Machinery Predictive Analytics and Decision Making

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DecisionIQ: Founders

Successful Engineer/Entrepreneur
<u>Technology Enabled Products & Businesses</u>

Apple Clone License / High Performance Computing

F-16 New Supersonic Cruise Wing

Andrew Lewis
Founder, CEO

- MBA, University of Chicago
- BS, Aerospace Engineering, Georgia Tech

Nagi Gebraeel, PhD
Co-Founder, Chief Data Scientist

- Professor, Industrial Engineering, Georgia Tech
- MS, PhD, Industrial Engineering, Purdue University

Georgia Tech Manufacturing Institute

Georgia Tech Center for Predictive Analytics

Georgia Tech High Performance Computing

Background

- DecisionIQ is an Atlanta-based startup company specialized in equipment predictive analytics and asset management.
- DecisionIQ is commercializing state-of-the-art research in this space that has been developed at Georgia Tech.
- Unique aspect of the DecisionIQ platform:
  - *Seamless integration between reliability engineering, sensor-based and optimization models for real-time decision-making for maintenance, operations, and (spare parts) supply chain.*

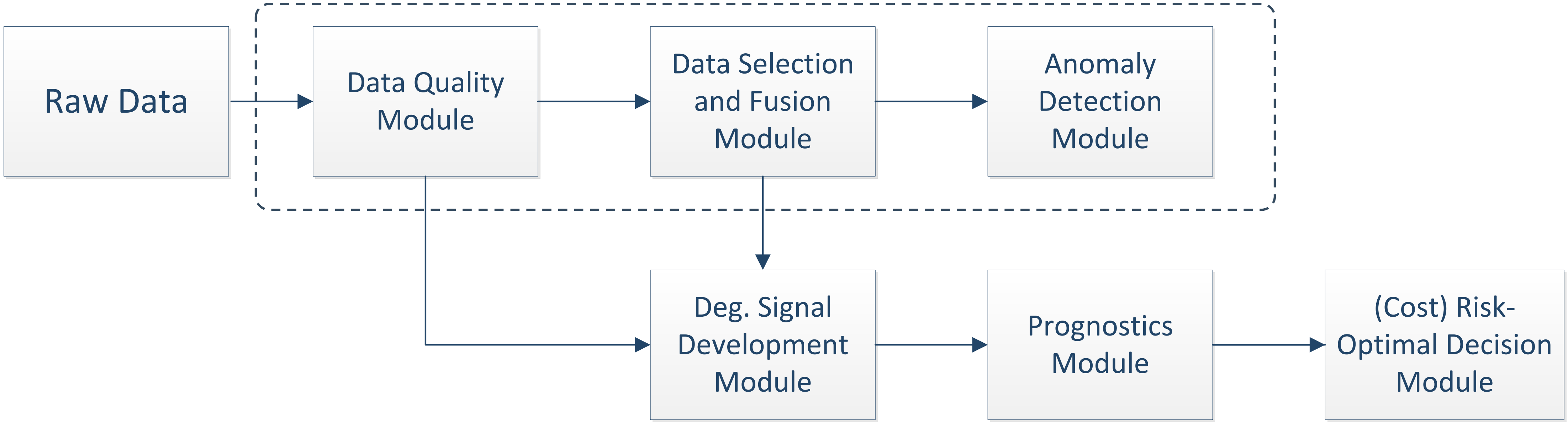
Balancing Flexibility and Scalability

- DecisionIQ is home to APDP:
  Adaptive **P**redictive Analytics **D**evelopment **P**latform

- APDP was developed on the basis of an **assemble-to-order** deployable analytics platforms
  - *Enables rapid development of custom-built analytic solutions that meet unique customer needs*
  - *Balances flexibility provided by customized solutions while ensuring scalability and ease of deployment that comes with one-size-fits-all solutions*

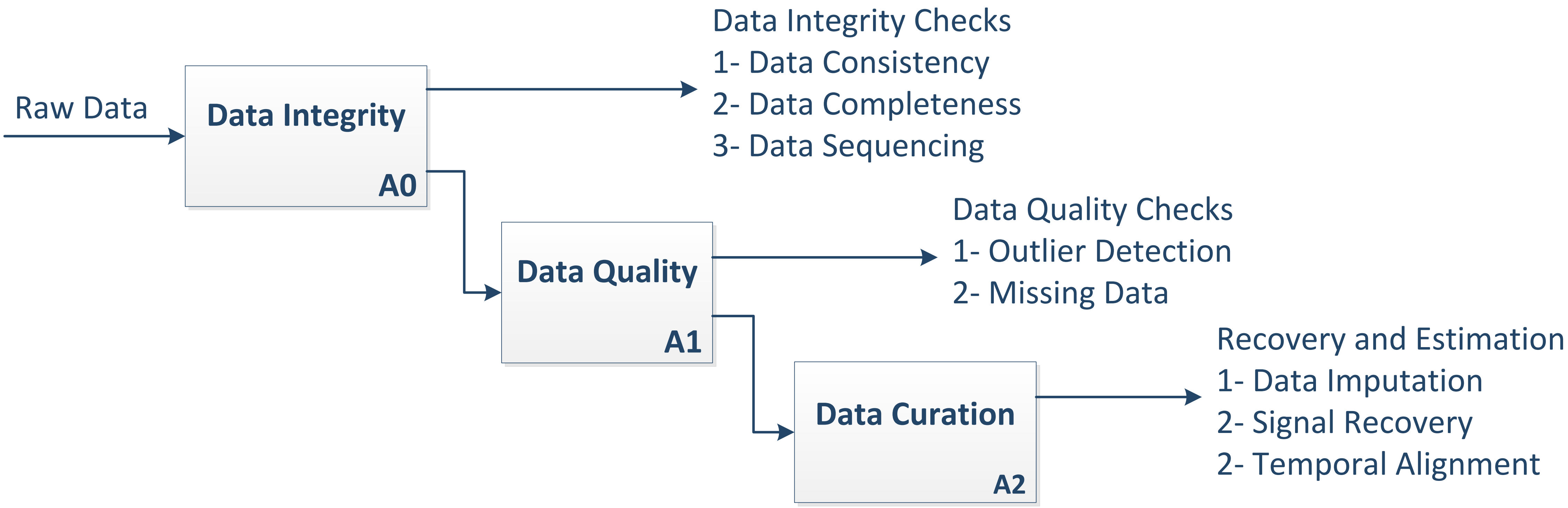
Platform Overview

- APDP consists of six modules
- Modules used for the SNC Monitoring Challenge are highlighted below



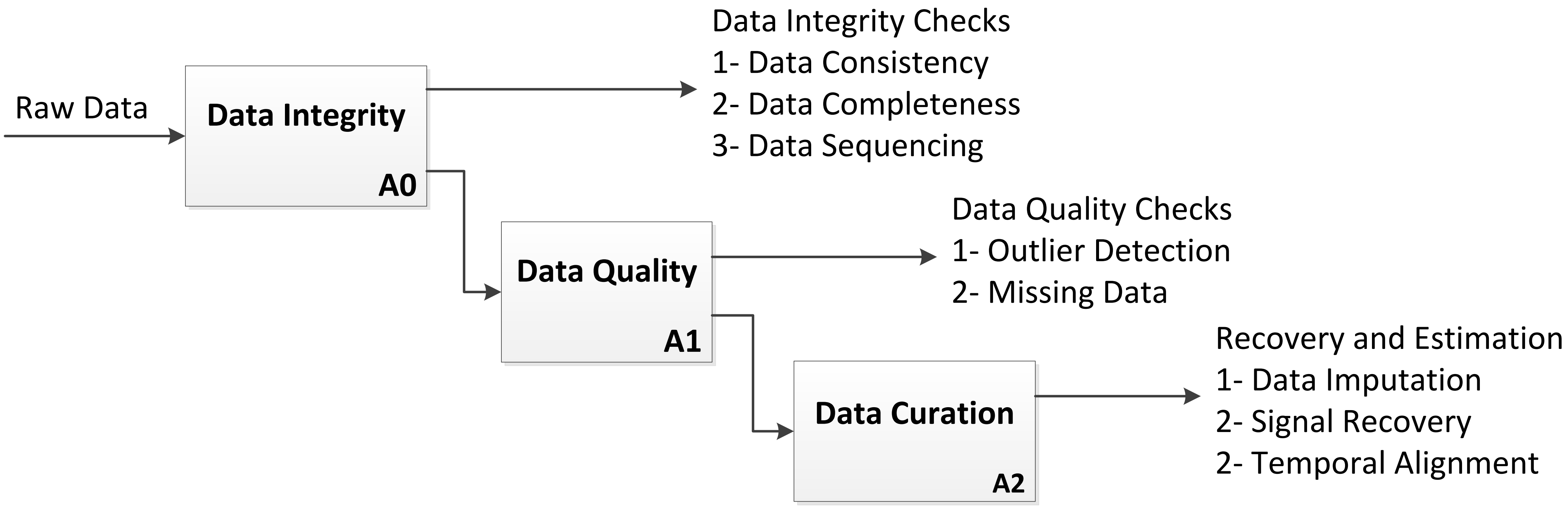
Data Quality Module

- DQM is where data quality and integrity checks are applied and data curation tasks are performed.



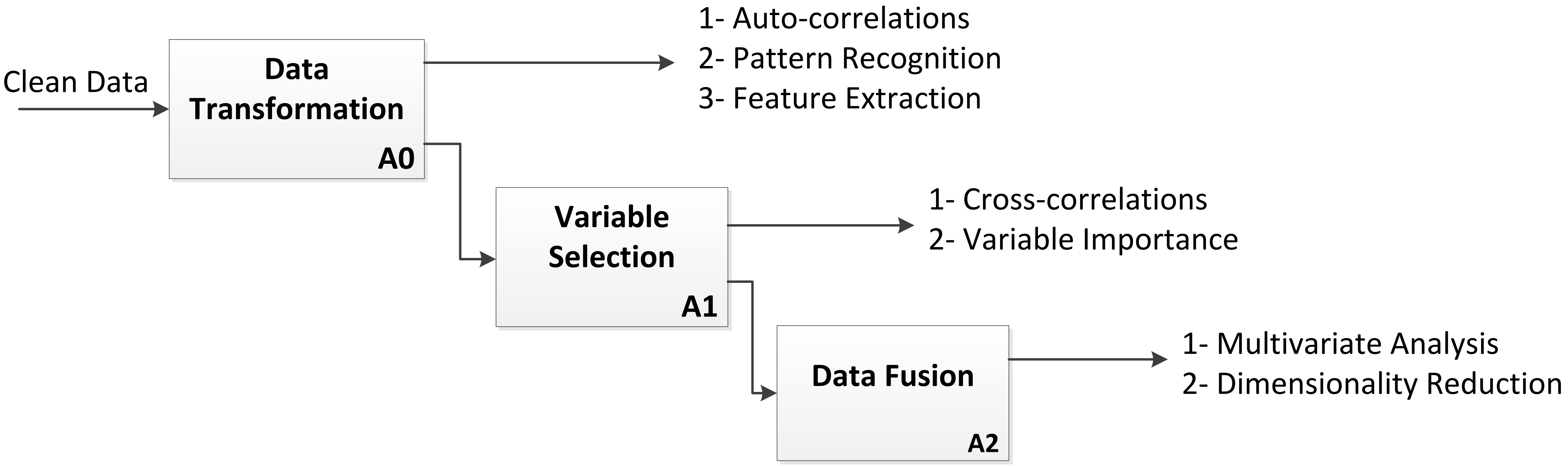
Data Quality Module

- *Data Quality plays a primary role in the effectiveness of diagnostic or prognostic techniques. **DQM** is where data quality and integrity checks are applied, and data curation tasks are performed.*



Variable Selection and Data Fusion Module

- *Variable Selection identifies the most informative data variables, and adaptively eliminating redundant variables.*
- *Data Fusion intelligently combines different variables to enable multivariate analysis.*

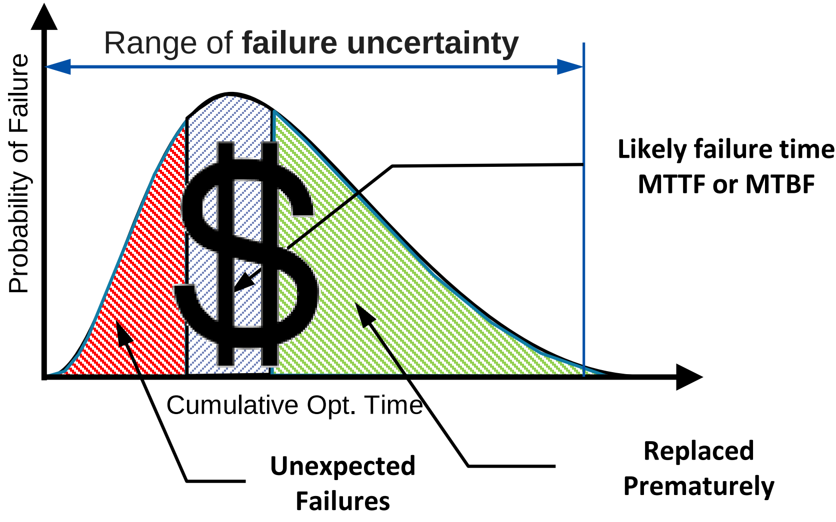


Anomaly Detection Module

- *Classical anomaly detection algorithms are often plagued with false alarms.*
- ***Individual Sensor Monitoring :** A sensor has about a 0.27% chance of generating a false alarm. If 50 sensors are monitored individually (each with 0.27% false alarm rate), the actual false alarm rate jumps to about 14%.*
- ***Fusion-Based Sensor Monitoring:** Controls false alarm rates but masks any diagnostics capability.*
- *Our ADM module, employs an Ensemble Anomaly Detection Approach where we leverage the strengths of a suite of algorithms that allow us to control the low false rates while simultaneously providing diagnostic capabilities*

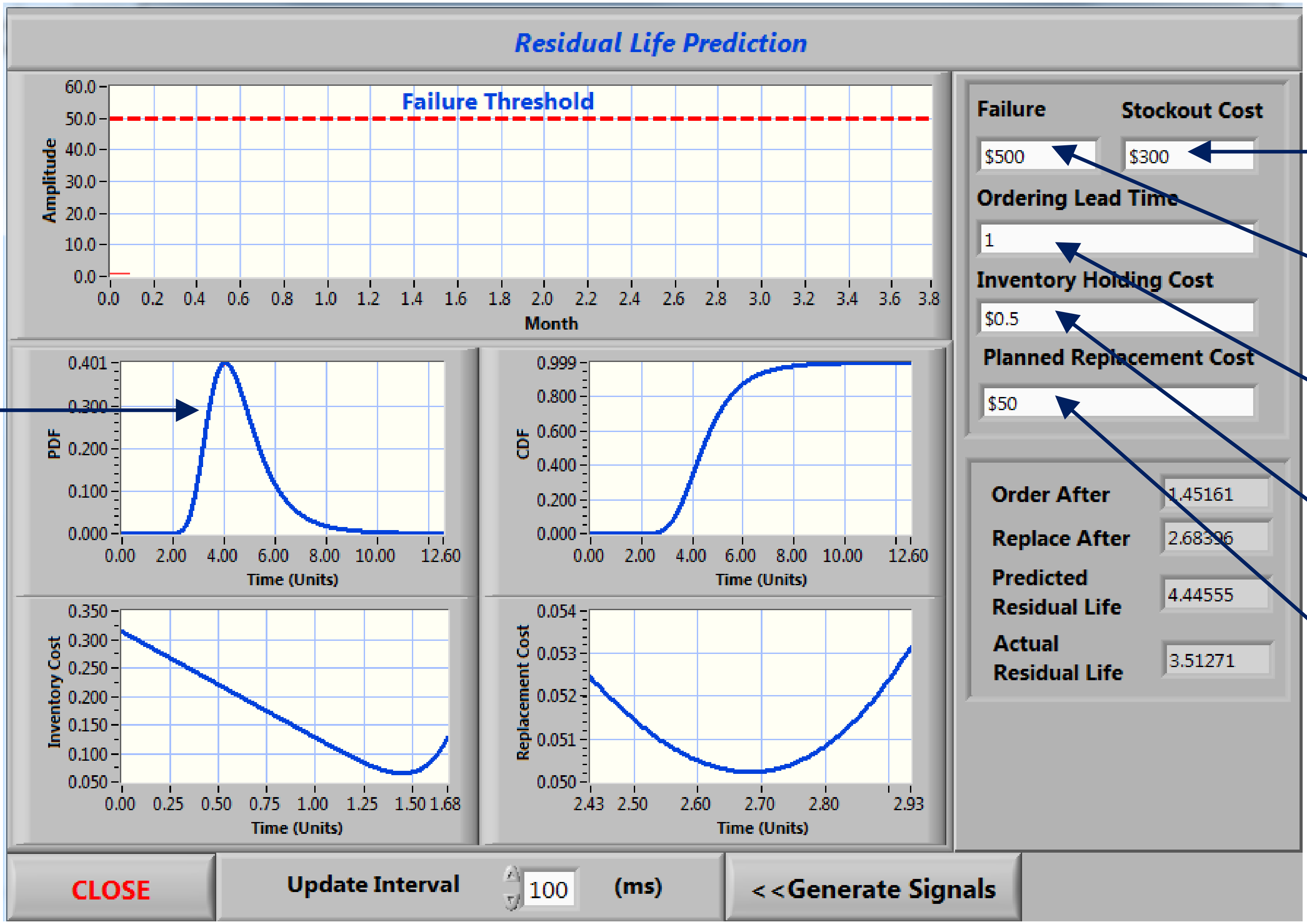
Prognostics Module: Combining Reliability & Condition Monitoring

- *Our Prognostics module combine the **best of both worlds.***
- ***What is achievable using Reliability Analysis cannot be accomplished by Condition Monitoring.***
    - Quantifying Failure Uncertainty
    - Managing and Monetizing risk
    - Strategic Planning and Decision Making (PMs)
- ***What is achievable using Condition Monitoring cannot be accomplished using Reliability analysis.***
    - Visibility into the asset health
    - Fault Detection and Diagnostics



Example: Starting with Reliability Data

Reliability Risk Profile



Cost of Spare Part Stockout

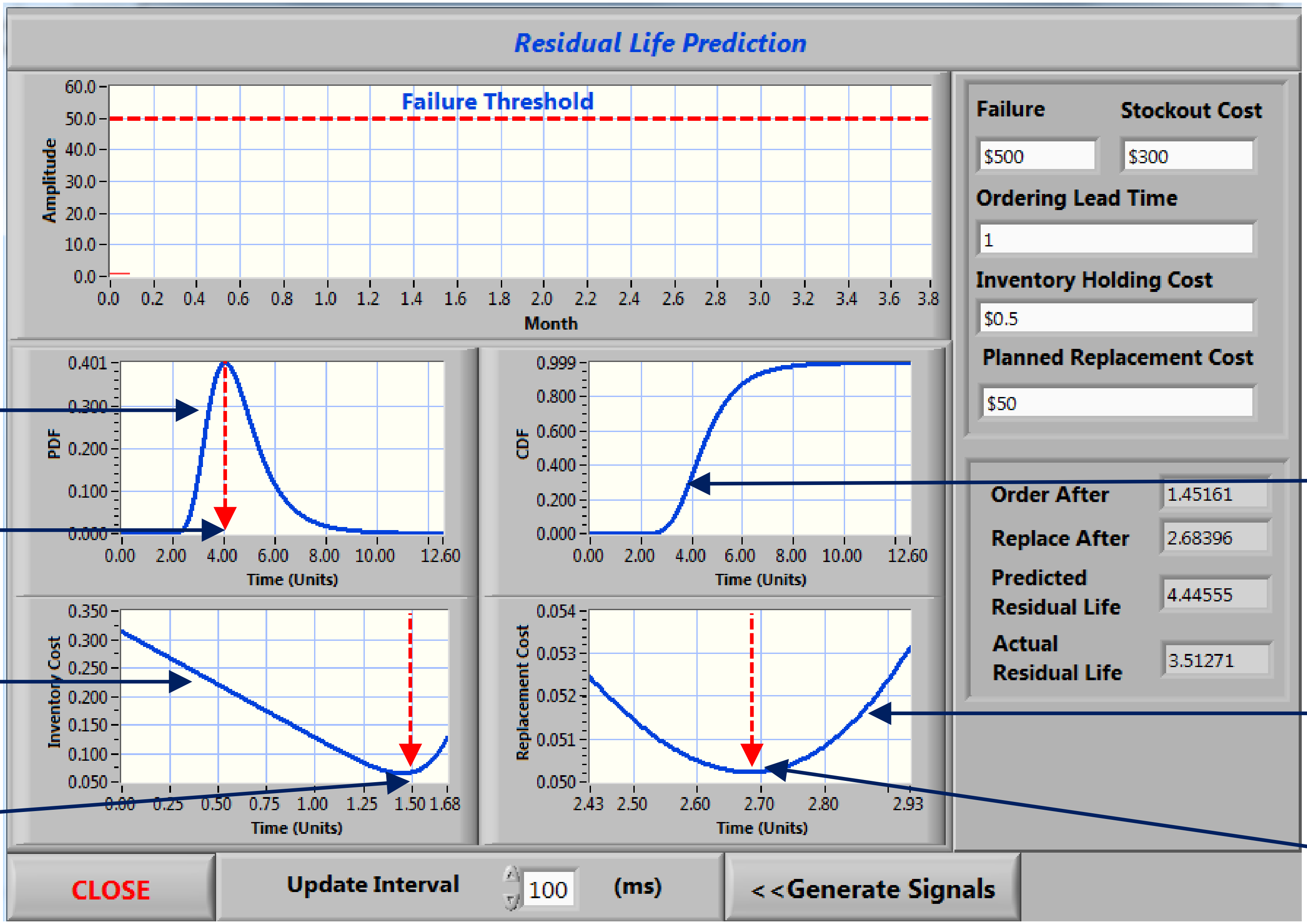
Cost of Unexpected Failure

Lead Time (Supplier to Warehouse)

Storage/carrying Cost (per day)

Preventive Maintenance

Example



Reliability Risk Profile

MTTF

Spare Part Inventory Cost Function

Optimal Spare Part Ordering Time (1.5 mons)

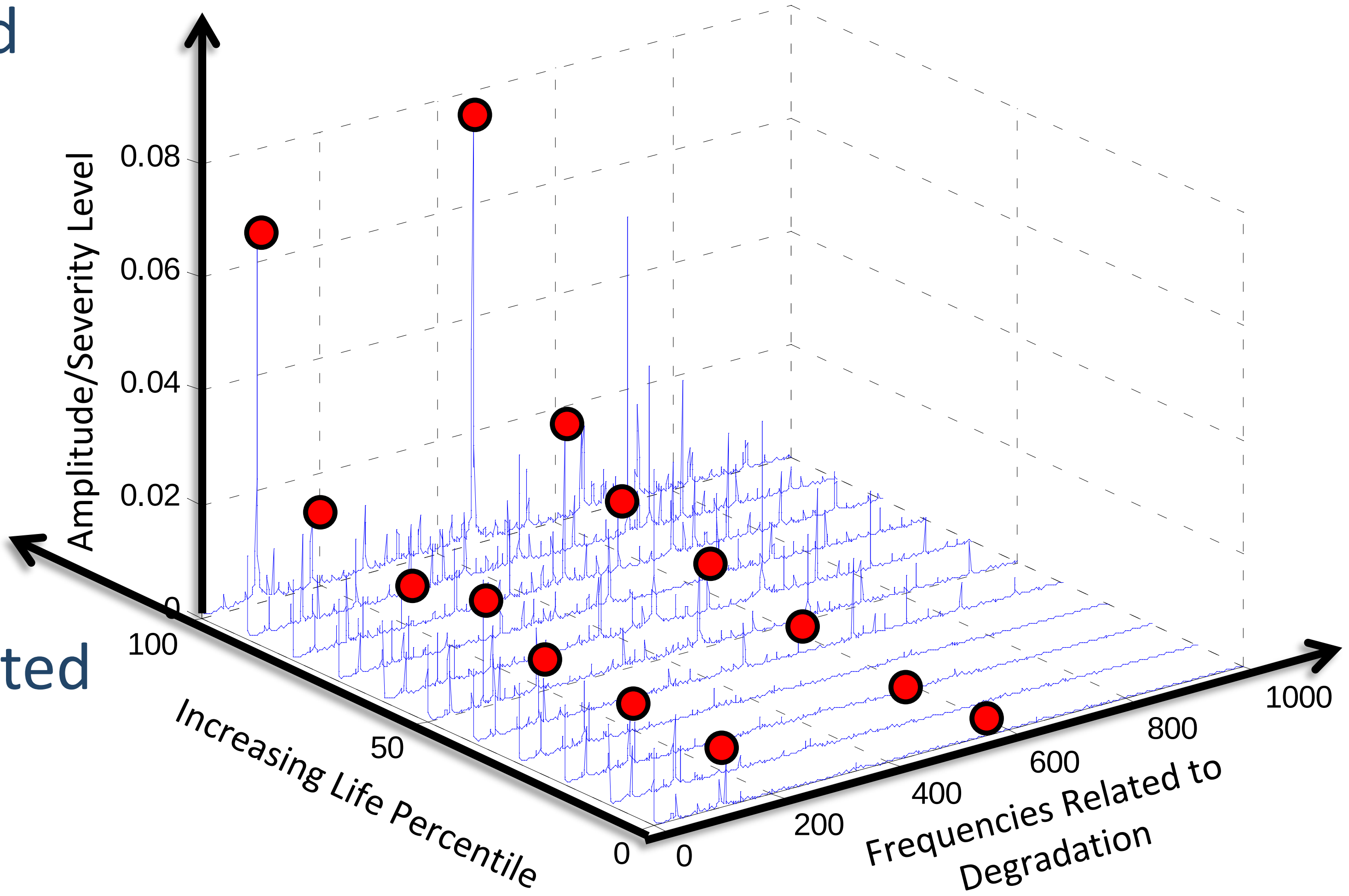
Probability Distribution

Repair/Replacement Cost Function

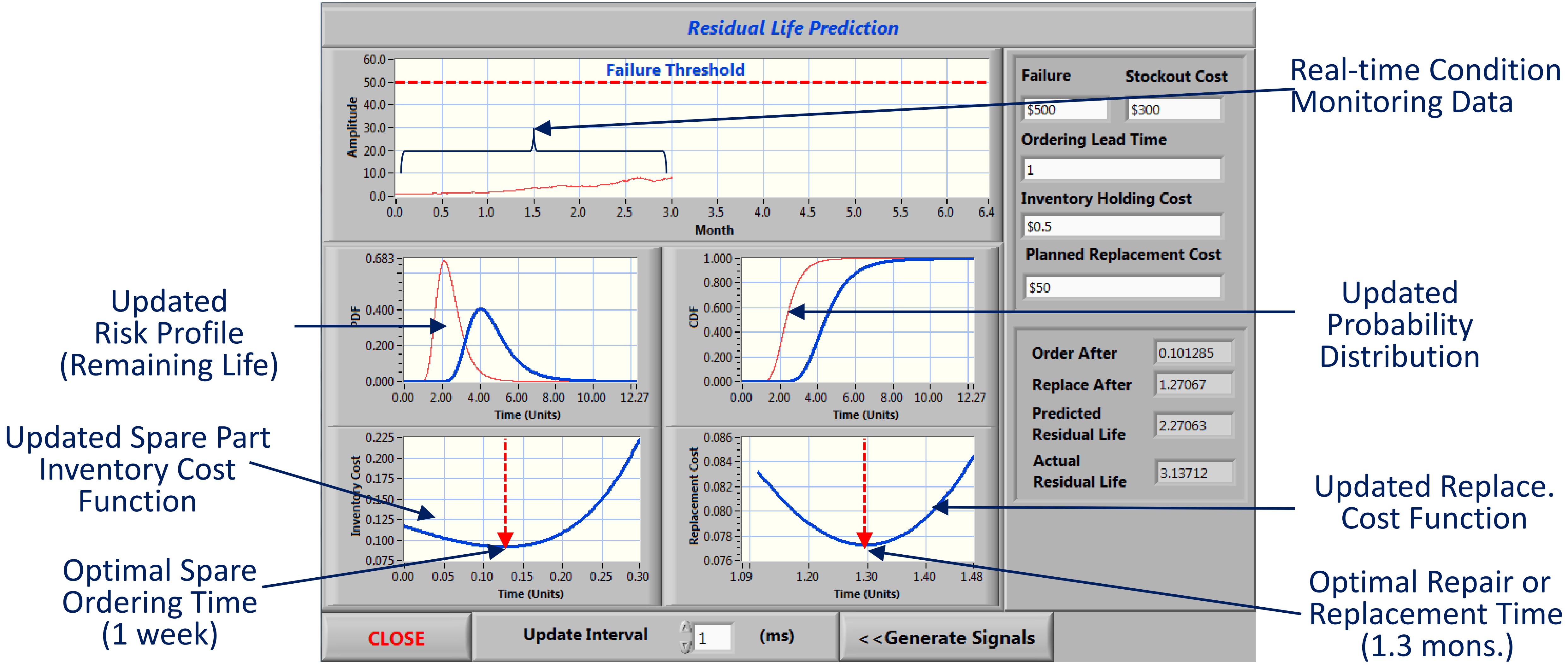
Optimal Repair or Replacement Time (2.7 mons.)

Example of Condition monitoring data

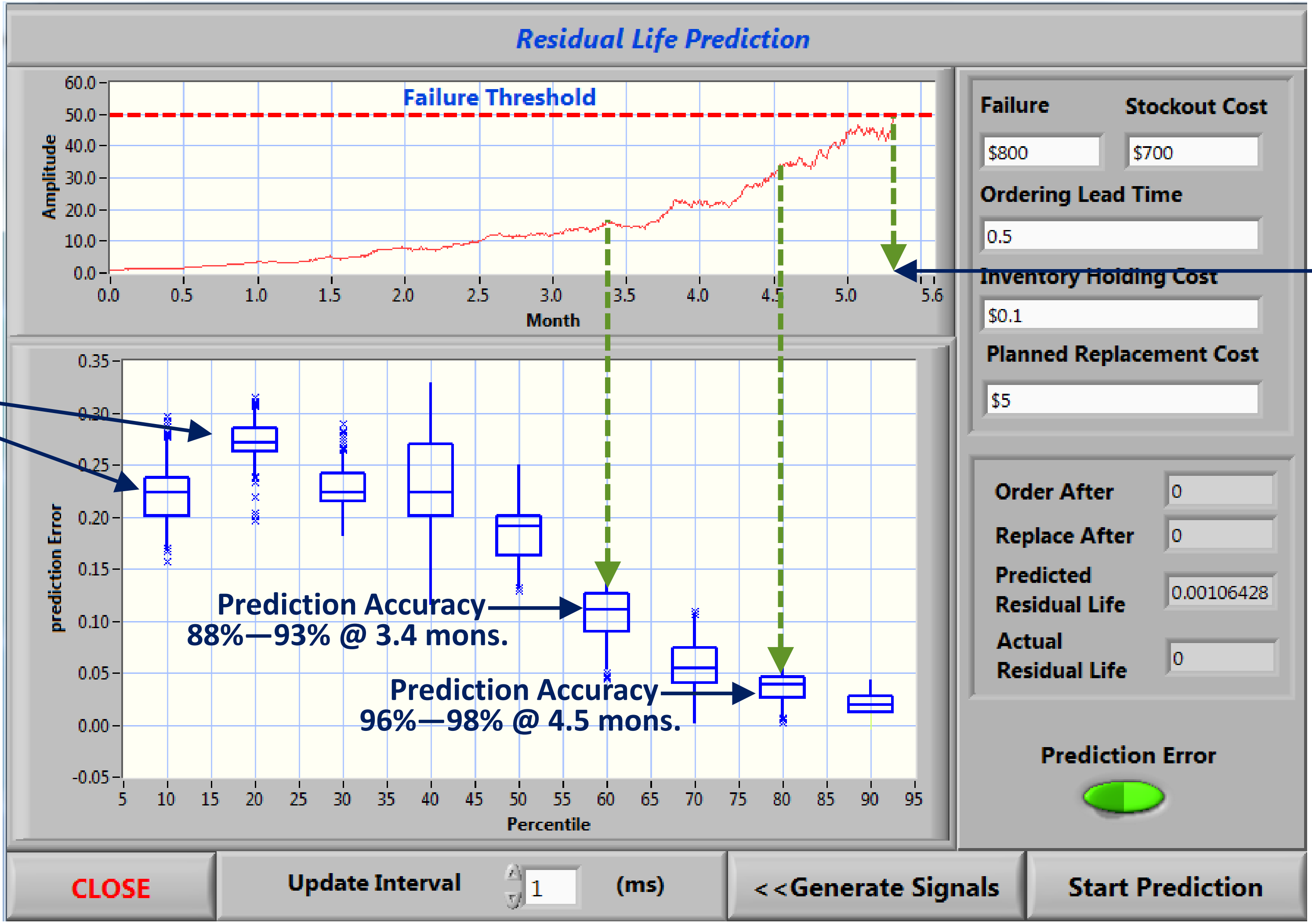
- Vibration signatures acquired as the asset/equipment progresses over its life cycle.
- The figure shows post-processed vibration data at different life percentiles of the equipment.
- Fault-specific features extracted in real-time (red dots) and modeled over time.



Example with CM Data



Prediction Accuracy



Early Prediction are based on Reliability Prediction Accuracy 69%—78% @ 0—1 month.

Actual Lifetime (5.5 mons.)

Thank you

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