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 overlayed 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

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

Knowledge Ecosystem

- Flow-In: Assisted Capture
- Flow-Down: Assisted Delivery
- Flow-Up: Controlled Crowd-Sourced Knowledge
- Flow-Back: Assisted Learning

Unified Stream of Knowledge (Readied for re-use)

- Customer Requirements

CAD, PLM, SIM
- Planning
- Shipyard Facility
- Construction
- Ship
- Office
- AR
- Onboard
- Maintenance
- Training
- Repair
- Ship Construction

AI
- Assisted Learning
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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

Project Knowledge Sources

Document Ingestor

Knowledge Packets

Auto-Classified Items

Provisioned Knowledge
Applying AI and AR to Ship Repair

- Estimating
- Project Management
- Training
- Planning/Production Control
- Production /QA & Test
- Critical Knowledge
- Procurement
- Doc Ingestor & AI Categorization
- Augmented Reality & Remote Assistance
- NAVSEA Customer Specs Work Package Etc.
- Service Technician
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
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

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

Arleigh Burke Class
Shipyard Use Cases
• Navy MACMO level estimating process and standard work captured
• Shared workflow with roles and responsibilities clearly identified
• Provisioned knowledge is utilized and evaluated resulting in effective knowledge transfer and visibility of project health
For On-Board maintenance support

Virtual doorways provide path from current compartment to destination compartment

Virtual image for maintenance support are overlayed scanned-in compartments

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