

# MRL 1-3 Team #2

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# Team Members

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# Feedback on Proposed Matrix Change

## MRL 1-3 Additional Criteria

- Team Assessment of proposed changes
  - Value added: Yes
  - Acceptable as is: No
    - Changes documented
  - General Comments/ Observations
  - MRL WG vet with other MRL 1-3 team suggestions

# Summary

- Workshop value
  - Changes needed
    - Read ahead
    - Time commitment
- Team assessment of ESH Matrix change
- Team assessment of MRL 1-3 Matrix Change
- Other comments

# Below are Slides for your Team

Use those that you need

Discard those you don't

# A.1 Industrial Base

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			Potential sources identified to address technology needs. Understand state of the art.	Industrial base capabilities surveyed and known gaps/risks identified for preferred concept, key technologies, components, and/or key processes.
Inputs	<p>Survey IB to initiate planning for IB sector studies.</p> <p>Assess Manufacturing feasibility and capability.</p> <p>Database of Industrial Capabilities exists and is available at programmatic formulation</p>	<p>IB Sector Studies conducted and potential industrial base investment needs have been identified.</p> <p>Assess Manufacturing feasibility and capability.</p> <p>Industrial Base cataloged by technology application.</p>	<p>Potential sources identified to address technology needs. Understand state of the art.</p> <p>Potential individual sources identified to address specific technology needs. Understand state of the art.</p>	<p>Industrial base capabilities surveyed assessed and known gaps/risks identified for preferred concept, key technologies, components, and/or key processes.</p>
Proposed	Survey of the IB to initiate planning for IB sector studies conducted.	IB Sector Studies conducted and potential industrial base capability needs have been identified.	Potential sources analyzed to address capability needs. Understand state of the art.	Industrial base capabilities assessed and known gaps/risks identified for preferred concept, key technologies, components, and/or key processes.
Team Input	Survey of research leaders to initiate planning	Survey of research facilities, capabilities and intellectual capital	Potential sources analyzed to address capability. Understand state of the art	

# A.2 Manufacturing Technology Development

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		New manufacturing concepts and potential solutions identified.	Manufacturing technology concepts identified through experiments/models.	Manufacturing Science & Advanced Manufacturing Technology requirements identified.
Inputs	Survey manufacturing technologies and capabilities relevant to future needs. Basic scientific manufacturing principles observed and reported. Potential new manufacturing technologies identified. Initial Tradespace studies developed.	New manufacturing concepts and potential solutions identified. New Manufacturing Science & Manufacturing concepts, technologies, and capability requirements identified to support potential solutions identified. New manufacturing concepts and potential solutions formulated. Speculative practical applications invented. Tradespace studies initialized.	Manufacturing technology concepts identified through experiments/models. Manufacturing technology concepts and capabilities identified refined through experiments/models and simulations. Manufacturing technology concepts identified through analytical and experimental critical function and/or characteristic proof of concept. Tradespace studies concluded & summarized. Perform initial "Gap Analysis" of MRL to TRL.	Manufacturing Science & Advanced Manufacturing Technology development requirements identified selected and analyzed for the AoA and the Acquisition Strategy.
Proposed	Survey conducted of manufacturing technologies and capabilities relevant to future needs.	Manufacturing Science & Manufacturing concepts, technologies, and capability requirements identified to support potential solutions. Tradespace studies initiated.	Manufacturing technology concepts and capabilities analyzed and refined through experiments/models and simulations. Tradespace studies concluded.	Advanced Manufacturing Technology development requirements selected and analyzed for the AoA and the Acquisition Strategy.
Team Input	Basic scientific manufacturing principles observed and reported	New manufacturing concepts and potential solutions formulated.	Manufacturing technology concepts and capabilities analyzed and refined through experiments/models.	Advanced Manufacturing Technology development requirements selected and analyzed.

# B.1 Producibility Program

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			Relevant materials/processes evaluated for manufacturability using experiments/models.	Initial producibility and manufacturability assessment of preferred systems concepts completed. Results considered in selection of preferred design concepts and reflected in Acquisition Strategy key components/ technologies.
Inputs	<p>Survey possible materials and process capabilities.</p> <p>Investigate potential industrial bases sources.</p> <p>Producibility program guidance and process instructions available as directives and reference material.</p>	<p>Possible materials/process capabilities and limitations identified. Identify potential possible materials, processes, capabilities, and limitations. identified.</p> <p>Possible materials/process capabilities and limitations identified.</p>	<p>Relevant materials/processes evaluated for manufacturability using experiments/models.</p> <p>Relevant materials and processes evaluated for manufacturability producibility using experiments, models and simulations.</p>	
Proposed	Survey possible materials and process capabilities conducted.	Identify potential materials, processes, capabilities, and limitations.	Relevant materials and processes evaluated for producibility using experiments, models and simulations.	No change
Team Input	Survey possible materials, processes and capabilities	Identify limitations of potential materials, processes, and capabilities.	Relevant materials and processes evaluated for producibility using experiments, models and simulations.	No change



# B.2 Design Maturity

Sub-Thread	MRL 1	MRL 2	MRL 3
Existing	Manufacturing research opportunities identified.	Applications defined. Broad performance goals identified that may drive manufacturing options.	Top level performance requirements defined. Trade-offs in design options assessed based on experiments. Product lifecycle and technical requirements evaluated.
Inputs	<p>Survey IB research for opportunities and knowledge to make informed decisions on future manufacturing requirements for potential designs.</p> <p>Manufacturing is included in the design process.</p> <p>Manufacturing research opportunities identified.</p> <p>Similarities to and differences from previously produced specified designs identified.</p>	<p><del>Applications defined.</del></p> <p>Future manufacturing, lifecycle, and technical requirements identified for design options. Broad performance goals identified <del>that may drive manufacturing options.</del></p> <p>Assess manufacturing readiness objectives.</p> <p>Manufacturing technology applications defined. Broad performance goals identified that may drive manufacturing options.</p> <p>Expand research for design similarities to include other products from other industries.</p>	<p>Top level performance, lifecycle, and technical requirements defined and evaluated. Design options assessed for maturity.</p> <p>Top level manufacturing technology performance requirements defined. Trade-offs in design options assessed based on experiments. Product lifecycle and technical requirements evaluated.</p> <p>Note identified aspects of design without similarity to known products.</p>
Proposed	Survey conducted of research for manufacturing requirements and opportunities to support future designs.	Manufacturing, lifecycle, and technical requirements identified for design options to include designs or applications from other industries. Broad performance goals identified.	<p>Top level performance, lifecycle, and technical requirements defined and evaluated.</p> <p>Identify aspects of design without similarity to known products.</p>
Team Input		Applications explored. Broad performance goals identified that may drive manufacturing options.	<p>Top level manufacturing technology performance requirements defined.</p> <p>Trade-offs in design options assessed based on experiments.</p>

# B.2 Design Maturity (cont.)

Sub-Thread	MRL 4
Existing	SEP and Test and Evaluation Strategy recognize the need for the establishment/validation of manufacturing capability and management of manufacturing risk for the product lifecycle. Initial potential Key Performance Parameters (KPPs) identified for preferred systems concept. System characteristics and measures to support required capabilities identified. Form, fit, and function constraints identified and manufacturing capabilities identified for preferred systems concepts.
Inputs	Change order of criteria.
Proposed	Form, fit, and function constraints identified and manufacturing capabilities identified for preferred system concepts. SEP and Test and Evaluation Strategy recognize the need for the establishment/validation of manufacturing capability and management of manufacturing risk for the product lifecycle. Initial potential Key Performance Parameters (KPPs) identified for preferred systems concept. System characteristics and measures to support required capabilities identified
Team Input	Proposed

# C.1 Production Cost Knowledge (Cost modeling)

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		Cost model approach defined.	Initial cost targets and risks identified. High level process chart model developed. Technology cost models developed for new process steps and materials based on experiments.	Manufacturing, material and special requirement cost drivers identified. Detailed process chart cost models driven by process variables. Cost driver uncertainty quantified.
Inputs	<p>Parametric costs for manufacturing and quality cost estimates identified. Evaluate the CAPE parametric costs inputs.</p> <p>Production cost projection guidance and process instructions available as directives and reference material.</p>	<p>Cost model approach defined. Rough process map created. Cost model approach defined. Initial cost targets and risks identified.</p> <p>Cost model approach defined. Rough process map created.</p>	<p>High level process chart model developed.</p> <p>Cost models developed for process steps and materials. Manufacturing cost estimates for potential solutions evaluated and results provided for study guidance.</p>	<p>Cost Models include Manufacturing, materials, and special requirements cost drivers identified. Detailed process chart cost models driven by process variables. Cost driver uncertainties quantified.</p>
Proposed	Parametric costs for manufacturing and quality cost estimates identified.	Rough process map created. Cost model defined with initial cost targets and risks identified.	Cost models developed for process steps and materials. Manufacturing cost estimates for potential solutions evaluated and results provided for study guidance.	Cost Models include manufacturing, materials, and special requirements cost drivers. Cost models driven by process variables. Cost driver uncertainties quantified.
Team Input	None	Rough process map created.	Existing	Existing, qualified instead of quantified

# C.2 Cost Analysis

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing	Identify any manufacturing cost implications.	Cost elements identified.	Sensitivity analysis conducted to define cost drivers and production development strategy (i.e. lab to pilot to factory).	Producibility cost risks assessed. Initial cost models support Analysis of Alternatives (AoA) and Alternative Systems Review (ASR).
Inputs	Identify <del>any</del> potential manufacturing cost implications. Cost analysis methodology established. Lifecycle cost drivers analyzed and characterized.	Cost model approach defined. Cost elements identified and defined. Cost elements identified. Identify any manufacturing cost implications. Significant Cost elements identified. Identify any manufacturing cost implications.	Sensitivity analysis conducted to <del>define</del> quantify cost drivers, risks, and production development strategy (i.e. lab to pilot to factory). Sensitivity analysis conducted to defined significant cost drivers and production development strategy (i.e. lab to pilot to factory).	Producibility cost risks assessed. Initial cost <del>models</del> analysis supports Analysis of Alternatives (AoA) and Alternative Systems Review (ASR).
Proposed	Potential manufacturing cost implications identified with associated cost analysis methodology.	Cost elements defined.	Sensitivity analysis conducted to quantify cost drivers and risks (i.e., lifecycle costs).	Producibility and lifecycle cost risks assessed. Initial cost analysis supports Analysis of Alternatives (AoA) and Alternative Systems Review (ASR).
Team Input	None	None	Proposed	proposed

# C.3 Manufacturing Investment Budget

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing	Potential investments identified.	Program/projects have reasonable budget estimates for reaching MRL 3 through experiment.	Program/projects have reasonable budget estimates for reaching MRL 4 by MS A.	Manufacturing technology initiatives identified to reduce costs. Program has reasonable budget estimate for reaching MRL 6 by MS B. Estimate includes capital investment for production-relevant equipment. All outstanding MRL 4 risk areas understood with approved mitigation plans in place.
Inputs	Program investments identified in the PPBES with Program Element funding identified in the FYDP for the life of the projected development program.	Program/projects have reasonable budget estimates for reaching MRL 3 through experimentation. Based on identified cost elements, program/projects have reasonable manufacturing and manufacturing technology budget estimates for reaching MRL 3 through experimentation. Funding authorized to support advancement through MRL 3. Actions necessary to continue funding past MRL 3 underway.	Based on sensitivity analysis, program/projects have reasonable manufacturing and manufacturing technology budget estimates for reaching MRL 4 by MS A. Program/projects have funding in place for reaching MRL 4 by MS A.	
Proposed	Potential manufacturing investments identified.	Based on identified cost elements, program/projects have manufacturing budget estimates established.	Based on analysis, program/projects have manufacturing budget estimates for reaching MRL 4 by MS A documented.	No change.
Team Input	proposed	Program/projects have reasonable budget estimates for reaching MRL 3.	Based on analysis, program/projects have manufacturing budget estimates	No change 13

# D.1 Maturity

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing	Material properties identified for research.	Material properties and characteristics predicted.	Material properties validated and assessed for basic manufacturability using experiments.	Projected materials have been produced in a laboratory environment.
Inputs	<p>Survey of material characteristics and properties identified for research.</p> <p>Current database/information resource available covering material characteristics and properties based on latest research.</p>	<p>Material characteristics and properties identified for research from literature.</p> <p>R&amp;D and experiments for immature materials investigated and assessed.</p> <p>Any necessary validation testing criteria established.</p>		
Proposed	Material characteristics and properties surveyed and identified for further research.	Research from literature, development and experiments for immature materials and properties investigated and assessed.	Material properties tested and validated for basic manufacturability using experiments.	No change.
Team Input	<p>Survey of material characteristics and properties identified for research.</p>	Material characteristics and properties surveyed and identified from research	Material properties evaluated and verified for basic manufacturability	No change

# D.2 Availability

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		Material availability assessed.	Material scale-up issues identified.	Projected lead times have been identified for all difficult to obtain, difficult to process, or hazardous materials. Quantities and lead times estimated.
Inputs	<p>Materials sources for initial evaluation identified</p> <p>Requirements for potential materials identified.</p> <p>Current database/information resource available covering material sources. Policy in place for identifying and sourcing new emerging material needs.</p>	<p>Materials sources and availability identified.</p> <p>Materials sources for initial evaluation identified.</p>	<p>Material scale-up issues and sources only available outside the NTIB identified with vulnerabilities.</p> <p>Material availability assessed.</p> <p>Material scale-up issues identified.</p>	<p>Projected lead times have been analyzed and identified for all difficult to obtain, difficult to process, or hazardous materials. Quantities and lead times estimated.</p>
Proposed	Potential industrial bases sources investigated.	Materials sources and availability identified. Material scale-up issues identified.	Material availability assessed. Material scale-up issues evaluated and sources only available outside the NTIB identified with vulnerabilities.	Projected lead times have been analyzed and identified for all difficult to obtain, difficult to process, or hazardous materials. Quantities and lead times estimated.
Team Input		Existing	Existing	Projected lead times have been identified and analyzed for all difficult to obtain, difficult to process, or hazardous materials. Quantities and lead times estimated.

# D.3 Supply Chain Management

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			Initial assessment of potential supply chain capability.	Survey completed for potential supply chain sources.
Inputs	Survey of IB for potential supply chain material sources. Supply Chain Management policy documents and directives in place to govern program execution.	Program Supply Chain Management documents in place to cover program execution.	Initial assessment of potential materials supply chain capacity and capability conducted.	Survey Analysis completed for of potential materials supply chain sources.
Proposed	Survey conducted of IB for potential supply chain material sources.	Potential supply chain materials sources identified.	Initial assessment of potential materials supply chain capacity and capability conducted.	Analysis completed of potential materials supply chain sources.
Team Input			Existing	Existing



# D.4 Special Handling

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		Initial evaluation of potential regulatory requirements and special handling concerns.	List of hazardous materials identified. Special handling procedures applied in the lab. Special handling concerns assessed.	List of hazardous materials updated. Special handling procedures applied in the lab. Special handling requirements identified.
Inputs	Initial special handling concerns identified. All Special Handling policy and process documents and directives in place to govern program execution.	Initial evaluation of potential regulatory requirements and special handling concerns.	Potential special handling concerns and regulatory requirements assessed. Special handling procedures developed. List of hazardous materials identified.	
Proposed	As part of material characteristics and properties survey, initial special handling concerns and policies identified.	Initial review and evaluation potential regulatory requirements and special handling concerns for applicability conducted.	List of hazardous materials identified. Potential special handling concerns and regulatory requirements assessed. Special handling procedures applied in the lab.	List of hazardous materials updated. Special handling requirements analyzed. Special handling procedures are being followed in the lab.
Team Input		existing	Existing	Existing

# E.1 Modeling & Simulation

## (Product & Process)

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		Initial models developed, if applicable.	Identification of proposed manufacturing concepts or producibility needs based on high-level process flow chart models.	Production modeling/simulation approaches for process or product are identified.
Inputs	Potential models and simulations identified. Program M&S plan including approach, objectives and output requirements identified in program documentation.	Initial Identified models and simulations developed for comprehensive analysis., if applicable.	Identification of proposed manufacturing concepts or producibility needs based on high-level process flow chart models. Modeling and simulation software utilized to model behavior of potential solutions. Planned learning curve and data requirements developed	Program M&S plan including approaches for process or product, objectives, and output requirements identified for program documentation.
Proposed	Potential models and simulations identified.	Identified models and simulations developed for comprehensive analysis.	Modeling and simulation software utilized to model behavior of potential solutions. Planned learning curve and data requirements developed.	Program M&S plan including approaches for process or product, objectives, and output requirements identified for program documentation.
Team Input		Existing	Existing	Existing

# E.2 Manufacturing Process Maturity

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing		Identification of material and/or process approaches.	Document high level manufacturing processes. Critical manufacturing processes identified through experimentation.	Complete a survey to determine the current state of critical processes.
Inputs	<p>Identification of manufacturing process approaches.</p> <p>Proposed materiel solutions should be assessed for manufacturability and producibility.</p> <p>Program instructions and directives created and approved for Manufacturing Process Maturity.</p> <p>Program instructions and directives created and approved for assessing the level of Manufacturing Process Maturity required for program.</p>	<p>Feasibility assessments of similar manufacturing process approaches conducted.</p> <p>Criteria for process maturity analysis studies established.</p>	<p>Feasibility assessments conducted identifying manufacturing risks (producibility, critical processes, special tooling, etc.) incurred for each concept.</p>	<p>Complete a survey to determine the current state of critical processes for the selected materiel solution.</p>
Proposed	Candidate manufacturing process approaches identified.	Criteria for process maturity analysis studies established.	Feasibility assessments conducted identifying manufacturing risks (producibility, critical processes, special tooling, etc.) incurred for each concept.	Complete a survey to determine the current state of critical processes for the selected materiel solution.
Team Input		Criteria for process maturity analysis studies established.	Feasibility assessments of similar manufacturing processes conducted.	Proposed

# E.3 Process Yields and Rates

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			Initial estimates of yields and rates based on experiments or state of the art.	Yield and rates assessment on proposed/similar processes complete and applied within Analysis of Alternatives (AoA).
Inputs	<p>Identification of similar existing manufacturing approaches with documented yields.</p> <p>Process yield and rate methodology identified and documented in Program documentation.</p>	<p>Yields and rates estimated from similar existing processes developed.</p> <p>Target yields and rates identified.</p>	Sources of variations and plans to address have been identified.	<p>Yield and rates assessment on proposed/similar processes complete and applied within Analysis of Alternatives (AoA).</p> <p>Process yield and rate methodology identified and documented in Program documentation.</p>
Proposed	Identification of candidate manufacturing approaches with estimated yields.	Yields and rates estimated from similar existing processes developed and initial goals identified.	Initial estimates of yields and rates based on experiments or state of the art. Sources of variations and plans to address have been identified.	<p>Yield and rates assessment on proposed/similar processes complete and applied within Analysis of Alternatives (AoA).</p> <p>Process yield and rate methodology identified and documented in Program documentation.</p>
Team Input			existing	Existing

# F.1 Quality Management

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Quality strategy identified as part of the Acquisition Strategy and included in Systems Engineering Plan (SEP).
Inputs	<p>Identify the initial quality management requirements to be met.</p> <p>Quality management policy and process documentation exists and aligned to program requirements.</p>	<p>Identify solutions or systems that address initial quality management needs and metrics.</p> <p>Program Quality Management Plan developed, approved and issued. Other program quality management documentation generated for program use.</p>	<p>Initial quality issues have been identified.</p> <p>Identify and specify quality management metrics for MDD.</p> <p>Analyze capability to meet quality management needs.</p>	Quality strategy identified as part of the Acquisition Strategy (AS) and included in Systems Engineering Plan (SEP).
Proposed	Initial quality management requirements to be met identified.	Identify quality management processes that address initial needs and metrics.	Analyze quality management capability to meet quality needs. Identify and specify quality management metrics for MDD. Initial quality management issues are identified.	Quality strategy identified as part of the Acquisition Strategy (AS) and included in Systems Engineering Plan (SEP). Quality management policy and process documentation exists and aligned to program requirements.
Team Input			Potential quality issues are identified.	existing

# F.2 Product Quality

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Product inspection and acceptance testing strategy identified as part of the Acquisition Strategy and included in Systems Engineering Plan (SEP).
Inputs	<p>Identify the initial product quality requirements to be met.</p> <p>Assess emerging technology maturity requirements.</p> <p>General Product Quality standards available for program use.</p>	<p>Identify solutions that could address product quality needs and meet product quality requirements.</p> <p>Assess emerging technology maturity requirements.</p> <p>Program Product Quality Standards in place and approved.</p> <p>Required and/or desired product quality attributes identified and where appropriate, specification levels set.</p>	<p>Initial product quality issues identified based on experiments or state of the art.</p> <p>Identify the impact of technology on quality and process state of the art.</p> <p>Initial product quality issues risks identified based on experiments or state of the art.</p> <p>Identify and specify product quality metrics for MDD.</p> <p>Initialize critical to quality (CTQ) analysis for likely components &amp; characteristics of product.</p>	
Proposed	Potential product quality requirements to be met identified.	<p>Solutions that could address product quality requirements identified.</p> <p>Desired product quality attributes identified and where appropriate, specification levels established.</p>	<p>Impact of quality technology and process state of the art on product quality is assessed and risks identified.</p> <p>Identify and specify product quality metrics for MDD.</p>	<p>Product inspection and acceptance testing strategy identified as part of the Acquisition Strategy and included in Systems Engineering Plan (SEP).</p> <p>Initialize critical to quality (CTQ) analysis for likely components &amp; characteristics of product.</p>
Team Input			Potential product quality issues identified based on experiments or state of the art.	Existing

# F.3 Supplier Quality Management

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Potential supplier base quality capabilities and risks identified, including sub-tier supplier quality management.
Inputs	<p>Identify initial supply chain quality management requirements.</p> <p>General Supplier Quality Management standards available for program use.</p> <p>"High level" product or system quality targets considered and initially set.</p>	<p>Identify and establish Supplier Quality Management metrics and solutions that could address quality needs.</p> <p>Program Supplier Quality Management Plan and other documentation in place and approved.</p> <p>Required quality system certifications (e.g. ISO 9001, etc.) specified.</p>	<p>Initial supplier quality issues have been identified based on experiments or state of the art.</p> <p>Initial supply chain supplier quality risks have been identified based on established metrics.</p> <p>Initial quality system audits conducted and any necessary supplier mitigation activity identified for follow-up.</p>	
Proposed	Initial supply chain quality management requirements identified.	Supplier Quality Management processes identified that address quality management needs and metrics.	Initial supplier quality assessed and issues identified based on established metrics, experiments, or state of the art.	No change.
Team Input				Existing

# G.1 Manufacturing Workforce (Engineering & Production)

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			New manufacturing skills identified.	Manufacturing skill sets identified and production workforce requirements (technical and operational) evaluated as part of AoA. Determine availability of process development workforce for the Technology Maturation and Risk Reduction Phase.
Inputs	Survey potential manufacturing skills sets and workforce capabilities relevant to future needs. Manufacturing workforce policy and requirements defined and identified for DoD and Service.	Identify initial manufacturing skills sets and workforce capability requirements. Program manufacturing workforce requirements defined and documented.	Identify workforce requirements, including new skills, special skills, and training requirements for study guidance. Impacts of new materials and potential regulatory impacts on the workforce assessed. Unique and challenging manufacturing skills documented and plan to acquire the required workforce in place.	Manufacturing skill sets <del>identified</del> and production workforce requirements (technical and operational) evaluated as part of AoA. Determine availability of process development workforce for the Technology Maturation and Risk Reduction Phase.
Proposed	Survey potential manufacturing skills sets and workforce capabilities relevant to future needs.	Identify initial manufacturing skills sets and workforce capability requirements.	Identify workforce requirements, including new skills, unique, challenging, special skills, and training requirements for study guidance. Impacts of new materials and potential regulatory impacts on the workforce assessed.	Manufacturing skill sets and production workforce requirements (technical and operational) evaluated as part of AoA. Determine availability of process development workforce for the Technology Maturation and Risk Reduction Phase.
Team Input		Survey potential manufacturing skills sets and workforce capabilities relevant to future needs.	Identify workforce requirements, including new skills, unique, challenging, special skills, and training requirements.	



# H.1 Tooling / Special Test and Inspection Equipment (STE/SIE)

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Tooling/Special Test Equipment (STE)/Special Inspection Equipment (SIE) requirements are considered as part of AoA.
Inputs	<p>Survey the IB for existing STE/SIE (including GFE) that could be potentially utilized.</p> <p>Sponsor ManTech Projects as needed.</p> <p>STE/SEI policy and directives identified and understood.</p>	<p>Identify existing and new manufacturing processes requiring tooling and/or capital equipment for new technology and materials.</p> <p>Sponsor ManTech Projects as needed.</p> <p>Program STE/SEI Plan and approach documented and approved.</p>	<p>Tooling, Special Test Equipment (STE), Special Inspection Equipment (SIE) have been identified.</p> <p>Tooling, Special Test Equipment (STE), Special Inspection Equipment (SIE) <del>have been identified</del> requirements for development evaluated and established. Identify requirements for unique or special transportation, handling, and storage equipment.</p> <p>Identify funding requirements for capital equipment, tooling, and test equipment. Statistical measuring system studies (i.e. Gage R&amp;R studies) identified &amp; initiated where appropriate.</p>	<p>Tooling, Special Test Equipment (STE), Special Inspection Equipment (SIE) requirements, including modifications, funding, and schedule, are considered as part of AoA.</p>
Proposed	<p>Survey conducted of the IB for existing STE/SIE (including GFE) that could be potentially utilized.</p>	<p>Existing and new manufacturing processes requiring tooling and/or capital equipment for new technology and materials identified.</p>	<p>Tooling, Special Test Equipment (STE), Special Inspection Equipment (SIE) requirements for development evaluated and established.</p> <p>Requirements for unique or special transportation, handling, and storage equipment identified.</p>	<p>Tooling, Special Test Equipment (STE), Special Inspection Equipment (SIE) requirements, including modifications, funding, and schedule, are considered as part of AoA.</p>
Team Input				

# H.2 Facilities

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing			Specialized facility requirements/needs identified.	Availability of manufacturing facilities for prototype development and production evaluated as part of AoA.
Inputs	<p>Survey the IB for existing facilities and capital equipment that could be potentially utilized.</p> <p>Assess facility availability.</p> <p>DoD/Service facility policy and directives identified and understood.</p>	<p>Identify initial facility and capital equipment requirements including unique or special requirements for transportation, handling, and storage equipment.</p> <p>Program facility plan developed and approved. General facility requirements/needs identified.</p>	<p>Assess the availability, design, rate and capacity capabilities of the facilities under consideration.</p> <p>Evaluate impacts on facilities by types of processes required (e.g., specialized fixtures, test chambers, laboratories, clean rooms, waste storage and disposal, etc.).</p>	<p>Capability, and availability of manufacturing facilities for prototype development and production evaluated as part of AoA.</p> <p>Funding needs for additions/modifications to existing facilities included in evaluation.</p>
Proposed	<p>Survey of the IB for existing facilities and capital equipment that could be potentially utilized conducted.</p>	<p>Initial facility and capital equipment requirements identified including unique or special requirements for transportation, handling, and storage equipment.</p>	<p>Availability, design, rate and capacity capabilities of the facilities under consideration assessed.</p> <p>Impacts on facilities by types of processes required evaluated (e.g., specialized fixtures, test chambers, laboratories, clean rooms, waste storage and disposal, etc.).</p>	<p>Capability, and availability of manufacturing facilities for prototype development and production evaluated as part of AoA.</p> <p>Funding needs for additions/modifications to existing facilities included in evaluation.</p>
Team Input				

# I.1 Manufacturing Planning & Scheduling

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Manufacturing strategy developed and integrated with acquisition strategy. Prototype schedule risk mitigation efforts incorporated into Acquisition Strategy.
Inputs	<p>Survey the IB to identify manufacturing planning and scheduling state of the art.</p> <p>Assess materials availability for candidate solutions.</p> <p>Manufacturing Management policy and directives identified and understood.</p>	<p>Initiate manufacturing planning and scheduling (include alternatives).</p> <p>Planning addresses: Producibility, Critical mfg. processes, STE/SIE, Test and demonstration, Potential mfg risks, and Funding constraints.</p> <p>Program Manufacturing Plan developed and approved.</p> <p>Preliminary Manufacturing Schedule developed.</p>	<p>Manufacturing plan developed as input to AoA study and future acquisition strategy. Plan includes: type of manufacturing organization, parameters for a make or buy plan, type of resources and mfg capability needed, and quantitative and qualitative data requirements.</p> <p>Manufacturing Schedule developed and approved.</p>	
Proposed	Survey of the IB conducted to identify manufacturing planning and scheduling state of the art.	Initial manufacturing planning and notional schedule outlined.	Notional manufacturing plans and schedules developed as inputs to AoA study and future acquisition strategy.	No change
Team Input				

# I.2 Materials Planning

Sub-Thread	MRL 1	MRL 2	MRL 3	MRL 4
Existing				Technology development article component list developed with associated lead time estimates.
Inputs	<p>Survey the IB for potential materials (capabilities) relevant to future needs.</p> <p>Initiate planning activities for future materials requirements.</p> <p>Manufacturing materials policy and directives identified and understood.</p>	<p>Identify materials (and alternatives) for considerations of technical maturity, characterization, fragility, sole source, domestic vs. foreign, etc.</p> <p>Initial Manufacturing Materials Plan developed.</p>	<p>Analyze the of feasibility of materials and alternatives.</p> <p>Analyze technical maturity and characterization of materials, sources, essential raw materials, special alloys, composite materials, etc.</p> <p>Evaluate vulnerability that could result from the lack of alternatives.</p> <p>Manufacturing Materials Plan tied to Manufacturing Schedule developed and approved.</p>	<p>Technology development article TMRR component list developed with associated lead time estimates from the AoA.</p>
Proposed	<p>Survey of the IB for potential materials (capabilities) relevant to future needs conducted.</p>	<p>Materials (and alternatives) identified for considerations of technical maturity, characterization, fragility, sole source, domestic vs. foreign, etc.</p>	<p>Feasibility of materials and alternatives analyzed.</p>	<p>TMRR component list developed with associated lead time estimates from the AoA.</p>
Team Input				