are timely, feasible, and supported by the entire metals value stream.

The sidebar highlights some of the technologies in which MAI has invested and the DoD and NASA systems impacted by those "MAI technologies." The list includes NASA, Navy, and Army systems, since it is in the interest of the Air Force to insert promising technologies whenever opportunities allow. Crossing Service and agency lines is embraced in MAI because this practice reduces insertion risk to Air Force systems whenever acquisition schedules, retrofit plans, etc., permit.

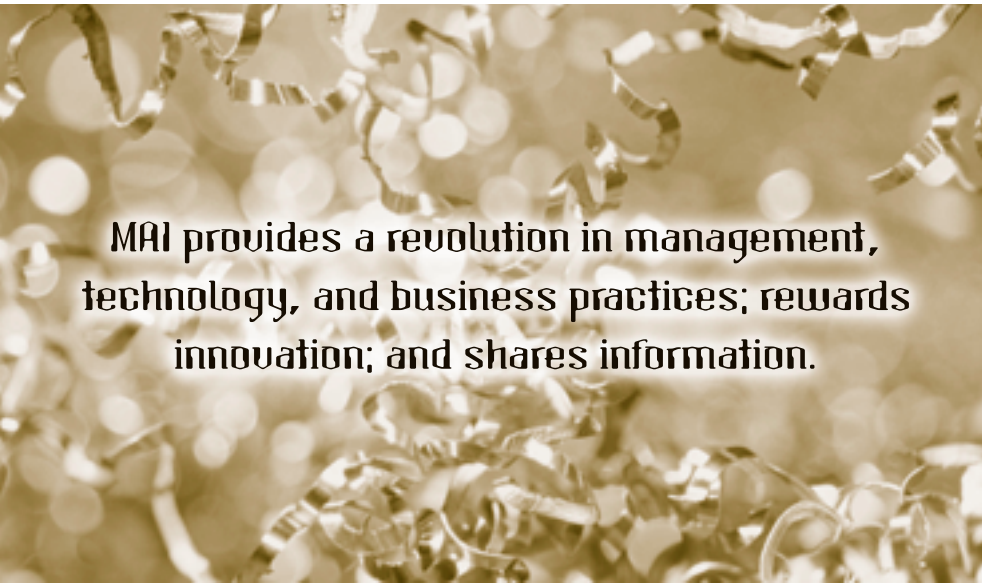
MAI Technologies and the DoD and NASA Systems Impacted

- High-Yield Investment Cast Superalloy Airfoils
  - F135, F136, F108 Turbine Blades
  - F414, AE1107, AE2100, AE3007H, T700, T800 and F100
- Affordable Machining
  - F-15 Wing Tip and Vertical Tail Leading Edge
  - F/A-18 E/F Drag Beam
  - F-22 Keelson and F-35 Weapons Bay Door Hinge
  - C-17 Pylon Panel and Structural Support
  - AE1107, AE2100 and AE3007H Compressor Discs
- Forged Titanium Alloy Modeling
  - F119 Fan Blades and Discs
  - F135, F136 Fan Discs and F-22 Plate Airframe Structure
- Direct Electron-Beam-Melted Titanium Slabs
  - F-15 Vertical Tail and F-15, C-17 Titanium Plate
  - C-40 and P-8 (Navy)
  - F/A-22, F/A-18 E/F, B-2, Global Hawk, JSF, Army Vehicle Armor Plate
- High-Stiffness Aluminum-Beryllium Structures
  - Lockheed Martin XSS-11 Gas Generator Brackets and Solar Array Hinges
  - Mars Reconnaissance Orbiter Brackets and ST5 Sensor Bracket
  - F/A-22 Missile Launch Detector Heat Sinks
  - Boeing Communication Satellite Wave Guides and Tube End Fittings
  - Apache Longbow, F-15 and F-35 Optical Housings
- New Low-Cost High-Temperature Structural Alloy (718Plus)
  - F136 Structural Rings

MAI as a Model of Government-Industry Collaboration

The organization and management of technical projects of 17 companies with common business interests can be challenging, but it is the collaborative nature of MAI that has enabled its impressive array of technology successes. In fact, the management of MAI programs is unique among government research programs. Since the industrial partners have a financial stake in the technology development programs, each company actively engages as part of the unified consortium technical oversight committee that works with the Air Force program manager to assess all projects and help guide the government funding towards efforts with the most tangible and yet greatest potential payoffs. By engaging each consortium member in the management of the technical program, the Air Force reaps the technical benefits of experienced industrial specialists and experts and also exposes technology investments to a wide private-sector audience. In addition to the collaborative and innovative nature of the management of technical efforts, the development and selection of the technical program is also unique and integral to the success of the consortium. There are two types of projects in MAI, and while the development and selection methodology differs for these types, the technical management of the efforts is consistent.

The first type of MAI project is one developed by industrial teams. Subsets of the consortium work together to develop specific technical efforts geared toward near- and mid-term insertion opportunities on any number of DoD systems. These clusters of companies form activity-integrated product teams (AIPTs) and compete against other AIPTs for funds made available to the consortium. The entire consortium then reviews all proposed efforts by all AIPTs and, under Air Force leadership, jointly chooses a technology portfolio with the greatest performance, cost, and schedule payoff potential to the DoD.



For example, a nickel casting technology worked between PCC Structurals, Allegheny Technologies, and GE under MAI might compete with a cost-saving titanium forging technology concept proposed by Ladish, Timet, Pratt and Whitney, Rolls-Royce, and Northrop Grumman. All proposals will be reviewed thoroughly by the Air Force and the entire consortium (including such competitors as Alcoa Howmet, Lockheed Martin, Boeing, RMI, and Honeywell).

Let's extend this hypothetical example and assume the consortium chose to fund the nickel casting technology rather than the titanium forging technology. Those technological advances made by the PCC-Allegheny Technologies-GE team are the intellectual property of that team, but their competitors are exposed to the technology. Since the competitors actively review and critique the technical project, it is clear that they will understand technical and business risks in a far more detailed manner than comes from reading a normal technical report resulting from a typical government research contract awarded under the limits of Federal Acquisition Regulation. Thus, the Air Force benefits from the depth of industrial expertise, while ensuring technology advances are distributed across the domestic metals supply chain.

The second type of MAI project is one developed in response to longer-term challenges that will enable future Air Force mission capabilities. In this case, the Air Force MAI program manager will present specific metals technology challenges to the consortium in a workshop environment. With the government priorities in hand, the consortium—as in the first type of MAI project—forms AIPTs in response to the Air Force long-term challenges. The Air Force program manager then picks those proposed efforts that best match long-term roadmaps and needs, and funds specific project teams. While the generation and selection of these projects is slightly different, the MAI technical community again participates in reviews of those longer-term efforts to increase the likelihood of pervasive technology transition. Further, while the business-case development and implementation paths are more speculative for these longer-term efforts, there is obvious benefit in anchoring needed future technologies across larger cross sections of the domestic metals value stream.

Collaboration as Enabler for Technology Transition

MAI has structured itself to enable a unique collaborative environment with an impressive array of technology transitions that speaks for itself. Some reflection on the relationship between collaboration and transition is warranted with the following question in mind: How has the collaboration in MAI made technology transition possible? We've outlined the merits of the collaborative environment for the Air Force—sustained access to industrial technical experts and a regular forum (MAI convenes meetings every quarter) for communicating government investments to a broad cross section of the value stream. While these are undeniably beneficial, the collaboration between the industrial members of MAI is the ultimate key to the consortium's success. The benefits of company-to-company interaction are manifest in several ways.

MAI provides an environment for metals vendors and suppliers to meet with and understand the needs of their customers. Unlike the often difficult superior-subordinate relationship that the typical business situation might produce, the interaction in MAI allows the lower tiers of the value stream to interact with their customers as technologists, on more neutral and collegial turf. This type of interaction is invaluable in creating high-performing teams focused on high-payoff solutions to problems. As technologists, AIPTs can work chiefly on technical aspects of problems, while allowing the Air Force to adjudicate on the business and implementation aspects of projects that the technical teams develop.

Likewise, MAI also provides a forum for industry to have some insight into the technology plans of their competitors. This benefit has many aspects to it. For example, the MAI consortium has three major aerospace casting companies as part of its membership: PCC, Alcoa-Howmet, and PCT (a subsidiary of Ladish). Casting technologies or advances made with MAI funding by one of these companies are brought to the attention of the others, allowing the technological bar to be continually raised at all three. Similarly, advances made in new-process technologies, like laser-additive manufacturing, are brought

into competition with more traditional processes, like forging and casting. The advent of emerging technologies either challenges those established businesses to improve their core technologies or to incorporate the new technology with their traditional processes to build new hybrid concepts that have unique system benefits.

Finally, MAI gives the technical community a place to discuss and develop technologies that best pay off when applied across the broad community. The best example of this type of pre-competitive technology is modeling and computational methods. The consortium has the ability to work collectively on models and tools and configure the tools such that they are applicable to a wide variety of issues and viable across a number of corporate technical architectures. The list of MAI technologies in the sidebar on the previous page includes modeling efforts that have been worked by and impact the majority of the consortium membership.

It might be argued that the benefits highlighted above resulting from MAI collaboration would occur naturally in the competitive free market anyway. Even if this supposition proved to be true, there is little doubt that the MAI consortium accelerates the advantages and allows them to take place in a forum that pays off directly for DoD.

Collaboration: Next Steps

The technology transitions of MAI have impacted a wide variety of fielded and in-acquisition systems. These transitions are noteworthy but have focused largely on Air Force systems. While this is the expected result of an AFRL-led initiative, it is clear that return on investment and transition opportunities will expand with the incorporation and the presence of program management from other Services and agencies. A logical next step for MAI will be for AFRL to invite government partnership in MAI. For example, if Army and Navy technical priorities are included in the long-term challenge workshop and then ultimately funded and managed by those Services with the added technical oversight of the consortium, then the domestic metals value stream is certain to be even further strengthened.

Clearly MAI provides a revolution in management, technology, and business practices; rewards innovation; and shares information. Continuing to utilize the consortium with the goal of expanding its impact fits within the strategic thrust of former Secretary Rumsfeld's vision. The DoD and the domestic metals infrastructure will both be beneficiaries of such action.

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"Korea's Best" continued from page 11.

The Foreign Comparative Test Program scours the world for the best equipment possible to meet our warfighters' requirements.

angle of attack—again without a hint of hesitation or complaint.

I returned to base, flying a precision radar instrument approach. Although I hadn't flown anything in five years (other than one T-50 simulator sortie the day before), I found the approach a breeze to accomplish. The T-50's directional and speed stability on approach proved impeccable, making even a rusty old aviator look like a hero.

After the flight, I engaged in a discussion of my T-50 experience with Hui Man "He-Man" Kwon—a U.S.Air Force Test Pilot School graduate and KAI's chief test pilot—and Kang. I asked Kwon about the lack of buffet at low speed/high angle of attack/high pitch rate conditions. He indicated that KAI had worked hard to eliminate any hint of buffet during the flight test program. He agreed with my assessment of the T-50's unassailable directional stability and enhanced control authority throughout its envelope, especially at low speed, stating that the larger control surfaces and vertical tail area keep the aircraft stable and yet responsive under all flight conditions.

The T-50 truly earns its title as a Golden Eagle. President Roh, KAI, and the Korean people may be rightly proud of this achievement. The Republic of Korea Air Force's gracious offer to me to be the first U.S. military pilot to fly the T-50 honors me beyond words. I found the design, manufacturing quality, assembly, performance, and handling qualities of the Golden Eagle to be world-class.

Given the demonstrated advanced state of the Republic of Korea's engineering and production capabilities, we in the Comparative Testing Office look forward to the Republic of Korea's industry proposals targeted at meeting our pressing warfighter requirements. And Korea's participation in the Dubai Air Show and active pursuit of contracts for the supersonic T-50 in Greece and the United Arab Emirates clearly demonstrate their intent to up the ante in the international defense aviation market.

The author welcomes comments and questions. Contact him at bob.mattes@osd.mil. For more information on the Foreign Comparative Test Program, visit <www.acq.osd.mil/cto/>.