

Space Exploration Supply Chain Modeling, Simulation, & Analysis using the SCOR model

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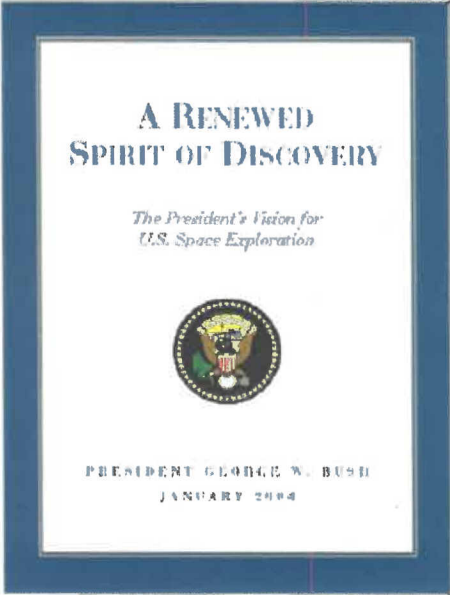
SCOR[®]
Supply-Chain Council


Supply-Chain World-North America 2006



Vision for Space Exploration

THE FUNDAMENTAL GOAL OF THIS VISION IS TO ADVANCE U.S. SCIENTIFIC, SECURITY, AND ECONOMIC INTEREST THROUGH A ROBUST SPACE EXPLORATION PROGRAM



A RENEWED SPIRIT OF DISCOVERY
The President's Vision for U.S. Space Exploration

PRESIDENT GEORGE W. BUSH
JANUARY 2004

Implement a sustained and affordable human and robotic program to explore the solar system and beyond

Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;

Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and

Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.



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Introduction

Why Supply Chain & NASA? Why now?

- A powerful end-to-end perspective and practice very applicable to NASA needs for developing Exploration Supply Chains that are flexible, responsive, and sustainable.
 - Where the money is – not in the direct, but rather in the indirect
 - Possible now, advances in handling knowledge and simulation methods
 - For understanding effects of new product technology
 - Enterprise / Program Macro-level view, from requirement to launch and beyond
 - Operations viewed as timely material and information flows, from supplier through to customer
 - Life-cycle focused



Introduction...

Current State, Future State?

- NASA Current, Simulation Tools
 - Operations and analysis tools, a portion of the Supply Chain
 - Shuttle and future systems operation simulations.
- NASA Future, Supply Chain Simulation
 - Generic, developed and verified based on experience and current systems, but flexible so as to support Exploration Supply Chain design decisions
 - The *entire* Supply Chain/logistics perspective



Introduction...

Space Exploration Supply Chain

We define an Exploration Supply Chain as:

The integration of NASA centers, facilities, third party enterprises, orbital entities, space locations, and space carriers that network/partner together to plan, execute, and enable an Exploration mission that will deliver an Exploration product (crew, supplies, data, information, knowledge, physical samples) and to provide the after delivery support, services, and returns that may be requested by the customer.

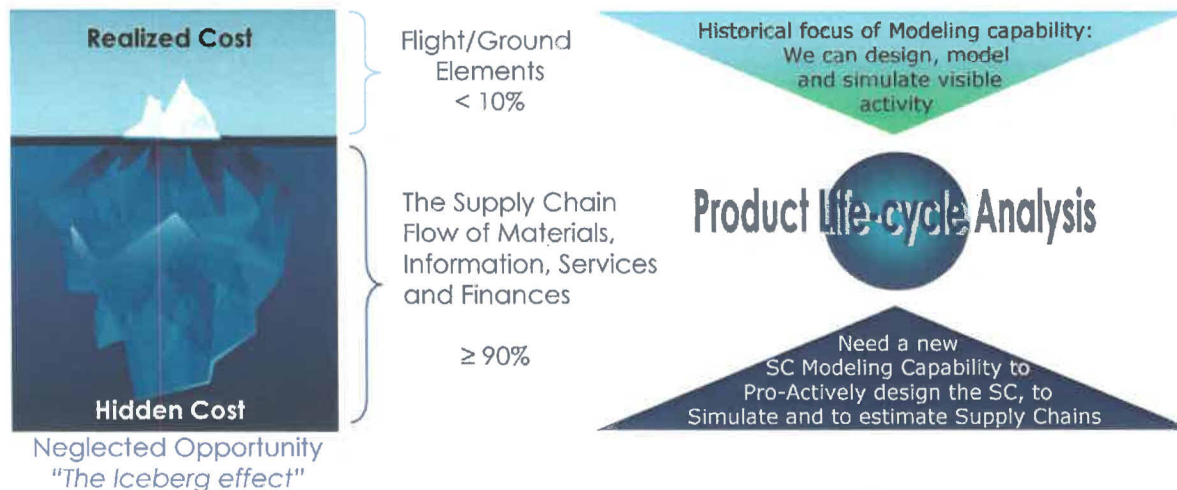


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Project Overview & Background

- Historically, processes and systems focused on the direct operations portion of the activity, neglecting the less visible enabling and supporting processes across the Supply Chain and logistics networks



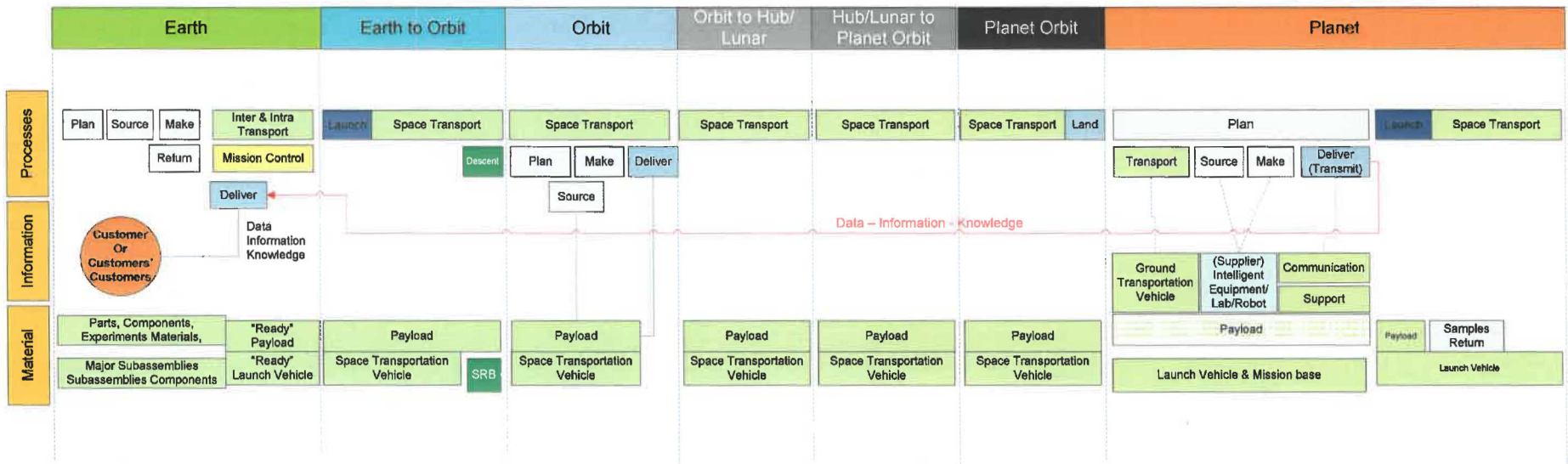
- Supply Chain modeling & analysis capability is required to understand and control the impacts of the end-to-end Supply Chain design on responsiveness, life cycle costs, flexibility, reliability, asset management efficiency and safety.



End-to-End Space Exploration Supply Chain



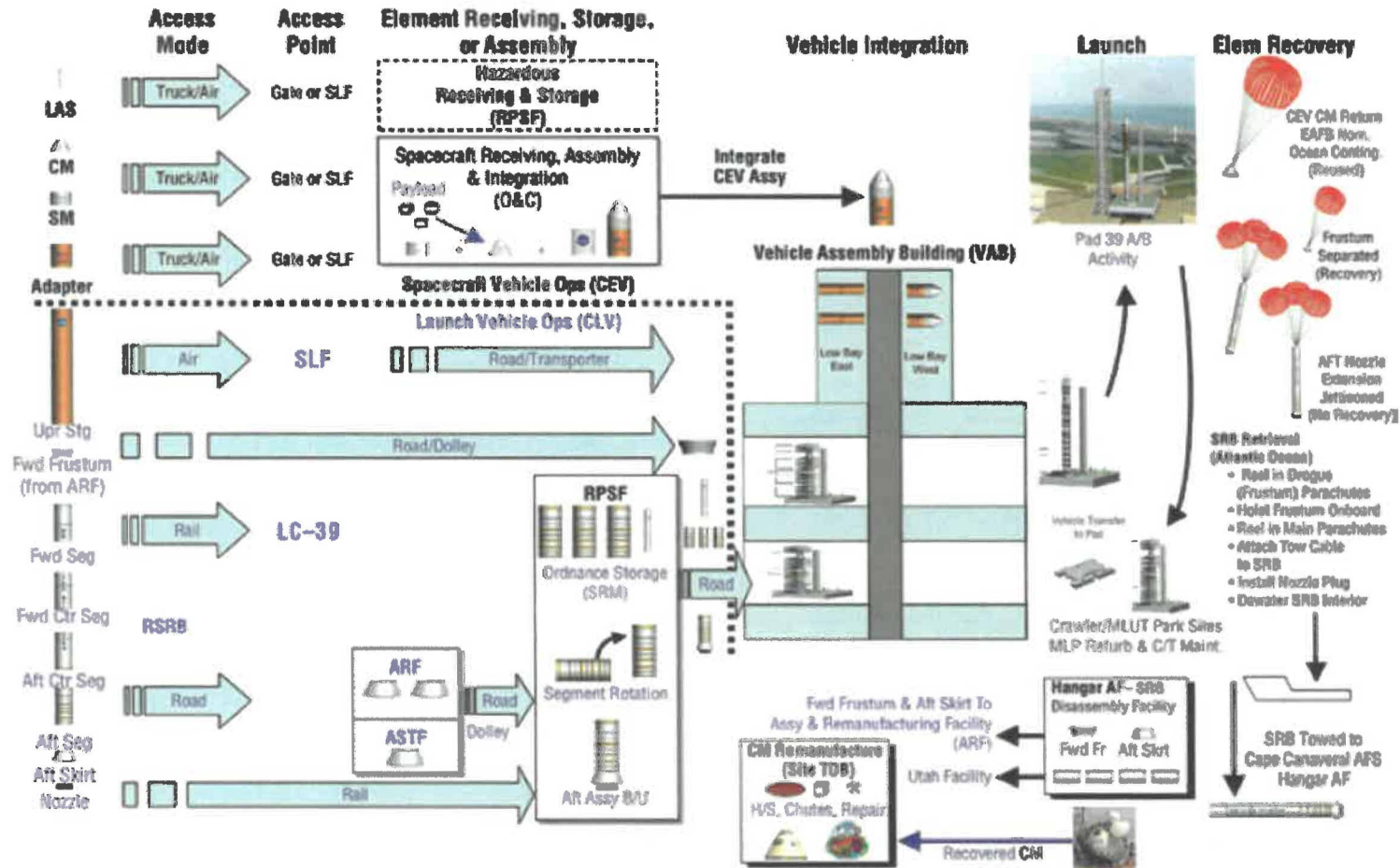
Land Launch Descent Land Execute Mission Finish Mission Launch



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Piece of the Exploration Supply Chain



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Features of Space Exploration Supply Chain

- The traditional features are given, in some scenarios at extreme levels
- The “Largest” Supply Chain known to Mankind
- Extends to locations: remote, no man has gone before, harsh, and uncertain
- Low volume
- Reusable components
- long lead times
- Mixed models: ETO, MTO, & MTS
- Supply Chain elements has different roles in different phases
- The transportation system is ETO/MTO
- The payload is very small percent
- Different deliveries at different phases



Approach

- ❑ A thorough **understanding** of Exploration/Space Transportation Supply Chain.
- ❑ A structured and explicit **definition** of the Supply Chain, from different views, e.g. SCOR process, information, material.
- ❑ A coherent **integration** of the different views defined, **interactions**, and **interdependencies** in an Ontology
- ❑ A **sharing** mechanism for the integrated definition.
- ❑ A methodology to **model** and **analyze** the dynamic and stochastic nature of the Supply Chain and its elements.
- ❑ Defining and using Supply Chain **Key Performance Indicators and Figures of Merit**
- ❑ An end-to-end Supply Chain **simulation** capability.
- ❑ A flexible **report** generation system.
- ❑ A methodology to **optimize** the Supply Chain.



Benefits for Space Exploration

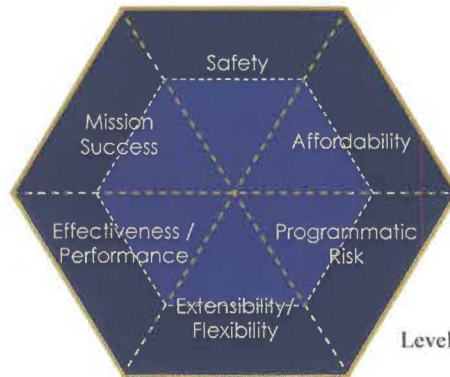
- A unique capability that will enable operations analysts and decision makers to understand, estimate, and make informed decisions about the Supply Chain for Exploration and Space Transportation Systems early in the decision making.
- Quantifiable and sustainable improvements in NASA operations, NASA Supply Chain and logistics operations directed towards Exploration performance goals.



Key Performance Indicators & Figures of Merit

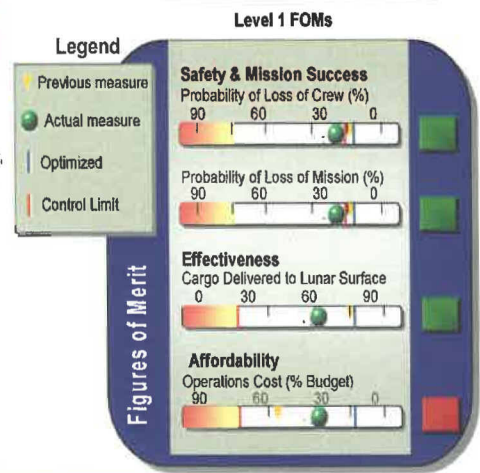
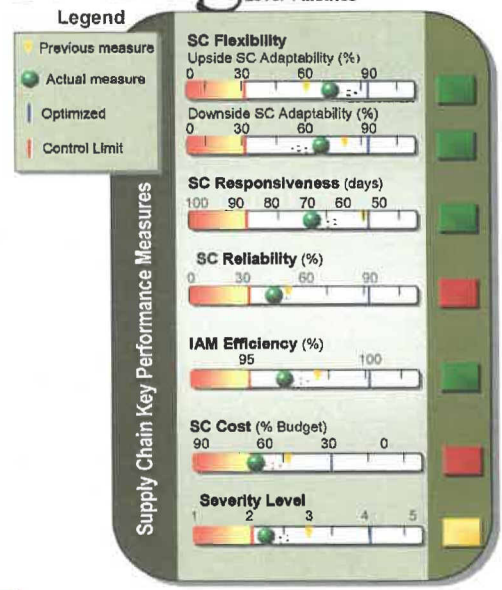


- Level 1 Metrics
- Level 2 Metrics
- Level 3 Metrics



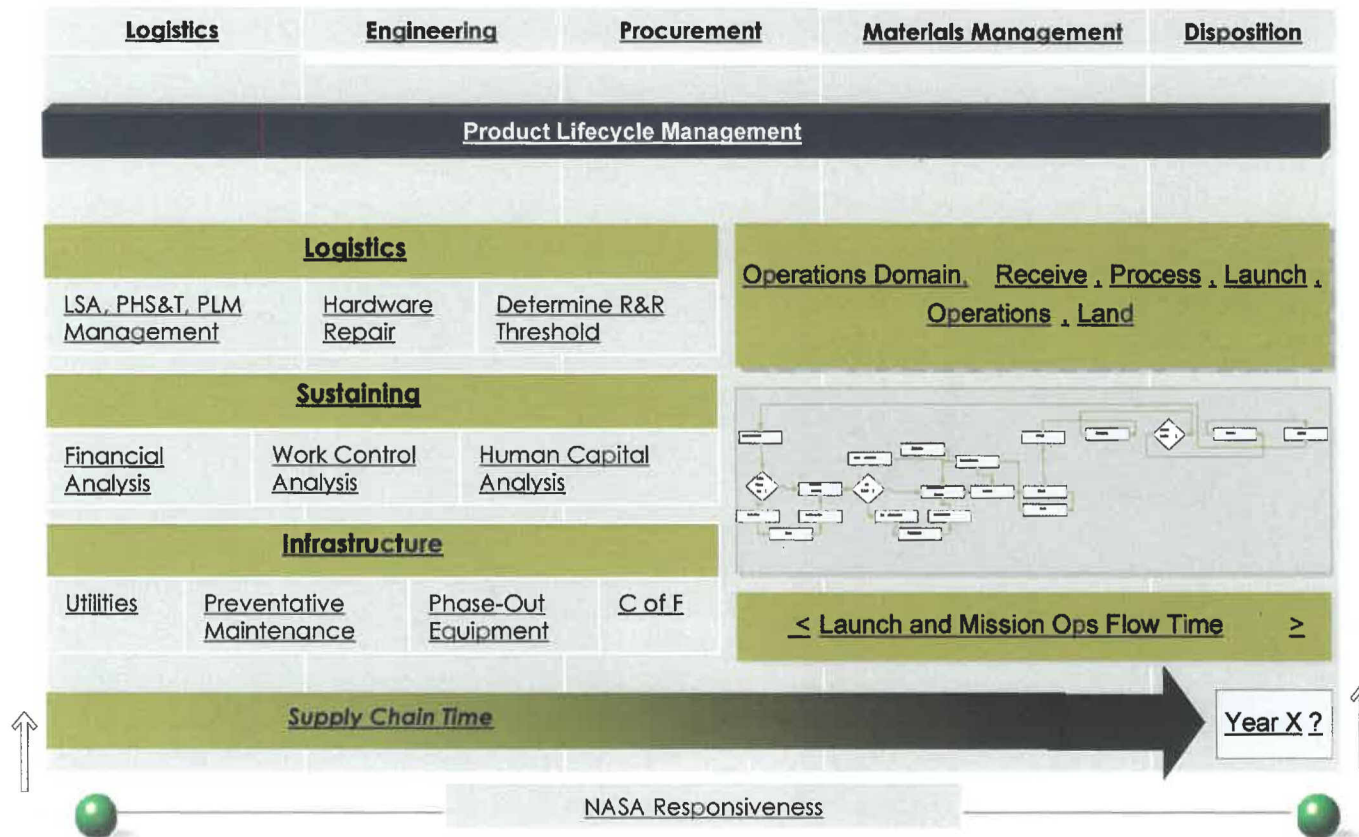
- Level 1 FOMs
- Level 2 FOMs

Safety and Mission Success	Effectiveness/Performance	Extensibility/Flexibility	Programmatic Risk	Affordability
Probability of Loss of Crew (P(LOC))	Cargo Delivered to Lunar Surface	Lunar Mission Flexibility	Technology Development Risk	Technology Development Cost
Probability of Loss of Mission (P(LoM))	Cargo Returned from Lunar Surface	Mars Mission Extensibility	Cost Risk	Design, Development, Test, and Evaluation (DOT&E) Cost
	Surface Accessibility	Extensibility to Other Exploration Destinations	Schedule Risk	Facilities Cost
	Usable Surface Crew-Hours	Commercial Extensibility	Political Risk	Operations Cost
	System Availability	National Security Extensibility		Cost of Failure
	System Operability			



KPI Example

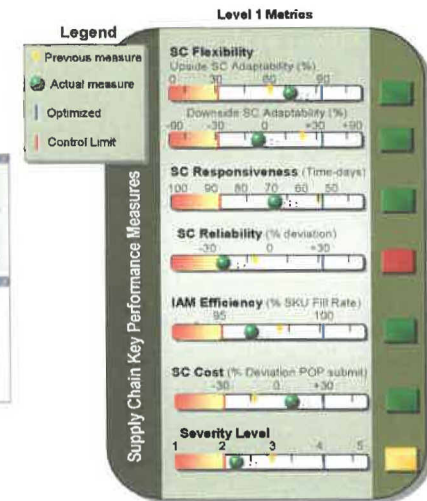
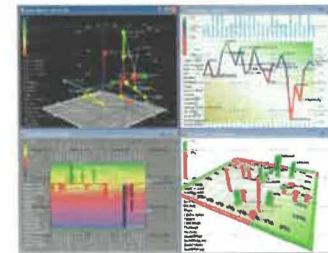
■ Responsiveness



Output Analysis

- For a certain Space Transportation System design or operating scenario, the output includes a probabilistic value of:

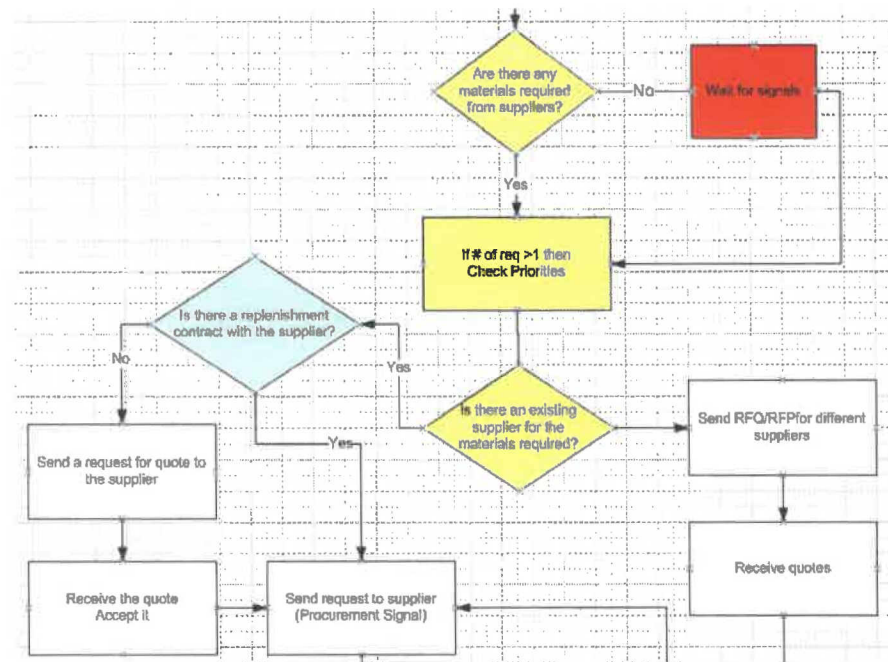
- Time
- Cost
- Availability/Utilization
- Risk
- Counts
- Other KPIs and FOMs
- Aggregated to Level 1 Metrics & FOMs



Scenario Analysis

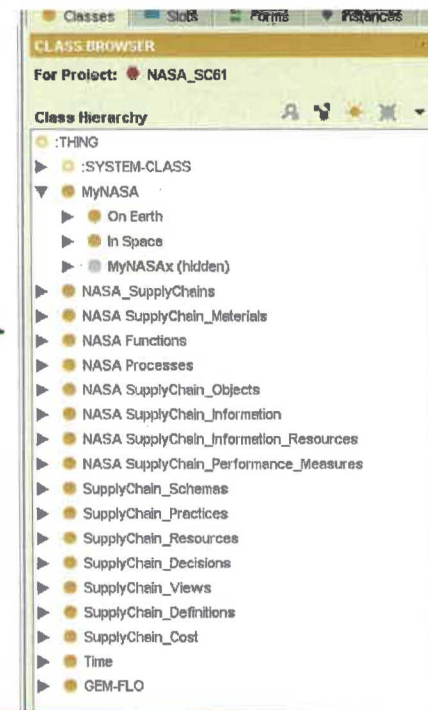
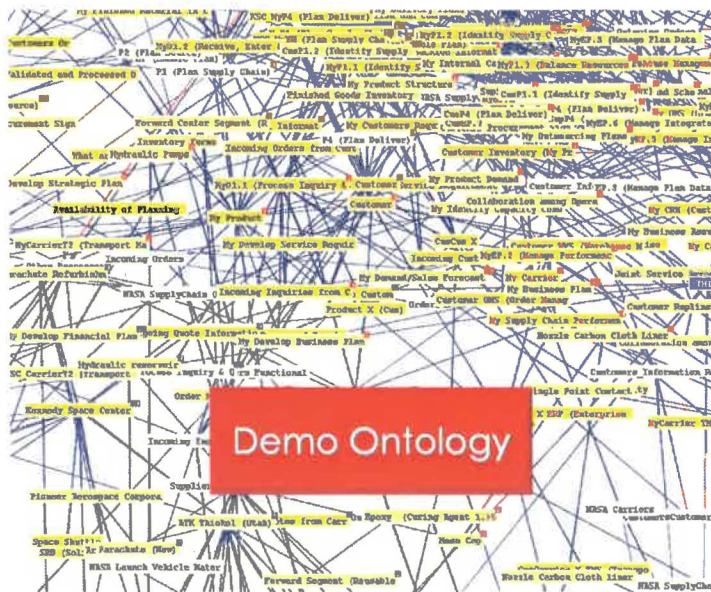
- Capability to analyze different, advanced operating scenarios and new initiatives:

- New designs & architectures
- New practices
 - e.g. VMI / VOI, RFID, e-Shop Floor, commonality, modularity, etc.



The Ontology

- ❑ A populated Supply Chain Ontology for NASA Space Transportation Systems for Exploration
- ❑ Core: Processes – SCOR+
- ❑ Middle: Information, Materials, etc.
- ❑ Outer: Generic Instances, Customized Instances



Complexity...managed...& understood...

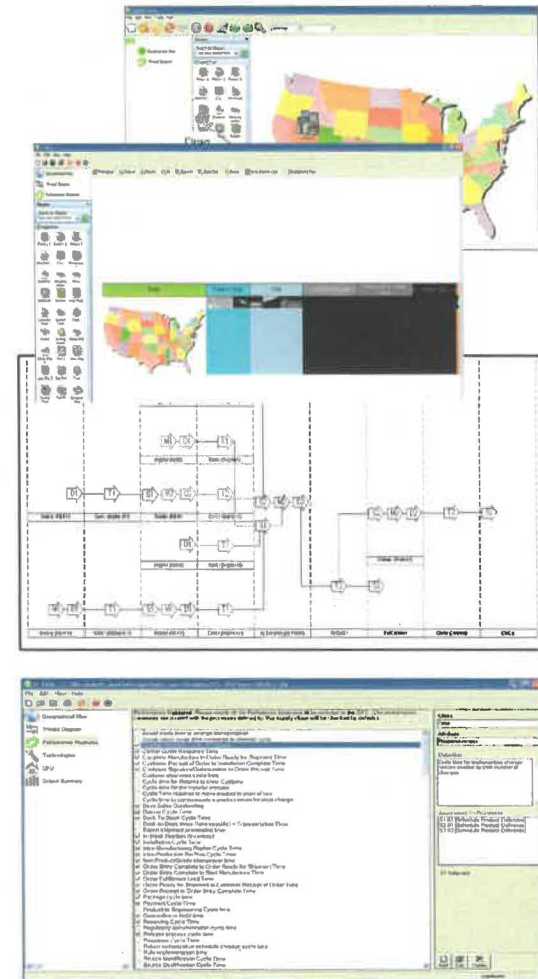


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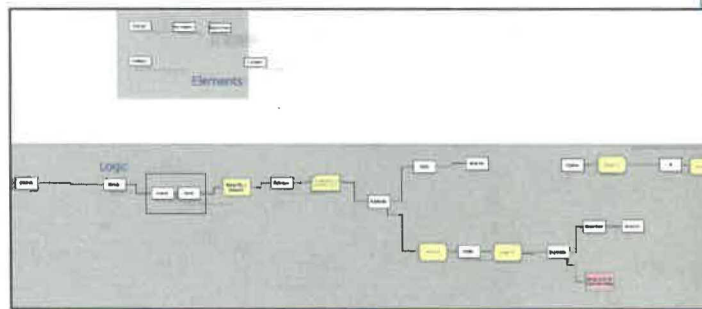
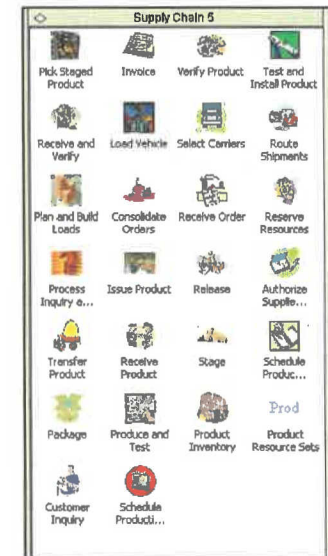
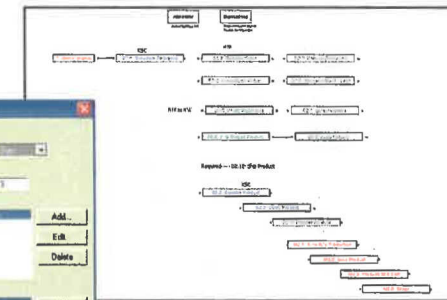
The Interface

- ❑ Define a Supply Chain on a geographic and Space-time map.
- ❑ Automatically generate the process flow of the end-to-end Space Exploration Supply Chain
- ❑ Automatically generates the Key Performance Indicators relevant to the Supply Chain



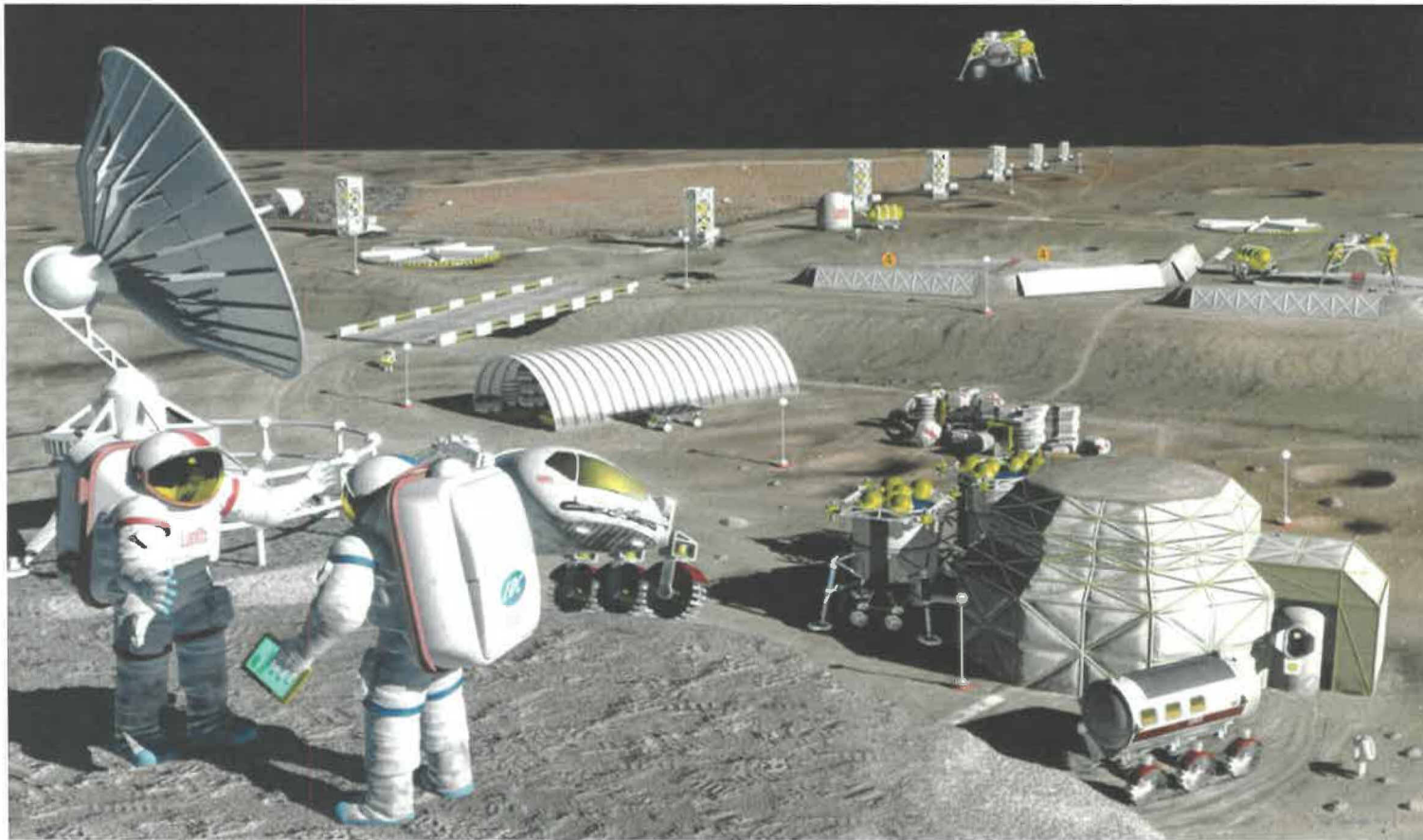
The Simulation

- Simulation templates consistent with SCOR – Source, Make, Deliver.
- Plan, Return, & Enable templates in progress.
- Automatically generate simulation models.

A screenshot of a dialog box titled "Schedule Product Deliveries". It has a "Select an Object Name:" dropdown menu with "TRIAN 2.4.6" selected. Below are sections for "Info/Objects In", "Info/Objects Out", "Objects Before", and "Objects After". Each section has a list of items and "Add...", "Edit", and "Delete" buttons. At the bottom are "OK", "Cancel", and "Help" buttons.



The Not too Distant Future



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Thank You

Contact us for more information



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