Core capabilities
- Guided Troubleshooting Solution
- Deliver System Availability through Comprehensive Integrated Diagnostics and Prognostics
- Embedded Diagnostics
- Design for Service

Credentials
- Multiple patents on core technology
- Multiple NASA Space Act Awards
- Technology Innovation Award
- Aviation Week Award
- Harry T. Jensen Award from AHS

Commercialized Products
- TEAMS-Designer®, TEAMS-RDS®
- TEAMATE®, TEAMS-RT®, PackNGo®

Customers using QSI technology
- NASA and DoD
- Aerospace
- Medical Equipment
- Semiconductor Equipment
- Automotive

Key Resources and Partnerships
- Renowned research team with long history of award-winning publications
- Partnerships with premier institutes such as Univ. of Maryland, Vanderbilt, UConn
- Longstanding partnership with primes

Commercialization Success
- Fifty percent of annual revenue from commercial sales and services
- Nearly 60% Commercialization Index with significant product sales in the past five years

Smart Manufacturing Equipment Maintenance using TEAMS®
Increased automation of manufacturing processes is a Fault Management challenge

- Complex and diverse equipment from different manufacturers working together co-operatively
- The manufacturing process, the associated equipment, their controls, timing and synchronization lead to significant challenges in timely failure detection, accurate failure root-cause(s) identification and mitigation
  - E.g., Product failure origin and its detection point locations can be in entirely different different equipment
- Lack of across-the-board process and equipment maintenance expertise, knowledge, training
Key initial step towards meeting fault management challenge:
- Identification of process-level failure modes and their effects
- Identification of equipment-level failure modes, cross-subsystem dependencies and their effects
- Identify cross-process and cross-equipment dependencies

Solution Approach:
- QSI and Warner-Robins Air Logistics Complex adopting a model-based methodology for automated development of Process-level FMECA, equipment-level FMECAs and their integration
- Failure-cause effect dependency models such as developed in TEAMS are easily updateable, configurable and provide for consistent information capture across different interacting machinery
- Reasoning algorithms using those models allow Health Assessment and Guided Troubleshooting across different equipment with drill-down capability
- https://youtu.be/D_eTd3QR384

TEAM® fault management adopted for MAKINO T4 equipment and the Advanced Metal Finishing Facility (AMFF) at Warner-Robins
Capture Modules, Interconnections, Hierarchy in a Directed Graph

Add Failure Modes and (affected) functions as appropriate

Add Tests and Effects with (monitored) functions as appropriate

TEAMS® identifies upstream failure modes (detections) for each test/effect and vice-versa

Smart Manufacturing Equipment Maintenance using TEAMS®
Process-level failure modes are equivalent to failure symptoms at the Equipment-level.

Bringing together Process-level and Equipment-level failures using TEAMS® hierarchical causal models.
QSI team is using some of the Dependency reports for model validation.
### FMECA, Testability Analysis, Additional Test Points Recommendation

**The Shortest Path to Uptime**

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<table>
<thead>
<tr>
<th>Identification Number</th>
<th>ITEM/FUNCTIONAL IDENTIFICATION (NOMENCLATURE)</th>
<th>FUNCTION</th>
<th>FAILURE MODES AND CAUSES</th>
<th>MISSION PHASE/OPERATIONAL MODE</th>
<th>LOCAL EFFECTS</th>
<th>NEXT HIGHER LEVEL</th>
<th>END EFFECTS</th>
<th>FAILURE DETECTION METHOD</th>
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</table>

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Test point recommendations focus on reducing ambiguities and improving fault isolation.
Focused Narrative

Adaptive
- Resource Constraints
- Setups performed
- Test Status
- Health Status

Dynamic Reasoner Driven

Logs

Cautions, Advisories, Warning

Multimedia

Links to Manuals, Doc servers

**TEAMS-RDS® generates the troubleshooting logic and assembles the instruction set based on user needs and capabilities**
Tomorrow 10:45am in Apache III - Tech Demo 4 - Testability Engineering And Maintenance System (TEAMS) Toolset

Thursday 3:15 – 4:45pm Paper Session 12B: Anomaly Detection II; Pueblo I & II

- An Integrated Model-based Approach for FMECA Development – for Smart Manufacturing Applications