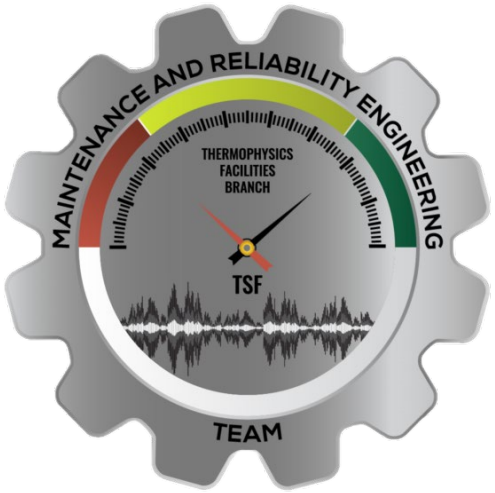
Maintenance Modernization in the era of Artemis

An RCM Journey



Chad Cleary

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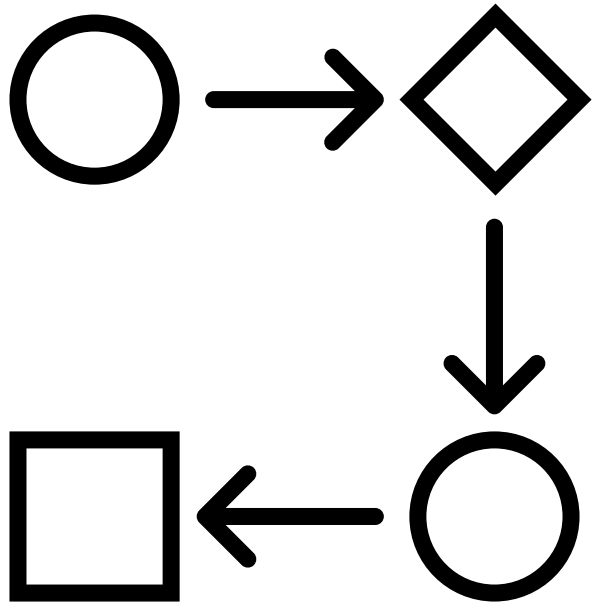
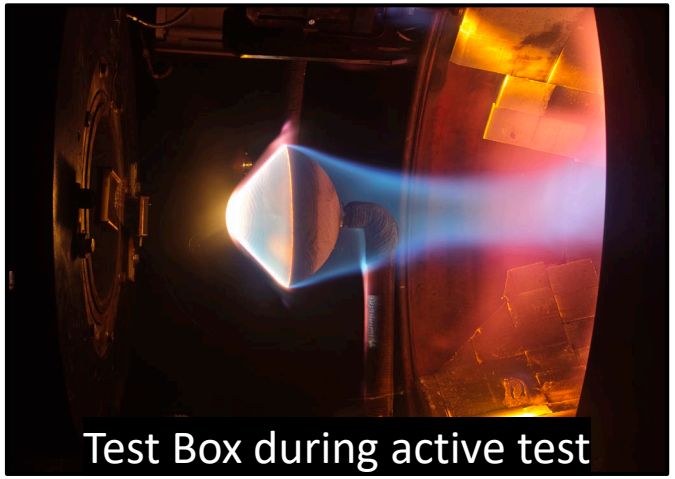
NASA Ames Research Center
Mountain View, CA

Agenda

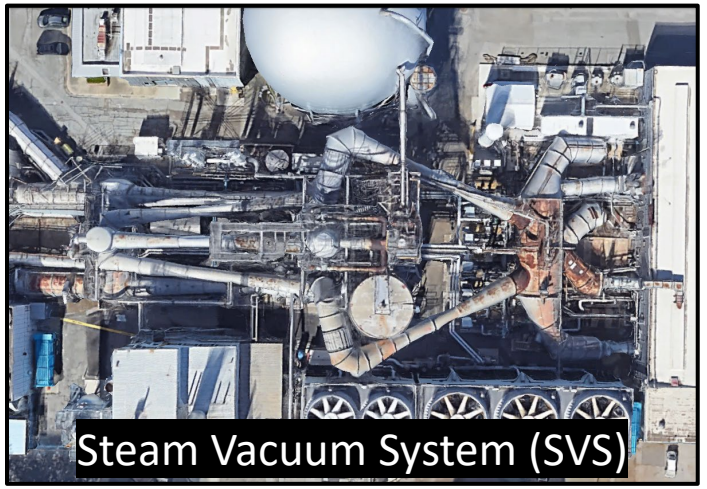
- Background and Context
- Initiation (Pilot) Phase
- Planning and Strategy
- Implementation
- Testimonials
- Impact Statements
- Lessons Learned
- Q&A



The Facility: Arc Jet Complex


Test Box during active test


Reverse Osmosis Plant


Steam Vacuum System (SVS)


Arc Jet Sub Station


Arc Jet Air Supply (AJAS)


Boiler Plant

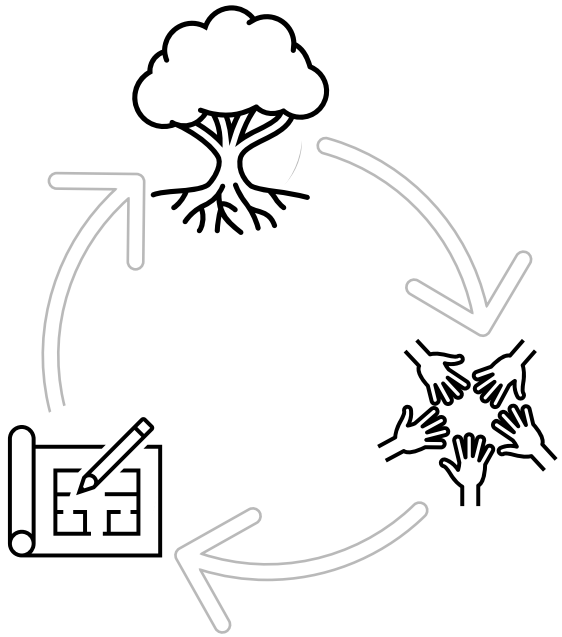
Space Environments Testing Management Office (SETMO) / Facilities and Real Estate Division (FRED)

From left to right: Charlene Conlan, Chad Cleary, Caleb Farris, Thoth Nowland, Chare Barnhart

From left to right: Alfredo Aguilar, Peter Zhou, Thoth Nowland, Doug Gray, Froilan Jimenez, Duy Nguyen.

Implementation Doesn't Have to be Difficult

- Implementing RCM requires:
  - Cultural changes
  - Organizational changes
  - Technical changes



- RCM is malleable and approachable at all maturity levels.*LB*

Background | History

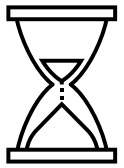
- Outdated maintenance processes
- Extensive dependency on tribal knowledge
- Unclear maintenance strategies
- Equipment failures captured in handwritten logs
- Existing, but under-utilized CMMS
- Siloed work practices *LB*

Background | Challenges

- Poor planning and scheduling
- Too much reactive maintenance
- Difficulties troubleshooting systems
- Lack or maintenance articulation
- Lack of maintenance records
- Lack of training and skills
- Undefined KPIs
- Poor asset management
- Lack of maintenance management
- Inadequate spare parts management
- Lack of digitization (data)
- Little proactive maintenance
- Little to no predictive technologies
- SME reliance
- Etc.

Background | Motivation for Change

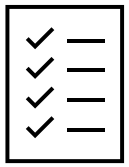
- Previous list of challenges



- Aging facilities

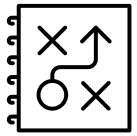
- Static or declining maintenance budget

- Lack of risk articulation



- NASA procedural requirements LB

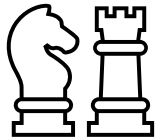
Initiation Goals and Objectives



- Develop a realistic plan

- Focus on digitization

- Emphasis on system ownership



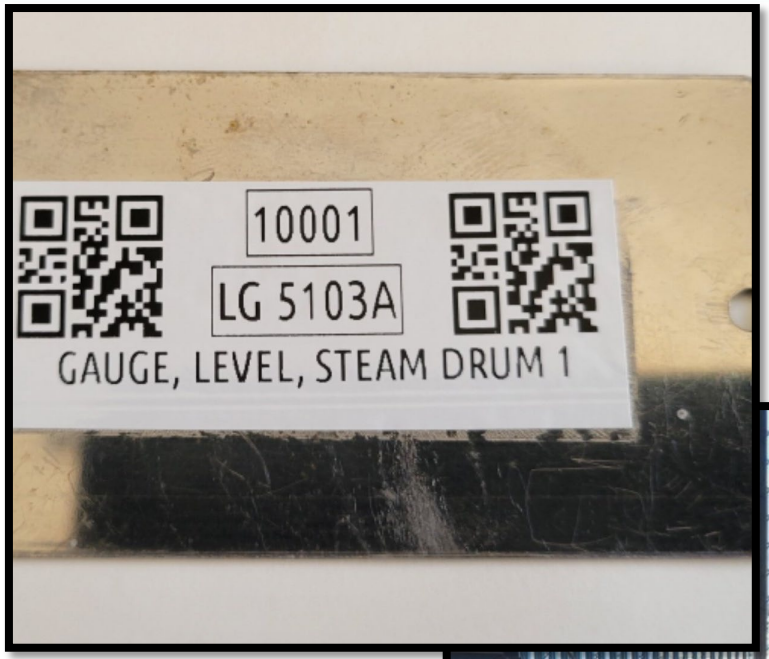
- Establish a sustainment strategy *LB*

Planning and Strategy | Methodology

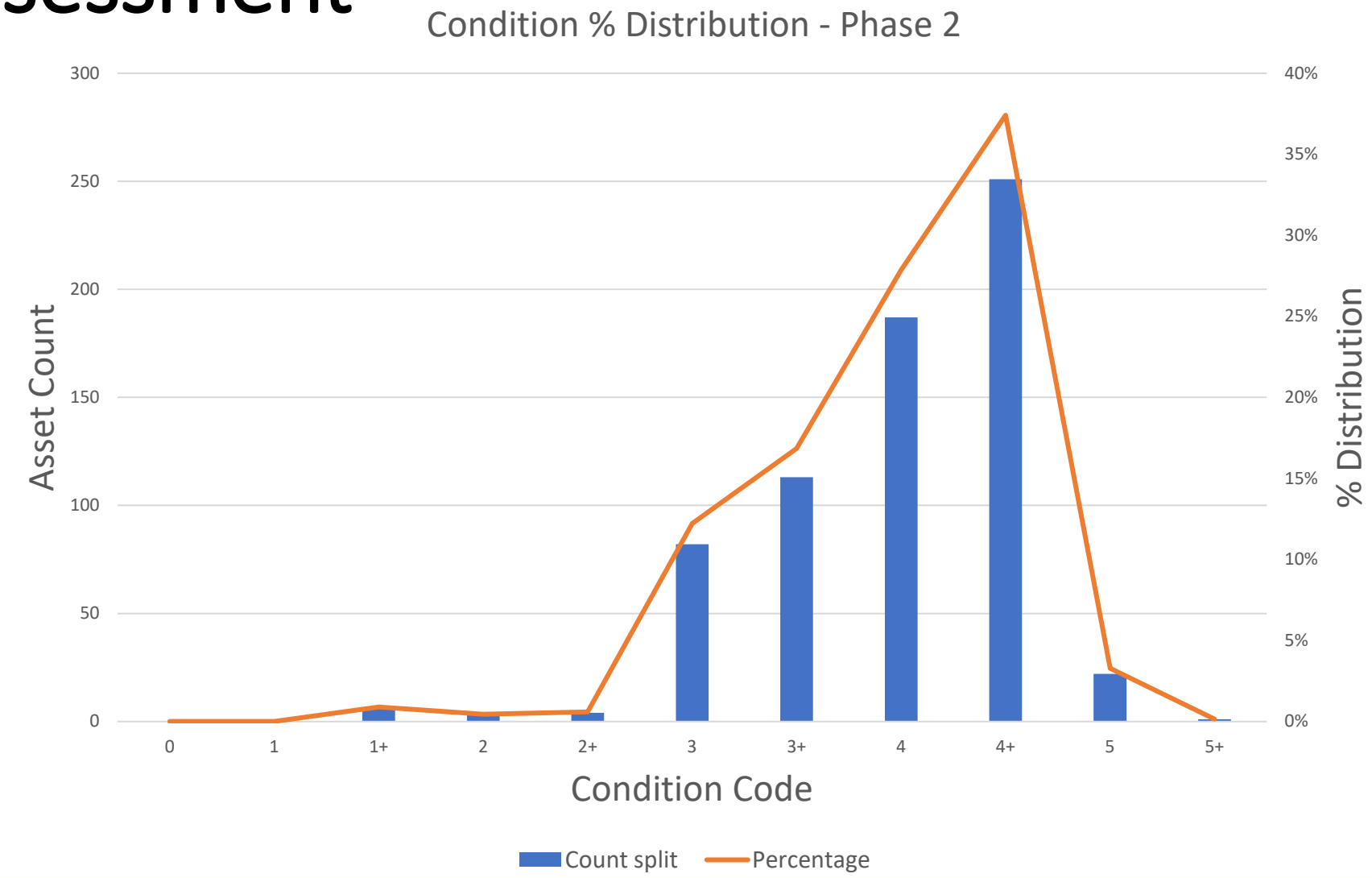
- Work plan
- Process development
- System boundaries
- Asset definition and identification
  - Virtual inventory
  - Field inventory
- Asset condition assessment
- Asset criticality
- RCM analysis (FMEA lite)
- Job plan development
- 5-year roadmap development
- Mobile device implementation plan
- Training

Asset Inventory

- Establish team to collect information
- Identify information to be collected
- Virtual inventory
  - Drawings
  - CMMS
  - O&M
- Physical inventory
  - Field walk
  - Picture
  - Condition assessment
  - Asset tagging (for mobile devices)
- Upload assets to CMMS$_{LB}$



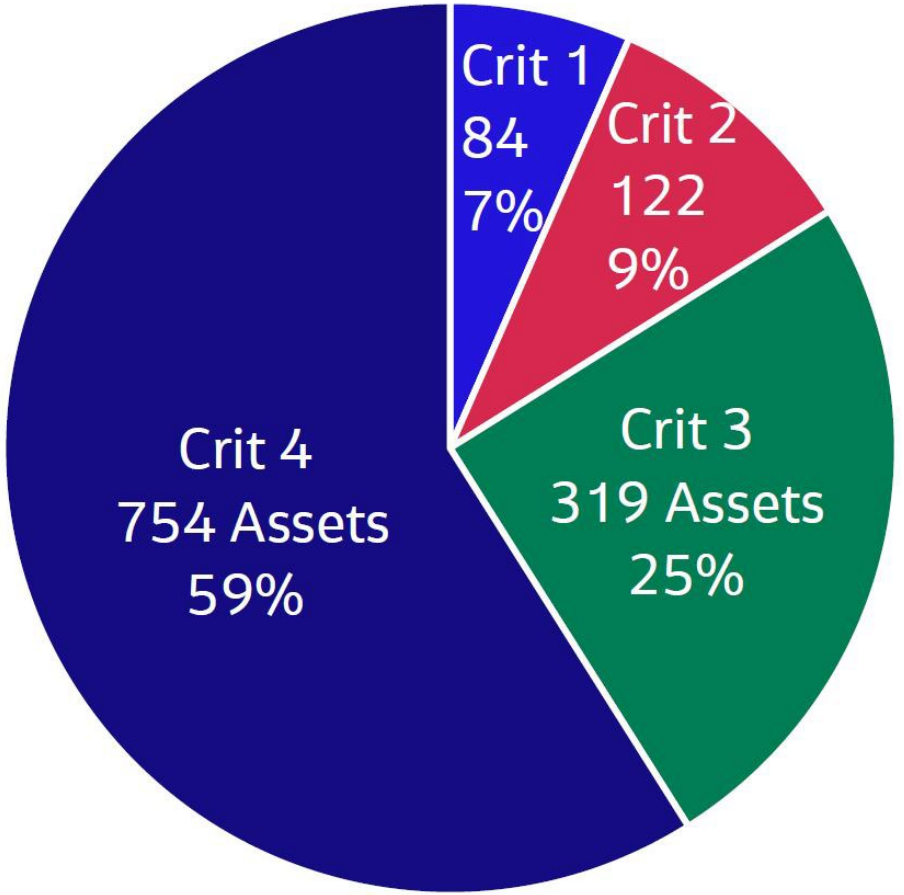
Condition Assessment



Asset Criticality

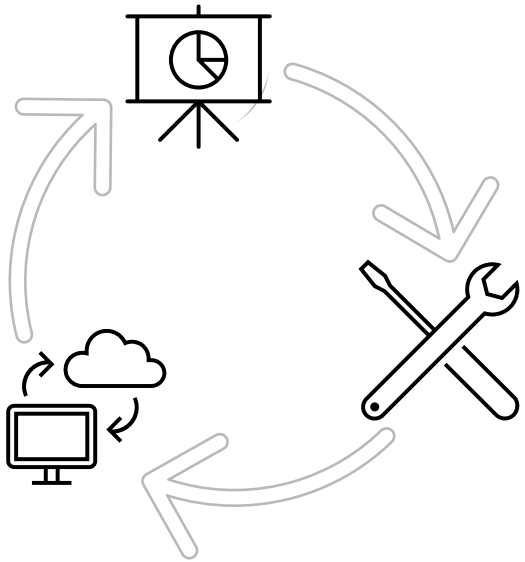
- Assembled and performed by evaluation team
- Scoring and scale is NASA Procedural Requirements (NPR) derived but tailored to our facility
- Meaningful and informed data driven decisions
  - Work prioritization
  - Optimized resource allocation
  - Increased reliability and subsequent facility uptime *LB*

Asset Criticality Distribution



Implementation – Training and Development

- CMMS
- RCM
- Implementation Process
- Workflow
- SMRP
- For: Craft, Supervisors, Administrative *LB*



RCM Analysis | FMEA Lite

- Establish evaluation team
- Develop evaluation process
- Identify:
  - Function
  - Failure mode
  - Root cause
  - Failure Mechanism
  - Failure effect
  - Maintenance Strategy
  - Maintenance Task$_{LB}$

An RCM Example

Scenario:

Cooling tower fan failure.

Electricians react with motor circuit analyzer.

Discovered current leakage and recommended replacement.

No spare available.

Impact:

Reduced operational capacity to 66%.

Couldn’t operate in the afternoon (lost test time).

Unnecessary wasted resource.

What could have prevented this?

Predictive testing and inspection (PT&I) tool.

Training on that tool.

Good data management and analysis.

What if RCM existed?

Predictive maintenance through data driven decision making.

Minimized schedule and cost impact of the event.

Personnel would have been properly trained on the use of PT&I and data analysis.

Early Successes and Testimonials

"I gained a better understanding of the various maintenance strategies, and how to apply them."

"The job plans are more comprehensive and give me more confidence in my maintenance abilities."

"I find it easier to voice needed changes to job plans."

"Assets and their information are much easier to find."

"RCM had made planning easier in that I can think better about spares and critical spare parts."

"I find it much easier to schedule maintenance."

"RCM has shed light on the many assets we were either undermaintaining, or not maintaining at all." *LB*

Challenges and Lessons Learned

- Increased emphasis on asset inventory.

“Garbage in is garbage out.”

- Increased forethought.

“Understand the downstream effects.”

“Data collected today will determine tomorrow’s decisions.”

- Understanding the difference between system ownership and criticality.
- Resistance to change.

“Grease the skids and get buy in at all levels.”

- Experiencing schedule slip in our 5-year plan.LB

Impact Statements – Quantifiable Results

- Process and workflow quality control up to

  >95%

  - Corrective maintenance captured
  - Work orders completed with meaningful labor hours
  - Work orders captured with meaningful log notes
    - Versus previous <5%

+40%

PM compliance

~99%

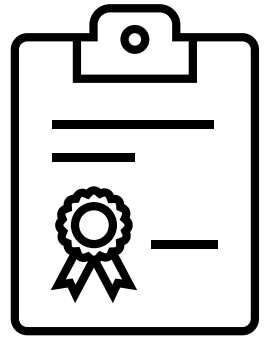
Collection of reliability metrics at the asset level

>70%

Digitized assets *LB*

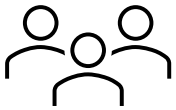
Impact Statements – Qualitative Results

- Improved documentation and process management.
- Enhanced equipment monitoring:
  - Started introducing PT&I technologies
- Improved maintenance efficiency:
  - Improved spare parts management
  - Routing
  - Planning and scheduling is process oriented no longer ad-hoc
- Increased staff engagement. *LB*



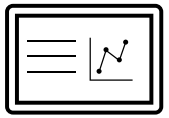
Our Future and Sustainment Efforts

- 5-year roadmap

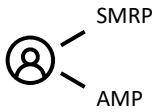


- Weekly maintenance meetings

- M&RE team



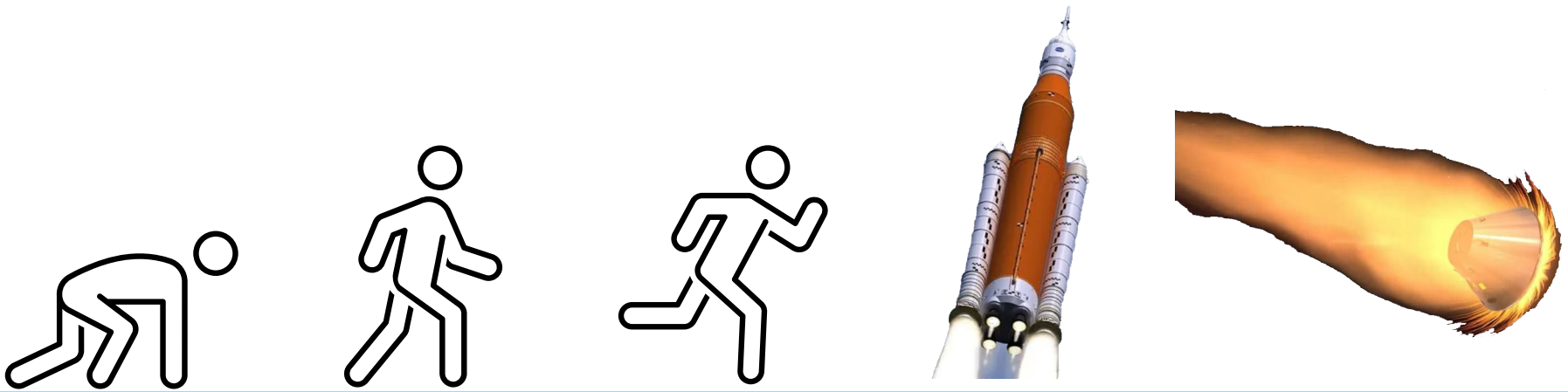
- Mobile device implementation



- Community of practice *LB*

Our Vision:

"In support of NASA missions, the Arc Jet Complex Maintenance Program will enhance asset safety, availability, and lifecycle through an engineered, Reliability Centered Maintenance approach that enables data-driven decisions, driving improved risk management and operational effectiveness."



Thank you!
Q&A