Welcome to SDMT Project Pitch Meeting

- Please type in your questions, everyone is on mute.
- Meeting goal:
  - Introduce project ideas to our voting panel members.
  - Help projects find collaborators and shipyard partners.
- Each project will have **5min** to provide project pitch, followed by questions from messaging window, as time permits.
- Projects due to Panel Chairs and ATI **August 12th** @12 (noon) Eastern, @9am Pacific.
- Contact: MSkowron@nassco.com

Time Eastern	Time Pacific	Presentation	Speaker
11:00	**8:00**	**Convene Meeting/ Meeting Logistics**	
11:00	8:00	Meeting Overview and NSRP Program Update	Monika Skowronska, NASSCO Vicky Dlugokecki Nick Laney, ATI
11:15	8:15	Development of NDT Calibration Block for Directed Energy Deposition Additive Manufacturing Processes	John Ralls, Newport News Shipbuilding
11:20	8:20	Temporary Firestop During Construction	Terry Mannion, STI Marine Firestop
11:25	8:25	Digital Twin manufacturing of ship structures	Martin Hardwick, STEP Tools, Inc. / ISO TC184/SC4 WG15
11:30	8:30	Artificially Developed CAD Models (Next Generation Capabilities)	Alicia D'Aurora-Harmon, Newport News Shipbuilding
11:35	8:35	Digital Twin Maturity Models (Next Generation Capabilities)	Alicia D'Aurora-Harmon, Newport News Shipbuilding
11:40	8:40	High Duty Metal Additive Manufacturing Using Cryogenic Cooling Thermal Control	Dennis Harwig, EWI
11:45	8:45	Knowledge Provisioning to Simplify Preliminary Design	Victoria Dlugokecki, Victoria Dlugokecki, P.E.
11:50	8:50	Using AI to Simplify Provisioning of Navy Standard Rqmts	Victoria Dlugokecki, Victoria Dlugokecki, P.E.
11:55	8:55	Industry Standards for Unmanned and Autonomous Surface Vehicles (USVs)	David Walker, ABS (American Bureau of Shipping)
12:00	9:00	Aluminum Sensitization on High Speed Vessels	Derek Novak, ABS (American Bureau of Shipping)
12:05	9:05	Autonomous System Design Integration	Pat David, SSI USA
12:10	9:10	Design - Build for Test	Pat David, SSI USA
12:15	9:15	Digital Scan Management	Pat David, SSI USA
12:20	9:20	State of Digital Drawing Delivery	Pat David, SSI USA
12:25	9:25	Next Generation Remote Operation Gear for Valves	John Walks, Ingalls Shipbuilding
12:35	9:35	Advanced Insulation Material Assessment	John Walks, Ingalls Shipbuilding

Time Eastern	Time Pacific	Presentation	Speaker
12:40	9:40	Comprehensive Aircraft Tie-Down Strength and Corrosion Evaluation	Steve Scholler, Ingalls Shipbuilding
12:45	9:45	Additive Manuf. for Seawater Heat Exchangers	Scott Kasen, Electrawatch
12:50	9:50	Large Scale Additive Manuf. for Composite Unmanned Hulls	Scott Kasen, Electrawatch
12:55	9:55	PUMPKIN Mounts	Alan Klembczyk, Taylor 10, Inc.
1:00	10:00	Tulip Studs to Replace Stand-Off & Flat & Angle Bar Clips	Clark Champney, Nelson Stud Welding Div. Stanley Blavk & Decker
1:05	10:05	Standardization of UxV Shipboard Interfaces	Isabelle Brown, NASSCO
1:10	10:10	Questions and any additional pitches	
3:00	**12:00**	**Adjourn**	

Program Update

Ship Design and Material Technologies Panel Project Idea Presentation Meeting

July 31th, 2020

Virtual

NSRP Mission

The mission of the National Shipbuilding Research Program is to reduce the total ownership cost and improve the capabilities of both United States Government and U. S.-flag commercial ships.

The Program accomplishes this mission by providing a collaborative framework to manage, focus, develop and share research & development, and leverage best practices in shipbuilding and ship repair.

NSRP Collaboration

Anti-Trust Rules

- Regarding your company's and/or your competitor's **product & services**:
  - Do not discuss current or future prices.
  - Do not discuss any increase or decrease in price.
  - Do not discuss pricing procedures.
  - Do not discuss standardizing or stabilizing prices.
  - Do not discuss controlling sales or allocating markets for any product.
  - Do not discuss future design or marketing strategies.

Anti-Trust Rules

- Regarding your company's and/or your competitors' selection of their **supplier companies**:
  - Do not discuss refusing to deal with a company because of its pricing or distribution practices.
  - Do not discuss strategies or plans to award business to remove business from a specific company.
- Regarding your company's and/or competitors' **trade secrets**:
  - Do not discuss trade secrets or confidential information of your company or any other participant.

Panel Project Proposal Process

1. **Offeror Teams** – Submit White Papers to Panel Chairs **and** Program Administrator
2. **Panel Downselect**
3. **Panel Chairs** – Submit (up to 3) White Papers
4. **White Paper Screening** – Offerors provide Q&A responses
5. **Panel Chairs** – Present to Executive Control Board
6. **Executive Control Board** – Selection and standby decisions
7. **Award**

Navy Sponsors – Feedback (to White Paper Screening and Executive Control Board)

Currently Open!
White Papers due to Panel Chairs and ATI by August 12th, 2020.
See NSRP.org for the solicitation and more details.

Panel Project Requirements

- Official requirements can be found in the Panel Project Solicitation and the Panel Project Guide Vol 1 located at https://www.nsrp.org/resource-library/:
- Deadline for Offerors to submit white papers to Panel Chairs ***and*** ATI is 12:00 p.m. (noon) ET on **August 12, 2020**.
- Deadline for Panel Chairs to submit top three white papers and any joint panel papers to ATI is 12:00 p.m. (noon) ET on **September 9, 2020.** Panel Chairs shall submit white paper(s), using the White Paper Submission Module.
- Deadline for Offerors whose white paper is one of the panel's top three to submit to ATI the Supporting Cost Data Table, required by the Panel Project Guide Vol 1 – Offerors Rev. T, is **September 9, 2020**.
- **NOTE: White paper submitters are reminded that each Panel Chair will have interim due dates to accommodate their panel's down-select process prior to submission to ATI. Please regularly check the NSRP website for those dates.**
- *Any questions can be directed to Ryan Schneider (ryan.schneider@ati.org) or Sarah H. Swain (sarah.swain@ati.org).*

Panel Project Requirements

- NSRP Executive Control Board member shipyards and panel members (as defined by individual panel membership by-laws) may submit white papers.
- No more than $150K in program-funded costs (Note: Fee or profit is not allowed)
- No more than 12 months in duration
- At least one member shipyard should be a project participant – ***multiple shipyard participation is strongly encouraged.*** An endorsement email for each participating member shipyard, specifically, an email from that yard's NSRP Shipyard Delegate (NSD) must be attached. These endorsement pages do not count toward the three page limit.
- If a Government organization will participate in the project, provide the name and contact information for the government point of contact who agreed to participate. If there is any issue with obtaining this information, offerors should contact the NAVSEA NSRP Program Engineer, Mr. Howard Franklin, at howard.l.franklin@navy.mil or (202) 781-2171 for early coordination.

Panel Project Requirements

- Offerors shall submit white papers directly to the appropriate Panel Chair and ATI (nsrp@ati.org).
- Any proposed prime contractor shall ensure all subcontractors will agree to the terms and conditions of NSRP's standard Base Task Order Agreement prior to submission of a white paper.

Panel Universal By-laws

- At minimum, panel voting membership will include all of the member shipyards.
- Each organization gets only ONE vote. If an organization has a qualified voting member in a NSRP leadership position (Panel Chair, Panel Vice Chair, or Major Initiative Team Leader) the organization will have an additional vote (not to exceed two votes).
- Except for member shipyards, organizations must meet panel membership requirements, as defined in the individual panel by-laws, to propose a panel project or vote in panel voting activities.

Development of NDT Calibration Block for Directed Energy Deposition Additive Manufacturing Processes

Project Lead Organization: Huntington Ingalls Industries – Newport News Shipbuilding
Project Team members: PennState ARL (participant), HII-Ingalls (unfunded participant), NAVSEA 05 (Advisory Role)

Concept/Idea

Issue: AM Calibration Reference Standards do not exist for additively manufactured material made using Directed Energy Deposition Processes. This type of AM technology supports larger scale fabrication approaches. The ability to evaluated and potentially remove this technology barrier is expected to support all shipyards in applying a common NDT inspection approach using a standardized baseline reference.

Proposed Solution(s): The goal of this project is to enhance technology adoption through the design and development of an NDT Reference Standard(s) (e.g. calibration block(s)) which will aid in accelerating the qualification of an AM DED process in accordance with the NDT requirements of NAVSEA T9074-AS-GIB-010-271.

Benefits/Justification

Benefits of the project

- Support development of future AM standards and requirements in the area of NDT.
- Minimize time and resources required for NDT qualification. Provided standard calibration blocks for potential use by other shipyards (retained by AM TWH).
- Support growth of AM in shipbuilding by establishing guidelines for simple and time-efficient process qualification. The results will be usable by any shipyard seeking to qualify an AM process to the NDT requirements of NAVSEA T9074-AS-GIB-010-271.
- Expected cost avoidance is realized by providing a standard solution across shipyards, vice each shipyard developing a custom solution. The cost of this project serves as a good estimate of the cost each shipyard would avoid with the ability to utilize the standardized solution.

Project Approach

High level statement of work

- Perform background industry literature review and develop AM DED NDT plan.
- Determine the feasibility of LPBF Reference Standard designs from NAVSEA S9074-BD-010-AM-LPBF for production of DED calibration blocks and select designs to manufacture and test.
- Fabricate DED calibration blocks for at least two materials and up to four DED processes (e.g., wire-arc, laser-wire, electron beam, and laser-powder DED). The final coupon details will be established as part of the project, however, it is anticipated that these coupons may be in both the as-printed and machined conditions.
- Perform NDT in accordance with NAVSEA T9074-AS-GIB-010-271 and analyze results.
- Develop final documentation for the DED calibration block design and provide guidelines for using the developed DED NDT Reference Standard to qualify DED processes in regards to NDT requirements.
- Potential to capture in-situ data for follow-on work or future panel or RA project developments by this team.

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150K (NTE)
- **Duration:** 12 Months

Metric(s) of Success

- Final report issued to NSRP with calibration block design and test results
- One set of calibration material provided to NAVSEA's AM TWH. Balance retained by NNS.

Temporary Firestop During Construction

Project Lead Organization: **STI Marine Firestop**
Project Team members: STI Marine Firestop, Yard A, Yard B

Concept/Idea

Issue: **Is Temporary Firestop to protect vessels under repair / construction in the drydock or dockside a viable requirement ?**

Proposed Solution: **Provide a temporary, re-useable, fire stop access port in way of existing fire doors**

Benefits/Justification

Benefits of the project

- **Allow existing fire doors to be closed when necessary**
- **Allow temporary cables, air and water lines to freely pass thru the bulkhead**
- **Provide a temporary firestop to adjacent compartments**
- **Possible access for AFFF and firehose without opening the fire door**
- **A re-useable firestop solution**

Project Approach

High level statement of work

- **With Yard input, compile lists of all temporary services normally routed thru open doors during repair / construction**
- **Develop solution(s) and test plan**
- **Conduct small scale test(s) at STI Marine Fire Lab in Somerville, NJ**

Metric of Success

- **Document results of Fire Lab tests and report comments of Yard stakeholders**

Cost/Images/Relevant Information

- **Project Estimated Cost: $150,000**

STI MARINE FIRESTOP

Digital Twin manufacturing of ship structures

Project Lead Organization: Shipyard with AP242 models for ship structures
Project Team members: STEP Tools, Inc.

Concept/Idea

Issue: When work is performed by multiple machines in many stages keeping track of the state of the product is challenging so many solutions are non-optimal.

Proposed Solution(s): Apply the Digital Twin framework for manufacturing (ISO 23247) to shipbuilding.

.

Benefits/Justification

Benefits of the project

- Increase throughput by dynamically assigning tasks to robots (25% faster for airframe assembly)
- Reduce weight by exact matching of fasteners to hole stack-up (500lb saving for an F35)
- Reduce costs by managing tool wear more precisely (15% reduction for aerospace machining)

Project Approach

High level statement of work

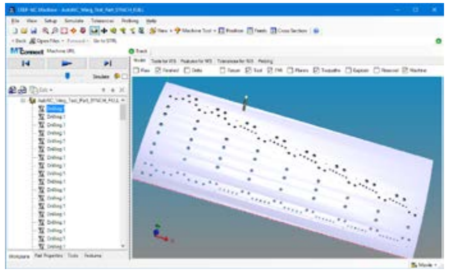
- Adapt aero structures uses cases for ship structures
- Demonstrate feasibility using a virtual testbed
- Estimate benefits

Metric(s) of Success

- Use cases demonstrated for ship structures
- Pilot selected for testing at a shipyard

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000



AP242 model of wing

Physical Testbed

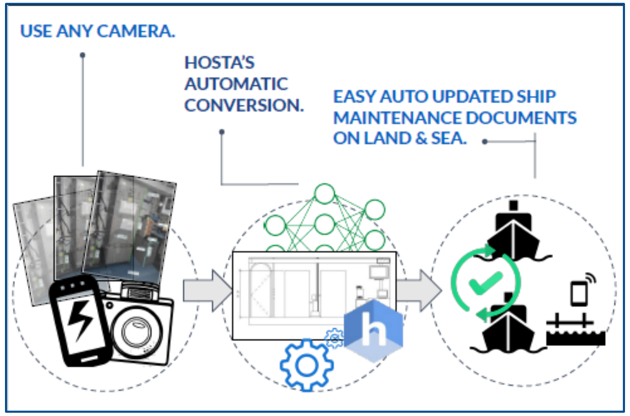
Artificial Intelligence (AI) Developed CAD Models (Next Generation Capabilities)

DRAFT 07-29-2020 by MDD

Issue

There is no automated process for creating CAD models from mobile device laser scan files.

Proposed Solution:
Evaluate software developed by Hosta Labs' A.I. which converts images of interior spaces/compartments into data and data into models, plans, and insights. It does this by assigning each pixel of an image to an object and adding properties to that object to enable contextual understanding *(i.e. a window belongs to a wall that has a 6 inch partition and a 2hr fire rating)*.



Benefits/Justification

Hosta Labs enables a significant efficiency increase in ship maintenance by:

- Automated CAD model generation from a simple image without any expert intervention
- Device-agnostic
- Full-digitization of ship maintenance data to allow for predictive maintenance & VR-supported maintenance enabling remote tracking of changes made on water with just a simple image (a ship maintenance officer can be equipped with a small device and track all changes onsite),
- Automatically creating product models from simple images or 2D drawings (no need to fly-in onshore teams)
- Providing bill of material data with timestamps as well as models of spaces or potentially parts for predictive maintenance, VR-maintenance solutions, and 3D printing.

Sample output can be found here: modler.io/n/ship_sample.pdf

Consideration for a cross BT & SDMT panel project.

Major Deliverables

- Documentation for evaluation use-case and capabilities.
- Document containing COTS software application evaluation results and application maturity levels.
- Strategic whitepaper on laser scan to CAD utilizing AI technology current state, next steps to support digital transformation, and implementation recommendations.

Schedule / Cost & Savings

- Investment = $150,000
- Return: Automation of manual processes by using AI
- Return on Investment (ROI): TBD Core for Digital Transformation
  - Future State efficiency
- Project Schedule = 12 months
- Team members: Hosta Labs TBD: US Shipyards,

Digital Twin Maturity Model Framework (Next Generation Capabilities)

DRAFT 07-29-2020 by MDD

Digital Twin definition: A digital twin is a virtual, computer-based representation of an asset or of a process. It is used to analyze and specify requirements, optimize the asset, understand its behavior, manage the asset's configuration, interface with the physical design and forecast future performance. The digital twin can exist in all phases of the digital thread – Design, Build, or Sustain.

Issue

The Defense Industry lacks consistent documentation for "Digital Twins" categorization (macro to micro level), usage, maturity level, and value/benefit as well as for their development and maintenance and configuration management costs.

Proposed Solution

Develop a framework which addresses types, uses, and costs for defining Digital Twin implementation strategies.

This project would concentrate on the:

- Development a Defense/Shipbuilding Industry reference document for the use of Digital Twins. This would also serve to create a single ontology around digital twin terms and their usage.
- Provide a framework to evaluate the Digital Twin maturity levels necessary to meet specified use-cases, capabilities, and requirements for Design and Operational DT's.
- Develop a ROI evaluation tool based on Digital Twin capabilities, complexity, and maturity levels.

Benefits/Justification

- The Digital Twin is a bridge between the digital world and the physical world. Its core use is to optimize business performance, through the analysis of data and the monitoring of systems to prevent issues before they occur and prevent downtime.
- This project will provide relevant information and documentation necessary to categorize, evaluate benefits, and the most effective use of Digital Twins.
- Provide the Shipbuilding Industry standardized definitions for Digital Twins.
- Provide a strategy for the planning and development of Digital Twins and their usage across the Design /Build /Sustain spectrum.
- Provide insight on the software, data, and system integration necessary to develop and support a Digital Twin.
- This project addresses the direction laid out in the NSRP 2020 Strategic Investment Plan & Technology Investment Plan.

Major Deliverables

1. Functional categorization documentation of Digital Twins.
2. Framework for Digital Twin Readiness to consider:
    - 3D Geometric Model
    - Digital Data
    - Sensor requirements
    - Technical Experience
    - Configuration Management – Governance
    - Fidelity/Performance of Functional Models
    - Hardware/Software, Security – Environment integration
    - Physical Asset
3. Framework for Digital Twin cross reference between capability, maturity level and benefit.
4. Final report for the use and evaluation of Digital Twins.

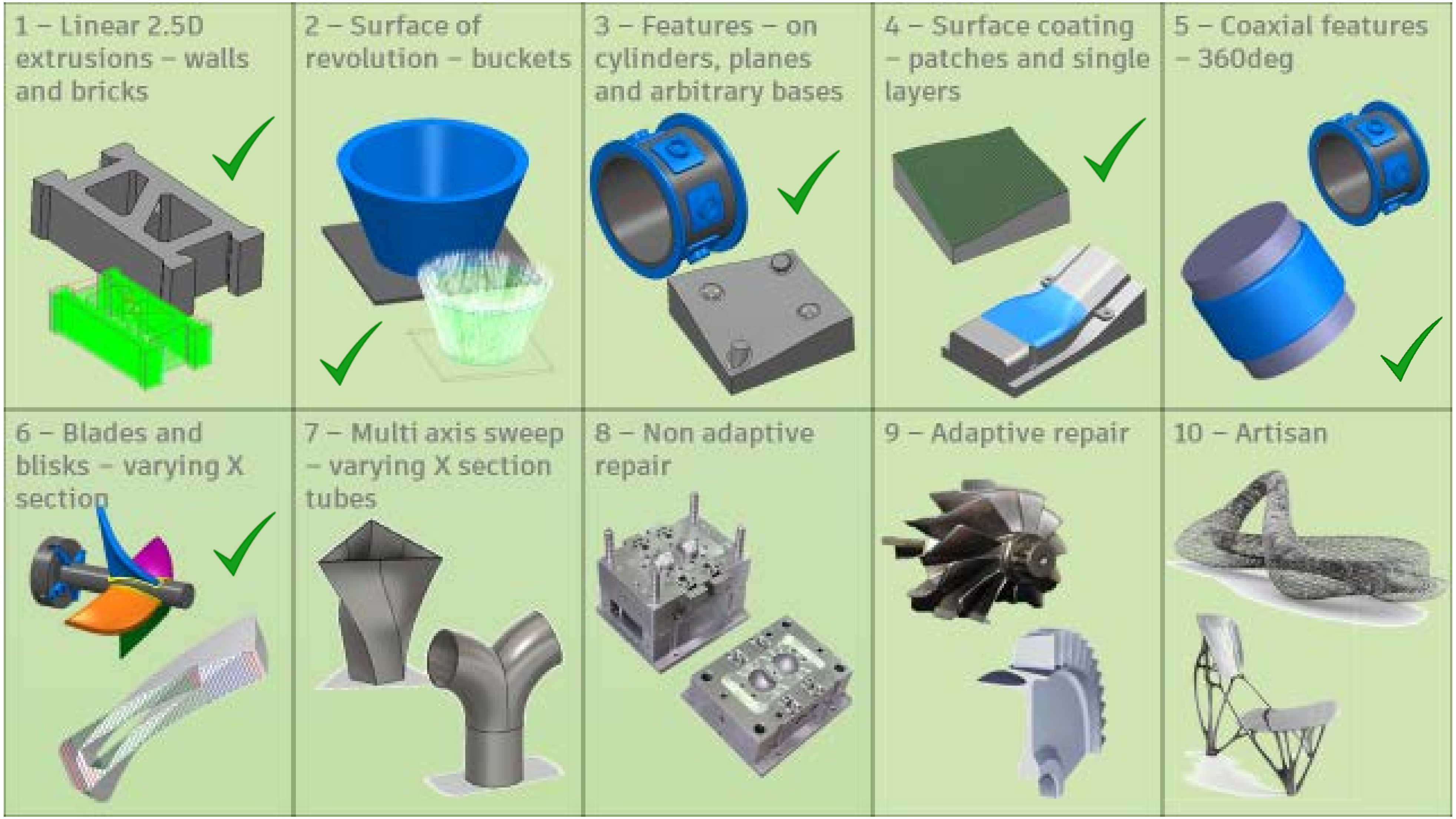
Schedule / Cost & Savings

- Investment = $150K
- Return: 10,000 man-hours on new design
- Return on Investment (ROI) = 8.0
- Project Schedule = 12 months
- Team members: GDEB, TBD: US Shipyards, Consultants, NIST, Navy

Presentation Objectives

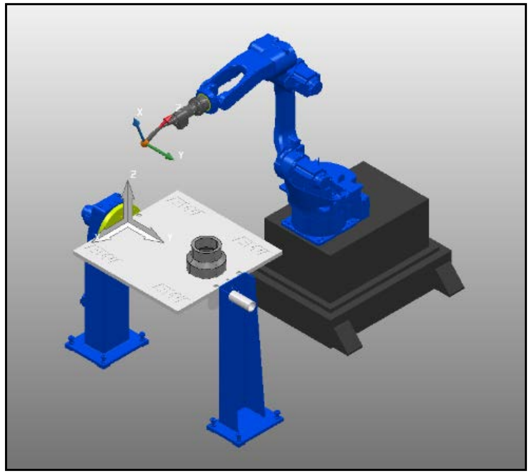
- Provide short overview on white paper proposal for SDMT consideration:
  - FY21 NSRP Panel Project - High Duty Metal Additive Mfg. using Cryogenic Cooling Thermal Control

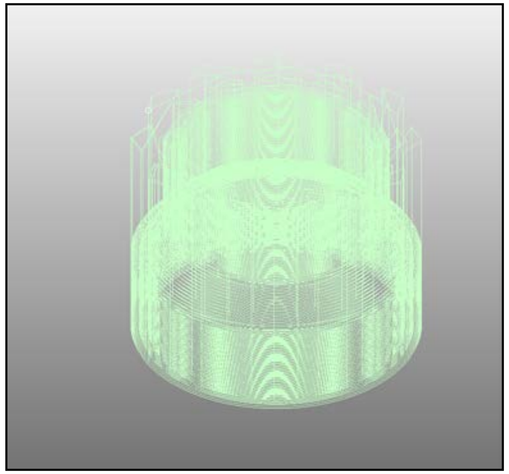
Autodesk Powermill Additive – DED Build Categories

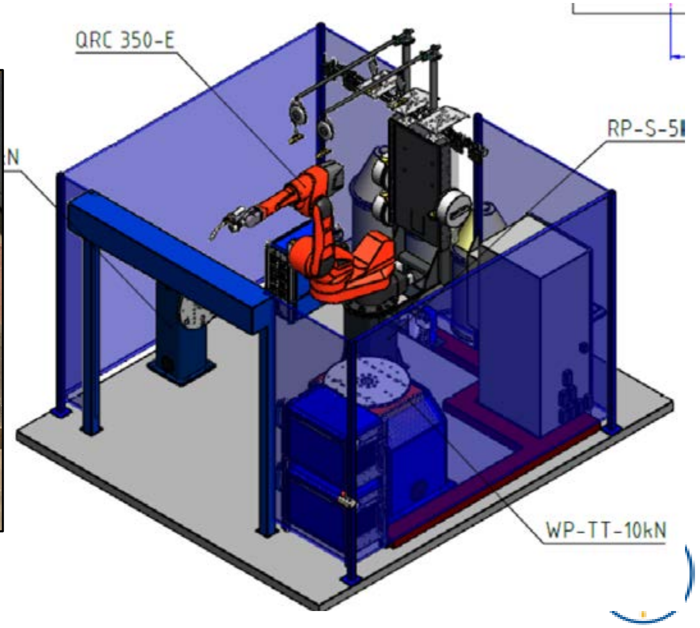


Cryogenic Cooling Technology for High Duty DED

- Background:
- Build rate and DED economics are impacted by interpass temperature requirements.
- On recent builds, up to 80% of build time was spent waiting for the build to cool between deposit passes.
- Forced air or water spray cooling can be used but have limitations for DED AM applications.
- Cryogenic cooling for either interpass cooling between deposits or in-situ cooling directly behind the torch for maximum duty
  - Commercial equipment available / implemented on thermal spray apps.



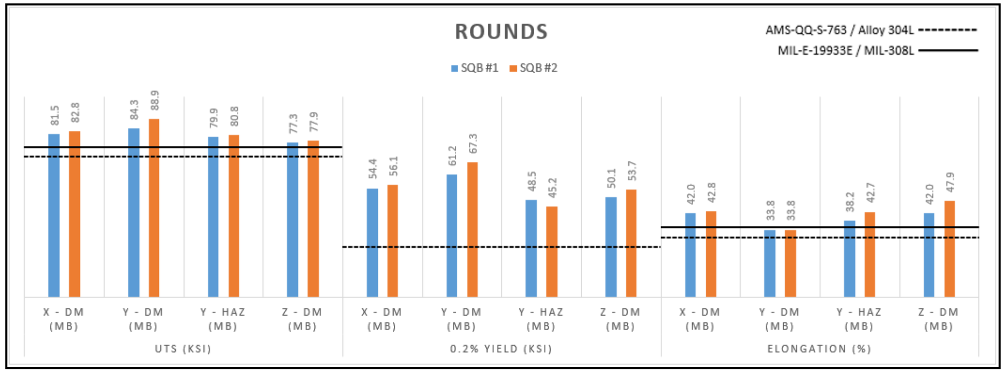




FY21 NSRP Panel Project Objectives

- Develop in-situ liquid nitrogen cryogenic cooling (ILNCC) technology for high productivity DED
  - Key variables will include location of the ILNCC nozzle behind the GMA-P torch, nozzle & flow barrier design, and LN phase (gas, gas-liquid, or liquid) and LN flow rate.
- Develop ILNCC Setups and Procedures for Different Features - Maximize productivity,
- Evaluate effects of ILNCC technology on SQB properties of target shipbuilding material(s),
- Recommend procedure variables for interpass temperature control & qualification, and
- Analyze the effects of ILNCC technology on process economics for the business case.

Standard Qualification Build (SQB)



Specification	Type	Minimum Ultimate Tensile Strength	Minimum Yield Strength	Minimum Elongation
AMS-QQ-S-763	Alloy 304L (Base Material)	70-ksi	25-ksi	30%
MIL-E-19933E	MIL-308L (Wire)	75-ksi	N/A	35%

FY21 NSRP Panel Project - High Duty Metal Additive Mfg. using Cryogenic Cooling Thermal Control

- Benefits:
  - Improved duty cycle (2-3X) and deposition rate for DED AM builds,
  - lower residual stresses and distortion,
  - Ability to use higher DED process heat inputs and deposition rates,
  - Provides clean surface (leaves no residue on build surface).
- Deliverables:
  - ILNCC procedures for maximizing duty of arc DED AM on a target material.
  - Equipment setup recommendations to control interpass temperature without arc process interference,
  - Procedure variable requirements to support process qualification, and
  - Baseline process metrics & economic data for business case development.

Effect of the Variation of Incoming Pipe Material Properties on Springback in Pipe Bending

Project Lead Organization: EWI, Inc.
Project Team members: Ingalls Shipbuilding

Concept/Idea

Issue:

- The legacy bending machines in the shipyards can be upgraded to compensate springback by integrating with the real-time monitoring sensors such as NDT and visual inspection tool.

Proposed Solution(s):

- EWI has developed a Machine-Learning (ML) based control algorithm method for the sheet metal formed part quality by correlating the incoming material properties and material formability / springback. A similar control approach can be used to control springback in pipe bending for the shipyards.

Benefits/Justification

Benefits of the project

- Compared to the empirical method for springback compensation, the proposed method can significantly reduce reworks on the bent pipes.
- Possibly reducing the scrap rate and the machine down-time
- Helping the operators compensate springback based on the real-time measured data (i.e. the large capital investment for new machine machines can be delayed or reconsidered)
- Gaining the ability to check the incoming pipe properties that can influence the final part quality.

Project Approach

High-level statement of work

- State-of-art (SOA) review on the best and latest practices in pipe bending
- Feasibility to inspect the incoming pipe material properties using an NDT sensor
- Feasibility to monitor the bend profile using the vision system
- Conceptual design of the bending manufacturing cell integrated with sensors

Metric(s) of Success

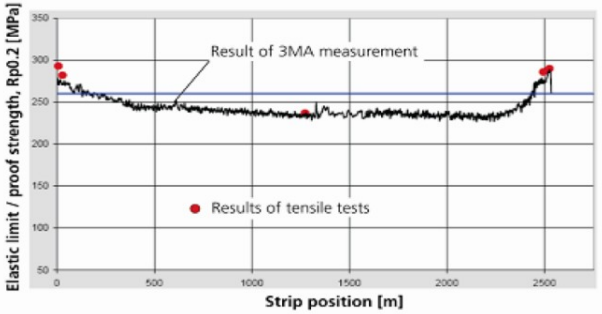
- Proofs of the feasibility to measure the pipe properties and springback using sensors
- Validate business case for implementation at a participating yard.

Cost/Images/Relevant Information

Project Estimated Cost:

- $150,000

Application of the NDT sensor to monitor the yield strength of steel strips



Knowledge Provisioning to Simplify Preliminary Design

Project Lead Organization: Auros Knowledge Systems
Project Team members: Express Marine, Shipyards - TBD

Concept/Idea

Issue: A significant percentage of a ship's cost is locked-in during the concept and preliminary design phase, before the functional design of a vessel even starts. The ability to quickly develop compliant designs, incorporating lean design and DFP concepts, and perform rapid trade-off studies to obtain the least cost option, has the potential to make a big impact on ship cost.

Proposed Solution(s): This project will build on the successes of previous knowledge provisioning projects (with SSI and ABS) and the SSI/Express Marine Integration project, to seamlessly connect knowledge throughout the structural design phases from concept design through detail and production design. The key deliverables will be an ability to connect Express Marine to the Auros Knowledge Systems to complete the integration of knowledge provisioning into the structural design process as well as provide documentation of the future state process to promote widespread future implementation.

Benefits/Justification

Benefits of the project

- Knowledge is provisioned into seamlessly connected design tools
- Simplified ABS / Owner Requirements compliance
- Allows for rapid change by use of parametric / rule-based configurations
- Early application of lean design and DFP best practices
- Early application of shipyard's design guidelines and lessons learned
- Active approach to knowledge management and provisioning

Project Approach

High level statement of work

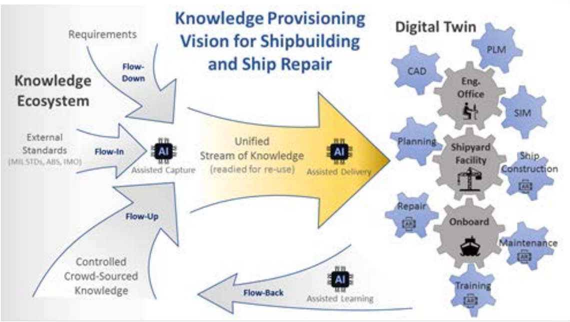
- Technology Transfer / Software Integration Requirements
- Develop Connector between Auros and Express Marine
- Structural Design Pilot Project
- Future State Process from Concept Design through Design/Production Design

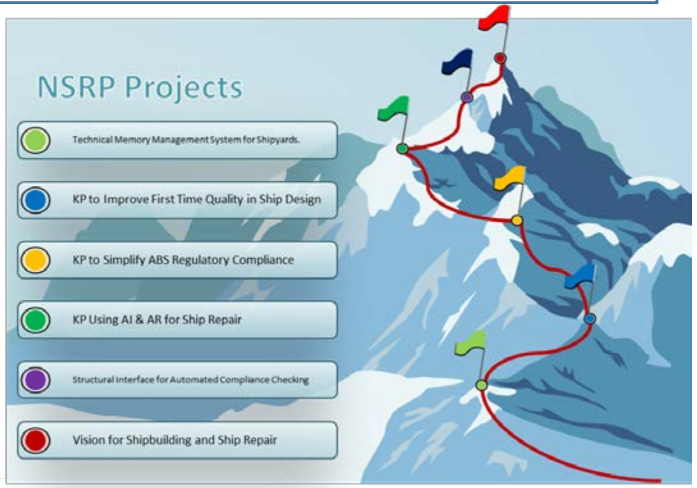
Metric(s) of Success

- Reduced cycle time / man-hours for structural design
- Improved first time quality of concept / preliminary design
- Reduced checking time

Cost/Images/Relevant Information

- **Project Estimated Cost:**
  $150,000





Using AI to Simplify Provisioning of Navy Standard Rqmts

Project Lead Organization: Auros, LLC
Project Team members: NAVSEA - TBD, Shipyards - TBD, Hepinstall Consulting Group

Concept/Idea

Issue: Navy Standards are available to shipyards in PDF, Word, and other "dumb" file formats, which include scanned in images. As a result, these "dumb" files require significant manual effort to parse and organize for provisioning and compliance tracking. In addition to the inefficiency of manually developing and updating check sheets, there is significant risk of human error to overlook or miss some standards.

Proposed Solution(s): Use Artificial Intelligence / Machine Learning to digitize the Navy Standard Rqmts by automatically parsing the standards files into logical individual rules and categorize each rule for provisioning into the shipyard workflow as required. This will avoid the need to manually develop check sheets and eliminate the risk of missing some standards due to human error. Through this approach, compliance can be captured through generated assessments.

Benefits/Justification

Benefits of the project

- Simplify Navy Standard Requirements compliance
- Automate provisioning and compliance tracking of Navy Standards through digitization
- Increased visibility and traceability
- Reduce risk of overlooking or missing some Navy Standards
- Reduce preparation time for new ship design cycle
- Provide foundation for Knowledge Operating System (KOS)

Project Approach

High level statement of work

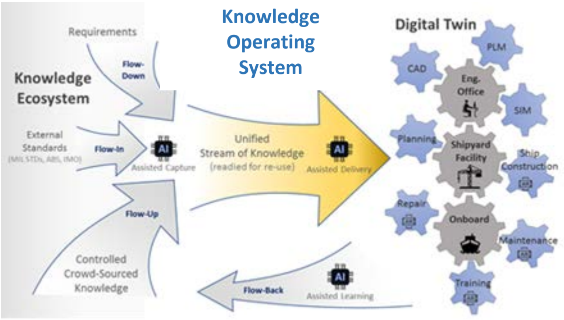
- Identify Use Case and relevant Navy Standard Rqmts
- Software Requirements to Integrate OCR capability with Document Ingestor
- Develop and integrate OCR capability to extract scanned in images through Document Ingestor
- Perform Pilot

Metric(s) of Success

- Reduced cycle time / labor to identify and apply Navy Standards
- Improved first time quality through compliance tracking and Mgmt overview
- Provide closed loop process to capture learnings from design process

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000



This project leverages capabilities developed in the ABS Compliance Simplification project and the AI / AR for Ship Repair project, extending the AI capability to address the unique features of Mil Stds, such as digitizing scanned images, to build on the foundation of a Knowledge Operating System.

Industry Standards for Unmanned and Autonomous Surface Vehicles (USVs)

Project Lead Organization: ABS
Project Team Members: Participating Shipyards, NAVSEA 05, PMS 406, PEO Ships – USC, ONR, DARPA (NOMARS)

Concept/Idea

Issue: They Navy is making major commitments to USVs within its forward-looking fleet mix. However, USVs must achieve key mission performance, reliability/endurance, and lifeycle cost targets to fulfill Navy objectives. Most USV discussions point toward a stronger reliance on "commercial standards and shipbuilding practices," but common, foundational USV requirements to facilitate USV program successes are limited.

Proposed Solution(s): ABS is in a unique position to work with industry and Government to develop Rules and Guides for USVs that provide common, foundational requirements aligned with Navy mission objectives. This project will focus on engaging both the shipbuilding industry and Government stakeholders in laying the foundation for such guidance/standards.

Benefits/Justification

Benefits of the project

- Framework for Rules and Guides that will provide the industry and the Government the flexibility for innovation in concepts and designs, but with guidelines to promote predictable reliability/performance and production efficiency
- ABS further development (outside of this project) of ABS Rules and Guides to close gaps in needed commercial standards identified through this project, benefitting future construction programs
- Industry supported standards for USVs that the Government can reference or incorporate with future USV design requirements and specifications

Project Approach

High level statement of work

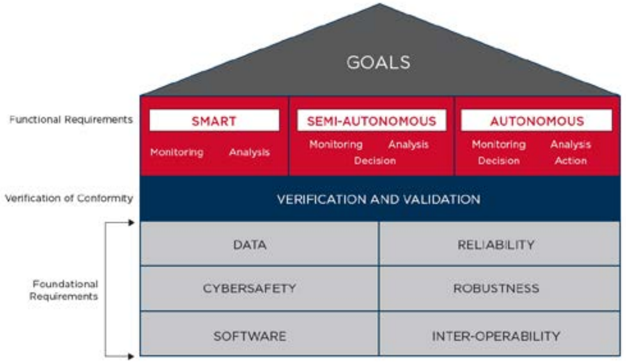
- ABS facilitated workshops to build one or more requirements matrixes for USV concepts and designs, including references to Government and/or commercial standards (current and future) supporting cost effective and reliable USVs
- Documentation of framework for foundational USV requirements, including stakeholder input on outlines for new commercial guides/standards as necessary

Metric(s) of Success

- Completion and use of the framework document for foundational USV requirements by Government stakeholders
- Expansion of ABS Rules and Guides to close identified gaps in commercial standards related to USV design and construction

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000



Aluminum Sensitization on High Speed Vessels

Project Lead Organization: American Bureau of Shipping (ABS)
Project Team members: Austal USA, ElectraWatch, Vextec, Military Sealift Command (MSC)

Concept/Idea

Issue: Temperature sensitization of aluminum alloys, especially those with high magnesium content, in structural members on high-speed vessels, can lead to serious stress corrosion cracking (SCC) issues with expensive repair/sustainment costs and adverse operational availability for ships

Proposed Solution(s): Utilize a structural digital twin composed of available material data, sensor data, and software tools to create a methodology to predict critical SCC on aluminum high speed vessels, providing key information for design stage improvement for future vessels and optimized ship sustainment decisions for in-service vessels

Benefits/Justification

Benefits of the project

- Practical demonstration of a data collection strategy and analysis tool/process for more effective management of aluminum sensitization to improve structural reliability through:
  - Improved repair planning and implementation
  - Optimized condition-based maintenance/monitoring plans (including deferred actions where appropriate)
  - Design improvements for future vessels
- Actual analysis results that MSC can use to improve repair planning, structural reliability, and ship operational availability for the EPF Class of ships using data already being collected for those ships

Project Approach

High level statement of work

- Codified written methodology for prediction of SCC in aluminum structures on high speed craft, including required data inputs, data collection strategies, and available tools
- Demonstration application results for an EPF ship, including recommendations for improved repair planning, condition-based asset management, and future design changes to most effectively manage SCC

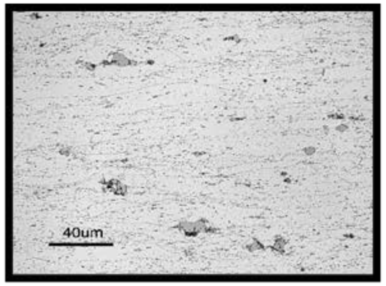
Metric(s) of Success

- Estimated improvement in ship availability from recommendation implementation for the EPF class of ships
- Estimated savings from failure avoidance and condition-based asset management implementation for the EPF class of ships

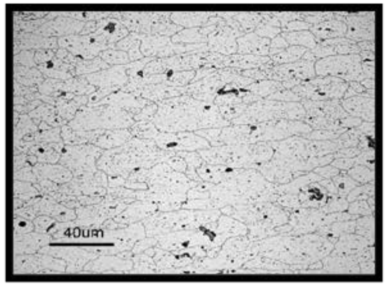
Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000

Not sensitized



Sensitized



Intergranular Corrosion Cracking

Autonomous System Design Integration

Project Lead Organization: SSI USA
Project Team members:

Concept/Idea

Issue: Reduce the rework associated with the initial routing of distributive systems in the 3D detail design model within engineering.

Proposed Solution(s): Integrate the generative distributed system design tool, NAME, funded by NAVSEA/ONR to support autonomous design with a production design tool, ShipConstructor. This project will transfer generative design data candidates into the detail design model and support early planning and scheduling and allow a designer to begin routing with provided routes.

Benefits/Justification

Benefits of the project

- Reduce cost and schedule by providing generative multiple routes quickly of distributive systems to identify the optimal route
- Allows for early distributive system requirements verification
- Allows designers to assess interference between distributive systems early in the detailed design effort
- Support early shipboard system design allowing distributive system routing when assessing unit breaks during preliminary design

Project Approach

High level statement of work

- Develop routing of multiple systems routing
- Assess the development of an interface of the system routes into the 3D detailed design model
- Validate designers follow the generative system routing during the detail design effort.

Metric(s) of Success

- Demonstrate the workflow of transferring generative system routes into the 3D detail design model
- Validate using generative system routes reduces designer rework

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000

Design - Build for Test

Project Lead Organization: SSI USA
Project Team members:

Concept/Idea

Issue: Eliminate the current research effort by those outside of engineering regarding distributive systems test criteria.

Proposed Solution(s): Provide distributive system testing particulars within the 3D detail design model associated to each specific system allowing engineering's testing requirements readily available to others

Benefits/Justification

Benefits of the project

- Allows distributive system testing information from the engineers to be centrally located within the 3D detail design model for ease of access and accuracy by other departments such as Test, QA, Planning
- Supports the reuse of the engineering digital data, in this case information supporting distributive system testing, to those that require it; thereby eliminating the time for independent research which could be in error and the rework associated with retesting in accordance with the previously approved requirements.

Project Approach

High level statement of work

- Ensure field exist within the 3D detail design model to contain distributive system testing requirements
- Develop a workflow to enter test requirements into the model
- Develop a workflow for others to access said test information

Metric(s) of Success

- Successful test of test requirement data management "in" and "out" of the 3D detail design model.

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000

Digital Scan Management

Project Lead Organization: SSI USA
Project Team members:

Concept/Idea

Issue: 3D Scanned data files, how to organize the numerous files of various file types and file naming conventions.

Proposed Solution(s): Determine shipyard requirements for easy saving, naming, sorting 3D scanned files for hull, scan date, vessel area, scan resolution, to name a few. Develop a matrix of the requirements ranking them through surveys. Develop a list of off the self products and staking them with cost information against the requirements.

Benefits/Justification

Benefits of the project

- Research shipyard issues with storing 3D scanned files and develop a requirements matrix to search for off the shelf products
- Provide a list of COTS software products with cost ranked against the requirements
- Faster and easier recall of past data – being able to logically search data with multiple parameters
- Digital Data reuse – save time and money of additional scans because one cannot locate and existing scan file

Project Approach

High level statement of work

- Engage shipyard engineers, and designers
- Develop requirements through surveys
- Research COTS software products
- Rank products based on cost and requirements
- Test (if feasible) the top ranked products

Metric(s) of Success

- Products vs Requirements matrix provided to industry
- Demo / Test top ranked COTS software products with results provided to industry

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000

State of Digital Drawing Delivery

Project Lead Organization: SSI USA
Project Team members: Design Automation Associates, Inc.

Concept/Idea

Issue: With the digital transformation of shipbuilding the next natural evolution is providing "digital drawing" engineering information to production. However there are many possible solutions and no good guide or reference for pros/cons of various approaches.

Proposed Solution(s): Provide a report+website to document the current state of hardware solutions and software solutions (data formats) for possible implementation and pros/cons of each.

Benefits/Justification

Benefits of the project

- Comprehensive, objective reporting on the current state of technology to support "digital drawing" delivery to communicate engineering data
- Reference website with supporting information and citations for further study
- Website/document able to be updated as technology progresses.

Project Approach

High level statement of work

- Identify business process and data requirements
- Identify available technologies and maturity levels
- Identify working implementations and feasibility/results

Metric(s) of Success

- Identification of current state-of-the-art for hardware/software options
- Website created and living document created with pros/cons/results

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000

Next Generation Remote Operation Gear for Valves

Project Lead Organization: Ingalls Shipbuilding
Project Team members: Mike Poslusny

Concept/Idea

Issue: Remote operation of valves is required on all ships based on damage control and human engineering requirements. The existing system is difficult to install, difficult to maintain, and is not standardized

Proposed Solution(s): Assess potential commercial remote valve operation systems for use on existing or future ship programs

Benefits/Justification

Benefits of the project

- Improved remote op gear installation
- Improved equipment maintenance
- Standardization of remote op gear across ship platforms

.

Project Approach

High level statement of work

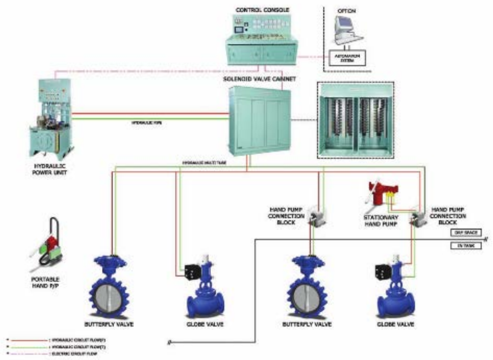
- Define the current state of remote operation of valves. Research potential advances in remote operation of valves
- Evaluate potential advances and upgrade in remote operation of valves.
- Discuss with the NAVSEA TWHs on the recommended upgrades

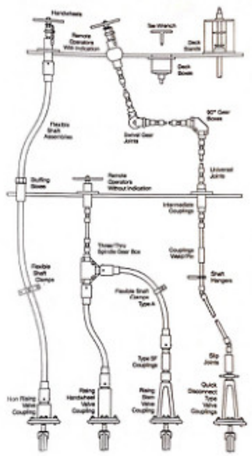
Metric(s) of Success

- Plan for standardization of Remote Op Gear across all platforms
- List of potential new Remote Op Gear that can be implemented on all ship programs

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000





Advanced Insulation Material Assessment

Project Lead Organization: Ingalls Shipbuilding
Project Team members: Rashadd Coleman

Concept/Idea

Issue: With the increase of compartments having fire and acoustic (airborne noise) requirements, there is a need to evaluate insulation that can meet both sets of requirements and reduce the cost of installation and rework

Proposed Solution(s): Research and evaluate commercial insulation material for potential use on existing and future ship programs

Benefits/Justification

Benefits of the project

- Improved insulation quality to meet the requirements for acoustics and fire
- Reduced installation of insulation material
- Decrease cost of rework

.

Project Approach

High level statement of work

- Define the requirements for acoustic and fire insulation for ship programs
- Evaluate potential insulation materials based on requirements.
- Discuss with the NAVSEA TWHs on the potential insulation materials
- Develop acoustic and fire test plans for potential insulation materials.

Metric(s) of Success

- New material that can utilized for Acoustics and Fire Insulation

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000
- **Potential Savings per Ship:** $500,000

Comprehensive Aircraft Tie-Down Strength and Corrosion Evaluation

Project Lead Organization: HII – Ingalls Shipbuilding
Project Team members: HII – Newport News Shipbuilding

Concept/Idea

Issue: ACTDs are susceptible to wear and corrosion due to coating damage from chain hooks and exposure to sea-water. Corrosion may be exacerbated by residual stress from manufacturing and installation welding. Research and testing are needed to identify material properties and design solutions that not only meet the design and life-cycle criteria but are also readily available to suppliers to ease significant supply chain challenges.

Proposed Solution(s): Research suitability of corrosion resistant materials for this application (producibility, durability, strength, hardness, etc.) Conduct testing on candidate materials and evaluate design changes to reduce manufacturing, installation, and life-cycle concerns.

Benefits/Justification

Benefits of the project

- Simplified procurement process
- Reduced cost and complexity of care and protection during construction (i.e., plastic covers no longer required)
- Improve aircraft tie-down life-cycle cost and performance

Project Approach

High level statement of work

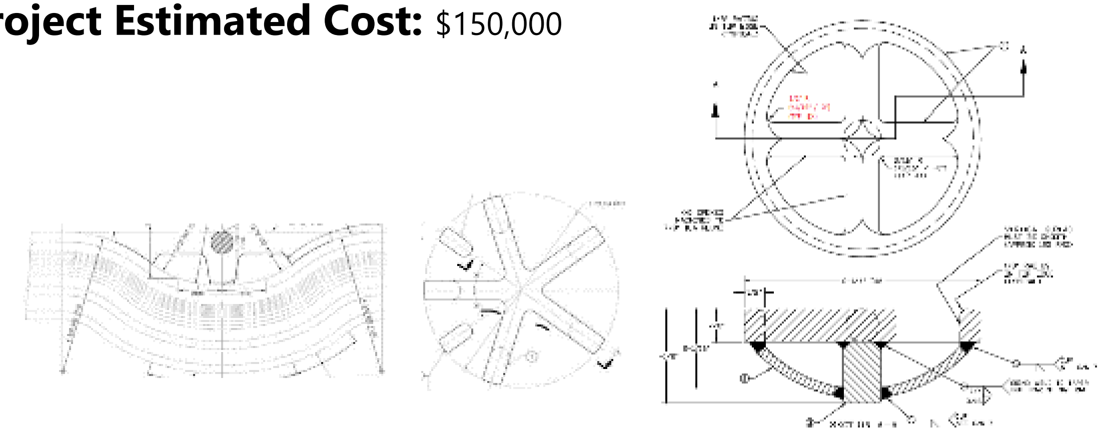
- Research corrosion resistant materials
- Evaluate design changes and installation methods
- Conduct pilot testing on selected candidate materials
- Conduct physical testing of improved material or design and compare it to a control (installed using Navy standard and Ingalls weld sequences)

Metric(s) of Success

- Recommend best tie-down design in terms of strength, corrosion, and installation/life-cycle cost
- Reduce material/design related replacement frequency (corrosion, cracking, etc.)

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150,000



Additive Manufacturing for Seawater Heat Exchangers

Project Lead Organization: ElectraWatch (Scott Kasen, skasen@electrawatch.com)
Project Team members: Metallum3D, Austal USA, NAVSEA 05T

Seeking an additional shipyard to join the team.

Concept/Idea

Issue:

- Seawater heat exchangers could see a significant performance boost from the design freedom afforded by Additive Manufacturing (AM)
- Current AM modalities are not well suited for use with CuNi: high reflectivity to laser energy, high thermal dissipation, powder agglomeration

Proposed Solution(s):

- A new AM modality is under development which overcomes these issues.

Benefits/Justification

Benefits of the project

- Meet the increasing heat loads demanded by customer's warfare integration packages, now and in the future
- Anticipate low capital investment and operating costs of production system
- Non-structural component: fleet/NAVSEA acceptance less stringent for sea trials

Project Approach

High level statement of work

- Thermodynamic-kinetic computational modeling
- Produce feedstock
- Printing and sintering trials
- Measurement and test campaign (thermal & mechanical)

Metric(s) of Success

- Quantify material properties against wrought CuNi (thermal and mechanical)
- Future testing: corrosion and biofouling resistance

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150k

3D printed green part

Sintering

Large-scale Additive Manufacture of Continuous Fiber-reinforced Composites for Unmanned Hulls

Project Lead Organization: ElectraWatch (Scott Kasen, skasen@electrawatch.com)
Project Team members: Continuous Composites, ABS, Luna Innovations, Austal USA

Seeking an additional shipyard to join the team.

Concept/Idea

Issue:

- Continuous fiber composites offer the most appealing material properties for marine structures but is expensive and limited in size using today's methods: layup, use of molds, autoclaving
- Adoption has been limited due to cost, fire & smoke requirements, poor vision for use of composites
- U.S. technology gap with foreign entities is growing (Sweden's Visby-class, for example)

Proposed Solution(s):

- Large-scale additive manufacturing for unmanned continuous fiber hulls
  - No molds, out-of-autoclave, fully automated, no size limit

Benefits/Justification

Benefits of the project

- Technical
  - Improved fuel efficiency: lightweight, new hull forms
  - Corrosion performance
  - Integral structural health monitoring
  - Low EM signature, impedance matching for stealth
- Strategic
  - Initial technical feasibility study for larger, follow-on effort (NSRP, ONR, DARPA)
  - Potential for faster production, higher volume
  - New opportunities / ships

Project Approach

Objective: Fabricate a demonstrator panel (hull form) with integral health monitoring

High level statement of work

- Panel design, fabrication, testing (demonstration of SHM'ing).
- Some limited techno-economic analysis

Metric(s) of Success

- ONR/DARPA interest
- Follow-on funding

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150k

Sweden's Visby-class corvette

Continuous Composites CF3D technology

PUMPKIN Mounts

Project Lead Organization: Taylor Devices, Inc.
Project Team members: Alan Klembczyk, David Taylor, Phillip Thompson

Concept/Idea

Issue: X and Y-Type vibration mounts have been in existence with the UK MOD since the 1960's and 1970's respectively and have become the cornerstone solution to protect ship-bourne equipment from UNDEX shock and (strong) vibrations on Royal Navy ships and submarines.

Proposed Solution(s): PUMPKIN mounts use an existing and highly effective proven technology that offers superior performance over standard UK and US Naval mounts while requiring substantially less the number of mounts.

Benefits/Justification

Benefits of the project

- Substantially less cost per system isolation
- Capacity increase to support larger payloads within the same footprint and/or reduce the number of mounting interfaces
- Leverage smaller footprints to maximize vertical volume
- Weight reduction
- Removes the asymmetric characteristic in the transverse direction of the X and Y-type mount range by providing a symmetric transverse characteristic
- Superior UNDEX protection caused by whipping loads and mount bottoming during large displacement excursions
- Improved performance over elastomer mounts esp. through environmental conditions

Project Approach

High level statement of work

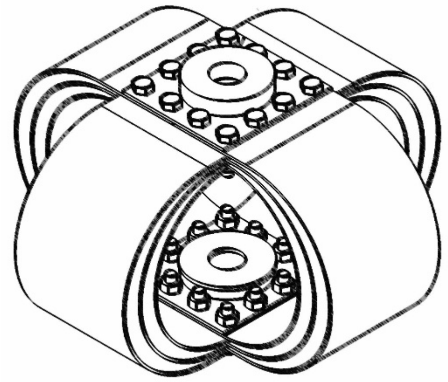
- NRE – Finite Element Analysis, Material Selection, Detail Drawings and Procedures
- Supplier Search and Down-select
- Prototype Manufacture
- Prototype Testing

Metric(s) of Success

- Test and cost data that outperforms the X and Y-Type mount

Cost/Images/Relevant Information

- **Project Estimated Cost:** $149,747.77
- Taylor Devices will be in cooperation with Thornton Tomasetti to provide effective test program and marketing campaign to gain maximum benefit of this technology in terms of cost savings and improved performance.



Ship Design & Materials Technology

NSRP | **Application of Tulip Studs to Replace Stand-Off Studs & Angle Bar Clips**

NSRP Panel Project — G20

2021

Project Prime Contractor & Lead:

Prime: Huntington Ingalls Industries - Newport News Shipbuilding (HII-NNS)

- Mitch Eisenhour (Lead, Structural Engineer), (757) 688-5788, Mitchell.L.Eisenhour@hii-nns.com
- Stan Reams (Industrial Engineer), (757) 688-8431, Stanley.Reams@hii-nns.com

Participants:

- Nelson Stud Welding (NSW), Clark Champney
- Huntington Ingalls Industries - Ingalls Shipbuilding (HII-Ingalls), Mike Poslusny)

Concept Description:

Electrical equipment/components are routinely mounted on Angle Bar Clips (Fig. 1) or Stand-Off Studs (Fig. 2) that are welded to ship bulkheads. 4½" of Weld → 2⅓" of weld for 3/4" → 1⅔" of weld for ½"

Angle 3/8 X 2 X 2½ Weight @ 8" Long = 4¼#

Fig. 1 Angle Bar Clip

Fig. 2 Stand-Off stud fixture

3/4 dia X 8" Long = 1# Weight

Weight Reduction 3¼ lbs.

4 Attachments = 13 lbs.

Newport News Shipbuilding (NNS) had discussions with NSW regarding the weight capacity limits of Stand-Off Studs and the installation challenges of Angle Bar Clips. Based on those discussions, NSW subsequently developed and patented the "Tulip" Stud (Fig. 3) as a replacement for Stand-Off Studs and Angle Bar Clips. The Tulip Stud design is similar to a Stand-Off Stud but has a reduced diameter at the weld base. This feature allows the stud to flex in a way that reduces the force on the equipment mounting bolts thus increasing the load carrying capacity and reliability. Preliminary testing of Tulip Studs indicates a significant increase in weight capacity.

Fig. 3 Tulip Studs and example utilization

Tulip Studs 2 or 4 studs Per Assy.

Load Test Specimen

Shock Test Specimen

8" Length

Figure 4 & s Tulip Stud Assemblies Before Shock Test

Deliverables:

Report that will provide:

- The preferred Tulip Stud design(s)
- A list of applications & Recommendation for formal shocktesting
- Document the expected benefits of Tulip Studs
- Proposal for a th forward

Benefits and ROI:

Tulip Studs are expected to offer the following benefits:

- Increased weight carrying capacity over Stand-Off studs and Angle Bar Clips
- ...-Drastically reduced manual welding time/cost compared to Angle Bar Clips
- ______ welded with smaller power sources/ existing welding equipment
- Versatility of ap ic_!tio/1 a c s multiple platforms and universal mounting applications
- WP.rlvt treattet1otl - 7;/0rvS

Customer Involvement: None

Technology Transfer and Implementation Approach: The shipbuilding community will be provided access to the report.

- Project final report will be made available to NSRP for distribution
- The report will be briefed at NSRP meeting to cascade the findings to other platforms/programs

Expected Duration: No more than 12 months

Program Funds: No more than $150K.

Goal to Support 300 Lb.
Transformers @ up to 8"!

Tulip Studs 6" & 8" Load Test

Double Clevis Mounted Cantilevered Shear load Test (8" length shown)
2 Studs in Tandem -

Figure 11

Clevis Mounted Cantilevered Shear load Test Displacement vs load
2 Studs in Tandem

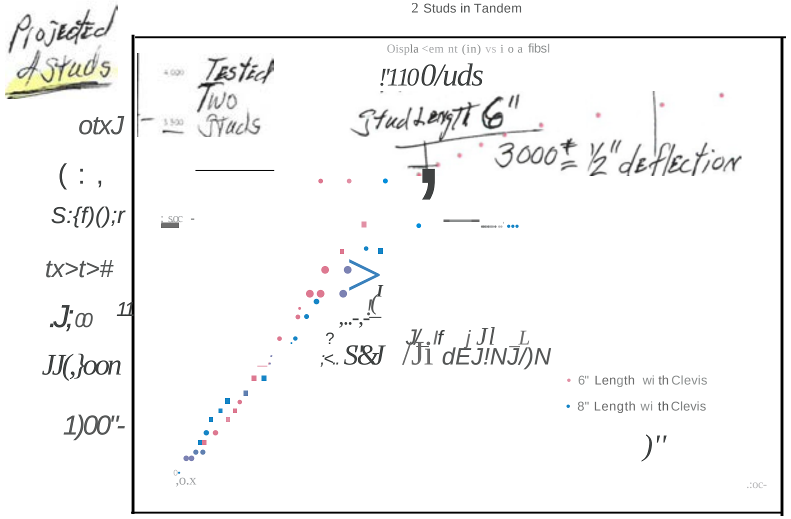


Figure 12

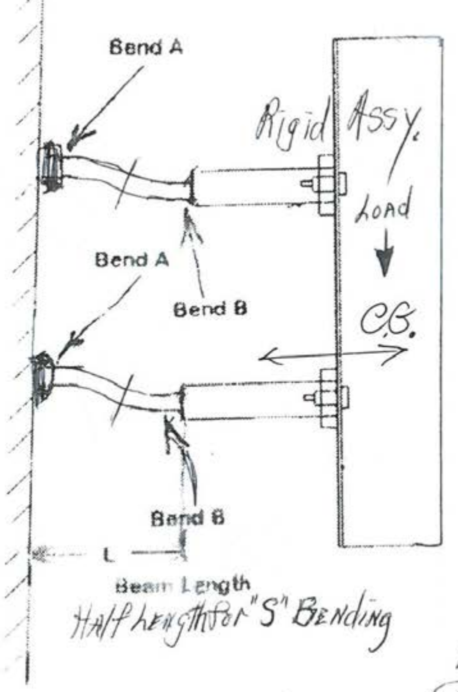
Strength of Tulip Studs

NELSON STUD WELDING

½" Dia. Base x 1½" Length

Normal Bend Strength = 408 Lbs.

2 Bends — "S" Bend Doubles this to 816 Lbs.



The "S" Bends at each End of the 1½" Beam Length Reduce the Length of the Beam to ¾".

The Reduction in the Beam Length Doubles the Strength Again to 1,632 Lbs. for Each Stud.

A four Stud Assembly mounted on Tulip Studs would Yield @ 6,528 Lbs.

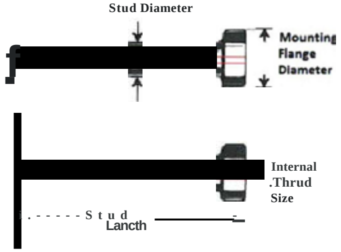
x 4 Stud Assembly Strength

4 x 408 Lbs. for Normal Bending @ 1½"

Nelson T3L Stand-Off Studs

3/4" Diameter

NNPN & Nelson Part Numbers



Description	Wgt. /Eacb Lbs.
3/4 x 3T3L	.468
3/4 x4 T3L	.585
3/4x 6 T3L	.825
3/4 x 7T3L	1,,946
3/4x 8T3L	1J)67

Calculation of Bending Strength of 3/4" Round Studs

Section Modulus of Rounds = Dia.^{3} x .098

Yield strength of steel stud= 50,000 psi

.750 ^{3} x .098 x 50,000

= **2,067 lbs** @ 1" length

17717263	I02-100-00I	Stud 3/4"	2	**3/8-16 x9/16**	1034	**73.4**
	102-I00-013		3	**3/8-16 x 9/16TAP**	689	
17717265	I02-100-002		4	**3/8-16 x9/16**	517	**73.4**
	I02-100-0I4		*5*	**3/8-16x9/16TAP**	413	
17717266	I02-100-003		6	**3/8-16 x9/16**	345	*52.5*
	102-100-015		7	**3/8-16 x 9/16TAP**	295	
17717267	102-100-004		8	**3/8-16 x9/16**	258	*20.1*
17717268	I02-100-009		2	**7/16-14 x21/32**	1034	*73.4*
	102-100-016		3	**7/16-14 x 21/32**	689	
17717270	102-100-010		4	7/16-14 x21/32	517	*73.4*
	102-100-0I7		*5*	7/16-14 x21/32	413	
17717271	102-100-011		6	7/16-14 x 21/32	345	*52.5*
	I02-100-018		7	7/16-14 x21/32	295	
17717272	102-100-012		8	7/16-14 x 21/32	258	*20./*
17717274	I02-100-005	Flange 1-1/4"	2	1/2-13 x3/4	1034	**73.4** *IL*
	I02-100-0I9		3	1/2-13 x3/4	689	/\ I /'_"
17717275	102-100-006		4	1/2-13 x3/4	517	**73.4**
						,/.Is
17717276	I02-100-007		[illegible]	1/2-13 x3/4	345	**52.5**
	I02-100-021		7	1/2-13 x3/4	295	[illegible]
17717277	102-100-008		8	1/2-13 x3/4	258	**20.)**

• Bend strength calculated using formula for unsupported round beams. Section Modulus D^3 x .098 x Area x Material Yield Strength/Length = Strength

•• Assumed loads based on tests listed in italic. Actual loads based on tests, listed in bold

1. The bending strength at 1" should be divided by the distance from the base plate to the center of gravity of the supported load to find the capacity
2. If studs are at multiple elevations and the supported assembly is rigid, both ends of the stud must bend. The section modulus of the tapped end of the stud is tubular. The beam length for calculating the strength of the tapped end is only the length of the stud

Bend Strength of Tapped End @ 1" Length: 3/4" dia w. 1/2"-13 Tap = 1,455 lbs


3/4" Weld base
1/2" DIA.
Tulip Stud
Stand Off Stud
3/4"
Round Corner
Square Studs
3/4 & 1/2"
Buttonlok &
Fairing Stud 5/8"
NELSON
STUD WELDING


for Templates
NELSON
STUD WELDING
TALL - # 100-101-228 (3/4")
Tall-228, 3/4"
W.-114, 1/2"
Tulip Stud


PE

Standardization of UxV Shipboard Interfaces

Project Lead Organization: General Dynamics NASSCO
Project Team members: Isabelle Brown

Concept/Idea

Issue: Unmanned and autonomous vehicles are playing an increasing role in fleet operations. UxV's help maintain the Navy's critical support of our nation's defense requirements and national strategic aims. Strategic and tactical deployments will only continue in the coming years. Currently, each class of UxV has it's own set of interfaces which decreases the interoperability of the UxV with different vessels and mission sets.

Proposed Solution(s): Creation of a set of standards for how the UxV interfaces to the host vessel as well as within the UxV.

Benefits/Justification

Benefits of the project

- Development of design guidance regarding unmanned platforms for production, integration, and operation for standards and interfaces for UxV.
- Creation of standards for UxV vehicles will mitigate or eliminate the need for custom interfaces and ensure UxV interoperability with other systems and vessels
- Standards for UxV shipboard interfaces will result in cost avoidance from future redesign.
- Lasting effect on military modularity and its incorporation into new and existing ship design.

Project Approach

High level statement of work

- Research into UxV capabilities, mission sets, and current standards
- Quarterly Reports
- Final Report
- Presentation

Metric(s) of Success

- Development of a basic standard for all UxV shipboard interfaces encompassing both what is currently available and future products.

Cost/Images/Relevant Information

- **Project Estimated Cost:** $147,085

Accelerated Development of Low-Cost Low-Density 130ksi Steels

Project Lead Organization: QuesTek Innovations LLC, Evanston, IL
Project Team members: Naval Surface Warfare Center, NSWC Carderock Division

Concept/Idea

Issue: Need for lightweight 130ksi structural steels that can enable significant weight savings in surface ships and submarines

Proposed Solution(s):

- Development of **FeMnAlC steels of 130-180 ksi yield strength** and toughness matching current levels of HSLA steels, maintaining current castability, workability with significantly reduced density.
- QuesTek use of its '**Materials-by-Design**' approach utilizing ICME-based computational models to develop an optimized FeMnAlC.
- Sub-scale material prototyping to facilitate optimization of composition and processing of steels by combining strength, toughness, ballistic performance and manufacturability

Benefits/Justification

Benefits of the project

- As previously demonstrated in the successful design and accelerated qualification of **aircraft landing gear steels by QuesTek**, the use of proven '*Materials by Design*' approach will provide a next generation of reduced density high strength steels with the enhanced reliability and predictability of designed systems, and a **much-tightened qualification timeframe with accelerated insertion of materials (AIM) methodology**
- The new designed lightweight steels will provide high performance with significantly reduced material cost and weight for steel structures in surface ships or submarines.

Project Approach

High level statement of work

- Utilize **QuesTek's CALPHAD-based design strategies correlating Process-Structure-Property** to computationally design new high performance FeMnAlC steels that includes; 1) Efficient synergistic co-precipitation mechanisms for strengthening, 2) TRIP effect to optimize toughness improvement
- Sub-scale material prototyping, state-of-the-art microstructural characterization and mechanical testing to validate designed steel compositions

Metric(s) of Success

- Successful alloy design and **experimental validation** of properties

Cost/Images/Relevant Information

- **Project Estimated Cost:** $150k / 12 months

Steels	YS (ksi)	UTS(ksi)	K_{JIC} (ksi-in$^{1/2}$)	TE (%)	Advantages	Shortcomings
HSLA-100	100	125	260	~20%	Low cost, Decent strength/toughness	Lower strength
HY-100	100	120	166	~20%	Low cost, Decent strength/toughness	Lower strength
HY-130	130	150	185	~15%	High strength, decent toughness	Weldability issues
Navy-10Ni	150	180	235	~23%	High strength, Good fracture toughness	Expensive Lower fatigue life
TRIP-130	130	180	317	~25%	Low magnetic permeability, Improved toughness	Expensive
FeMnAlC (duplex, austenitic steels)	70-140	140-210	-	30-80%	**Low density (~8-18% reduction), Improved toughness & ductility.** Low magnetic permeability	Manufacturability, low strength in non-optimized conditions

Thank you for attending!

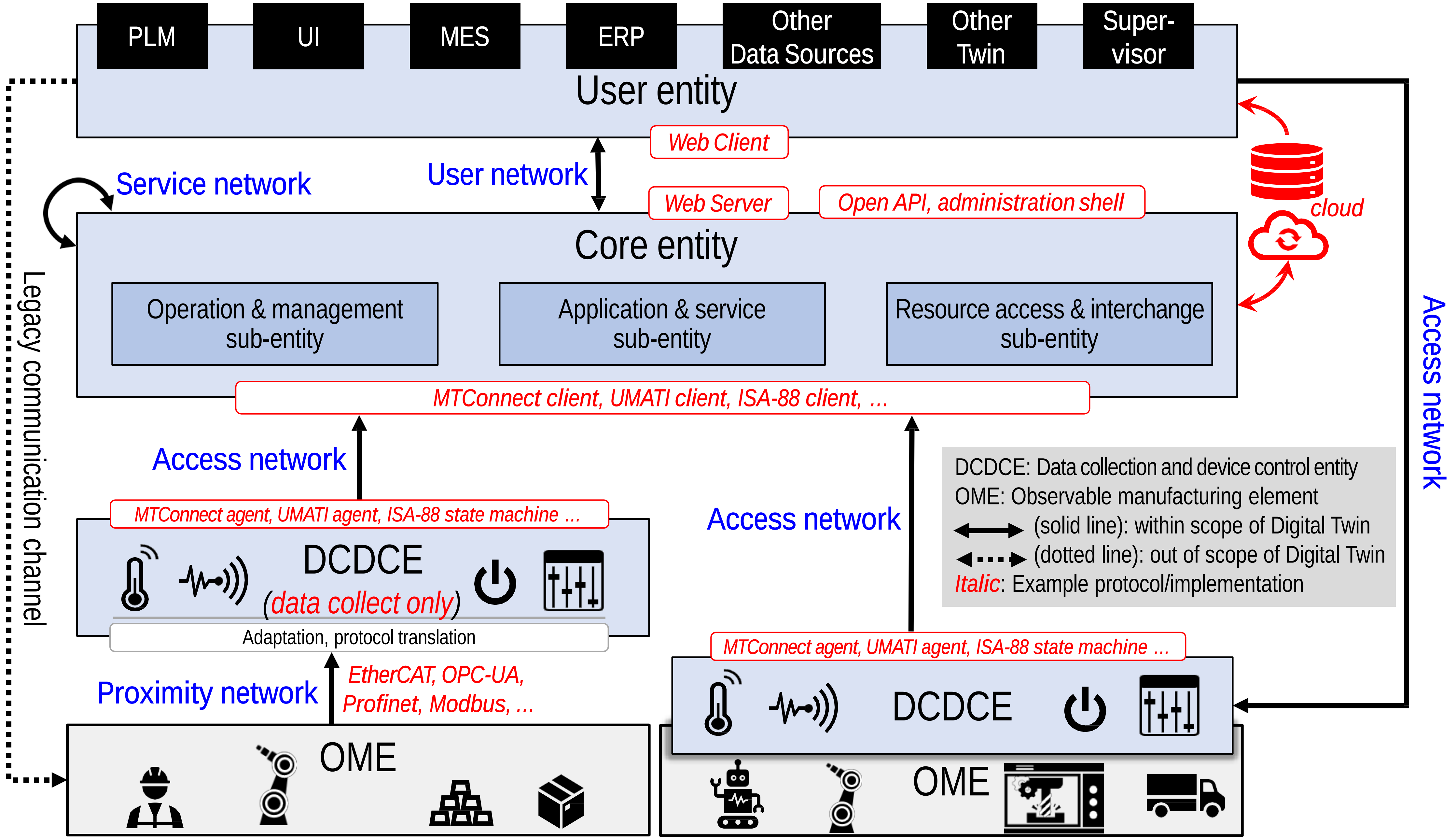
- **Upcoming Meetings/Events**
  - **12 August @ noon ET**– Panel Projects due to Panel Chairs and ATI
  - 22-23 September – RA Selection/ECB Meeting
  - 29 Sept – 2 Oct – SNAME Maritime Convention
  - **17-18 November** – Panel Project Selection/ECB Meeting
  - 19 November – NSRP Day at NAVSEA; Washington Navy Yard
  - 20 November – ASNE Technology, Systems, and Ships; Arlington, VA
- **Coming up Panel Project Elections:**
  - One vote per member organization.
  - Unless qualifying for 2nd vote through NSPR leadership participation.

BACK-UP SLIDES

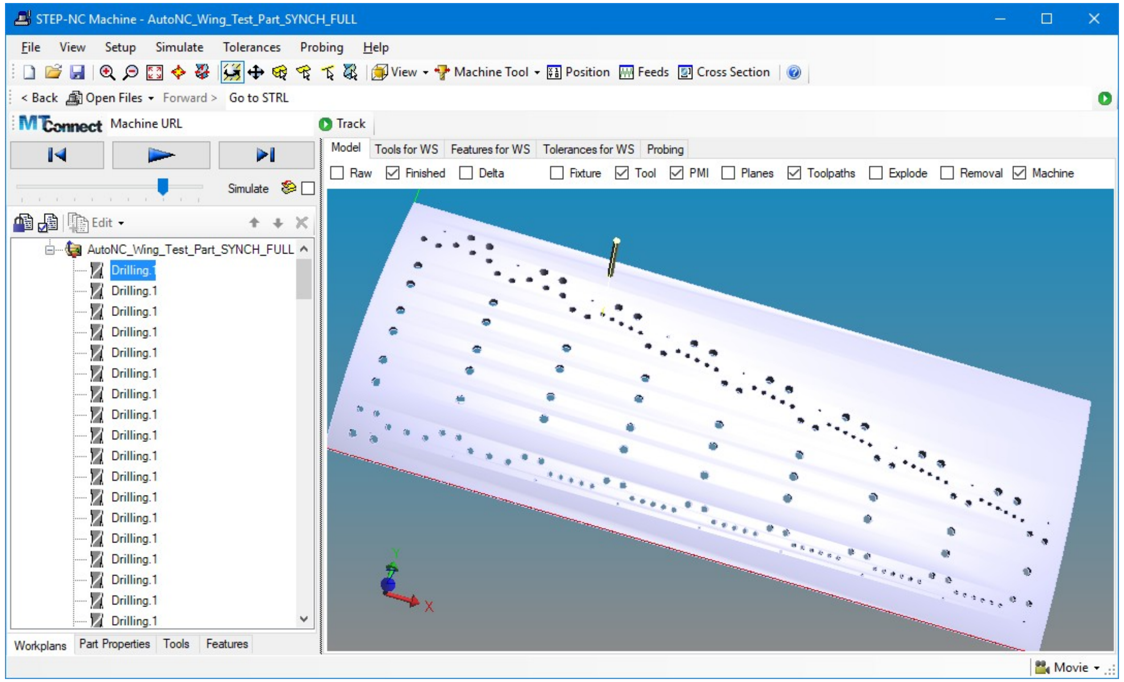
ISO 23247 Digital Twin
Use case Testing

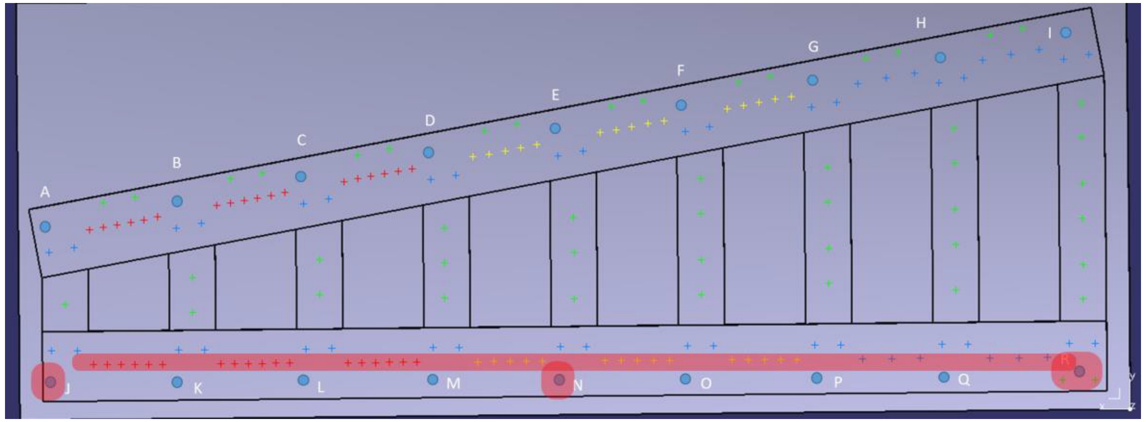
Results of July 21 Conference call

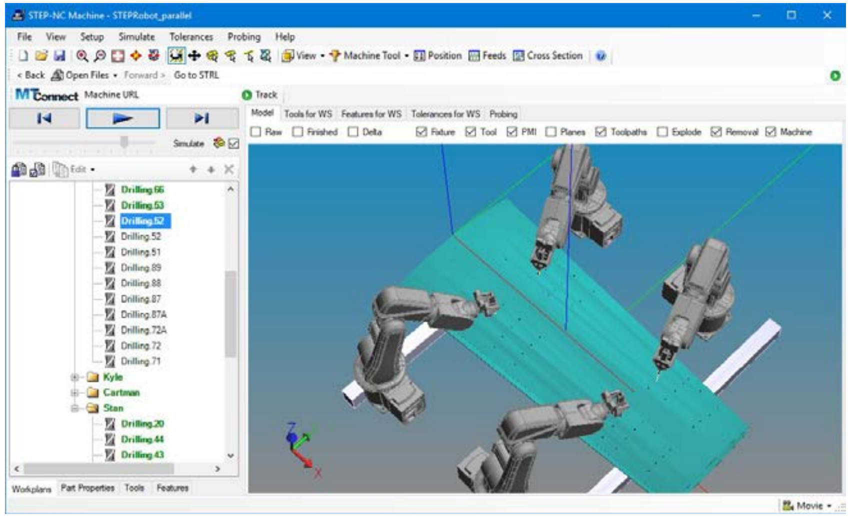
ISO 23247-4 Figure A.1



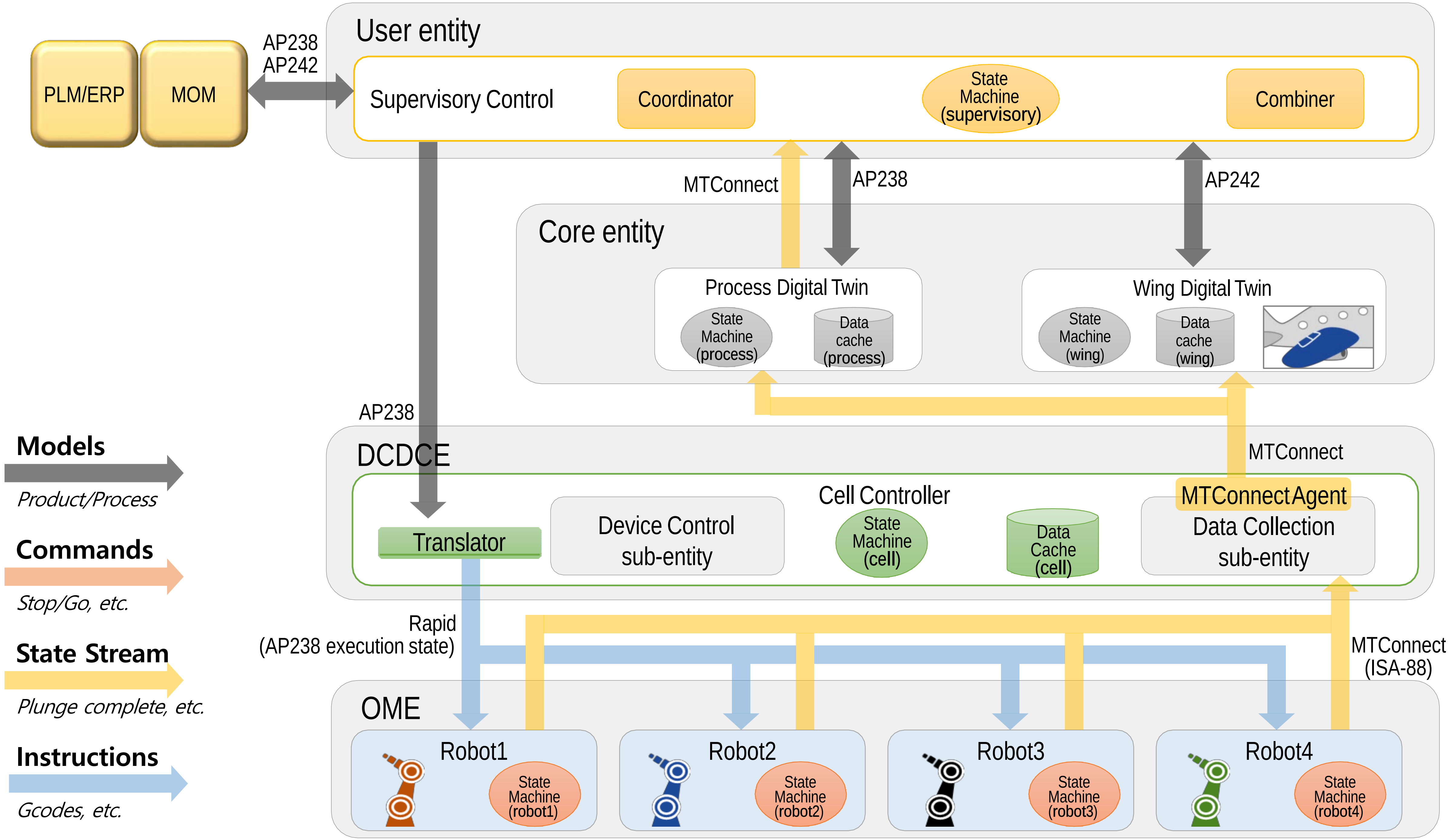
Use Case 1 – flexible schedule for robot drill & fill





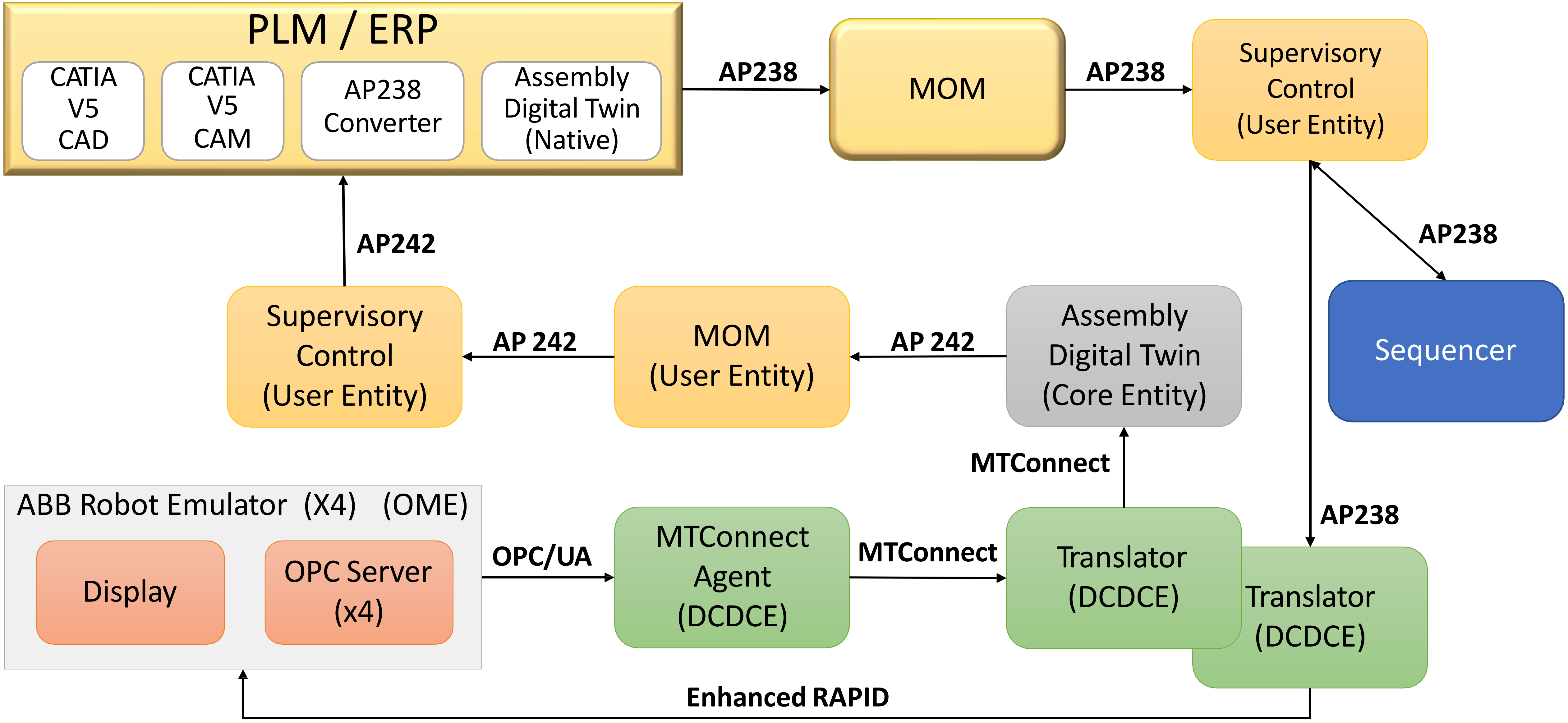


On-shoring can increase by 50%



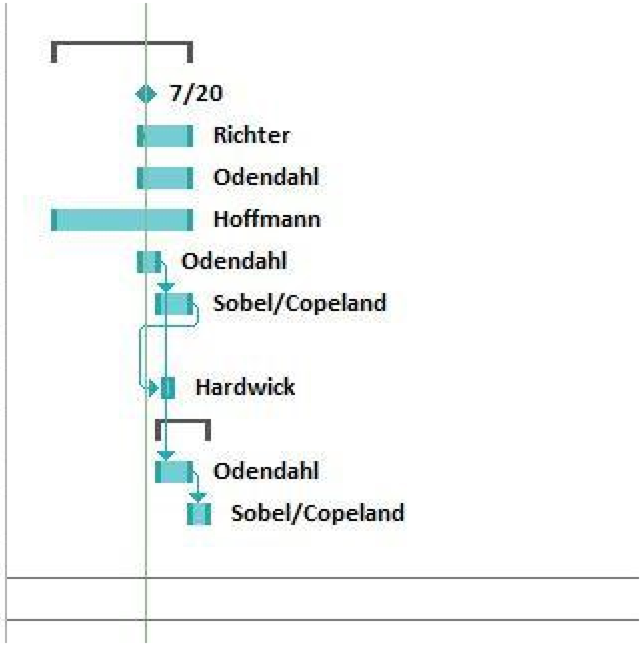
PLM/ERP
MOM
AP238
AP242
User entity
Supervisory Control
Coordinator
State Machine (supervisory)
Combiner
MTConnect
AP238
AP242
Core entity
Process Digital Twin
State Machine (process)
Data cache (process)
Wing Digital Twin
State Machine (wing)
Data cache (wing)
AP238
MTConnect
DCDCE
Cell Controller
Translator
Device Control sub-entity
State Machine (cell)
Data Cache (cell)
MTConnect Agent
Data Collection sub-entity
Rapid
(AP238 execution state)
MTConnect
(ISA-88)
OME
Robot1
State Machine (robot1)
Robot2
State Machine (robot2)
Robot3
State Machine (robot3)
Robot4
State Machine (robot4)
Models
Product/Process
Commands
Stop/Go, etc.
State Stream
Plunge complete, etc.
Instructions
Gcodes, etc.

Assembly/Process Flow



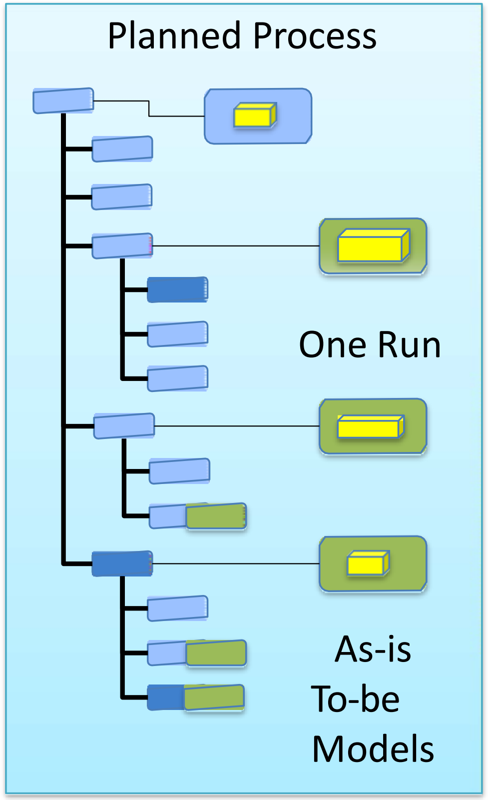
Schedule

CAD /CAM	**16 days**	**Mon 7/6/20**	**Mon 7/27/20**		
CATIA V5 -> AP238	0 days	Mon 7/20/20	Mon 7/20/20		Odendahl
Supervisory Control	6 days	Mon 7/20/20	Mon 7/27/20		Richter
AP238 -> Rapid	6 days	Mon 7/20/20	Mon 7/27/20		Odendahl
Setup OPC/UA Server	16 days	Mon 7/6/20	Mon 7/27/20		Hoffmann
Define OPC/UA Tags	3 days	Mon 7/20/20	Wed 7/22/20		Odendahl
Define MTConnect Tags	3 days	Thu 7/23/20	Mon 7/27/20	30	Sobel/Copeland
Setup MTConnect Adapter/Agent					
MTConnect -> Digital Twin	1 day	Fri 7/24/20	Fri 7/24/20	31	Hardwick
State Machine	**6 days?**	**Thu 7/23/20**	**Thu 7/30/20**		
Define OPC/UA Tags	3 days	Thu 7/23/20	Mon 7/27/20	30	Odendahl
Define MTConnect Tags	3 days	Tue 7/28/20	Thu 7/30/20	35	Sobel/Copeland
Map MTConnect to PackML					
PackML Client					

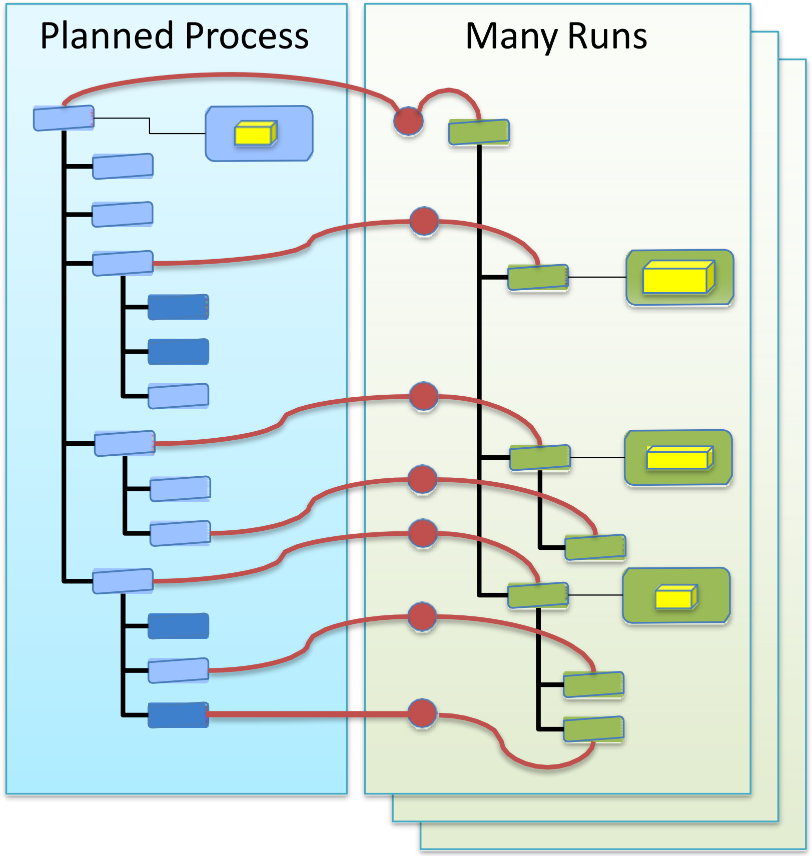


Digital Twin process model

https://stepmfg.github.io/ap238e2/data/clause5.htm#fig-twinmodel



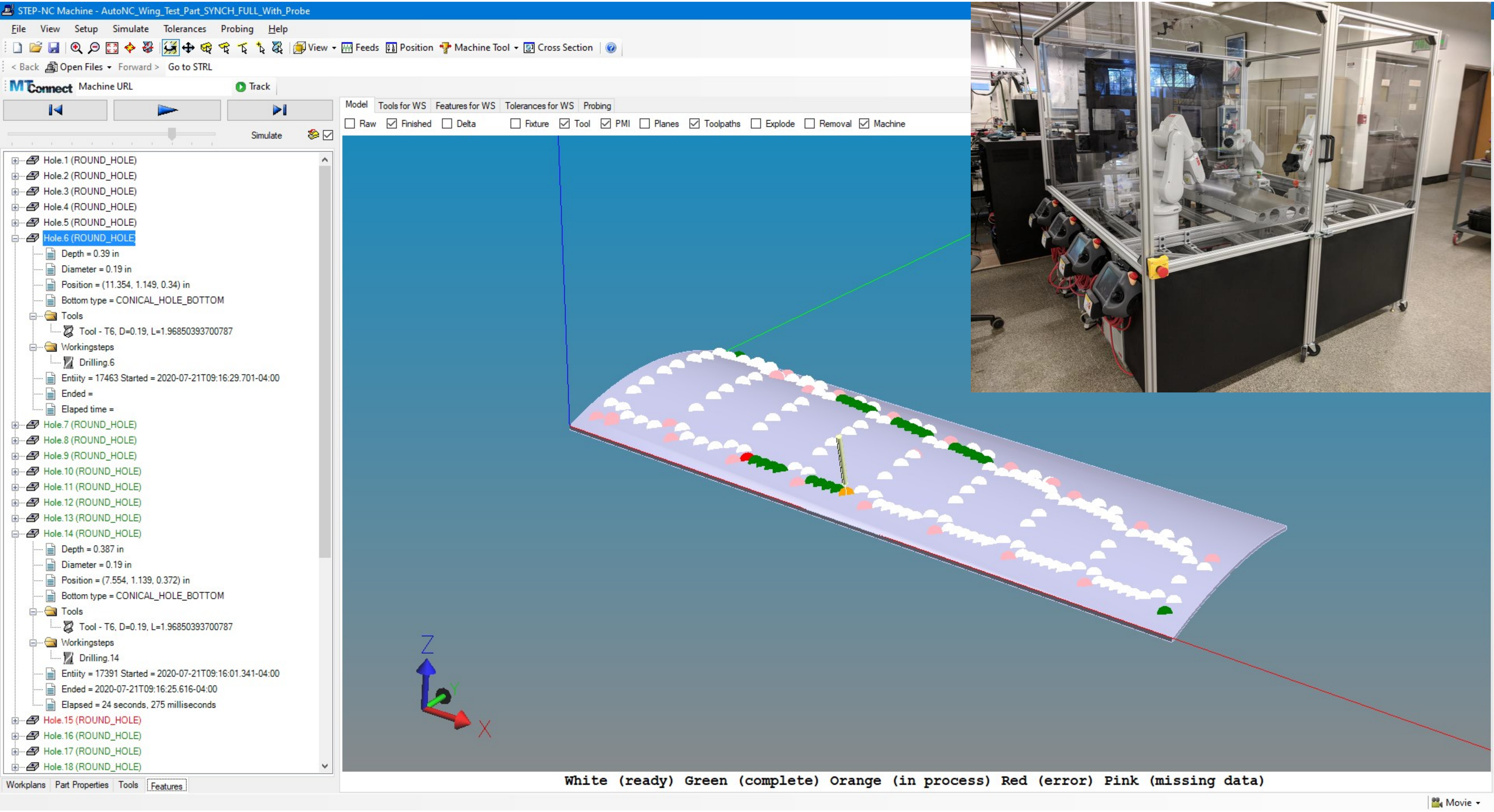
Model process state using new attributes



Link runs using Part 21 Edition 3

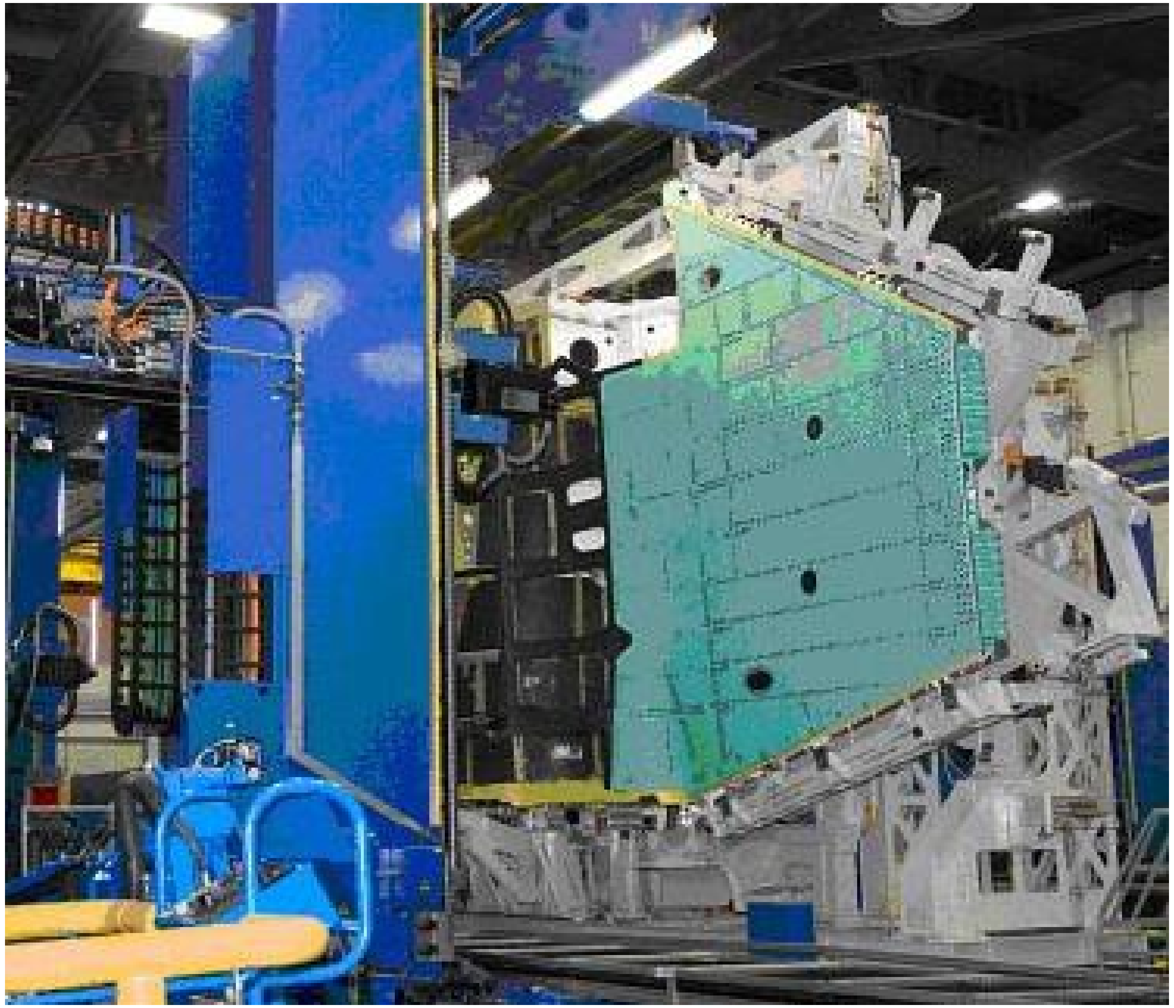
```
ENTITY executable
  [ ... other attributes omitted ... ]
  twin_source: OPTIONAL twin_source_enum;
  twin_plan: OPTIONAL executable;
  twinning_start : OPTIONAL Date_time;
  twining_end :   OPTIONAL Date_time;
  twinning_exception : OPTIONAL explanation;
END_ENTITY;

TYPE twin_state_enum = ENUMERATION OF (simula
ted, machined); END_TYPE;
```

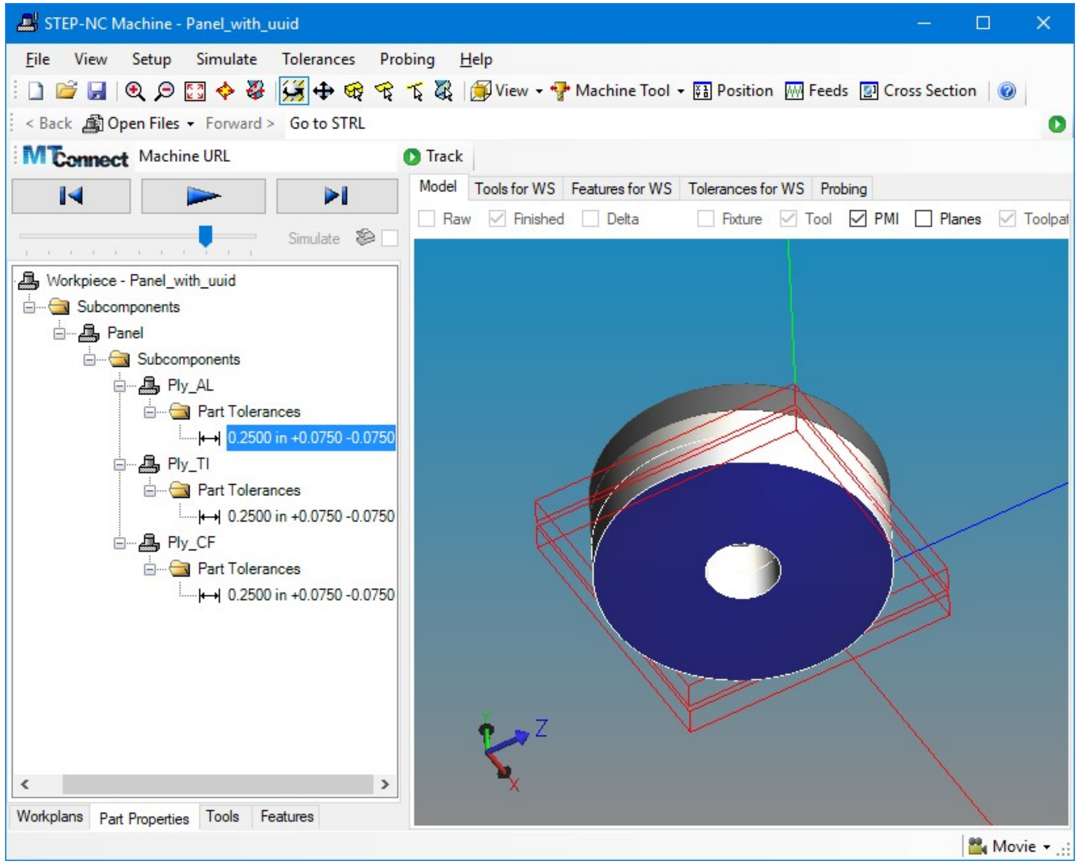
Executable is supertype of all processes.
Definition above shows new attributes for Edition 2


STEP-NC Machine - AutoNC_Wing_Test_Part_SYNCH_FULL_With_Probe
File View Setup Simulate Tolerances Probing Help
View Feeds Position Machine Tool Cross Section
< Back Open Files Forward > Go to STRL
MTConnect Machine URL Track
Simulate
Model Tools for WS Features for WS Tolerances for WS Probing
Raw Finished Delta Fixture Tool PMI Planes Toolpaths Explode Removal Machine
Hole.1 (ROUND_HOLE)
Hole.2 (ROUND_HOLE)
Hole.3 (ROUND_HOLE)
Hole.4 (ROUND_HOLE)
Hole.5 (ROUND_HOLE)
Hole.6 (ROUND_HOLE)
Depth = 0.39 in
Diameter = 0.19 in
Position = (11.354, 1.149, 0.34) in
Bottom type = CONICAL_HOLE_BOTTOM
Tools
Tool - T6, D=0.19, L=1.96850393700787
Workingsteps
Drilling.6
Entity = 17463 Started = 2020-07-21T09:16:29.701-04:00
Ended =
Elaped time =
Hole.7 (ROUND_HOLE)
Hole.8 (ROUND_HOLE)
Hole.9 (ROUND_HOLE)
Hole.10 (ROUND_HOLE)
Hole.11 (ROUND_HOLE)
Hole.12 (ROUND_HOLE)
Hole.13 (ROUND_HOLE)
Hole.14 (ROUND_HOLE)
Depth = 0.387 in
Diameter = 0.19 in
Position = (7.554, 1.139, 0.372) in
Bottom type = CONICAL_HOLE_BOTTOM
Tools
Tool - T6, D=0.19, L=1.96850393700787
Workingsteps
Drilling.14
Entity = 17391 Started = 2020-07-21T09:16:01.341-04:00
Ended = 2020-07-21T09:16:25.616-04:00
Elapsed = 24 seconds, 275 milliseconds
Hole.15 (ROUND_HOLE)
Hole.16 (ROUND_HOLE)
Hole.17 (ROUND_HOLE)
Hole.18 (ROUND_HOLE)
Workplans Part Properties Tools Features
Z
Y
X
White (ready) Green (complete) Orange (in process) Red (error) Pink (missing data)
Movie

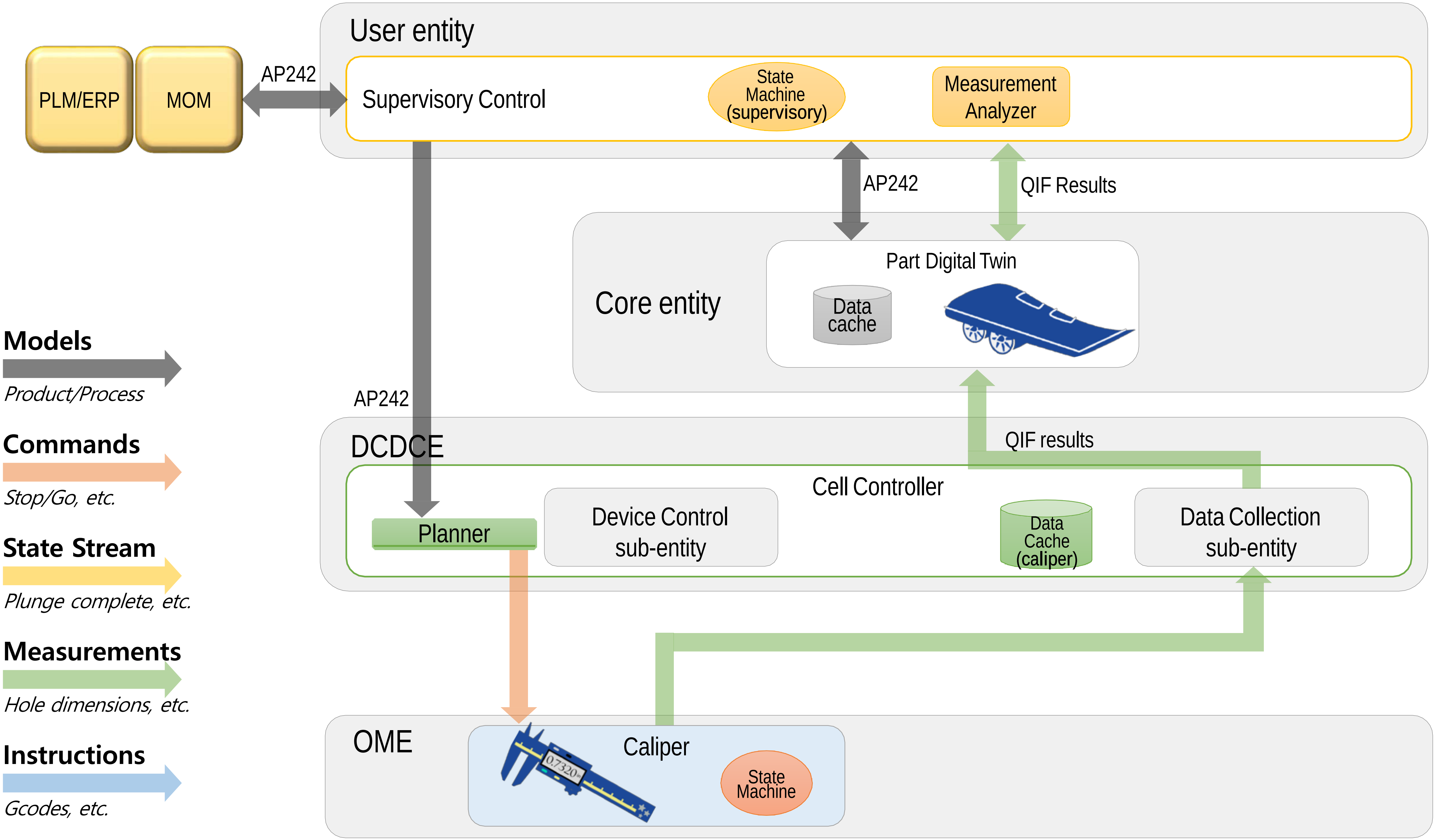
Group/Name	Task	23247 Use Case Reference	Completion Percentage	Completion Date	Status
Vice Commodore	Generate AP238 from CATProcess	External	100	6/22/2020	Complete
Fred Richter	Fake MOM	External	0		Asking
Fred Richter	Fake Supervisory Control	User Entity	0		Asking
AutoNC	Sequencer	User Entity/External Modules	0		Refused
Vice Commodore	RAPID Translator	DCDCE	50%		In Work
MicaH	ABB Emulator	OME/Robot 1-4	10%		in Work
BiTech	Loader Emulator	OME/Loader	0%		Asking
Will Sobel	MT Connect Adapter	OME/Robot 1-4	0%		Asking
Will Sobel	MT Connect Agent	OME/Loader	0%		Asking
Vice Commodore	Assembly Digital Twin	Core Entity	0%		Agreed
Vice Commodore	Generate CATPart from AP242	External	0%		Agreed
	Pack-ML State Machine	OME/Robot 1-4	0%		
	Pack-ML State Machine	OME/Loader	0%		
	Pack-ML State Machine	User Entity	0%		
	Pack-ML State Machine	Assembly Digital Twin	0%		
	Pack-ML State Machine	DCDCE	0%		
	Pack-ML State Machine	Supervisor Control	0%		

Use Case 2 – weight reduction





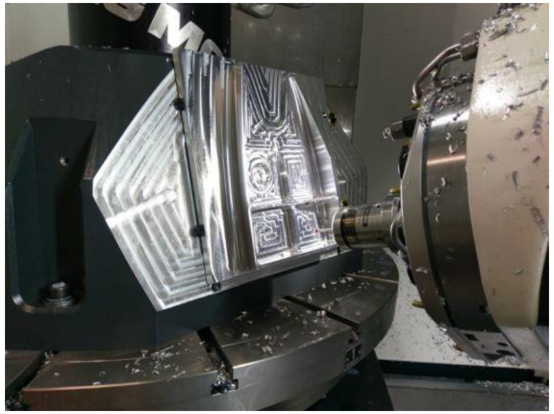
Exact match of fastener to hole depth can reduce weight by 500lb



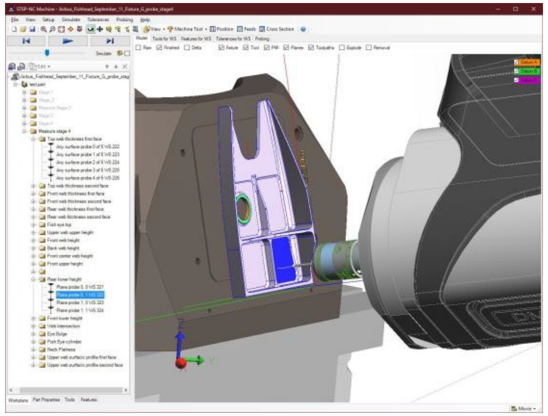
User entity
PLM/ERP
MOM
AP242
Supervisory Control
State Machine (supervisory)
Measurement Analyzer
AP242
QIF Results
Core entity
Part Digital Twin
Data cache
Models
Product/Process
Commands
Stop/Go, etc.
State Stream
Plunge complete, etc.
Measurements
Hole dimensions, etc.
Instructions
Gcodes, etc.
AP242
DCDCE
QIF results
Cell Controller
Planner
Device Control sub-entity
Data Cache (caliper)
Data Collection sub-entity
OME
Caliper
0.7320
State Machine

Group/Name	Task	23247 Use Case Reference	Completion Date	Completion %	Status
Jan De Nijs	Define Use Case		16-Mar-20	100%	Complete
Martin Hardwick	Document Use Case		22-Apr-20	100%	Complete
Jan De Nijs/L Maggiano	Author MBDs	PLM/ERP	14-May-20	100%	Complete
L Maggiano	Export AP242 Nominals	User Entity	14-May-20	100%	Complete
L Maggiano	Export QIF Plan	DCDCE	14-May-20	100%	Complete
Hany Abdel-Motaleb	Measure Parts (key-in)	OME	14-May-20	100%	Complete
Hany Abdel-Motaleb	Export QIF Measured Results	DCDCE	15-May-20	100%	Complete
Martin Hardwick	Import QIF Measured Results	Core Entity	20-May-20	100%	Complete
Martin Hardwick	Assemble AP242 Digital Twin	User Entity	20-May-20	100%	Complete
Sung Hei Kim	Revise Use Case		30-Jun-20	100%	Complete
Xometry	Fabricate Parts		17-Jul-20		Approved
Hany Abdel-Motaleb	Measure Parts (as-built)	OME	24-Jul-20		
Hany Abdel-Motaleb	Export QIF Measured Results	DCDCE	24-Jul-20		
Martin Hardwick	Import QIF Measured Results	Core Entity	31-Jul-20		
Martin Hardwick	Assemble AP242 Digital Twin	User Entity	14-Aug-20		
Jan De Nijs	Evaluate Assembled Digital Twin	PLM/ERP	28-Aug-20		

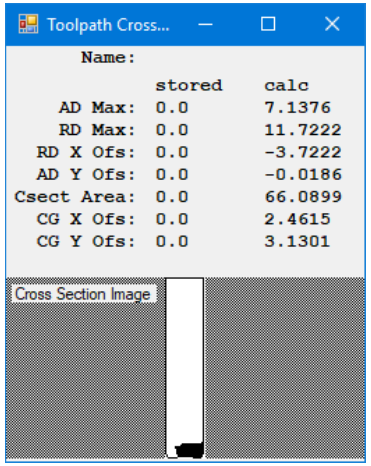
Use Case 3 – tool life optimization



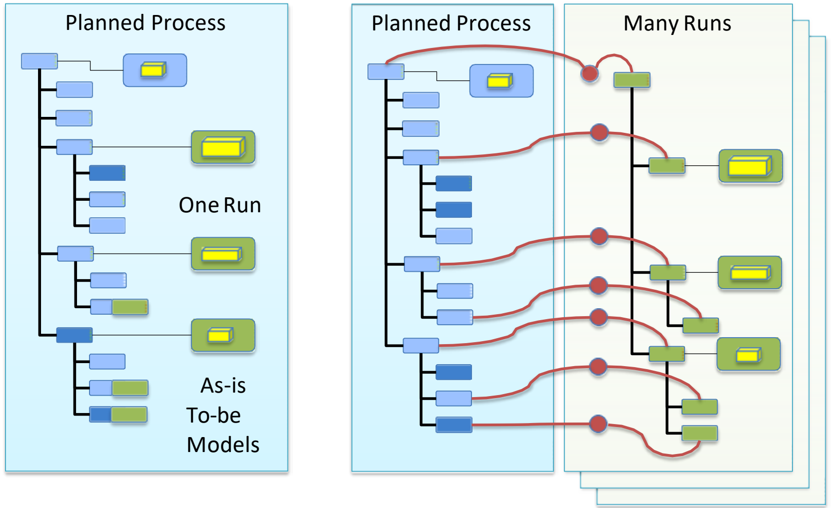
Machine parts



Monitor tool diameter



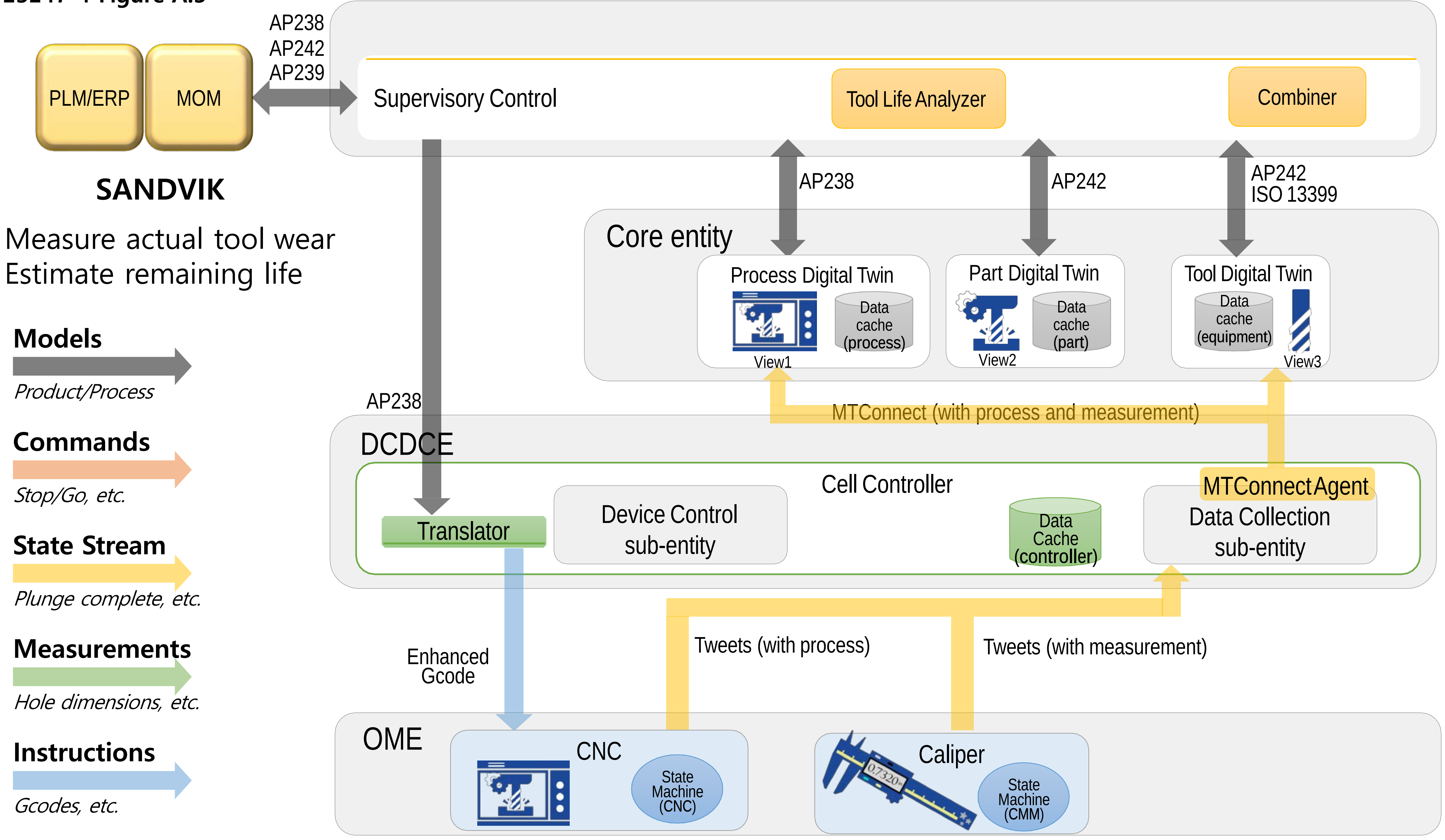
Compute tool engagement

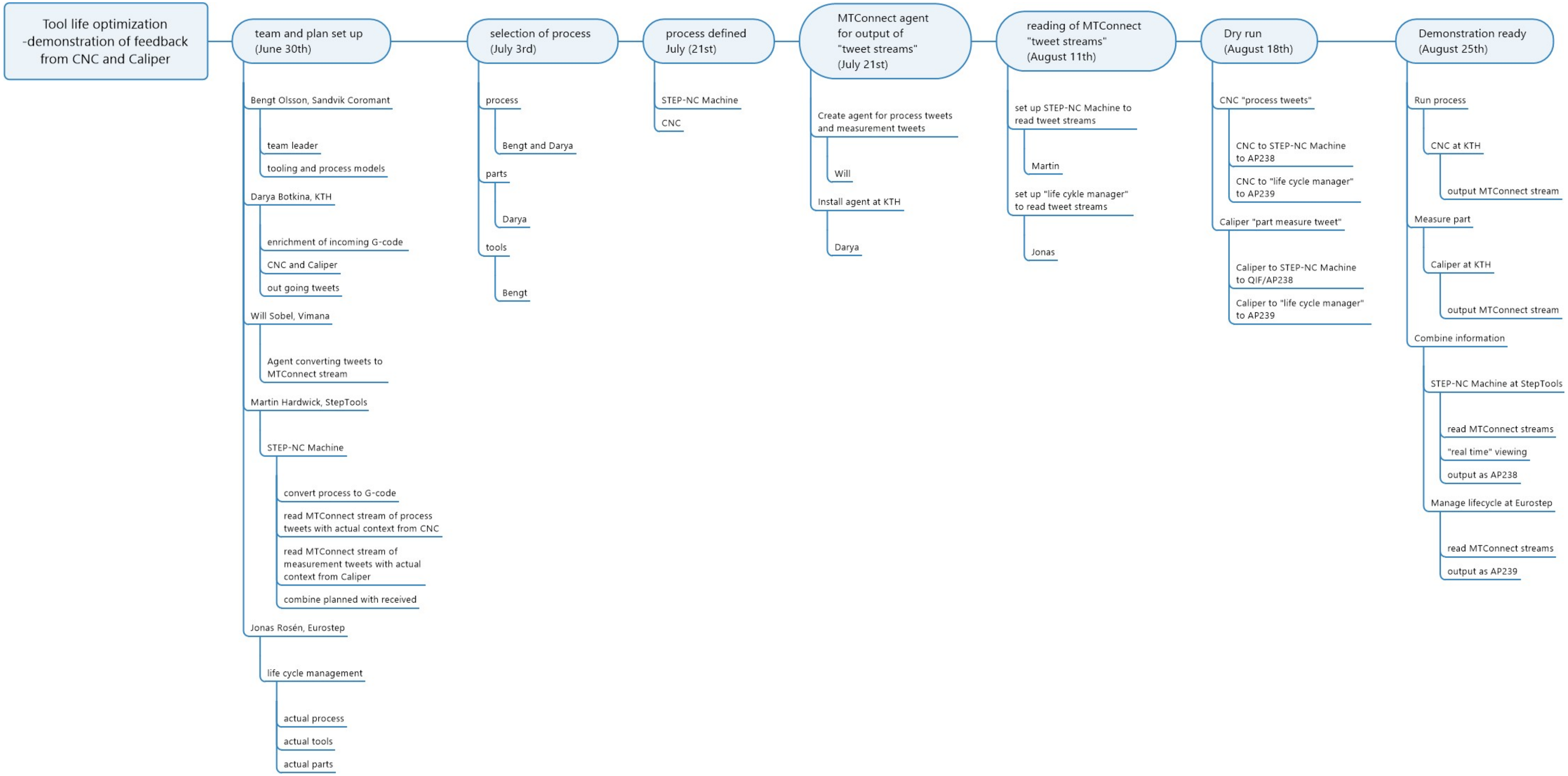


Store linked data

OMAC	ANSI	STEP Tools	ISO	
Machining Context Macros →	MTConnect →	STEP Agent →	STEP-NC	Tool life can increase by 15%
Gcode ops	Stream results	Apply Results	Twin model	

ISO 23247-4 Figure A.3




Tool life optimization -demonstration of feedback from CNC and Caliper
team and plan set up (June 30th)
Bengt Olsson, Sandvik Coromant
team leader
tooling and process models
Darya Botkina, KTH
enrichment of incoming G-code
CNC and Caliper
out going tweets
Will Sobel, Vimana
Agent converting tweets to MTConnect stream
Martin Hardwick, StepTools
STEP-NC Machine
convert process to G-code
read MTConnect stream of process tweets with actual context from CNC
read MTConnect stream of measurement tweets with actual context from Caliper
combine planned with received
Jonas Rosén, Eurostep
life cycle management
actual process
actual tools
actual parts
selection of process (July 3rd)
process
Bengt and Darya
parts
Darya
tools
Bengt
process defined July (21st)
STEP-NC Machine
CNC
MTConnect agent for output of "tweet streams" (July 21st)
Create agent for process tweets and measurement tweets
Will
Install agent at KTH
Darya
reading of MTConnect "tweet streams" (August 11th)
set up STEP-NC Machine to read tweet streams
Martin
set up "life cykle manager" to read tweet streams
Jonas
Dry run (August 18th)
CNC "process tweets"
CNC to STEP-NC Machine to AP238
CNC to "life cycle manager" to AP239
Caliper "part measure tweet"
Caliper to STEP-NC Machine to QIF/AP238
Caliper to "life cycle manager" to AP239
Demonstration ready (August 25th)
Run process
CNC at KTH
output MTConnect stream
Measure part
Caliper at KTH
output MTConnect stream
Combine information
STEP-NC Machine at StepTools
read MTConnect streams
"real time" viewing
output as AP238
Manage lifecycle at Eurostep
read MTConnect streams
output as AP239