Louisiana Master Plan Research Advisory Committee (MPRAC)

Advanced Materials and Manufacturing (AM&M) Task Force

AM&M Task Force Report to MPRAC and the Louisiana Board of Regents

October 31, 2014

Address questions or correspondence to:

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MPRAC Task Force Report on Advanced Materials and Manufacturing
October 31, 2014

Preamble

Just this month (October, 2014), the United States President's Council of Advisors on Science and Technology (PCAST) has issued a report* to the President entitled *Accelerating U.S. Advanced Manufacturing* authored by their Advanced Manufacturing Partnership 2.0 Steering Committee. The entire PCAST report is informative and consistent with the federal priorities upon which this Task Force report is based. However, three specific components of the PCAST report merit highlighting, because they reinforce specific themes that will be echoed throughout this MPRAC Task Force report:

- *Recommendation #3:* Establish a new public-private manufacturing research and development infrastructure to support the innovation pipeline, which complements Manufacturing Innovation Institutes at earlier and later technology maturation stages, through the creation of manufacturing centers of excellence (MCEs) and manufacturing technology testbeds (MTTs) to provide a framework that supports manufacturing innovation at different stages of maturity and allows small and medium-sized enterprises to benefit from these investments.

- *Recommendation #4:* Develop processes and standards enabling interoperability of manufacturing technologies; exchange of materials and manufacturing process information; and certification of cybersecurity processes for developers of systems.

- *Highlighted as a major component in support of Recommendation #4:* Establishing and Supporting the National Network for Manufacturing Innovation (NNMI):

Louisiana stands poised to play a major role in the nation's resurgent manufacturing sector. And Louisiana's research universities have already made significant investments in the scientific and engineering fields necessary to support that role. Nonetheless, additional coordination and investment will be required to ensure that Louisiana can take its place as a national leader in advanced materials and manufacturing—securing great economic and social benefits to our current and future citizenry. This Task Force report is intended to identify priority directions for such growth and investment.

*The PCAST report is available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/PCAST/amp20_report_final.pdf.

MPRAC Task Force Deliberation and Report

The Task Force on Advanced Materials and Manufacturing (AM&M) is pleased to submit its recommendations for research strategies for the State of Louisiana to advance research, innovation, and economic development in areas of advanced materials and manufacturing. This report summarizes the charge of the committee, the overarching recommendations (that would impact research, technology development and transfer, and workforce development), and the specific high priority recommendations in the domain.

As with the other MPRAC Task Forces, the AM&M Task Force was asked to recommend investments and funding priorities/targets which would advance research, innovation, and economic development agendas in Louisiana related to our specific area of focus. The AM&M Task Force leaders (1) engaged members with expertise in the field of materials and manufacturing; (2) engaged LED personnel who have responsibilities in the target area; (3) identified priorities and targets based on previous efforts and insights (e.g., the Battelle report from 2013; the work of this Task Force in fall of 2013); and (4) identified major university-based assets and role-players in advanced materials and manufacturing within Louisiana.

Advanced Manufacturing and Materials (AM&M) Task Force Members:

- Kenneth Sewell, University of New Orleans, Leader
- Stan Napper, Louisiana Tech University, Co-Leader
- Michael Khonsari, Board of Regents and Louisiana State University
- Michael Stubblefield, Southern University Baton Rouge
- Ramu Ramachandran, Louisiana Tech University
- Ward Plummer, Louisiana State University
- Ahmed Khattab, University of Louisiana Lafayette
- Leonard Spinu, University of New Orleans
- Jenee Slocum, Louisiana Economic Development
- Michael Pernisi, Louisiana Economic Development
- Les Guice, Louisiana Tech University (*ex officio* involvement as MPRAC Chair)

The AM&M Task Force report utilized the template requested by the Board of Regents (see Appendix), and identified priority research, commercialization, and workforce development areas as well as action-oriented strategies for State investment. Recommendations include short-term (less than one year) and intermediate (1-3 year) strategies, and address Research Strategies (RS), Technology Transfer and Commercialization Strategies (TTC), and Workforce Development Strategies (WD). During the course of the Task Force deliberations, a large number of potential strategies were identified and discussed. After group discussion, a prototypical analysis approach was utilized by the Task Force to identify the highest priority recommendations. Thus, recommendations in the final report represent those viewed as the highest priorities collectively by the Task Force members. All members participated in at least one common conference call, and had opportunity to recommend additional initiatives or to modify those under discussion.

Overarching Recommendations

Three recommended strategies were considered to impact all three sections of the report equally (RS, TTC, and WD), so they were listed at the beginning of the report and dubbed ***overarching recommendations***. These three recommendations are related and emphasize inter-institutional collaboration, resulting in a network of resources throughout Louisiana that could dramatically increase the competitiveness of the State for major center funding (such as the National Network for Manufacturing Innovation program). These recommendations also leverage prior investments in statewide collaborations such as the Louisiana Optical Network Initiative, the NSF-funded Louisiana Simulation Guided Materials Analysis, and investments on individual campuses. If implemented

individually or in combination, these efforts would synergistically catalyze all three of the desired outcomes (research advancement, technology transfer/commercialization, and workforce development) within this domain.

First, the Task Force strongly recommends linking existing university-based or university-affiliated laboratories, centers, and institutes relevant to advanced materials and manufacturing under an umbrella networked organizational structure. To make such a network effective, a seamless and uniform contracting vehicle would need to be constructed (and permitted under State regulations) to allow industry users to access the facilities for R&D partnerships, specific testing protocols, prototype development, systems analysis, and other partnered uses. Predictable fees and contracting processes would afford potential industry users a single point of initiation and execution, regardless of what facility within the network is being utilized. This network would also provide a coordinated "front door" to the State's academic resources in this sector, which would then allow effective marketing and relationship management with industry. Finally, this network would provide a formidable platform to build inter-university collaborations in pursuit of large, multi-institutional center grants. Establishing such a network in an effective manner would require substantial seed funding to staff the infrastructure and to initiate the necessary institutional and statewide policy/regulation/statute changes. Given the nature of the regulatory accommodations required, substantial legislative support would be needed to allow private, fee-based utilization of facilities within state-owned buildings, uniform procurement processes, and streamlined (boiler-plated) contracting processes.

Secondly, the Task Force sees great potential benefit to the State in linking existing university-based or university-affiliated laboratories, centers, and institutes relevant to advanced materials and manufacturing *electronically* to create a ***Louisiana Advanced Manufacturing Network Initiative*** (LAMNI)—a virtual super-center of advanced materials and manufacturing. Such a virtual super-center would leverage the State's LONI supercomputing network to create a number of electronic AM&M laboratories across Louisiana, from which all of the linked facilities could be accessed, observed, and even operated (via integrated remote computing technologies). Each research university within the State might have one or more such electronic AM&M labs, but key industry partners might invest in building such access-points at the industry site as well. LAMNI would provide a convenient and cost-effective way to facilitate inter-university and industry-academia collaborations in pursuit of large, multi-institutional center grants. Building LAMNI would require substantial seed and maintenance funding to build the electronic infrastructure into the existing laboratories, centers, and institutes, to maintain that infrastructure, and to construct, staff, and maintain LAMNI. As LAMNI would likely be the first of its kind nationally, it would provide a powerful marketing tool for the State's attraction of companies in the sector, and to recruit top students and faculty into the academic programs that would access and utilize LAMNI. Successful execution of this initiative can become a model for many other statewide priorities to follow.

The third over-arching strategy strongly recommended by the Task Force is to create and fund a statewide cluster-hire initiative that would bring a mix of senior and junior faculty in areas relevant to this sector to Louisiana universities, so that the State can compete more effectively for future National Network for Manufacturing Innovation (NNMI) institute announcements. The original federal NNMI plan has been expanded to add up to 45 institutes. Only three have been created so far. Adding critical mass in this area would significantly enhance the likelihood that a Louisiana-led NNMI proposal would be successful. In addition to increasing the research productivity and State competitiveness in

this sector, additional faculty expertise will boost the size and quality of academic programs related to materials and manufacturing such as chemistry, physics, materials science, and a variety of engineering disciplines.

As mentioned at the outset, the above three overarching initiative recommendations are neither mutually exclusive nor mutually interdependent. If any of these initiatives are implemented effectively, highly positive outcomes are very likely to bear fruit. However, if any two—or optimally all three—of these strategies are realized, the positive impacts could, in fact, be multiplicative rather than merely additive; the combination would establish Louisiana as a true leader in linking academic resources in service of the advanced materials and manufacturing sector.

Three Major Priorities: Topical/Content Emphases within the Domain

In addition to the overarching recommendations, the Task Force Identified three topical/content areas within the broader domain of advanced materials and manufacturing that represent the greatest strengths and potential for growth, excellence and commercialization at Louisiana's research universities: Polymers and Composite Materials; Biomaterials; and Metals Manufacturing and Materials. These three focal areas are discussed individually below.

Polymers and Composite Materials. Louisiana has made considerable investment in research infrastructure in advanced materials and manufacturing, as identified in the Battelle report, and summarized in the attached Task Force report (see the sections on Key Participants, and Existing and Prospective Strengths). The industrial base in the State includes a variety of chemical processing facilities, with more capital investment coming, especially in energy related industries. Many of the research projects in the LaSIGMA consortium relate to polymers and composite materials, and many of the academic institutions have strengths in designing, producing, and analyzing these types of materials. The National Center for Advanced Manufacturing has some specialized large-scale equipment to support this type of research and development.

Biomaterials. Louisiana has not developed a significant biomaterials industry, but has made significant investments in research activities that will lead to commercializable technology. Wet lab incubators in New Orleans (Louisiana Bioinnovation Center) and Shreveport (Biospace 1) provide unique facilities for biotechnology companies to continue development. The newly re-formed Louisiana Biotechnology Industry Organization (BIO) provides a network of small business and larger industry connections to support the development of a biomaterials industry. The LSU Health Sciences Centers in New Orleans and Shreveport include research projects that yield new knowledge and technology related to biomaterials, as do many of the State's research universities. Louisiana has also developed a number of venture funds to support biotechnology startup companies (e.g. Louisiana Fund, MediFund, and the New Angel Fund of the Biomedical Research Foundation of Northwest Louisiana).

Metals Manufacturing and Materials. Louisiana has made considerable investment in research infrastructure in advanced materials and manufacturing, as identified in the Battelle report, and as summarized in the attached Task Force report (see the sections on Key Participants, and Existing and Prospective Strengths). The industrial base in the State includes a variety of metals manufacturing and

forming facilities; e.g. Benteler Steel, Haynes International. Many of the research projects in the LaSIGMA consortium relate to metals, and many of the academic institutions have strengths in designing, producing, and analyzing these types of materials. A number of universities in Louisiana combined in 2013 to compete for one of the National Institutes of Manufacturing Innovation, for which the topic was Light Weight Materials Manufacturing. This proposal reached the final two before another consortium was selected in early 2014. Nevertheless, significant momentum in this exciting field of R&D has been generated in Louisiana. In fact, a five-year, $20M research infrastructure improvement proposal in the area of metal manufacturing and advanced material is currently pending at NSF EPSCoR for funding consideration. Furthermore, in collaboration with industry, this multidisciplinary and multi-institutional initiative will have significant broader educational impact across the State.

Focal Strategy Recommendations

The Task Force identified a number of immediate and short-term ***focal*** strategies to promote research advancement, technology transfer/commercialization, and workforce development in this arena. These focal recommendations are described in greater detail in the Appendix, and are merely listed below.

- Research Strategies
  - Develop a rewards system to encourage industry-funded R&D in addition to federal funding
  - Develop signature facilities and capabilities for the development and testing of advanced and intelligent manufacturing research & development related to manufacturers' needs and the national manufacturing agenda
  - Offer seed grants and grant-writing funding support to promote Louisiana universities pursuing federally funded industry-university research centers (e.g., NSF Industry-University Cooperative Research Centers [I/UCRCs])
  - Create campus-based "Experimentation Stations" in which experienced former industry and government personnel, funded on soft money, can collaborate with existing faculty to build industry-sponsored R&D

- Technology Transfer and Commercialization Strategies
  - Develop a statewide translational research and pre-commercialization fund to enhance faster prototyping and other means of commercializing university research
  - Create, resource, and publish a statewide or region-by-region database of service providers with expertise and experience working with entrepreneurs and serial entrepreneurs, and then market those services

- Workforce Development Strategies
  - Create incentives and tools to spur industry-university collaborations to establish experiential learning opportunities in emerging growth sectors to increase the number of graduates with real-world skills
  - Develop a comprehensive strategy for leveraging advanced manufacturing sector research and innovation assets to maximize sector-related job growth, funding, and federal research center development

- Develop faculty professional development programs with industry to create curricula and credentials that reflect current trends within the advanced materials and manufacturing sector
- Incentivize universities, the Louisiana Community and Technical College System, and economic development organizations to create industry-educational liaison positions and implement comprehensive training programs for university economic development and corporate relations officers

Louisiana's research universities have a variety of strengths and assets related to these potential initiatives; many such strengths and assets are listed in the Appendix in association with each domain. So resourcing and implementing any or all of these strategies would not be starting from ground zero; rather, the investments and efforts already in place within the State can be leveraged with additional investments to make Louisiana a front-runner in this critical and growing sector.

APPENDIX
MPRAC Task Force Report on Advanced Materials and Manufacturing
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Overarching Recommendations

	Short-term (<1 year)	Intermediate (1-3 years)	Long-term (3-5+ years)
A Overarching Recommendations that would Impact Research, Technology Development/Transfer, and Workforce Development	**OA1.** *Link existing university-based or university-affiliated laboratories, centers, and institutes relevant to advanced materials and manufacturing under an umbrella* **networked** *organizational structure and devise a seamless and uniform contracting vehicle to allow industry users to access the facilities for R&D partnerships, specific testing protocols, prototype development, systems analysis, etc.* • Cost analysis, fee schedules, and contracting processes coordinated such that potential industry users have a single point of initiation and a single process for contract execution, regardless of what facility within the network is being utilized. • Would provide a coordinated "front door" to the state's academic resources in this sector, which would then allow effective marketing and relationship management with industry. • Would provide a formidable platform to build inter-university collaborations in pursuit of large, multi-institutional center grants. • Would require substantial seed funding to staff the infrastructure and to initiate the institutional and statewide policy/regulation/statute changes that would be needed. • Would require substantial legislative support—in particular to allow: o Uniform allowance of private, fee-based utilization of facilities within state-owned buildings		***The Task Force recommends that these initiatives be implemented in the short-/intermediate-term timeframes; if implemented, they should yield significant long-term results and benefits.***

	Short-term (<1 year)	Intermediate (1-3 years)	Long-term (3-5+ years)
	- Uniform procurement processes - Streamlined (boiler-plated) contracting processes **OA2.** *Link existing university-based or university-affiliated laboratories, centers, and institutes relevant to advanced materials and manufacturing* electronically *to create the Louisiana Advanced Manufacturing Network Initiative (LAMNI)—a* **virtual super-center** *of advanced materials and manufacturing.* - Leverage the LONI supercomputing network to create a number of electronic AM&M laboratories across the state, from which all of the facilities within the virtual super-center can be accessed, observed, and even operated (via integrated remote computing technologies). - Each research university might have one or more such electronic AM&M labs, but key industry partners might invest in building such access-points on-site for industry partner. - Would provide a convenient and cost-effective ways to facilitate inter-university collaborations in pursuit of large, multi-institutional center grants. - Would require substantial seed and maintenance funding to build the electronic infrastructure into the existing laboratories, centers, and institutes, to maintain that infrastructure, and to construct, staff, and maintain LAMNI. - Would provide a powerful marketing tool - For the state's attraction of companies in the sector, as this network would likely be the first of its kind nationally. - To recruit top students and faculty into the academic programs that would access and utilize the network LAMNI.		

	Short-term (<1 year)	Intermediate (1-3 years)	Long-term (3-5+ years)
	OA3. *Create and fund cluster-hire initiative to bring a mix of senior and junior faculty in areas relevant to advanced manufacturing to Louisiana universities, so that the State can compete more effectively for future National Network for Manufacturing Innovation (NNMI) institute announcements.* • The original federal NNMI plan has been expanded to add up to 45 institutes. Only 3 have been created so far. Adding critical mass in this area would greatly enhance the likelihood that a Louisiana-led NNMI proposal would be successful. • This program could also include state-wide hiring in the cluster of "Integrated Computational Materials Engineering" (ICME). • In addition to increasing the research productivity and state competitiveness in this sector, additional faculty expertise will boost the academic programs (enrollment, quality) related to materials and manufacturing (chemistry, physics, materials science, engineering, etc.) • If we attract and retain the right kind of talent in these disciplines to Louisiana universities, the State should benefit greatly from future national investments in materials and manufacturing. ***NOTE: The above three overarching initiative recommendations—although conceptually integrated around coordinate our efforts across the state administratively, electronically, and intellectually—are neither mutually exclusive nor mutually interdependent. If any were implemented, we would anticipate very positive outcomes. However, if two or three were implemented, the impact could be multiplicative rather than merely additive—as the combination would establish Louisiana as a true leader in linking academic resources in service of the advanced materials and manufacturing sector.***		

	Short-term (<1 year)	Intermediate (1-3 years)	Long-term (3-5+ years)
A* Identification of Key Participants	Board of Regents Universities & University Systems University Foundations/R&T Parks Industry Partners State Legislature/Governor		
B Existing and Prospective Strengths which Support 1.A Strategies, Initiatives, Outcomes	LSUAG - Materials & Chemicals from Biobased Materials LSUBR - Materials Science & Engineering; Conventional & Renewable Energy; Core Computing/High Performance Computing; Center for Advanced Microstructures and Devices (CAMD), Center for Computation and Technology (CCT), Materials Characterization Center (MCC), Center for Rotating Machinery (CeRoM). LaTech – Institute for Micromanufacturing, Center for Applied Physics Studies, Trenchless Technology Center , Interdisciplinary PhD Programs in Biomedical Engineering, Computational Analysis and Modeling, Engineering, and Molecular Science and Nanotechnology Loyola - Materials Science and Spectroscopic Analysis SUBR - Advanced Materials & Nanotechnology Tulane - Materials Science; Health-Related Research TUHSC - Cancer Biology & Treatment Innovation; Environmental Health; Sustaining Health & Wellness; Infectious Disease Prevention & Treatment; Chronic Disease & Novel Therapeutic Approaches UL Lafayette - Institute for Materials Research and Innovation includes (Louisiana Accelerator Center, Center for Structural and Functional Materials, Microscopy Center, Laboratory for Composite Materials, Structural Engineering and Materials Laboratory, Biomedical Materials Laboratory); Energy Institute, Louisiana Immersive Technologies Enterprise, Center for Advanced Computer Studies, and Center for Business and Information Technologies ULM - Biomedical & Healthcare Advancements; Agricultural, Biological and Environmental Advancements UNO - Advanced Materials Research Institute; Naval Architecture & Marine Engineering; Power and Energy Research Laboratory Xavier - Nanomedicine & Drug Delivery; Materials Science LSU and UNO – National Center for Advanced Manufacturing (housed at NASA's Michoud Assembly Facility)		
B* Identification of Key Participants	Universities & University Systems University Foundations/R&T Parks Industry Relationships		

Section 1. Research Strategy Recommendations

1.A Research Strategies, Initiatives, Outcomes	**RS1.** *Develop a rewards system to encourage industry-funded R&D in addition to federal funding* • LED, the Board of Regents and other government entities develop incentives to promote commercializable R&D	**RS2.** *Develop signature facilities and capabilities for the development and testing of advanced and intelligent manufacturing research & development related to manufacturers' needs and the national manufacturing agenda* • Establish partnerships with regional manufacturers interested in supporting facility development **RS3.** *Offer seed grants and grant-writing funding support to promote Louisiana universities pursuing federally funded industry-university research centers (e.g., NSF Industry-University Cooperative Research Centers [I/UCRCs])* • Identify and develop campus-based and statewide funding for substantial proposal development seed grants • Campuses keep on retainer external proposal development consultants to	***All relevant strategies are recommended by the Task Force to be implemented in the short-/intermediate-term timeframes, but should be expected to yield long-term results and benefits.***

		provide feedback to faculty **RS4**. *Create campus-based "Experimentation Stations" in which experienced former industry and government personnel, funded on soft money, can collaborate with existing faculty to build industry-sponsored R&D*	
1.A* Identification of Key Participants	Board of Regents Universities & University Systems University Foundations/R&T Parks Industry Partners State Legislature/Governor		
1.B Existing and Prospective Strengths which Support 1.A Strategies, Initiatives, Outcomes	LSUAG - Materials & Chemicals from Biobased Materials LSUBR - Materials Science & Engineering; Conventional & Renewable Energy; Core Computing/High Performance Computing; Center for Advanced Microstructures and Devices (CAMD), Center for Computation and Technology (CCT), Materials Characterization Center (MCC), Center for Rotating Machinery (CeRoM) LaTech - – Institute for Micromanufacturing, Center for Applied Physics Studies, Trenchless Technology Center , Interdisciplinary PhD Programs in Biomedical Engineering, Computational Analysis and Modeling, Engineering, and Molecular Science and Nanotechnology Loyola - Materials Science and Spectroscopic Analysis SUBR - Advanced Materials & Nanotechnology Tulane - Materials Science; Health-Related Research TUHSC - Cancer Biology & Treatment Innovation; Environmental Health; Sustaining Health & Wellness; Infectious Disease Prevention & Treatment; Chronic Disease & Novel Therapeutic Approaches UL Lafayette - Institute for Materials Research and Innovation includes (Louisiana Accelerator Center, Center for Structural and Functional Materials, Microscopy Center, Laboratory for Composite Materials, Structural Engineering and Materials Laboratory, Biomedical Materials Laboratory); Energy Institute, Louisiana Immersive Technologies Enterprise, Center for Advanced Computer Studies, and Center for Business and Information Technologies ULM - Biomedical & Healthcare Advancements; Agricultural, Biological and Environmental Advancements		

	UNO - Advanced Materials Research Institute; Naval Architecture & Marine Engineering; ; Power and Energy Research Laboratory Xavier - Nanomedicine & Drug Delivery; Materials Science LSUAG and UNO – National Center for Advanced Manufacturing (housed at NASA's Michoud Assembly Facility
1.B* Identification of Key Participants	Universities & University Systems University Foundations/R&T Parks Industry Relationships

Section 2. Technology Transfer and Commercialization Strategy Recommendations

2.A Technology Transfer and/or Commercialization Strategies, Initiatives, Outcomes	**TTC1.** *Develop a statewide translational research and pre-commercialization fund to enhance faster prototyping and other means of commercializing university research* • Identify a funding source that could provide funds on a fast turnaround for building prototypes • Create policies to provide academic rewards to faculty undertaking tech transfer • Conduct cost-benefit analyses of potential tech transfers in parallel with research/technology development	**TTC2.** *Create a statewide or region-by-region database of service providers with expertise and experience working with entrepreneurs and serial entrepreneurs, and then market those services* • Establish statewide website linking all academic assets and research expertise by research area • Support universities in hiring an industry-academia liaison to help build relationships between researchers and potential users of developed technology	***All relevant strategies are recommended by the Task Force to be implemented in the short-/intermediate-term timeframes, but should be expected to yield long-term results and benefits.***

2.A* Identification of Key Participants	Board of Regents Universities & University Systems University Foundations/R&T Parks Industry Partners LED State Legislature/Governor
2. B Existing and Prospective Strengths which Support 2.A Strategies, Initiatives, Outcomes	Campus-based Technology Transfer and Commercialization Offices LED's Playbook for Economic Development in Higher Education Industry-University Relationships
2.B* Identification of Key Participants	Universities & University Systems University Foundations/R&T Parks Industry Partners LED

Section 3. Workforce Development Strategy Recommendations

3.A Workforce Development Strategies, Initiatives, Outcomes	**WD1.** *Create incentives spurring industry-university collaborations to establish experiential learning opportunities in growth sectors to increase the number of graduates with real-world skills* • Develop websites and tools related to industry/academia collaborations that might facilitate internships or other experiential learning • Consider creation of online courses for industry personnel seeking professional development or additional education in their field of employment	**WD4.** *Incentivize universities, community colleges, and economic development organizations to create respective industry and educational liaisons and implement training programs for economic development and corporate relations officers* • Engage experienced professionals who have served for several years in industry R&D to serve as *professionals-in-residents* or *professors of practice* • Pursue larger private investment	***All relevant strategies are recommended by the Task Force to be implemented in the short-/intermediate-term timeframes, but should be expected to yield long-term results and benefits.***

	WD2. *Develop a comprehensive strategy for leveraging advanced manufacturing sector research and innovation assets to maximize sector-related job growth, funding, and federal research center development* • Identify needed investments in existing capacity and pockets of excellence that would advance current standing quickly • Pursue funding sources to address needs **WD3.** *Develop faculty professional development programs with industry to create curriculum that reflects current trends within advanced manufacturing & materials* • Build on similar activities already underway in Louisiana • Modify the traditional academic reward system to encourage faculty participation • Consider development of an industrial master's degree program	in business incubators located at Louisiana universities	
3.A* Identification of Key Participants	Board of Regents Universities & University Systems University Foundations/R&T Parks		

	Industry Partners LED LWC State Legislature/Governor
3.B Existing and Prospective Strengths which Support 3.A Strategies, Initiatives, Outcomes	Coordinated oversight of STEM workforce development initiatives evolving at many universities, in part as a positive response to LED's Playbook
3.B* Identification of Key Participants	Universities & University Systems LED