

Advanced Knowledge Provisioning Using AI & AR for Ship Repair

All Panel Meeting – March 24, 2021

Agenda



- Project Overview
- Applying AI and AR to Ship Repair
- Shipyard Pilots
- Phase 2

Project Overview - Team

- Pacific Shipyards
- Conrad Shipyards
- Fincantieri Marine Systems, N.A.
- Auros Knowledge Systems
- D'Angelo Technologies
- Hepinstall Consulting Group



- NSRP Technical Manager
 - Jim House, ATI
- NSRP Project Technical Representative
 - Shawn Wilkerson, HII-Ingalls

Terms

- AI – Artificial Intelligence
 - Wide ranging branch of computer science focused on building smart applications capable of learning and performing tasks that typically require human intelligence.
- AR – Augmented Reality
 - The virtual display of information overlaid on the real-world environment.
- KP – Knowledge Provisioning
 - An active way to Capture, Share, Deliver, and Reuse Shipyard Corporate Knowledge/Ship Repair Information

Why the Focus on Ship Repair



“We don’t have enough (ship repair) capacity for peacetime,” let alone to repair combat-damaged ships during wartime.

First, Rear Adm. Eric Ver Hage
Commander of Navy Regional Maintenance Center (CNRMC)
and Director of Surface Ship Maintenance and Modernization

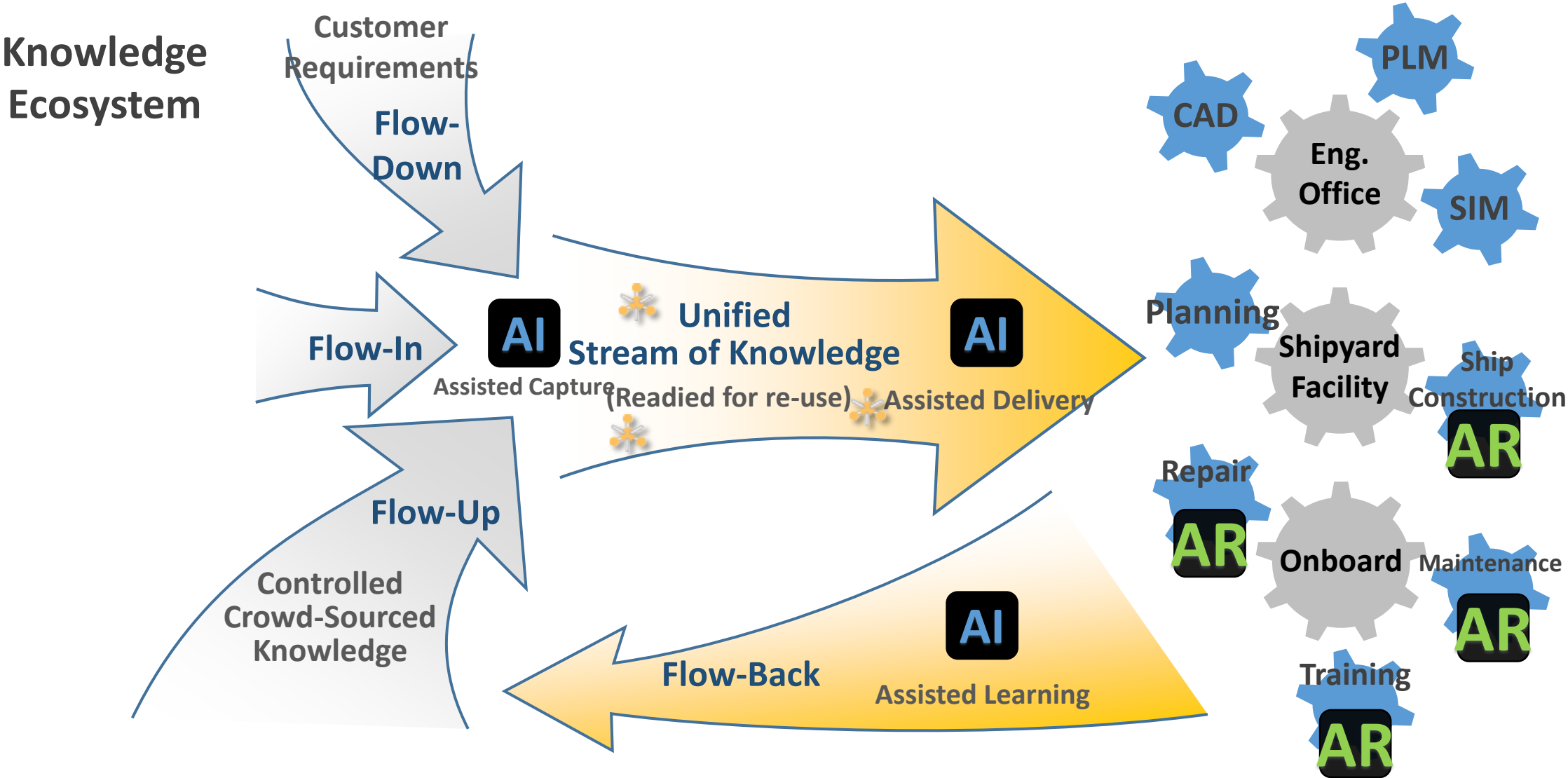
Aug 26, 2020, USNI News, [Lack of U.S. Warship Repair Capacity Worrying Navy](#)

Overall Project Objective



Automate the provisioning of critical knowledge directly into the ship repair workflows using Artificial Intelligence (AI) and Augmented Reality (AR)

Knowledge Operating System Vision



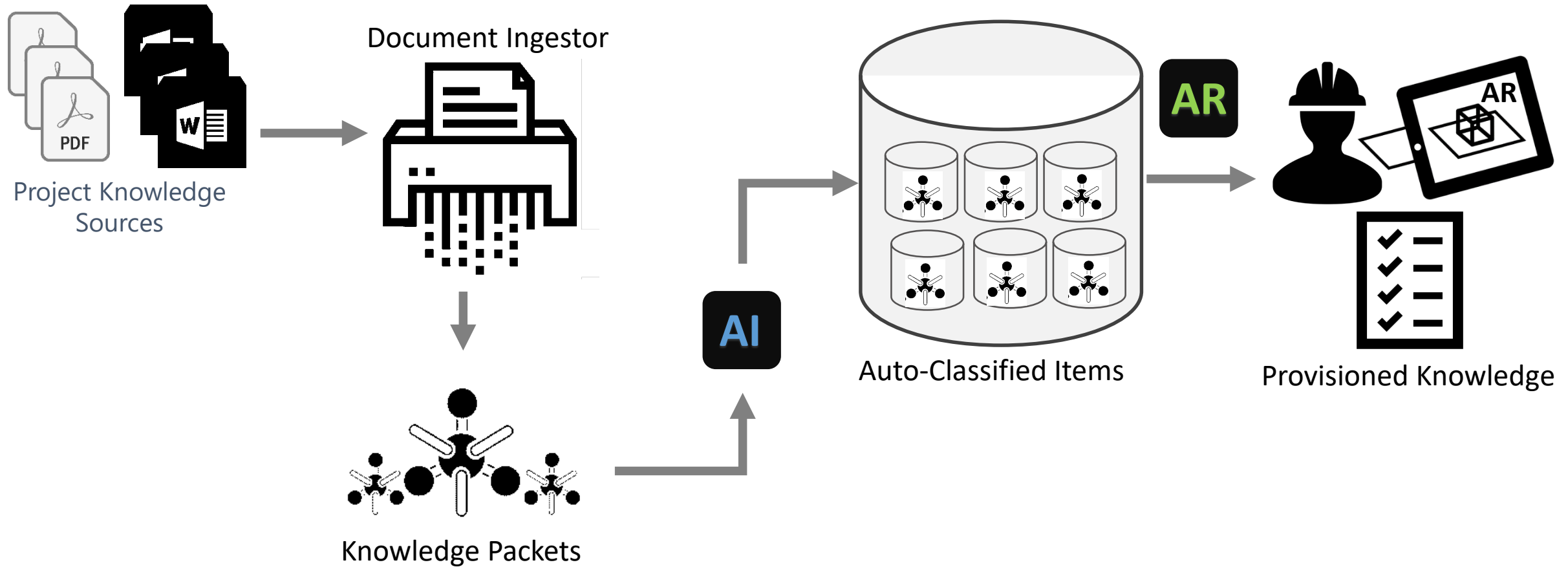
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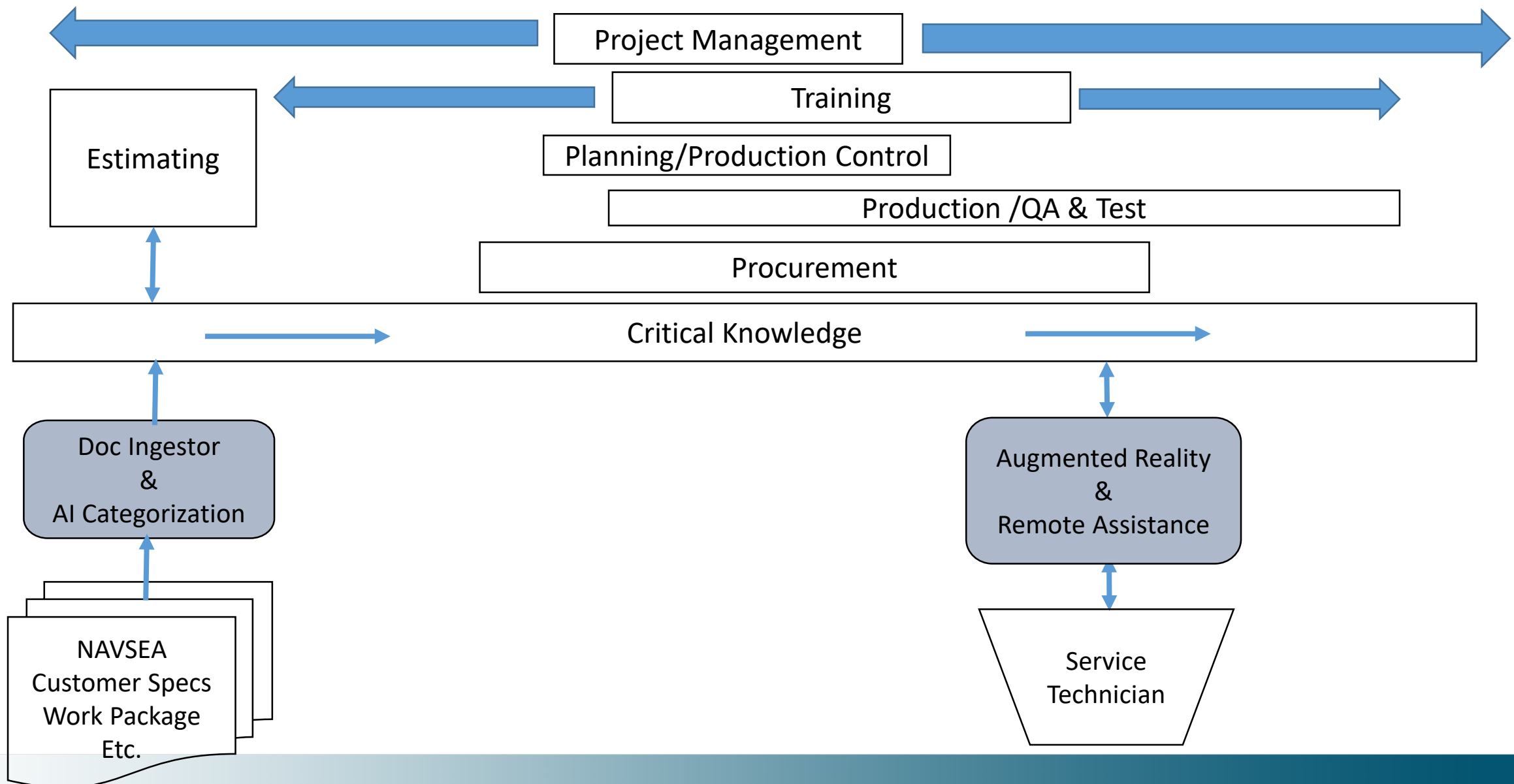
Value Proposition

- AI-assisted capture and packaging of critical knowledge/information
 - Customer requirements, Standards, Shipyard crowd-sourced knowledge
- Automated mapping of customer specifications and regulatory requirements into work control artifacts:
 - Estimating packages, Test and inspection plans, Planning work instructions, Job safety hazard notices, and Standard production work
- Augments ship repair workflow
 - Real-time viewing of reference materials while on ship
 - AR content persists for other users (Sticky Notes)
 - Virtual reference content (Designation nodes, animations)
 - Navigation feature assists in pathfinding to compartment
 - Remote Assistance feature provides live feedback from an SME via video chat

Applying AI and AR to Ship Repair

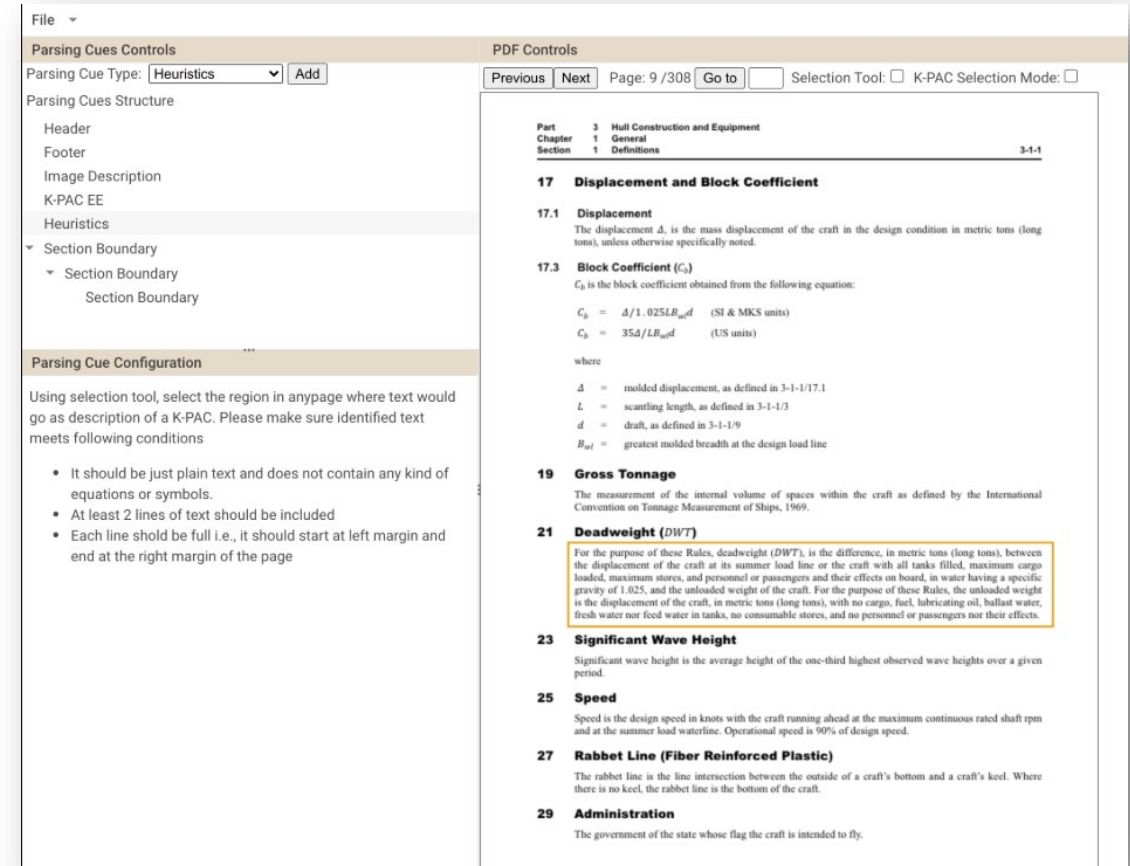


Applying AI and AR to Ship Repair



Artificial Intelligence Update

- Develop core functionality to auto-parse documents
 - Document Ingestor utilizes user identified parsing cues to automatically extract critical knowledge from project related documents.
- Develop machine learning module to auto-classify parsed items
- Develop continuous learning process to auto-refine machine learning module



Doc Ingestor Core Functionality Prototype

Artificial Intelligence Update

- Phase 1 Objectives – 99% Complete
 - Develop core functionality to auto-parse documents
 - Develop machine learning module to auto-classify parsed items
 - Develop continuous learning process to auto-refine machine learning module
- Phase 2 Objectives – 50% Complete
 - Develop simplified user interface to auto-parse documents
 - Develop simplified user interface to auto-classify parsed items

Augmented Reality Update

- Augmented Reality Features
 - Allows for information to be linked to specific ship compartments
- Navigation
 - Turn-by-turn directional system
 - Virtual arrow points user toward the entrance to the next compartment
- Remote Assistance
 - Supports more effective assistance for workers from off-site SMEs
 - Companion web client for use by SME
- Auros Connector
 - Gives worker access to provisioned knowledge and reference materials
 - Live adjustment to work item conformance states



View of a scanned compartment area

Augmented Reality Update

- Phase 1 Objectives – 99% Complete
 - Develop Augmented Reality features
 - Develop and map Navigation system
 - Develop Remote Assistance application
 - Configure Auros Connector for web-based interface
- Phase 2 Objectives – 50% Complete
 - Improve user interfaces
 - Add more specificity to Navigation
 - Remote Assistance - optimize connection maintenance

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Pilot Project Highlights - PSI

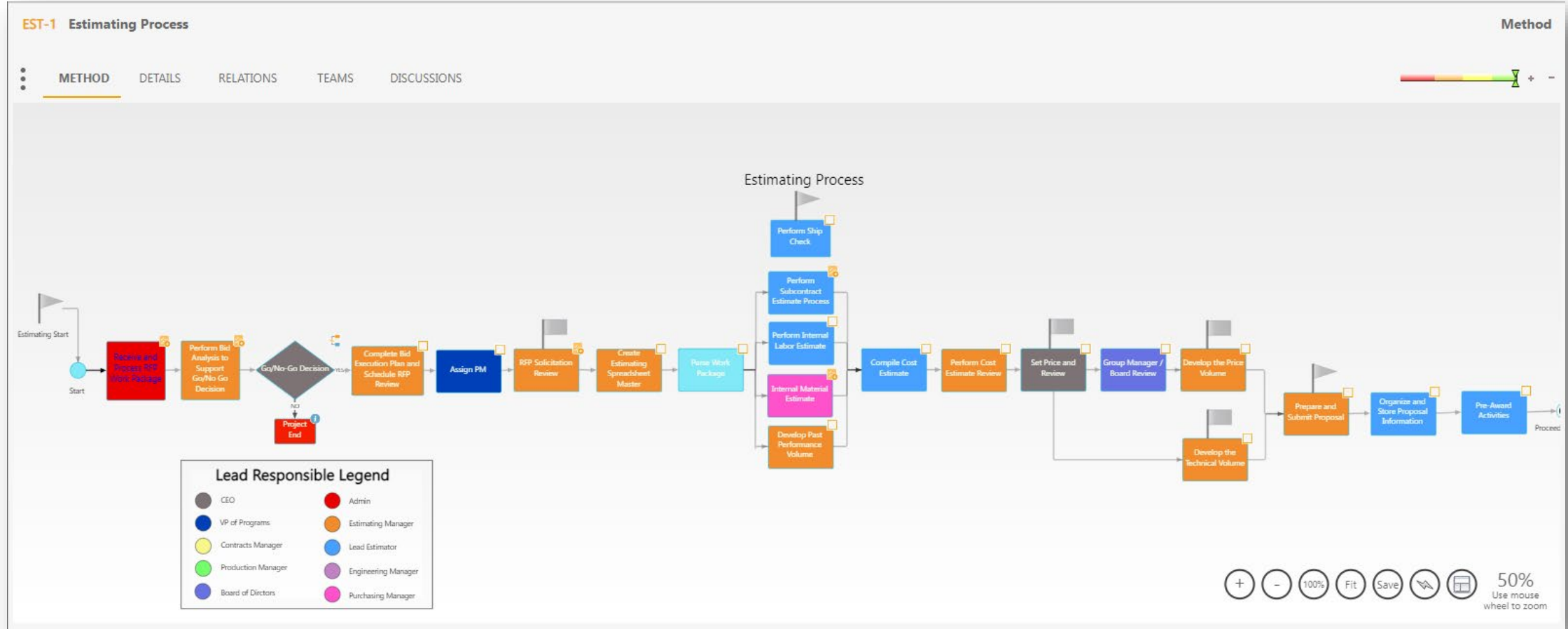
Arleigh Burke Class

- CNO SRA Availabilities
 - Work Package Items
 - NAVSEA Standard Items



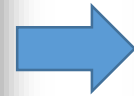
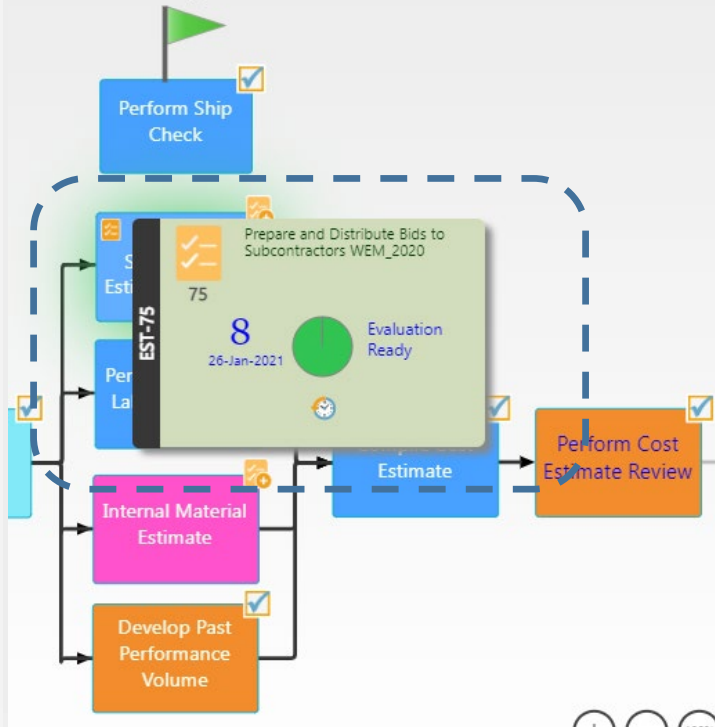
Shipyard Use Cases





- Navy MACMO level estimating process and standard work captured
- Shared workflow with roles and responsibilities clearly identified

Estimating Process



WEM_2020

Options Issues Reports Filter Views View Options No Grouping Set Defaults

Prepare and Distribute Bids to Subcontractors

| Conformance State | K-PAC ID | Status Icons | K-PAC Title | Description | Explanation | Support Document | LineItem Attach |
|------------------------------------|----------|--------------|--|---|--|---|-----------------|
| NE Red Yellow Green NA | EST-26 | V1 | Create the Email body to specify the WTs to bid, POP, and RFQ Due Date | Create the Email body Email a narrative that specifies standard information to include in the email to subcontractors inviting them to bid. 1. Obtain Period of Performance and Subcontractor RFQ Due Date from Lead Estimator. 2. Use the Subcontractor RFQ Email Template to create Project Specific Email. (See Support Documents) - Use the Subcontract Quote List to identify specific work items and paragraphs for each subcontractor. - Access Subcontract File on X drive to identify Point of Contact Information for each vendor/subcontractor - Create standard List of Deliverables - Request for Exclusions 3. Create RFP Email for each subcontractor. | The distributor will undergo, and must pass, waterproofness test. The component shall be submerged in tapwater, with the component uppermost surface a minimum of one inch below the surface of the water. The component shall be checked for leaks, there shall be no bubbles escaping from the interior of the component when the test chamber is evacuated to a pressure six pounds below atmospheric by applying 6 psi internal pressure for one minute while submerged. | Subcontractor RFQ Email Template.docx | 0.0 View |
| NE Red Yellow Green NA | EST-33 | V1 | Determine distribution method ie SAFE, email, ect | Determine distribution method (ie SAFE, email, etc) If there are export/IAR controlled requirements, the Subcontract RFP Package has to be emailed using the SAFE environment. (Find out from PSI who does this and how is this performed). Also - does it make sense to always communicate through SAFE during the bid process since it's business sensitive? | The class I distributor, including distributor shaft to crankshaft coupling, will operate for 600 hours with no maintenance except resetting of breaker points at 100 hour intervals, and lubrication of breaker cam, breaker lever pivot and felt wick under rotor. Subsequently, the distributor assembly must operate as specified in 3.5.1 and 3.5.2 | | 0.0 View |
| NE Red Yellow Green NA | EST-30 | V1 | List of Required Subcontractor RFQ Deliverables | List of Deliverables: - PSI Bid sheet - Request for exclusions - List of support services required by Work Item. (Support Services Request by Work Item) - Laydown requirements? (Laydown Requirements Template) - Proposed Schedule Note: Click on the K-PAC ID link to the left to open the K-PAC Details view. Once opened, see Support Documents chapter for template This list provides a checklist of other requirements that the subcontractor will be expected to meet if they are selected for award. Demonstrate Support, Control/IAR Controls are in place, if applicable. | The distributor will be operated and must conform to either 3.5.4.1 or 3.5.4.2 as applicable (see 4.10.6). | PSI RFQ Bid Sheet-R1.xlsx List of Support Services-R1.xlsx Subcontractor Proposed Schedule.xlsx | 0.0 View |

- Provisioned knowledge is utilized and evaluated resulting in effective knowledge transfer and visibility of project health

Estimating

Planning

Project
Management

Production

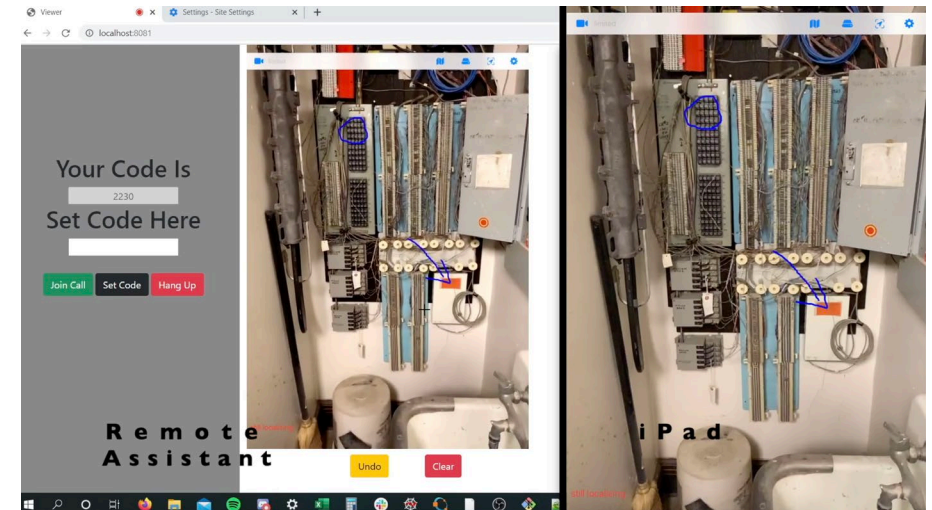
Quality

For On-Board maintenance support



Virtual image for
maintenance support
are overlaid
scanned-in
compartments

Virtual doorways
provide path from
current compartment
to destination
compartment



Remote Assistance
provides
communication with
off-site SME

Pilot Project Highlights - FMSNA

- Ship Service Generator Engines
- Maintenance Procedures
 - Tech Manuals
 - Supplemental Procedures
 - Maintenance Repair Cards (MRC)

Littoral Combat Ship



Pilot Project Highlights - Conrad

- Customer Specification Compliance



Specialty Barges

Push Boats



Tank Barges



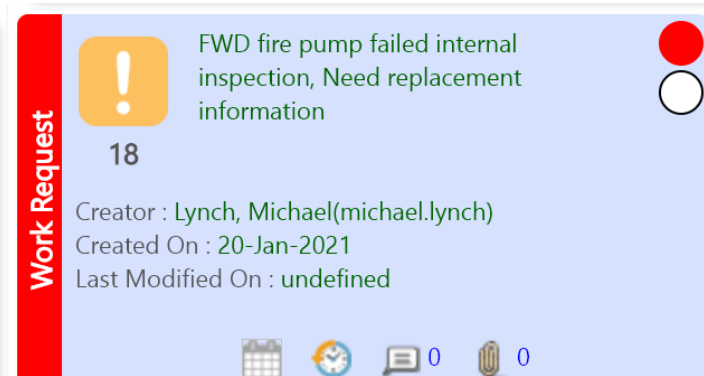
Pilot Project Highlights - DRBA

- Dry-Docking, Repowering and Repairs
 - Major Modifications
 - New Propulsion Train and Controls
 - Passenger Lounge Upgrades
- Assessments to Track Repair Specifications Progress / Issues

M/V NEW JERSEY



Capacity: 100 cars, 800 pass.
Year of build: 1974



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Recap of Accomplishments/Benefits to Date

- ✓ **Document Ingestor** Completed (Development Environment)
- ✓ **AI K-PAC Auto Classifier** / Categorization of Specs Completed (Development Environment)
- ✓ **6,516** Ship Repair Knowledge Packets
- ✓ Work Package imported and classified in **2 Days vs 21 Days**
- ✓ **8 Major Workflows** Completed or Under Development
- ✓ **AR User Interface** and **Auros Connector** functionality for compartment-specific information delivery completed
- ✓ Integrated the **Remote Assistance** capability to connect remote supervisor or subject matter expert to see and interact with worker at job site. (Especially useful during COVID).

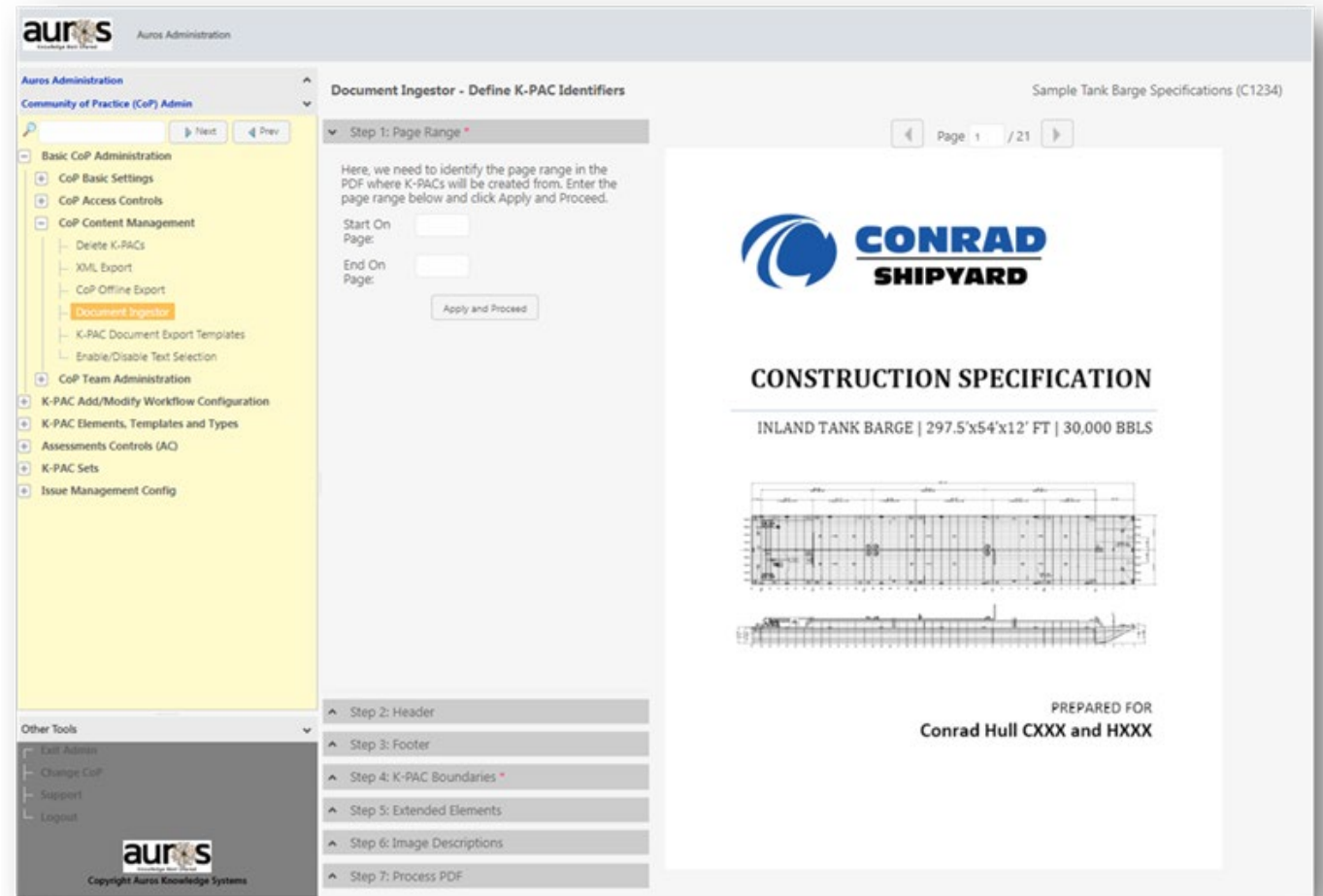
Phase 2 Plans (Feb 2021 – Oct 2021)

- Conduct shipyard pilots
- Measure effectiveness
- Upgrade/harden the application for Ship Repair
- Release AI/AR Knowledge Provisioning Application for Ship Repair
- Develop Implementation Offerings
- Disseminate results to industry



Phase 2 Improvements Identified

- AI Improvements
 - Enhance usability with more intuitive interface
 - Extend AI to address more tagging strategies
 - Integrate AI into Auros IQ platform (Releases IQ-6, IQ-7)



Phase 2 Improvements Identified

- AR Improvements
 - AR - optimize/speed up re-localization, status messages, simplify user experience, enhance designation codes (i.e., color code by craft, etc.)
 - Navigation - Pathfinding can be more specific,
 - Auros Connector - central data repository, improve offline function
 - Remote Assistance - optimize connection maintenance
 - Improve user interface and experience



Scanning a compartment

AI/AR Knowledge Provisioning



Questions
TBD