The Digital Manufacturing Institute

MxD REQUEST FOR PROPOSAL

TECHNICAL SUMMARY, PROGRAM OVERVIEW and PROPOSAL PREPARATION INFORMATION

MxD-20-18-02:

Capacity and Mobilization: Digital Twin Virtual Commissioning Scenarios

Revision 1.3 Release Date: May 18, 2023

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I. RECORD OF CHANGE

Revision	Date	Sections	Description
1.0	15 Nov, 2022	N/A	Original
1.1	8 Dec, 2022	Overview	Submission date extended to 1/12/2023
1.1	12 Jan, 2023	Overview	Submission date extended to 2/2/2023
1.2	17 Apr, 2023	Several	Re-released with updated requirements
1.3	18 May, 2023	Network, Facility, & General Requirements	Re-released with updated requirements for specific cybersecurity features to be addressed.

II. PROJECT OVERVIEW

Project Type	CARES Act/BioFab TIA Project
RFP Released	15 November, 2022
Team Formation List	Updated on Rolling Basis
Technical and Cost Proposal Due	May 25, 2023
Anticipated MxD Funding	$750,000
Minimum Cost Share Amount	$750,000 or requested funding amount, whichever is lower
Period of Performance	12 Months

III. INTRODUCTION

MxD: The Digital Manufacturing Institute is where innovative manufacturers go to forge their futures. In partnership with the Department of Defense, MxD (also referred to as the Institute) equips U.S. factories with the digital tools and expertise they need to begin building every part better than the last. MxD's core mission is to transform American manufacturing, by fully integrating the digital thread across the manufacturing enterprise to reduce overall manufacturing costs, stabilize and grow the manufacturing industrial base and improve US competitiveness through the world.

MxD has invested over $120 million in more than 85 applied research and development projects in areas including design, product development, systems engineering, future factories, agile and resilient supply chains, and cybersecurity.

MxD is also the DoD's National Center for Cybersecurity in Manufacturing. MxD operates from a nearly 75,000-square-foot innovation center near downtown Chicago. Its future factory floor features some of the most advanced manufacturing equipment in the world, which partners can

use for experimentation and training on everything from augmented reality to advanced simulation techniques.

MxD uses a broad and collaborative process to develop the Strategic Investment Plan (SIP) and Technology Roadmap to ensure its technology, outreach, and education investments provide U.S. manufacturing with the right skills, solutions, and tools to compete globally. A Request for Proposal (RFP) is initiated when MxD desires new and creative solutions to problems and/or advances in knowledge, understanding and technology for digital manufacturing and design. Once the RFP topic is developed and approved, the MxD RFP will be posted to the MxD website and represents the official notification to Proposal Teams of a request to submit the required documents.

This RFP contains the following elements:

1. Technical Summary: description of a specific technology objective
2. Program Overview: description of technical and program requirements
3. Proposal Preparation Information: background and guidance for the preparation of required forms and instructions needed to submit a proposal to MxD

The RFP is available on the MxD website at https://mxdusa.org/projects/. Amendments to a MxD RFP may be used to extend due dates, clarify procedural requirements, or modify technical requirements. If an updated RFP is issued, the previous RFP will be rescinded. Proposal Teams should carefully monitor the MxD website after an original posting of an RFP, up to the time of the Technical Proposal and Cost Proposal submission date. Any revisions, amendments or updates will appear in the same section of the website as the original solicitation. It is the responsibility of the Proposal Team to monitor the MxD RFP updates and ensure their proposal meets the solicitation requirements. MxD welcomes any comments or suggestions for improving the contents of this guide. Please address them to projects@mxdusa.org.

MxD refers to the Proposal Team Lead as the non-Federal organization that submits a proposal in response to a Request for Proposals. Proposal Team members are other participants on the proposal and are further broken down into Recipient/Subrecipient relationships similar to a prime/subcontractor relationship in traditional contracting.

Any questions regarding this solicitation must be provided to projects@mxdusa.org. The questions will be sent to the appropriate MxD and/or Government POC, and answers will be published on the MxD website, if appropriate. Questions submitted within one week prior to a deadline may not be answered.

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TECHNICAL SUMMARY

IV. TECHNICAL SUMMARY

PROBLEM STATEMENT

The Covid-19 pandemic has demonstrated the need for manufacturers to quickly evaluate different production scenarios. These scenarios can have many objectives including increased throughput, rapid product changeovers, and optimizing operations for reduced availability of workforce.

However, during emergency situations, such as a pandemic, critical components are in high demand. The factories that manufacture these components cannot afford to shut down operations for unproven changes. Manufacturers need a way to evaluate potential improvements without interrupting ongoing production.

This project aims to use a digital twin to accomplish two goals. The first goal is to use a descriptive digital twin to monitor the status of raw material and work-in-progress material to prevent process shutdowns due to material shortages. The second goal is to virtually make programming changes to a robot control system to optimize throughput of the robot without interrupting production. The resultant behavior of the system will be evaluated with both the digital twin and then confirmed with the physical asset.

This project will build an automated discrete manufacturing cell incorporating these digital twin goals. The cell will be built in the MxD factory and will be used for demonstration, education, and use case testing purposes. It is MxD intention that this cell will be used by the manufacturing community for these purposes long after the project completion.

OBJECTIVES

The goal of the project is to implement two digital twins. Implementation of the two digital twins will rely on the creation of a small manufacturing cell to be installed on MxD's Factory Floor. The first digital twin will be a descriptive, 2-D digital twin of the entire cell. This digital twin will enable users to see real time status of the cell. This digital twin will also provide data analytics of the raw material and blank work-in-progress (WIP) material to report material usage and prevent material shortages during production.

The second digital twin will be a 3-D digital twin of the cobot. This digital twin will provide an environment for virtual programming of the cobot. Variable motion and order of operations of the cobot can be tested for optimized throughput of material. The digital twin will have the capability to download code to the cobot controller to mirror what is in the digital twin for physical testing.

While the above use cases refer to two digital twins to clarify the use cases, they can either be the same or two different digital twin environments at the discretion of the project team. The purpose of the digital twin is to enable virtual programming of the PLCs and robot controllers. This is done to investigate various scenarios targeting improved throughput of product through the cell without disrupting ongoing production. If the desired scenario is achieved, the digital twin will upload code to the cell for implementation.

The following objectives outline the key attributes, outcomes, and impact that MxD considers necessary to achieve the programmatic goal of this project and the CARES Act funding.

1. Demonstrate, characterize, and quantify the benefits of a Digital Twin in formulating scenarios response plans, especially in an emergency. How can a Digital Twin be used to improve response speed and decision quality?
2. Provide guidance and context to other organizations which might be exploring Digital Twins for scenario response planning. Accelerate the adoption of this technology by sharing lessons learned, best practices, and pathways to evaluating project success.
3. Generate transition pathways for the developed technology and ideally a ramp to commercial availability. This should be considerate both of private industry needs/benefits for the technology and governmental/regulatory interests in future emergencies, especially as relates to regulation.

Through these objectives, the project principally seeks to address the following use cases:

> *As a production planner, I need visibility into my production process status in order to anticipate shortages or excess WIP and avoid line slowdown.*
>
> *As a manufacturing engineer, I need to test the impact of robotic programming changes in a virtual environment in order to evaluate different scenarios and their impact.*

RFP Scope of Work

The above objectives must be completed within the following project constraints:
Period of Performance: 12 months
Anticipated MxD Funding: $750,000
Minimum Cost Share Contribution: $750,000

This project's key objectives are separated into three categories which subdivide the overall intended scope of the project.

- **Design & Installation of a Production Cell** which will serve as a foundation for the digital twins. The cell will follow a digital thread process from design to finished good as shown below in Figure 1. The purpose of this process is to align with the similar product processes found in industry and provide the robust base needed to test and demonstrate the digital twins. The proposal team is encouraged to make value-added changes or alterations to the process as shown in Figure 1 to enhance the system's capability.
- **Creation of 2D Descriptive Process Digital Twin** which correlates the current state of sensors, work-in-progress, buffer/raw material, and other parameters. This digital twin should utilize information (both simulated and measured) from the manufacturing process to monitor the status, inform the operator, and ideally perform some level of analysis to enhance performance. One example is using past data to prevent material shortages by notifying personnel when the digital twin detects insufficient stock.
- **Creation of 3D Robotic Virtual Commissioning Digital Twin** which enables a programmer to virtually make programming changes to a robot control system to optimize throughput of the robot without interrupting production. A human user is able to evaluate different motion or process scenarios in this virtual environment. The resultant behavior of the system will be evaluated with both the digital twin and then confirmed with the physical asset and can ideally be seamlessly promoted from this digital twin/virtual environment to the real control system.

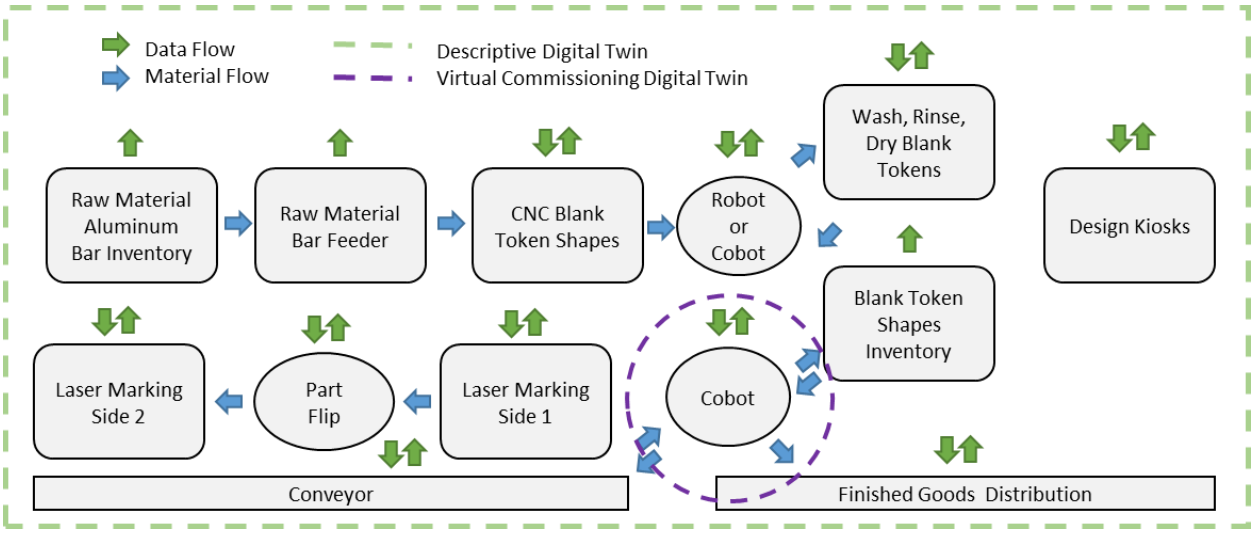

Figure 1 – Process Flow Concept

The cell will manufacture a small aluminum “token”. Figure 2 below shows an example of what such a token could look like (note that for this project, part marking should be performed with a laser rather than a CNC engraver).

Figure 2 – Sample “token”. The diameter of the part shown is 43mm.

System Functional and Operational Requirements

Factory Floor Installation and Operation

In addition to the programmatic goals of the CARES Act, this project will produce a manufacturing cell asset that is intended to replace the existing "Discrete Cell" at the front of MxD's Future Factory space. This asset is heavily utilized for the demonstration and explication of digital manufacturing technologies during Factory Floor tours. It is also utilized to produce member benefits such as data which can be shared. Proposers are encouraged to view the MxD Virtual Tour "Discrete Testbed" for reference of current capabilities.

Current Functionality/Characteristics to Preserve

- The Discrete Testbed is composed of industrial-grade machinery and software that would not be out of place in a commercial machine shop.
- System is composed of hardware and software from multiple vendors which more accurately replicates the install base of American manufacturers.
  - This also highlights and enables the demonstration of neutral/standards-based interfaces and methods to aggregate data to a common destination
- System is open to a variety of use cases, including those added by MxD engineering personnel. Ability to add new equipment, sensors, visualizations is mandatory.

New Functionality/Characteristics to Change

- The current Discrete Testbed is surrounded by a guard fence due to the use of an industrial robot.
  - This new system must be able to operate according to safety requirements without the use of a guard fence, this should be possible with a cobot.
- MxD Factory Tours can vary greatly in length and degree of detail.
  - It is required for MxD to be able to operate/demonstrate portions of the system individually so a tour guide can "make it move" for even a few minutes.
- The current Discrete Testbed uses manufacturing equipment that is substantially oversized for the product made (a small token).
  - Sizes of machines/layout should be selected to enable visitors to move through the cell and easily view handoffs between subsystems.
- The current Discrete Testbed does not present many opportunities for a visitor to "interact" with the system.
  - Consideration should be made as to which systems could have a "hands-on" component for learning, teaching, and exploration.
- The current Discrete Testbed is a closed cell and would require substantial re-configuration and re-installation to integrate with other systems
  - Layout should be designed with expansion/integration/reconfiguration in mind. The future vision for MxD's Factory Floor will include physical and data integration between installations.
  - One potential example is transferring parts between systems via AGV, requiring the cell's layout to be "loose" to enable the AGV to move to pickup points.

Manufacturing Cell Description and Requirements

Token

- Tokens will be fabricated from aluminum. The grade of aluminum is flexible but must be compatible with the CNC process with a preference towards lowest material cost.
- Token size will be between 35mm – 45mm diameter depending on the capabilities of the CNC machine chosen. The thickness should be 1mm – 3mm.
- Tokens will be in as machined finish and be free from any burrs.

Automation

- Raw material placement and feeder loading can be manual.
- Machine maintenance is manual.
- All other operations will be fully automated and initiated by input at a design kiosk.

Design Kiosk

- There will be three to six design kiosks based on budget availability.
- The design kiosk will be connected to the network using MxD's private 5G system.
- The design kiosk will be portable and plug into a standard 15A 110v outlet.
- The design kiosk will be a PC, monitor, and software on a standalone workspace which can be placed anywhere in the MxD facility.
- Design Kiosks will be outside of the 19ftx22ft cell.
- The design kiosk will have two modes. A guest mode which allows the user to select from predefined token shape, predesigned graphics, and add custom text. Guest mode can only make one token per entry. The second mode is an MxD employee mode which will allow the user to select predefined token shape but allow custom graphics to be uploaded and add custom text. Employee mode can request fabrication of multiple tokens per entry.

Raw Material and Bar Feeder

- There will be an area to store raw aluminum bar stock. The area must use sensors or other accommodations to report inventory level and data for the digital twin
- Bar stock and bar feeder will be sized according to the needs of the CNC machine and token size selected. Raw material storage must fit in the 19ft x 22ft cell.
- The bar feeder must use sensors or other accommodations to report material left on current bar in relationship to token quantity.
- The system must be able to report when the bar feeder reaches a minimum threshold to provide configurable alerts and data for the digital twin.
- A bar and bar feeder is used to illustrate the desired raw material processes. However, other material form factors and loading mechanisms can be selected based on CNC process/machine chosen.

Machining

- The specific CNC machine and process is flexible provided it meets the objectives of the project. Examples include a swiss type lathe, turning center, router, mill, or any combination thereof can be used if requirements are met.

- The machine(s) must be integrated with the controls system.
- The machine must report status data for the descriptive digital twin.
- The CNC machine(s) must have part ejection or other accommodation for the robot to pick the finished part.
- The machine must have the capability to produce a limited number of different outline shaped tokens (e.g.: round, dog tag style, etc.). The machine must be able to cut the selected shape on demand as communicated from the cell control system.

Cleaning

- The cell will have an automated cleaning system capable of cleaning oil from the tokens due to the machining process.
- Parts will be placed into and removed from the system by the robot
- The system will wash, rinse, and dry the token.
- The machine must be integrated with the controls system.
- The machine must report status data for the descriptive digital twin.

Robot

- A robot will be used to transport different shaped tokens from the CNC machine, to/from the cleaning station, and into the blank token WIP inventory location.
- The robot must be integrated with the controls system.
- The robot must report status data for the descriptive digital twin.
- Optionally, the robot can be replaced by another cobot or consolidated with the existing cobot currently shown in Figure 2 if technically feasible and there is no cross contamination between dirty and clean parts.

Blank Token Inventory Area

- An inventory area will store blank tokens of the various shapes produced by the CNC machine.
- The inventory area must be fully integrated with the robot/cobot for entry/exit of material.
- Inventory must be segregated by shape.
- The inventory area must have sensors or other accommodations for detecting the amount of inventory present for each shape.
- The inventory area must be integrated with the controls system.
- The inventory area must report status data for the descriptive digital twin.
- The system must be capable of setting minimum/maximum inventory thresholds. If minimum thresholds are crossed, the system will initiate CNC of additional blanks until the maximum level is reached.

Cobot

- A cobot will be used to transport different shaped token blank token inventory area, to/from the conveyor, and place into the finished goods distribution area.
- The cobot must be integrated with the controls system.
- The cobot must report status data for the descriptive digital twin.

- This cobot will also be the target for virtual commissioning with the 3-D digital twin. It must be compatible with the digital twin platform selected by the project team.

Marking Area

- The marking area will consist of a conveyor, two lasers, and a method of flipping tokens over.
- The marking area must accommodate the different shape tokens and hold orientation as place by the cobot for rotational alignment with the lasers.
- The lasers will be capable of marking graphics and text on unfinished, as-machined, aluminum. Lasers are expected to be fiber lasers in the range of 20w to 50w.
- The marking area components, including conveyor, lasers, and flipping fixture must be integrated with the control system.
- The marking area components must report status data for the descriptive digital twin.
- The lasers must be capable of engraving different designs as assigned by the control system.

Finished Goods Distribution Area

- After marking is complete, the cobot will remove the token from the conveyor and place it in the distribution area.
- The distribution area will have the capability to hold 20 tokens in individual slots for pickup by personnel.
- The distribution area will have the capability to control placement of an individual token to a specific slot.
- Each slot will be able to sense if a token is present/empty.
- The system will keep track of which token is placed in each slot.
- A display will be used to identify to users which slot their token is located.
- The distribution area must be integrated with the control system. Tokens will only be placed in empty slots. Alerts are to be given if all slots are occupied and a token is awaiting distribution.

DESCRIPTIVE 2D DIGITAL TWIN DESCRIPTION AND REQUIREMENTS

- A descriptive digital twin will show the real-time status of all areas as summarized above.
- Emphasis will be placed on throughput, consumption, and raw/WIP material inventory levels throughout the cell.
- The descriptive digital twin will be illustrated in 2-D form using text and/or graphics.
- The descriptive must have user control and is to be accessible through the MxD network.
- Selection of the software is at the discretion of the project team providing requirements are met.
- On-premises or cloud installation can be used. If on-premises is used, MxD will supply the server and storage.

ROBOTIC VIRTUAL COMMISSIONING 3D DIGITAL TWIN

- The virtual commissioning will focus on the cobot only.

- The digital twin will be able to virtually reprogram the cobot controller to optimize motion and throughput.
- The digital twin will be able to run virtual, predictive scenarios of the cobot behavior with the new programs.
- The digital twin will have the capability to display these predictive virtual results in 3-D formats.
- The digital twin will have the capability to upload cobot controller programs to the physical asset after proven virtually.
- The digital twin environment can be the same digital twin as used for descriptive analytics described earlier or given the limited scope, can be a separate environment at the option of the project team.
- Selection of the software is at the discretion of the project team providing requirements are met.
- On-premises or cloud installation can be used. If on-premises is used, MxD will supply the server and storage.

Network, Facility, and General Requirements

MxD Support and Facility Information

- MxD will provide facility support including electrical wiring and mechanical installation
- MxD will provide a floor space in its factory for installation of the cell. The space allocated is 19ft x 22ft.
- MxD will provide IT and cybersecurity support for network connectivity including 5G wireless connectivity
- MxD will provide CNC engineering, systems integration engineering, and mechanical engineering support on a consulting basis as needed
- The cell must meet OSHA and any other applicable safety or code requirements.
- MxD will supply display monitors for the space as needed. MxD will provide an overhead gantry for display monitors as needed.

System Considerations

- All data will remain secure and subject to MxD cybersecurity guidelines. Specific cybersecurity features to be addressed should include encryption of data in motion and at rest, end point detection and response (EDR), intrusion detection and response (IDR), asset identification, allow-listing, and/or zero trust concepts in the end design.
- MxD plans to make data available for institute members. How to access stored data from outside of the digital twin environment must be considered.
- Displays are to be used throughout the cell to show the digital twin(s) and data. Displays at each station will show the status of the station. Displays over the cell will show the overall digital twin and any other relevant system data.
- Ongoing maintenance for both hardware and software must be considered in system design and a maintenance plan will be delivered as part of the project.
- System components will be agnostic for both data and communications protocols. Interoperability and expansion for future projects must be considered.
- Maintenance and operations training guides will be delivered as part of the project.

- Ongoing operational costs, especially software license fees, outside of the period of performance are to be kept to a minimum. Perpetual licenses are preferred to reduce ongoing costs for the institute.

Optional

- Prescriptive results are considered out of scope for this project. However, MxD will consider proposals for expanded scope if the program remains in budget and within the period of performance.
- Predictive maintenance use cases are considered out of scope for this project. However, MxD will consider proposals for expanded scope if the program remains in budget and within the period of performance.
- Quality considerations or calculations for OEE are considered out of scope for this project. However, MxD will consider proposals for expanded scope if the program remains in budget and within the period of performance.

During the period of performance, the Proposal Team will produce deployable deliverables that will be shared with the MxD membership in accordance with the Membership Agreement. The recommended deliverables are listed below in Table 1, but **the Proposal Team is encouraged to include additional deliverables or provide value-added changes to the recommended set of deliverables**.

IMPORTANT: If changes are made to the deliverables, the Proposal Team must provide the reasoning and detail any assumptions to provide context for the changes. Their proposed set of deliverables must align with MxD's focus on achieving deployable outcomes and enabling the transition of the research.

Table 1. *Technical Deliverables*

Deliverable	Description	Deliverable Due Date (Month #)
Discovery and Requirements Finalization	Hardware, data, and software assessment of the manufacturing cell. Proposal for communications, data/digital twin architecture, and risk assessment.	Month 2
Concept Architecture and Design Review	Complete architecture design including all hardware and software specifications. Review architecture with MxD for approval.	Month 4
Manufacturing Cell Installation	Transport, assembly, and installation of manufacturing cell to MxD's Factory Floor	Month 8
Systems Integration and Software Install	Integrate all control systems, network hookup, and software.	Month 9
Storyboard and Demo Script Review	Complete storyboard and tour/demo script evaluation with MxD's Factory Floor team. Review script with MxD for approval.	Month 9
Descriptive Digital Twin	Successful test and demonstration of digital twin near real time descriptive representation and display	Month 10

Test and Demonstration		
Virtual Commissioning Digital Twin Test and Demonstration	Successful test and demonstration of digital twin ability to represent virtual reprogramming of PLC and robot controllers	Month 11
Training	Onsite training of the factory floor team for digital twin operation, maintenance, and modification to accommodate future manufacturing cell changes	Month 11
Final Report and Lessons Learned	Final report highlighting objectives, procedures, results, lessons learned, and future recommendations.	Month 12
Final Report Presentation	Presentation in slide format, presented to manufacturer, MxD membership, and government officials.	Month 12

The Proposal Team is expected to develop a transition plan, which is detailed in Table 2 in Section V. MxD is focused on supporting the transition of project outcomes to its membership in the form of pilot integrations on their factory floors, follow-on research projects or commercialized products available for use. Proposal Teams are expected to tailor their deliverables to their transition goals in order to provide outcomes that have continuing impact after the period of performance is complete. **Pilot deployments and actionable transition plans are a priority for MxD to help maximize the benefits of funded research to the membership and ultimately, help increase the competitiveness of the US manufacturing base through new technological advancements. Thus, it is important that proposals emphasize not just technical merit but transition and deployment.**

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PROGRAM OVERVIEW

V. PROGRAM REQUIREMENTS

COLLABORATION

Participation in this program is enhanced by collaboration with a team of organizations with diverse capabilities. Competitive teams which include representation from the manufacturing base, academia, solution/service providers will be viewed favorably by the evaluation board.

The Proposal Preparation Information section outlines the opportunities that MxD provides to facilitate proposal team development:

- Team Formation List: MxD will collect contact information from parties interested in forming a team during the first month of the proposal period and will then disseminate the compiled list of contacts to the responders via email.
- Participation in the Team Formation List is optional and NOT required in order to submit a proposal.

PROGRAM MANAGEMENT

MxD will be responsible for managing the project to ensure the team meets all the technical objectives and requirements proposed within the project's period of performance and budget. The MxD Project Manager will coordinate with Principal Investigators (PIs) of the Proposal Team to manage the program following MxD's project processes. The Senior Director of MxD's Project Management Office (PMO), in coordination with the assigned MxD Project Manager, will monitor technical performance and project costs of the associated subaward, the agreement that governs a project awarded by MxD to the Proposal Team Lead. Proposal Teams will submit the reports listed below in Table 2 to their identified Project Manager to fulfill their reporting requirements. These reports will be internally accessed by the MxD Senior Director of MxD's PMO, the Government, the Project Manager and other authorized MxD staff members in the course of their official duties. Technology advancements will be summarized at least annually in order to support reporting to the Executive Committee, Technical Advisory Committee, MxD Members, and the Government, when applicable.

Table 2. Program Deliverables

Deliverable	Description
Project Immersion Workshop	Face to face meeting with manufacturer(s) including stakeholders from key business units to review project transition plan and define pilot requirements.
Transition Plan	Written plan for successful transition of project outcomes after period of performance including technology integration, educational distribution, and potential commercialization.
Monthly Technical and Financial Reports	Monthly report from the Project Team Lead including the financial and technical status of the project
Member Technical Reviews	Presentation encompassing all technical advancements made prior to key milestone and presented to the MxD Project Manager, members of the Technical Advisory Committee, and other interested MxD members.
Presentations at MxD	Presentation and demonstration of developed technology presented in person at MxD
Annual Patent Reports	Report of inventions and subcontracts

Intellectual Property Reports	Participants must promptly notify the MxD Project Manager apprised of Project IP created, filing status, claims against the Project IP, and BIP licensed to other Members.
Safety Accident/Incident Report	Participants must report any major accident/incident (including fire) resulting in any one or more of the following situations: one or more fatalities or one or more disabling injuries; damage of Government property exceeding $10,000; impact to Project planning or production schedules or degradation of the safety of equipment under contract. Such report will also identify potential hazards requiring corrective action.
Draft Final Technical Report	Draft report must include a comprehensive, cumulative, and substantive summary of all technical advancements and significant accomplishments achieved during the project.
Final Technical Report	See above
Project Team Lead Release	Release by Project Team Lead confirming scope of work to be complete
Property Report	List of all MxD funded equipment and planned disposition
Final Patent Report	Report of inventions and subcontracts

Travel Requirements

Proposals should include funding for three (3) trips per year for two (2) people for each member of the Proposal Team. These trips will be used for discovery, design review, face to face meetings, and presenting to the MxD membership. These trips may be for travel to MxD or to another location at the request of MxD (e.g., a conference, workshop, showcase, etc.). For estimation purposes, use Chicago, IL as the destination.

Period of Performance Requirements

Proposed projects should be no more than 12 months in duration. Please note that projects are initiated once the subaward is signed, therefore, the project duration must include the subcontracting of all project participants between the Proposal Team Lead and each member of the Proposal Team.

Ownership of Deliverables and Intellectual Property

To accelerate digital adoption, cybersecurity, and workforce development across the U.S. manufacturing sector and to support the increased priority from our funding partners to transition project technology, MxD desires to own or co-own all the rights to intellectual property (IP) created during the project (Foreground IP or Project IP). It is the expectation that a member of the Proposal Team will co-own or will have a non-exclusive, non-transferable license to use the Foreground IP it creates. MxD will negotiate in good faith to achieve this result. MxD expects that the IP Management Plan (Attachment 1b) submitted with this proposal will reflect this position. MxD will have no rights to pre-existing intellectual property (Background IP) belonging to any member of the Proposal Team except as may be expressly agreed to in the Project documents. It is important to note that MxD will consider proposals that do not meet this request; proposals with IP Management Plans that reflect this will be favorably reviewed.

Funding Requirements

MxD anticipates awarding one project for no more than $750,000 of Federal Funding, not inclusive of required cost share, under the MxD-20-18-02 RFP. MxD reserves the right to fund all, some or none of the Technical Proposals received under issued RFPs. Final award amounts will be adjusted accordingly based on proposals received and subsequent evaluations.

This project requires a **minimum** 1-to-1 Cost Share in aggregate by the Proposal Team. For every dollar of Federal funding awarded, the Proposal Team must contribute at least a dollar of in-kind effort or cash. Thus, the Proposal Team in aggregate will need to provide at **minimum** 50% of the total project cost (inclusive of labor, equipment, materials, indirect, etc.) in cost share. This cost share can be in-kind or cash and can be distributed among the members of the Proposal Team however the team decides. Cost share must be accounted for in the cost proposal, as described in the Cost Development Guide found in the Proposal Preparation Kit.

Neither MxD nor the U.S. Government has any responsibility for costs associated with Technical Proposal or Cost Proposal development, submissions, or pre-award negotiations.

If down selected, the Proposal Team must submit substantiating documentation for all Proposal Team Member costs (including cost share) and MxD will complete a comprehensive cost analysis (including cost reasonableness and cost realism) prior to award. In addition, the Government Agreements office may conduct a cost analysis of all submitted cost proposals to approve the project. Approval of the Cost Proposal and Technical Proposal by the Government Agreements office and the DoD Program Manager is required for all MxD projects.

NOTE: Project award timelines are subject to approval of the project plan by the government and the allotment of funds from the government.

VI. ELIGIBILITY

MxD Membership

This RFP is open to the public; any organizations regardless of membership status may submit a Technical Proposal and Cost Proposal in response to this RFP. However, the MxD Membership Agreement must be fully executed with every Proposal Team member within 30 days of notification of project down select; acknowledgement of this is required in the Technical Proposal submission. Additionally, any organizations which are already members of MxD must ensure they are a member in good standing within 30 days of notification of project down select.

Any non-MxD members are strongly encouraged to conduct a legal pre-review of the Membership Agreement prior to submission as this is a common source of delay during negotiations with proposal teams that have been chosen during down selection. Please direct questions to MxD's Director of Business Development, Tony Papke (tony.papke@mxdusa.org). For more information on how to become a MxD Member, please visit the MxD Membership page on our website.

Federally Funded Research and Development Centers (FFRDCs) and Government entities (Government/National laboratories, military educational institutions, etc.) are subject to applicable direct competition limitations and cannot propose to RFPs in any capacity unless they address the following conditions:

- FFRDCs or Government entities may not exclusively team on any specific proposal team.
- FFRDCs must clearly demonstrate that the proposed work is not otherwise available from the private sector and must also provide a letter on letterhead from their sponsoring organization citing the specific authority establishing their eligibility to compete with industry and propose to solicitations utilizing Government funding.
- Government entities must clearly demonstrate that the work is not otherwise available from the private sector and provide written documentation citing the specific statutory authority, as well as, where relevant, contractual authority, establishing their ability to propose to solicitations utilizing government funding.

Government agencies interested in participating in MxD RFPs as part of Proposal Team should notify MxD in advance of Proposal submission. For RFPs utilizing Federal funding, special agreements and considerations may need to be implemented to enable participation.

Notification of Participation by Foreign Firms & Non-U.S. Citizens

Membership in MxD shall be granted only to U.S. companies, firms, organizations, institutions, or other entities organized or existing under the laws of the United States, its territories, or possessions (as defined in Section 120.15 of International Traffic in Arms Regulations, 22 CFR § 120 et. seq. ("ITAR")).

Membership and project participation (or participation in projects without membership status) will be granted on a case-by-case basis at the sole discretion of the MxD Senior Leadership Team upon approval of the U.S. Government for any of the following:

- Any agency or instrumentality of a foreign government;
- Companies, firms, organizations, institutions, or other entities not organized or existing under the laws of the United States (as defined in Section 120.16 of the ITAR); and
- Non-U.S. Citizens.

In such event, all Members will be notified immediately of the foreign entity's role.

If a Member is a Corporation with subsidiaries or affiliates, its membership will include its wholly-owned and controlled and majority-owned and controlled U.S. subsidiaries and affiliates who qualify as a U.S. person under Section 120.15 of the ITAR.

It is a requirement that work related to the project must be completed in the U.S. by people legally authorized to work in the U.S. If any member of the proposal team is not either a U.S. citizen or a lawful permanent U.S. resident (green card holder), please reach out to MxD at projects@mxdusa.org before submitting a proposal. All proposed project participation by non-U.S. Citizens must be disclosed to MxD on Attachment 2c MxD Foreign Firms, Travel, & Non-U.S. Citizens at least 60 days prior to proposed participation. Written approval of foreign firms and/or non-U.S. Citizens must be received by the member of the Proposal Team from MxD prior to commencing work.

VII. TECHNICAL & COST PROPOSAL EVALUATION

Evaluation Process

An MxD Evaluation Board (EB) will review and evaluate each submitted Technical Proposal utilizing the evaluation criteria specified in the following section.

The EB may consist of recognized experts from industry and academia and key government stakeholder representatives (when appropriate). MxD representatives, such as the Senior Director PMO, and respective Project Managers, may participate in and lead EB meetings. All members of the EB will need to meet strict standards of personal and organizational conflict of interest. The evaluators may be supported by subject matter experts to review and comment upon the proposed work.

Through its deliberations, the EB will determine "selectability" of each submission. Selectability determination incorporates average EB score, judgement of market impact, and budget availability. The EB will identify a list of all proposed Technical Proposals that are "selectable for negotiation" leading to a subagreement award, along with their associated evaluation scores, to the Project Manager. The Senior Director, PMO, with the consultation of other MxD representatives, will determine which subset of the proposed Technical Proposals deemed "selectable for negotiation" will be down selected for negotiations. This determination will take into account the EB's recommendation, funding availability, alignment with MxD's SIP as well as external stakeholder requirements (when applicable).

Evaluation Criteria

MxD's primary goal is to apply digital manufacturing technologies to solve business problems. To this end, successful proposers must demonstrate an understanding of both the business needs as well as the technology solutions. Proposals should provide a clear explanation of how the solutions address business problems and technical requirements outlined in the RFP, any assumptions, and considerations for deployment of developed solution through a pilot.

Each proposal is evaluated by a specific set of criteria. Below are the Proposal Evaluation criteria for this RFP:

Proposal Evaluation Criteria	Order of Importance
Requirements Compliance • *Clearly articulates how the team will meet all the capabilities required by the RFP* • *Proposed solution clearly addresses problem statement and use cases identified in RFP* • *Clear identification of assumptions, risks, and mitigations; proposed deliverables align with requirements* • *Program management plan meets requirements in the RFP and is reasonable for the scope of work described in the technical proposal*	1
Methodology • *Clear and concise work effort scope targeted at problem statement* • *Proposed effort of direct relevance to RFP* • *Clear identification of barriers to implementation and explanation of how they will be overcome* • *Innovative methodology with high-potential for market impact* • *Significant and impactful use of external resources* • *Methodology demonstrates scientific and technical merit* • *SMART metrics and KPIs identified and described and demonstrate clear understanding of proposed work* • *Provides a maturity level assessment of both current and future state of technology with substantiation of assessed levels* • *Deliverables are fully described and identified*	2
Transition Plan • *Transition plan clearly articulates all project results and application into commercial and/or government products, systems and applications* • *Plan includes detailed descriptions of project results, risks/assumptions/mitigations, all required actions and timing, detailed funding and ROI strategy, key milestones, schedule and go/no-go decision points* • *Proposed team includes appropriate representation from supply chain, researchers and industrial partners* • *Transition tasks and partners identified and thoroughly defined, both to MxD members and the broader industry* • *Solution and strategy to rapidly enable the adoption of the new technologies across the US manufacturing base is presented* • *Clearly defined IP ownership and innovative licensing strategies designed for rapid adoption of the new technologies* • *Discussion of future transition and/or commercialization demonstrates a clear understanding of the industry and possible markets for the technology* • *Benefits of technology are clearly defined and substantiated.*	3

Team Qualifications • *Members of proposed team are highly qualified to accomplish project tasks with clear delineation of roles and responsibilities* • *Solid evidence of commitment by team members, such as letters of commitment from their companies* • *Team members have unique capabilities that are directly associated with the target technology* • *Team includes a broad mix of capabilities and experiences to ensure success along with the commitment of top-tier facilities to accomplish all project tasks.*	4
Cost Factors • *Proposed cost estimates are reasonable and realistic for the proposed work effort* • *The minimum cost share proscribed in the RFP has been met or exceeded* • *Cost share is clearly defined and directly applicable to the performance and success of the project* • *Cost share value is readily discernable* • *Cost share from partners is documented with letters of commitment.*	5

VIII. PROJECT AWARDS

CONTRACT

This project will be funded under the CARES Act as distributed by BioFab's Technology Investment Agreement (TIA), Contract Number W911NF-17-3-003 between BioFab and the Government. MxD will execute a subaward flowing from this contract to the winning proposal team. All contractual negotiations related to RFPs will be executed by MxD. Funds will be distributed to the Proposal Team Lead selected through the evaluation/selection process utilizing an Subaward Agreement. This subaward is usually Cost Reimbursement/Cost Share agreements; Milestone Payment/Cost Share based contracts will be considered upon request.

MxD has provided a subaward template within the PPK for Proposal Teams to **review** prior to proposal submission. **The subaward should not be submitted with the proposal.** After receiving a notification of down selection, MxD will request the down selected Proposal Team to officially begin contract review and negotiations. **The subaward must be fully agreed with the proposal team lead within 60 days of down selection notification;** acknowledgment of this is required in the Technical Proposal submission. MxD would prefer to execute an subaward only with the Proposal Team Lead. Once the subaward is executed, the Proposal Team can begin working on the project. When applicable, it is the sole responsibility of the Proposal Team Lead to issue contracts with applicable flow down clauses outlined in the subaward to any subcontractors, consultants, and any suppliers.

FINAL TECHNICAL PROPOSAL & COST PROPOSAL REVISIONS

MxD reserves the right to negotiate the cost and scope of the proposed work with the Proposal Team that has been down selected prior to award. MxD will facilitate the creation of a Statement of Work with the Proposal Team including technical scope modifications and program

management aspects. All members of the down selected Proposal Team who intend to pursue selection are required to participate in the proposal revision process prior to award. For example, MxD may request that the organizations revise the technical scope to better align to RFP requirements.

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PROPOSAL PREPARATION INFORMATION

IX. PROPOSAL PREPARATION INFORMATION

This Proposal Preparation Information section offers detailed instructions on how to respond to this RFP; the Proposal Preparation Kit (PPK) includes the required proposal templates and reference documents on how to complete the templates. Together, the Proposal Preparation Information and PPK are intended to provide the basic information necessary for assembling complete proposals.

NOTE: MxD recommends Proposal Teams review the Request for Proposal Technical Summary & Program Overview prior to the PPK.

X. TEAM FORMATION OPPORTUNITIES

TEAM FORMATION LIST

To facilitate proposal team formation, MxD will collect contact information from parties interested in forming teams during the first month of the proposal period. MxD will then disseminate the compiled list of contacts to the responders via email. If you are interested in submitting your contact info to this distributed list, please email projects@mxdusa.org with the following information:

> ***"Subject: MxD-XX-XX RFP Team Formation***
>
> *[Organization Name]*
>
> *[Name of Contact]*
>
> *[Email address of contact]*
>
> *[1 sentence description of expected contributions to Proposal]*
>
> *I agree to have the information herein disseminated to other organizations that have indicated interest in forming a team for MxD's RFP XX-XX."*

XI. SUBMISSION INSTRUCTIONS

SUBMISSION DETAILS

Each Proposal Team must submit their Technical Proposal and Cost Proposal no later than 5:00PM Central Time, May 25, 2023. All proposals must be submitted via the MxD website. The SUBMIT button can be found on each RFP webpage at www.mxdusa.org/projects. By clicking the SUBMIT button, applicants will be directed to the official Submission Form.

REQUIRED PROPOSAL DOCUMENTATION

The following section provides guidance on the necessary documentation, templates and submission formats required to submit a Technical Proposal and Cost Proposal in response to this RFP.

Below are the documents (organized by PPK folder) that must be completed and submitted by the due date:

Required Proposal Documentation			
Title	**Document**	**Template**	**Submission Format**
Technical Proposal ONE PER PROPOSAL TEAM	Technical Proposal	Attachment 1a MxD Technical Proposal Template.docx	PDF
	Resume(s) of the Principal Investigator and Key Technical Personnel	N/A	PDF
	Letter(s) of Commitment	N/A	PDF
	Intellectual Property Management Plan (IPMP)	Attachment 1b MxD IP Management Plan.pdf	PDF
Cost Proposal and Participant Certification ONE PER PROPOSAL TEAM	Cost Proposal	Attachment 2a Project Cost Proposal Template.xlsm	XLS
	Cost Narrative	Attachment 2b Cost Narrative Template.docx	PDF
	Certification of Foreign Firms, Travel and Non-U.S. Citizens	Attachment 2c Foreign Firms, Travel, & Non-U.S. Citizens.docx	PDF

- Each Proposal Team must submit **one Technical Proposal** (Attachment 1a). The instructions for completing the Technical Proposal are in the Technical Proposal template provided in the PPK folder. All questions are required, and attachments should be included.
- Each Proposal Team must submit **one completed IP Management Plan** (Attachment 1b) for the entire team with the Proposal. Instructions for completing the IPMP are provided in the pdf. An additional IP Management Plan will be requested if the proposal team is awarded, an excel version of the IPMP will require the team to document Background Intellectual Property (BIP), Project (Foreground) IP, and assertions of limited rights to the Government.
- Each Proposal Team must submit **one Cost Proposal** (Attachment 2a) **including the Cost Narrative** (Attachment 2b) that is a summary or "roll-up" of all Proposal costs including cost share. Please reference the MxD Cost Proposal Development Guide for instructions on how to develop the Cost Proposal. An example Cost Proposal Excel Sheet and Cost Narrative are provided for reference. **Proposal Teams should be prepared to provide substantiating documentation for all Proposal Team Member**

costs within two weeks of down selection if the proposal is down selected. Additionally, if the proposal is down selected, the Proposal Team Lead must provide single audit results or other audited financials if Proposal Team Lead is not subject to single audit requirements.

- Each Proposal Team must submit **one Certification of Foreign Firms, Travel and Non-U.S. Citizens** (Attachment 2c) with information from every Proposal Team member. If there is personally identifiable information, separate certifications may be submitted
- The subaward is provided for review prior to submission. **The subaward should not be submitted with the proposal.**

Proposals that do not include the minimum requirements identified in the RFP will be deemed non-responsive and will not be evaluated.