



# Building “Failure Data and Prediction Models” for Ship Construction and Sustainment Support

(Focus on Artificial Intelligence Model Development)  
Project Final Technology Transfer Presentation

## NSRP Sustainment Panel Meeting

June 16, 2026 Danville, VA

### Project Leads:

Subrat Nanda; American Bureau of Shipping (ABS)

Karen Cassidy; HII-Ingalls Shipbuilding

Mark Debbink; HII-Newport News Shipbuilding

Alaysha Shearn; HII-Newport News Shipbuilding



# Project Participants



## NSRP RA Project 2024-01

- Newport News Shipbuilding (HII-NNS)
- Ingalls Shipbuilding (HII-Ingalls)



- NAVSEA 05Z with NSWC Philadelphia & USCG Surface Forces Logistics Center
- NOAA, MSC

# Problem Statement

- Sustainment costs for ships continue to be a large and difficult to manage cost for the Navy and other services
- Considerable effort is being spent on sensing and measurement of parameters that may help identify and predict failures
- Opportunities remain to extract much more value from the amount of data already being collected

Challenges Affecting Navy Ships Availability	Ticonderoga-class cruiser (CG-47)	Nimitz-class aircraft carrier (CVN-68)	Arleigh Burke-class destroyer (DDG-51)	Freedom-class littoral combat ship (LCS-1)	Independence-class littoral combat ship (LCS-2)	America-class amphibious assault ship (LHA-6)	Wasp-class amphibious assault ship (LHD-1)	San Antonio-class amphibious transport dock (LPD-17)	Whidbey Island-class dock landing ship (LSD-41)	Harpers Ferry-class dock landing ship (LSD-49)
Service life longer than anticipated	•	•							•	•
Unexpected replacement of parts and repairs		•	•	•	•		•	•		•
Access to technical data		•								
Delays in depot maintenance	•	•	•	•	•	•	•	•	•	•
Delays in intermediate maintenance	•		•		•		•			
Shortage of trained maintenance personnel	•		•	•	•	•	•	•	•	•
Unscheduled maintenance	•	•	•	•	•	•	•	•		
Diminishing manufacturing sources	•	•	•		•		•			
Parts obsolescence	•	•	•	•	•		•	•		•
Parts shortages and delays	•	•	•	•	•		•	•	•	•

• Applicable maintenance issue  
Source: GAO analysis of Navy information. | GAO-23-106673



Amphibious Assault Ships



Destroyers



Submarines



Aircraft Carriers



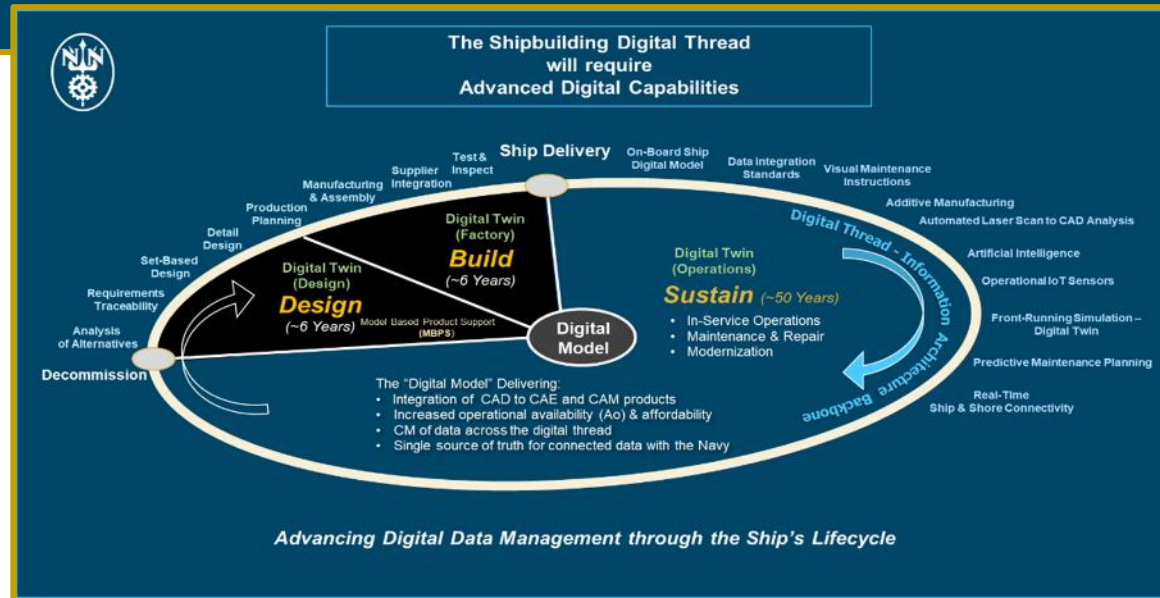
# NSRP RA Project 2024-01 FINAL REPORT

1. Provide a failure data readiness/quality assessment and develop a roadmap for government fleet owner/operators and shipyards to:

- (1) Optimize yard availabilities
- (2) Provide feedback to follow-on vessels using advanced data analytics of available ship condition

2. Lay the foundation for increased use of advanced data analytics that:

- (1) Reduce the cost and improve the predictability of scheduling for yard availability periods for ships
- (2) Reduce the total cost of ownership of ships produced and sustained by yards, especially due to unrecognized vulnerabilities and material conditions that lead to failures



# AI Tools Used to Preprocess the Data: NLP

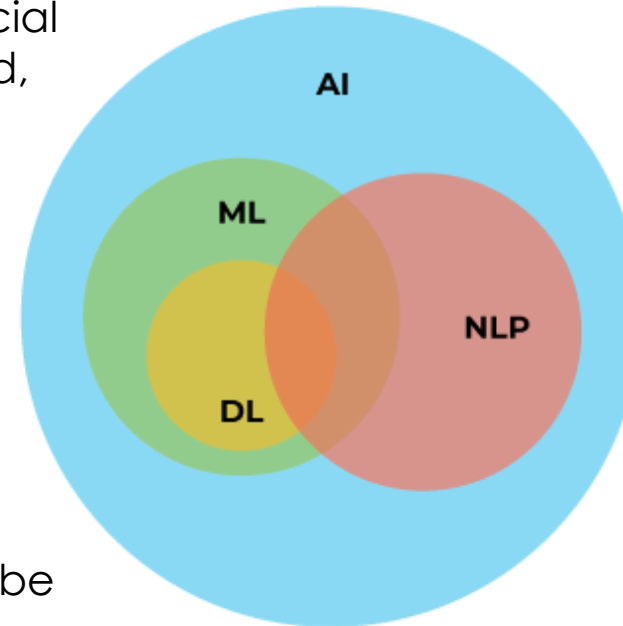
**Natural Language Processing (NLP)** is a field of artificial intelligence which enables computers to understand, interpret and generate language

## Some Common Tasks:

- **Text Classification**
- Machine Translation
- **Named Entity Recognition**
- Summarization

## Objectives:

- Ingest and prepare the data
- Determine processes by which key data will be extracted from text
- Explore data-driven insights into common failure modes for machinery
- Provide solutions and next steps to reduce downtime & improve reliability



- Artificial Intelligence
- Machine Learning
- Language Processing
- Deep Learning

**Artificial Intelligence (AI)** refers to computer systems that can perform complex tasks normally done by human-reasoning, decision making, creating, etc. AI algorithms are used to analyze large amounts of data and identify patterns and trends that can inform the design of more efficient and effective ships.

Machine Learning	Deep Learning
Simple (regression, tree based)	Complex (neural net, transformer)
Interpretable	Black box
More preprocessing	More contextual understanding

# What Do Artificial Intelligence-Based Machinery Analytics Provide?

## Anomaly Detection

Insights to make data-driven operational & maintenance decisions (*active and pro-active*)

- Detect incipient issues (prior to potential failure) > reduce unplanned failures
- Identify target areas for closer monitoring
- Augment upcoming planned maintenance > condition based
- Plan for corrective action (when failures confirmed) > flexibility

## Disposition

- Provide most likely and actionable IP
- Continuous program improvement
- Identify additional components or failure modes

**RAMS** (Reliability, Availability, Maintainability and Safety)

## Insights for Planning & Optimization

- Understanding system reliability & trends
- Identify bad actors and/or systemic FMs
- Detect emergent reliability-related risks
- Perform vessel-to-vessel benchmarking
- Insights for ABS surveyors: inputs to PCM; targeted & focused
- Identify data quality issues
- Potential insights using CMMS data:
  - Parts and spares
  - Maintenance cycles
  - Vessel operations

## Salient Features

- Data-driven tools to augment customer's decision-making
- Insights to assist with planning, maintenance scoping and operational inputs
- Customer-ABS current processes undergo **no** change...only data-driven insights to support decision-making
- Perform continuous improvement in algorithms and data quality processes



# Accessing Data & Categorization

**Open Architectural Retrieval System (OARS)** – maintained by NAVSEA logistics center  
(All fleet data from all hulls go into that database)

- DCACA Program (old term) Data collection, analysis and corrective actions
- FRACAS (New Term) = Failure reporting analysis and corrective actions
- We track by part number; systems could have multiple parts
- Each ship class has their own list of what are the mission-critical systems to track

## OARS – Data Structure

Program Class	Period of Failure Tracking	Equipment & Failures Track	Failure Type	Report forms	Solution
Any Naval Ship	Latest 9 years, from delivery to operation	EVERYTHING	EVERYTHING	Database	We run a query and review the results

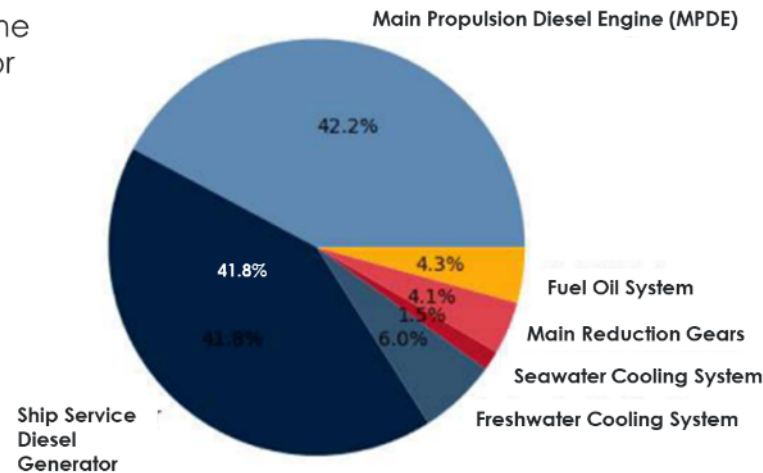


# Representative Data Sets for Data Analytics Demonstration Cases

The data utilized in this analysis consists of multiple structured files (excel) sourced from the Navy's ESWBS system, with one file provided for each vessel system of interest:

- 1) Main propulsion diesel engine
- 2) Ship service diesel generator
- 3) Main reduction gears
- 4) Seawater cooling system
- 5) Freshwater cooling system
- 6) Fuel oil system

Analyzed System Distribution



\* ESWBS = Extended ship work breakdown structure

# Training Data



# Normalization & Feature Engineering

## Where is our data coming from?

- Multiple sources that have been labeled by a Subject Matter Expert (SME)
- Supplemented with a few thousand rows of LPD-17 data

## Which columns are we looking at when it comes to model training?

- We're focused on the text columns that SME uses for classification task

## What systems are we looking at?

- Main propulsion diesel engine
- Ship service diesel generator
- Main reduction gears
- Seawater cooling system
- Freshwater cooling system SIMULATED DATA for Presentation
- Fuel oil system

Job Summary	Description	Solution
1B MPDE LOP FASTENERS	DURING NORMAL OPERATION, S/F FOUND THAT NR 2, NR 3, & NR 4 LUBEOILPUMP FASTENERS WER MISSING 1 HOLD DOWN FASTENER EACH.	S/F RECOMMENDS ER04 ASSIST IN THE RECRETION OF 3 LUBE OIL PUMP FASTENERS.
JW EXP. TNK TLI OOC	DURING ROUTINE MAINTENANCE, SHIP'S FORCE DISCOVERED THAT THE JACKET WATER LEVEL INDICATION WAS FAULTY. UPON FURTHER INBESTIGATION, IT WAS DETERMINED THAT THE LEVEL SWITCH WAS CORRODED AND IN NEED OF REPLACE.	SHIP'S FORCE WILL ORDER AND INSTALL NEW PARTS



## Normalization:

- Misspellings
- Abbreviations/entity linking
  - OOC -> out of compliance
  - xfrmr -> transformer
  - ER04 -> engine room #4
- Spaces/NoSpaces
  - Mpdecrankcase -> MPDE crankcase

## Feature Engineering:

- How can we make features as meaningful as possible?
  - NAVSEA S6430-AE-TED-010
  - NAVSEA HANDBOOK S9233-DL-HBK-010

Job Summary	Description	Solution
1B MPDE LUBE OIL FASTENERS	DURING NORMAL OPERATION, SHIP'S FORCE FOUND THAT LUBE OIL PUMP FASTENERS WERE MISSING 1 HOLD DOWN FASTENER EACH.	S/F RECOMMENDS ENGINE ROOM 4 ASSIST IN THE RECRETION OF 3 LUBE OIL PUMP FASTENERS.
JACKET WATER EXPANSION TANK TANK LEVEL INDICATOR OUT OF COMPLIANCE	DURING ROUTINE MAINTENANCE, SHIP'S FORCE DISCOVERED THAT THE JACKET WATER LEVEL INDICATION WAS FAULTY. UPON FURTHER INVESTIGATION, IT WAS DETERMINED THAT THE LEVEL SWITCH WAS CORRODED AND IN NEED OF REPLACE.	SHIP'S FORCE WILL ORDER AND INSTALL NEW PARTS

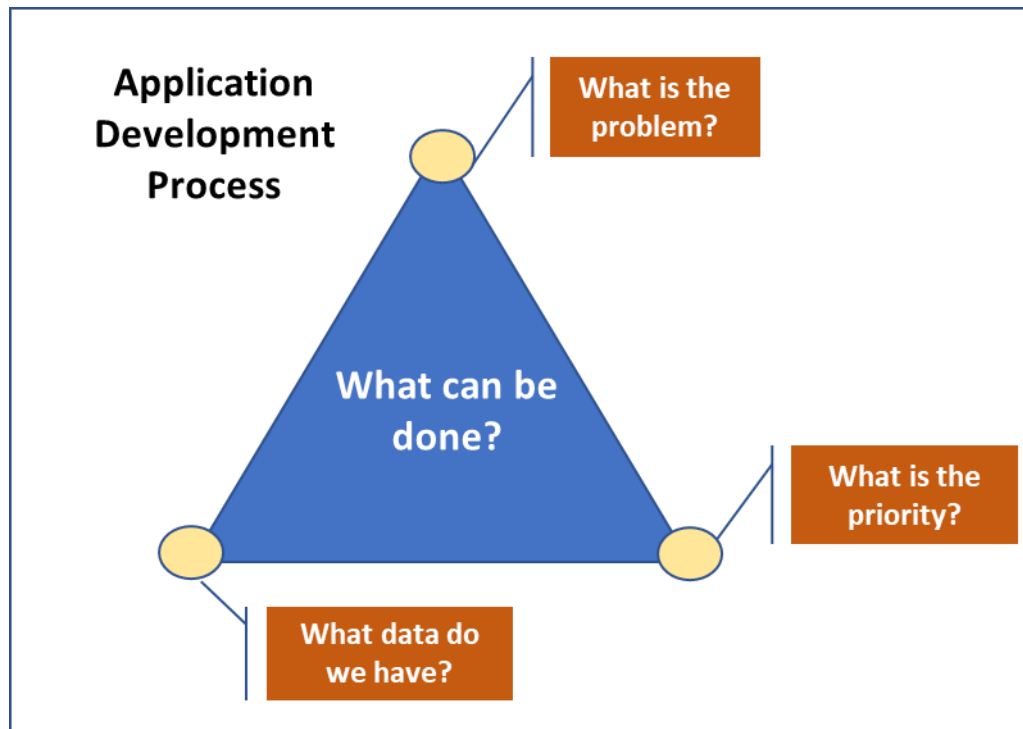


# ABS Failure Data Processing “User Guide” (DELIVERABLE)

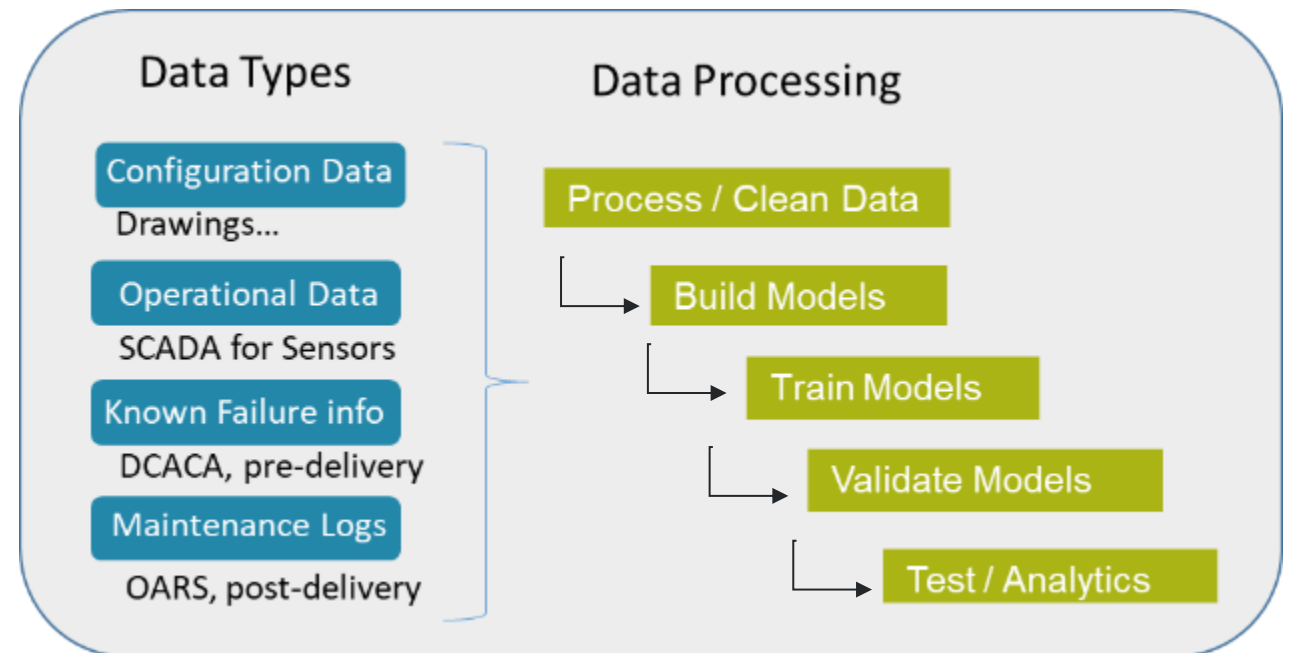


A key deliverable for this project is the **ABS User Guide**. This will provide guidance on the sequence of work (the *what to*) necessary to develop an AI architecture to support ship sustainment activities.

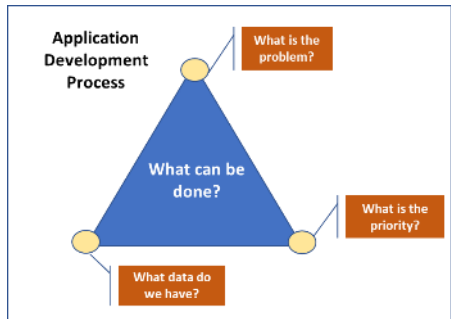
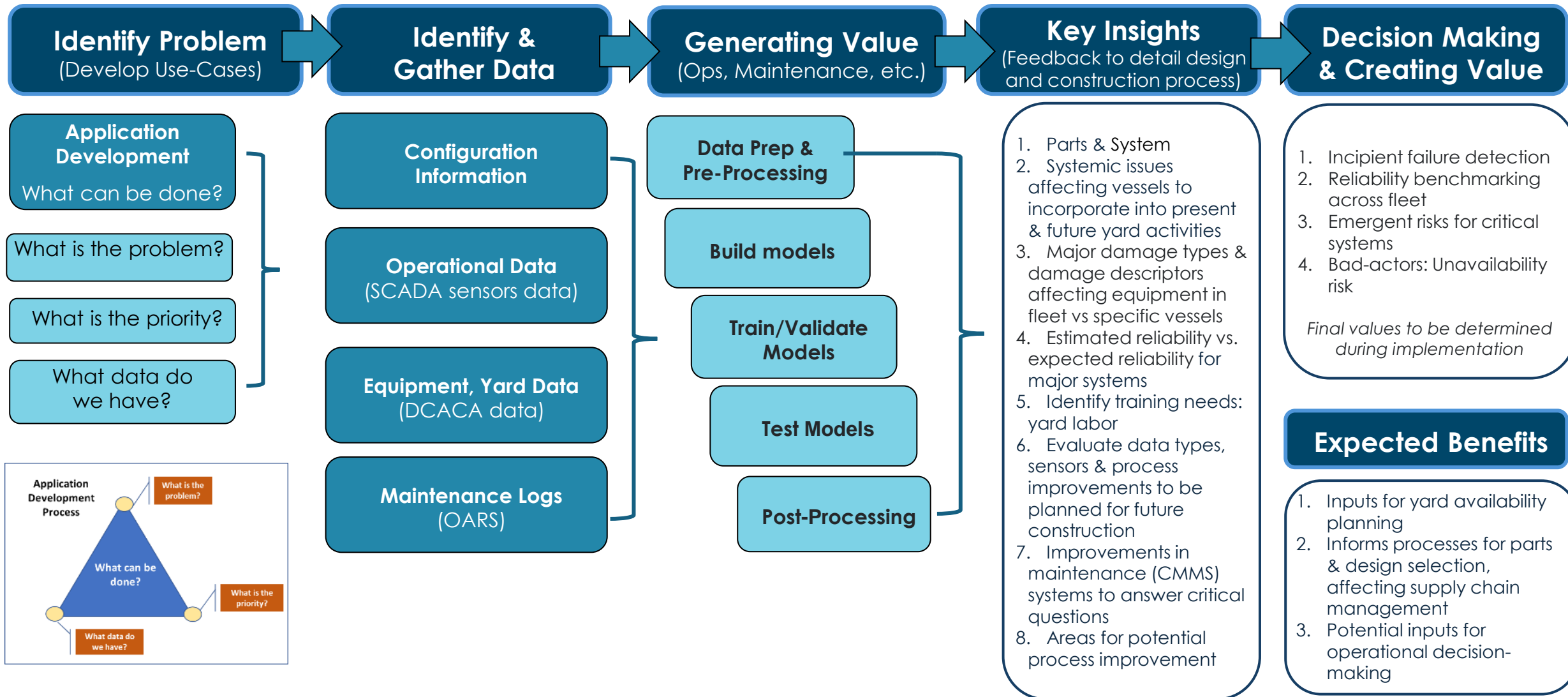
Primary steps in the User Guide will include:



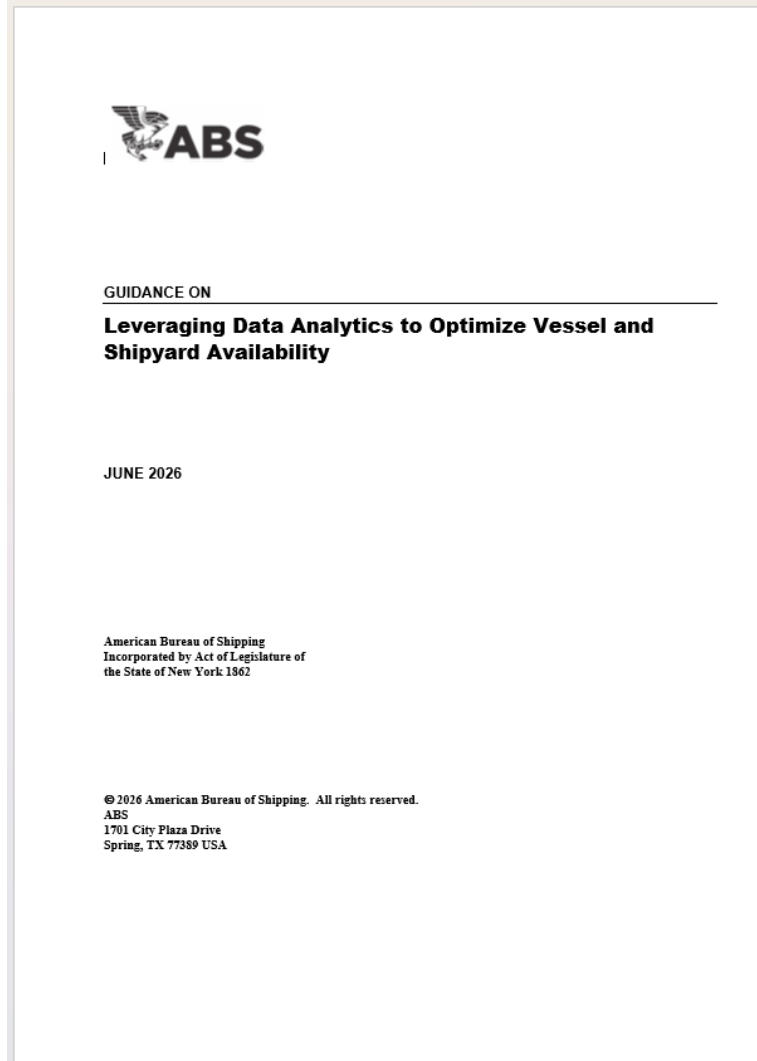
## Data Management Process



# ABS Program “Roadmap” (DELIVERABLE)



# ABS Guidance on current NSRP effort



ABS developing a guidance on 'Leveraging Data Analytics to Optimize Vessel and Shipyard Availability'

Discusses topics related to critical technologies and methods used as part of this program

Will be made available post-internal review process

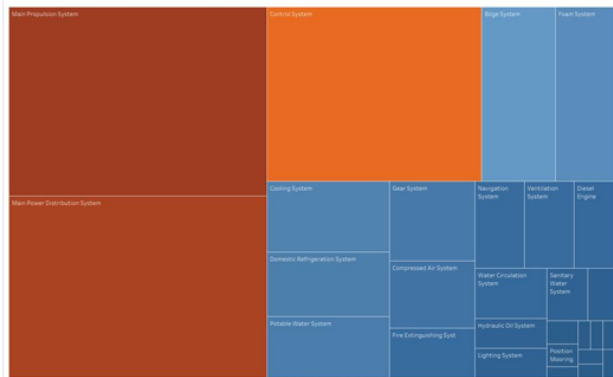
# Estimating Reliability Metrics using actual CMMS data

## Bad Actors



Quantify operational RAM risks

- Benchmark current reliability of major sub-systems.
- Identify emergent reliability risks
- Provide reliability trends over time
- Quantify the relative risk in reliability amongst multiple maintenance facilities



## Quantify Asset to Component Level Risks



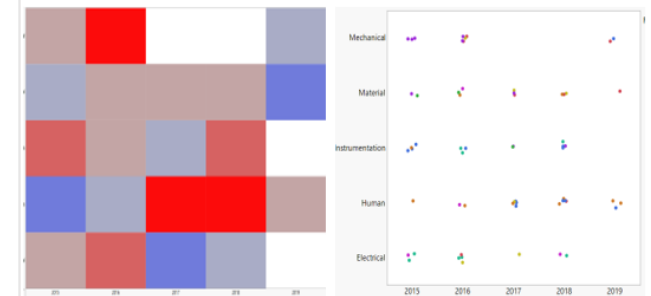
- Statistical & Risk models to benchmark baseline reliability risks
- Fleet wide risk assessment
- System to Component level models



## People or Process or Product ?



- Identify main factors causing RAM risk
- Data improvement



# Sensor-Based Anomaly Detection

## Detecting anomalous signatures for proactive maintenance planning

### Performance Analysis



Detailed analysis of the machinery performance for an asset or a fleet of assets

### Collect Additional Data

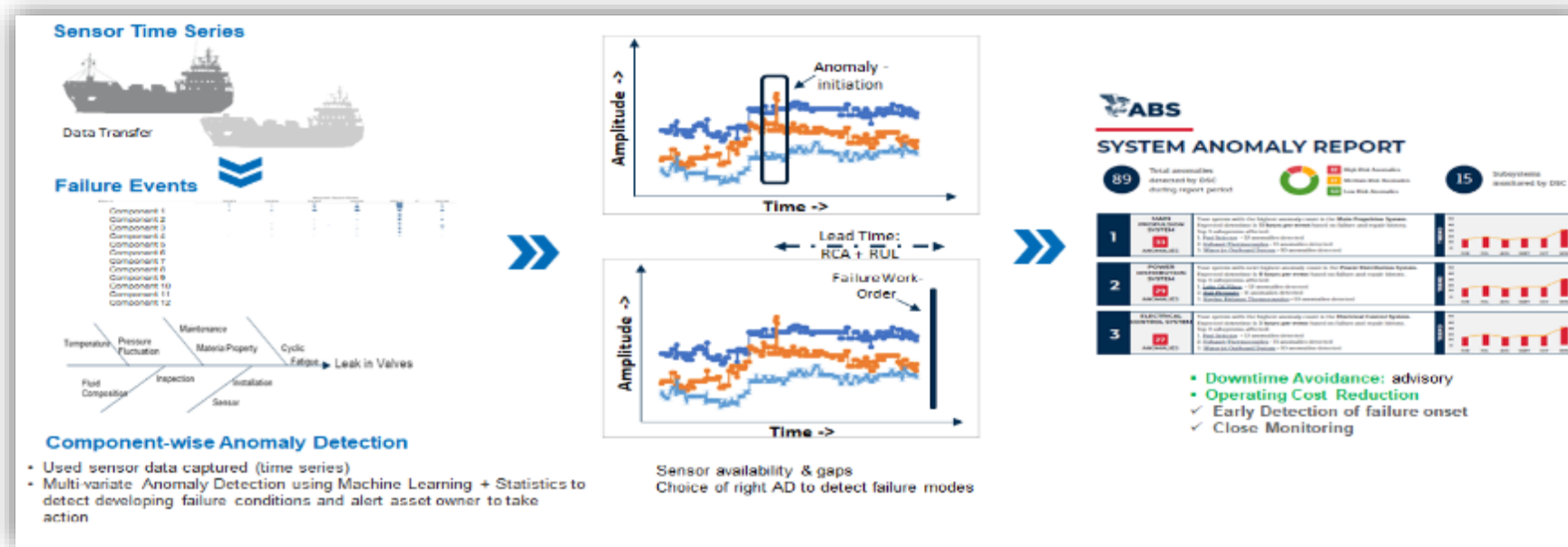


- Fusion of sensor, survey & customer data
- Signature analysis & pattern mining

### Identify, Monitor and Predict Anomalies



Reoccurring reports & alerts of identified anomalies



# Project Summary



- ✓ We have provided processes to unlock the power of failure/condition data sets through advanced analytics, including tools such as Artificial Intelligence (AI) and Machine Learning (ML), as well as more traditional reliability engineering techniques, by:
  1. Alignment of the many stakeholders engaged in the availability planning / execution process
  2. Providing the critical technical insights to identify and address early failures for planned and scheduled corrective action
  3. Providing a feedback loop to eliminate vulnerabilities during construction of subsequent ships in a vessel class
- ✓ We have provided a failure data readiness/quality assessment user guide to improve ship availability work identification process and accurately schedule to reduce unscheduled work and time-at-dock
- ✓ We will evaluate the AI OARS model for use on additional ship classes and integrate into our processes

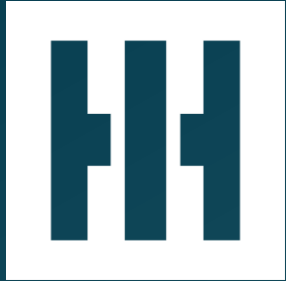
**Delivered:** Failure Data & Prediction Models Roadmap posted to NSRP ATI site RA 2024-01



**Delivered:** Failure Data & Prediction Models User Guide posted to ABS site



Thank you for your attention



## Discussion...



Building “Failure Data & Prediction Models” for Ship Construction & Sustainment Support