Supply Chain Research & Analysis: Illuminating Risks in Complex Systems

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Presentation Topics

• Goddard’s Mission Portfolio and Supply Chains
• Strategic Challenge: Supply Chain Risks
• Supply Chain Research & Analysis
  – Objectives / Key Attributes
  – Analytical Framework
  – Core Process / Report Types
  – Products of Interest
  – Case Examples
  – Visual Analytics
• Supply Chain Risk Management
• Bringing It All Together
• Summary / Discussion
NASA’s First Space Center
Lines of Business
Goddard Space Flight Center

Astrophysics
Heliophysics
Earth Science
Cross Cutting Technology & Capabilities
Planetary & Lunar Science
Communications & Navigation

Human Exploration & Operations
Suborbital Platforms
Selected Mission Highlights
Goddard Space Flight Center

**TESS**
Search for planets outside of our solar system while monitoring the brightness of more than 200,000 stars

**Parker SPP**
Repeatedly sample the near-Sun environment

**OSIRIS-REx**
Rendezvous with the asteroid Bennu and return a sample to Earth in 2023

**GOES-S**
Significantly improve the detection and observation of Earth’s environmental phenomena

**GOLD**
Investigate the dynamic intermingling of space and Earth’s uppermost atmosphere

**ICESat-2**
Measure the elevation of Earth’s ice sheets, glaciers, sea ice and global vegetation biomass

GSFC Mission Portfolio: ~ 25 Key Projects in Development
Transiting Exoplanet Survey Satellite (TESS)

Medium Class Explorer

NASA GSFC performed project management

Launched April 18, 2018
Major Partners and Subcontractors
Transiting Exoplanet Survey Satellite (TESS)
System / Supply Chain Complexity
Transiting Exoplanet Survey Satellite (TESS)

Observatory (system) = spacecraft + instrument
- Subsystems, components, assemblies, parts
- 329 products tracked throughout configuration levels 1 to 11
- 68 suppliers, located in six countries
Strategic Challenge / Supply Chain Risks

GSFC mission projects rely upon multitiered, interconnected and global supply chains subject to a broad, dynamic array of risks that threaten – and when realized – disrupt or deny the timely, affordable provision of products and services as required for mission success.

Building Knowledge and Processes for Informed Planning, Oversight and Decision Making

As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don’t know we don’t know. Donald Rumsfeld, Secretary of Defense, 2002
A World of Risks Threaten Supply Chains

Trends / conditions driving risks, including:

• Globalization of markets, technology and industry with supply chains operating across geographical, political, social, cultural and economic environments
  – Supply chains yield advantages and exposure to risks
• Competition and conflicts
• Climate change

Dynamic interplay of a wide array of risk types, such as:

<table>
<thead>
<tr>
<th>Natural Disasters / Hazards</th>
<th>Man-Made Disasters / Hazards</th>
<th>Geopolitical Events</th>
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</thead>
<tbody>
<tr>
<td>Regulatory Shifts</td>
<td>Litigation</td>
<td>Enterprise Management</td>
</tr>
<tr>
<td>Workforce / Talent Losses</td>
<td>Diminishing / Single / Sole Sources</td>
<td>Foreign Influence / Dependency</td>
</tr>
<tr>
<td>Product / Service Security</td>
<td>Cyberattacks</td>
<td>Fragile Supplier</td>
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<td></td>
<td>Transport Network / Logistics</td>
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Building Supply Chain Visibility is Key to Managing Risk Exposure
Supply Chain Management
Goddard Space Flight Center

Mission Performance
Spacecraft, Science Instruments, Ground Systems

Outcomes
- Quality Products and Services
- On-Time Delivery at Acceptable Cost
- Innovative Problem-Solving / Continual Improvements
- Risk Avoidance / Reduction

Core Functions

Supplier Development
- Technology Investments
- Procurement Policy
- Small Business Program
- Outreach

Performance Management
- Project Management / Contract Oversight
- Mission Assurance Requirements
- Surveillance, Inspections and Alerts
- Parts to System-level Testing

Evaluation & Risk Management
- Project Lifecycle Reviews
- Internal Management System Assessments
- Supply Chain Assessments, Research & Analyses
- Project and Enterprise Level Risk Management

Acquisition
- Acquisition Strategy
- Proposal Team Building
- Procurement (direct and indirect)

Meta and other Information Systems for Process / Data Management and Informed Decision-Making

= Safety & Mission Assurance
= Flight Projects Management
= Engineering & Technology
= Procurement
Worldwide Locations of Suppliers

Goddard Space Flight Center

Supply Chain Research & Analysis reports on 136+ organizations

Source: NASA’s Meta information system
Objectives / Key Attributes
Supply Chain Research & Analysis

Objectives
• Provide situational awareness of and insight into the operating environment, management and operations of current and potential suppliers
• Illuminate concerns, risks and issues
• Build visibility into current and evolving supply chains
• Enable and support informed decision-making, oversight and risk management

Key Attributes
• Holistic analytical framework
• Guided by priorities, concerns, needs, products / services of interest
• Open source information + NASA / U.S. Government information
• Internal use only
• Non-intrusive
• Timely, Affordable
• Sound, Credible
• Enhance / complement other project management / SMA disciplines and methods
## Categories

<table>
<thead>
<tr>
<th>Categories</th>
<th>Key Factors</th>
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<tbody>
<tr>
<td>Technical / Production</td>
<td>Quality Management, Manufacturing, R&amp;D/Innovation</td>
</tr>
<tr>
<td>Business Enterprise</td>
<td>Leadership, Strategy, Organization, Workforce, Supply Chain Management, Financial Health, Business Alliances</td>
</tr>
<tr>
<td>Market</td>
<td>Industry Position, Trends and Conditions, Regulatory/Legal</td>
</tr>
<tr>
<td>Security</td>
<td>Geopolitical Situation, Socioeconomic Environment, Cybersecurity, Physical Security</td>
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</tbody>
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Core Process / Report Types
Supply Chain Research & Analysis

Levels of Research & Analysis / Report Types

- Rapid Supplier Insight
- Supplier Information Profile
  - SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis
  - Risk Statements
Some Products of Interest
Supply Chain Research & Analysis

- Bipropellant Thruster Valve
- Lithium-Ion Battery
- Thruster Engine
- Spacecraft Bus
- Inertial Reference Unit
- Optical Encoder
- Solar Array
- Semiconductor
- Charge-coupled device
- Star Tracker
- Software
Case Examples
Supply Chain Research & Analysis

• Case 1: Very small, privately-held company (less than 10 employees) located 3500+ miles from GSFC under contract to produce components on the critical path of several GSFC mission projects
  – Leadership / business continuity: “one-man show”
  – Inadequate quality management, history of delivery delays and security concerns

• Case 2: Well-established, recurring commercial source (~$300 million / year) of a critical component for GSFC mission projects acquired by a large corporation (~$3.0 billion / year)
  – Possible operational disruptions due to acquisition; consolidation of sources

• Case 3: Very small, privately-held company (less than 10 employees) that assembles a critical component for spacecraft instruments facing an “existential crisis” as its large corporate competitor and source of a key part closes down its fulfillment of outside orders
• Case 4: Very large U.S. corporation (~$10 billion / year) with multiple subsidiaries that supply key components / subsystems for GSFC mission projects experienced prior cyberattack and illicit technology transfer events
  – Future security incidents could impair design, production and space system operations

• Case 5: Entrepreneurial business established in 2001 with experience in design / technology development for space systems identified as a potential subcontractor to develop and integrate micro-satellites for a possible mission
  – Home-based company led by an entrepreneur lacks capabilities …no facility for production/integration/test nor quality management

• Case 6: Large U.S. corporation (~$2.5 billion / year) with production sites / headquarters in the U.S. which provides a key electronics part used in GSFC mission projects is highly dependent upon production, labor, customers and ownership based in China & Hong Kong

Supply Chain Research & Analysis reports illuminate strengths, weaknesses, opportunities and threats in providing insight and situational awareness
Suppliers, On-site Assessments, Research & Analysis

Worldwide

Supplier =  On-Site Supplier Assessment =  Supplier R&A =  Supplier Assessment + R&A =

Source: NASA's Meta information system
Visual Supply Chain Analytics
Meta Information System

Note:
• blue nodes = projects
• orange nodes = suppliers
• Sizing of supplier nodes dependent upon the number of project relationships

Source: NASA's Meta information system
Supply Chain Research & Analysis to Risk Management
Supply Chain Risk Management
Goddard Space Flight Center

Adapted from 21st Century Supply Chain Risk Management Maturity Model, Supply Chain Risk Management: An Emerging Discipline by Schlegel, G. & Trent, R., 2015

Visibility

Definition

· Supply Chain Data Integration / Management

· Supply Chain Mapping / Analytics

Foresight of Supply Chain Risks

Supply Chain Risk Management

Optimized Supply Chain Risk Management

Mission Success

· Project Management & Procurement
· Project Lifecycle Reviews
· Internal Management System Assessments
· Supply Chain Assessments, Research & Analysis

· Supply Chain Mapping & Analytics
· Integrated Risk Management
· Meta Information System
· Digital Transformation
Bringing It All Together
Meta Information System

- Integrated platform for process performance, data / information management and analytics supporting NASA mission performance, GSFC quality management and GSFC integrated risk management (includes supply chain risks)
- Meta applications bring together data / information / processes to build supply chain visibility and provide greater insight into suppliers and their products / services for space systems
- Extending Meta capabilities to identify / assess / manage risks within and across the supply chains of GSFC mission projects
An Old Proverb
For want of a nail the shoe was lost;
For want of a shoe the horse was lost;
For want of a horse the rider was lost;
For want of a rider the battle was lost;
For want of a battle the kingdom was lost;
And all for the want of a horseshoe nail.

In proven and innovative ways we are building knowledge for informed planning, oversight and decision-making as we reduce the risks of exploring the Earth and space in achieving mission success.

Thank you! Jonathan Root, jonathan.f.root@nasa.gov