



34th Annual **INCOSY**
international symposium

hybrid event

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Modeling NASA's Procedural Requirement Processes – Implications for a Digital Future

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Patrick Barnes – ASRC

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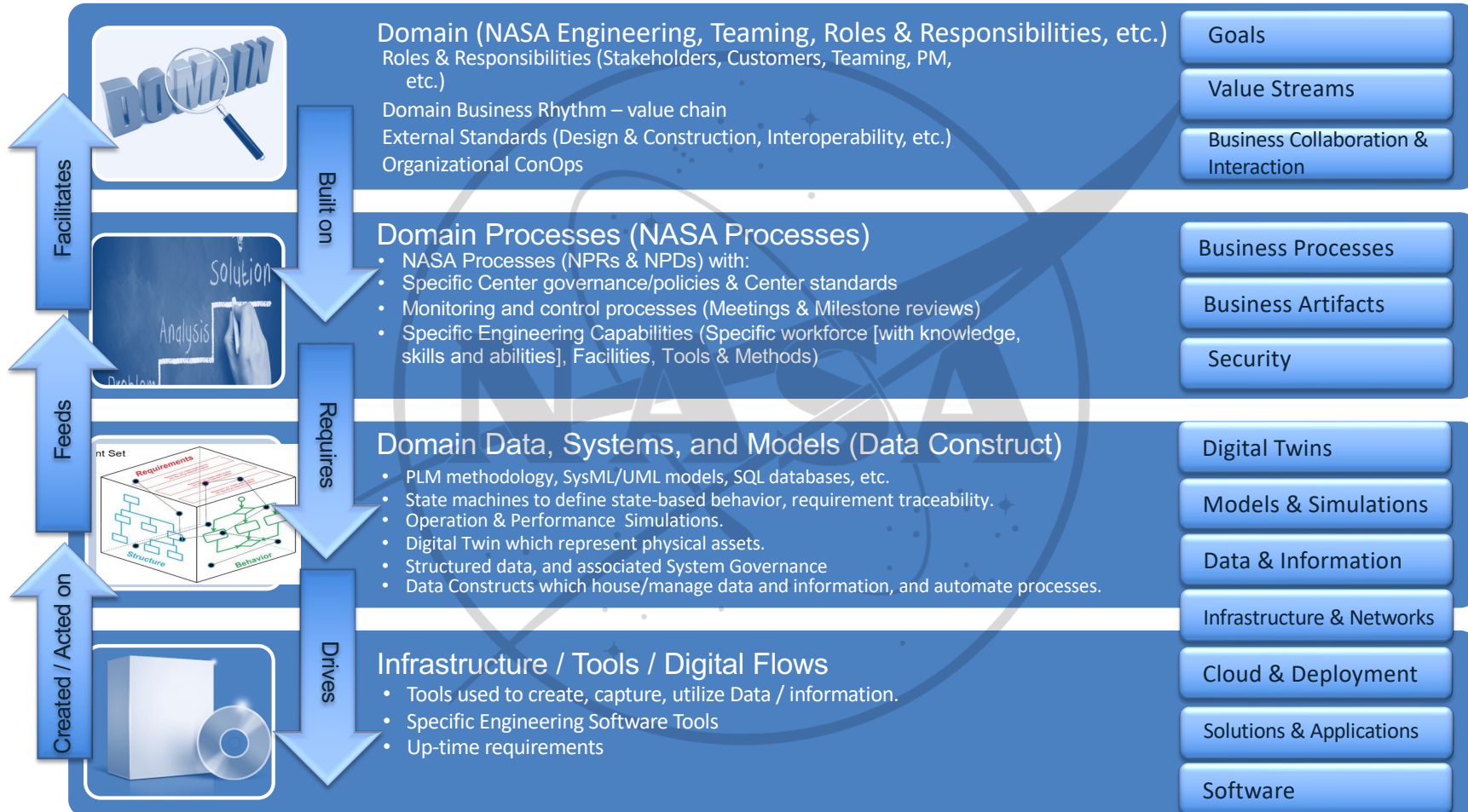


BACKGROUND

The “4-Layer Cake” Analysis for Identification of Digital Transformation Opportunities

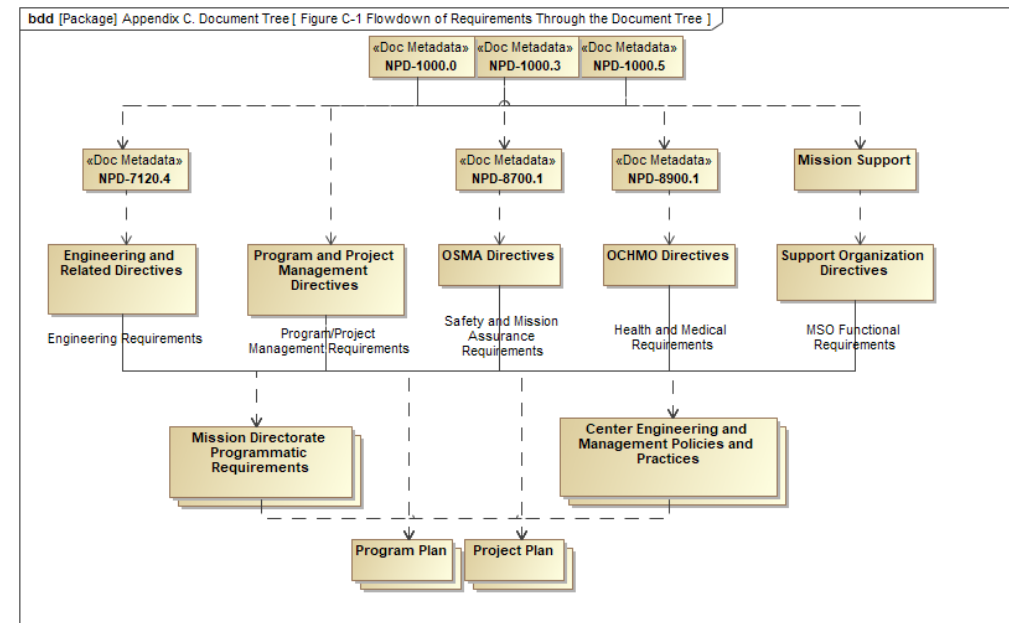
Developed by the Office of Chief Engineer's Digital Engineering Leadership Team

Architectural Elements

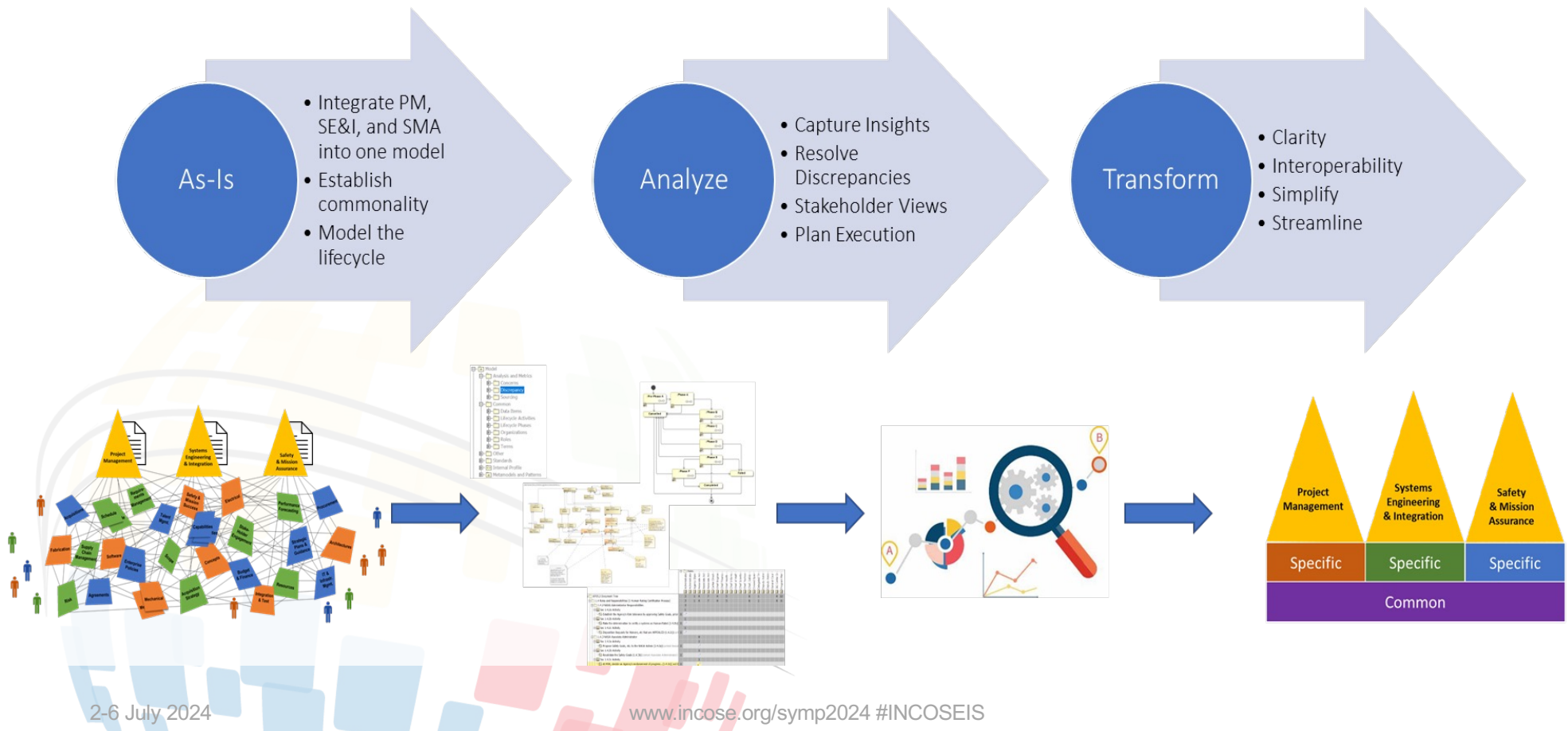


NPDs and NPRs: NASA Guidance

- NASA's success has been built upon well-established policies and procedures that evolved from best practices and lessons learned
 - NASA Policy Directive (NPD)
 - Provides broad vision and goals
 - Intended as guidance
 - NASA Procedural Requirements (NPR)
 - High-level implementation guidance for the workforce
- Provides guidelines on how work should be performed
- Aligns with the Organizational Structure
 - Programmatic Authority
 - Technical Authority
 - Institutional Authority
- Modeling effort focused on Program/Project Management, Systems Engineering, and Safety and Mission Assurance



APPROACH: BREAK IT DOWN TO THE DATA & INFORMATION LEVEL WHERE DECISIONS ARE MADE

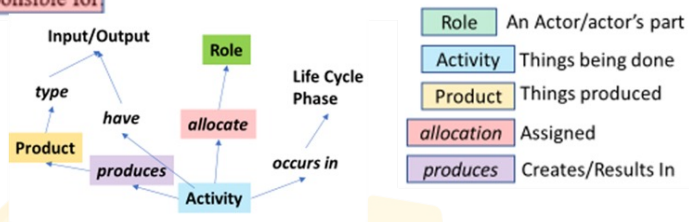




AS-IS CAPTURE & ANALYSIS

Parsing and Patterns

2.8.1 The Chief, SMA is responsible for advising the Administrator and other senior officials on matters related to risk, safety, and mission success and serves as the lead SMA T.A. To provide independent oversight of programs and projects in support of safety and mission success, the Chief, SMA, is responsible for

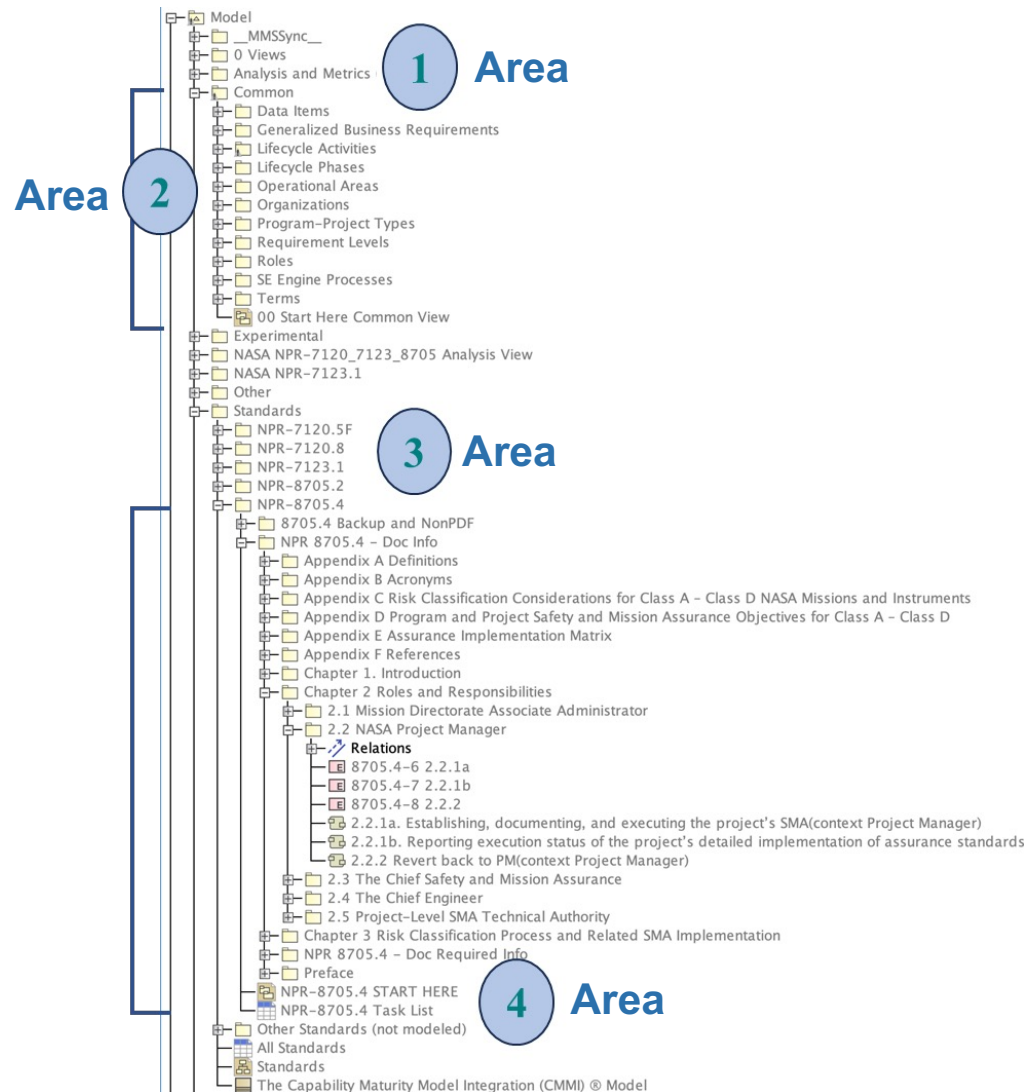


- Simple pattern focused on:
 - Allocating Roles to Responsibilities
 - Equating responsibilities into activities
 - Inputs/output of activities are the data/product
 - Putting them together visualizes the overall process
- Ability to produce human and machine readable from a single source
 - Machine-verification rules used to verify parsing and completeness
 - Human verification of format/layout
 - Additional views added to enable humans to verify parsing

Model Structure

Multiple documents are integrated into one common model

- **Area 1: Views and Metrics**
 - What is exposed from the model during reviews
- **Area 2: Common**
 - Terms or data items that are used in multiple documents
- **Area 3: Modeled Documents**
 - Contains text, activities, requirements, etc.
- **Area 4: Documentation that hasn't been modeled**
 - Reference material





Analysis Process

		Analysis Tags Acquisition/Contracts... Assurance Authorities Decision Authority ConOps / Concept Cost Design Human Rating Implementation Integration and Produc Logistics No Grouping Operations Performance Planning Process Quality Requirements Schedule Technology Developme... V&V Waivers/Exception...																							
		45	56	2	34	71	60	60	29	38	65	66	45	25	54	57	61	39	27	35					
Common		104	105	330	202	36	164	62	159	27	64		152	3	16	11		202	44	50	101	147	51	11	
Policies, Directives and Standards																									

Quality Score: 1

Excessive Continuities

Multiple Impacts

Vague Words

Optional Escape Clauses

Optional Open-Ended Clauses

Superfluous Infinitives

Cross-Referencing Pronouns

Unmeasurable Qualifiers

Quality Warnings:

Universal Quantifiers

Passive Voice

Unclear Focus

of Similar: 0
(Similarity Threshold: 75%)

2.1.3.1.1 As with programs, projects vary in scope and complexity and thus require varying levels of management requirements and Agency attention and oversight. Consequently, project categorization defines Agency expectations of project managers by determining both the oversight council and the specific approval requirements. Projects are Category 1, 2, or 3 and must be assigned to a category based initially on: (1) the project life-cycle cost (LCC) estimate, the inclusion of significant radioactive level, and whether or not the system being developed is for human space flight; and (2) the priority level. The priority level is related to the importance of the activity to NASA, the extent of international participation (joint effort with other government agencies), the degree of uncertainty surrounding the application of new or untested technologies, and spacecraft/payload development risk classification. (See NPR 8705.4, Risk Classification for NASA Payloads.) Guidelines for determining project categorization are shown in Table 2-1, but categorization may be changed based on recommendations by the Mission Directorate Associate Administrator (MDAA), who considers additional risk factors facing the project. Projects that continue operations and production, including integration of capability upgrades, with an end point are assigned to Category 1 unless otherwise agreed to by the Decision Authority. The end point is defined in Section 2.4.1.3.6. The NASA Associate Administrator (AA) approves the final project categorization. The project category is identified in the Formulation Authorization Document (FAD) and is documented in the KDP B Decision Memorandum. The Office of the Chief Financial Officer (OCFO) is responsible for the official listing of NASA programs and projects. 4 For purposes of project categorization, the project LCC estimate includes phases A through F and all Work Breakdown Structure (WBS) Level 2 elements and is measured in real-year (nominal) dollars.

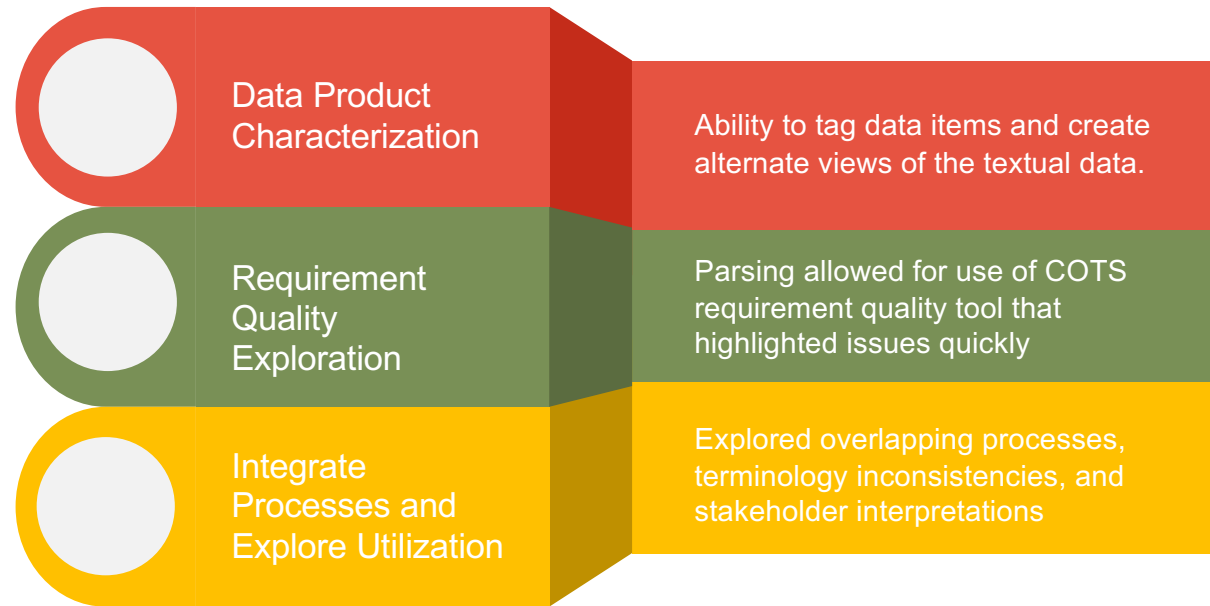
Summary Example – NPR 7120.5 2.1.3.1

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- As-Is
 - Activities (Blue)
 - One shall requirement applicable to all
 - One "is responsible for" statement
 - Data/Deliverables Items
 - 10+ inputs (yellow)
 - 1 output – project categorization
 - Documented in 4 Deliverables (orange)
 - Allocated to 5 Roles (green)
 - Assume project
 - Requirement owned by CCE
 - References 2 different NPRs and 2 items within this NPR
- Analysis planning (Discrepancies & Concerns)
 - Inconsistent use of terms (LCC estimate, WBS L2 elements)
 - Data inputs
 - Priority level only impacts projects that are less than \$305M
 - NPR call out add additional requirements (~30)
 - Data outputs/consistency/traceability
 - WBS Structure and Project Categorization needed in Project Plan
 - Roles/requirements/activities that are buried in the text or matrices in the appendices
 - Requirement compliance to Easy Approach to Requirement Syntax (EARS)
 - Score of 1 out of 5

Table 2-1 Project Categorization Guidelines

Priority Level	LCC < \$305M	\$305M ≤ LCC ≤ \$2B	LCC > \$2B, significant radioactive material, or human space flight
High	Category 2	Category 2	Category 1
Medium	Category 3	Category 2	Category 1



2-6 July 2024

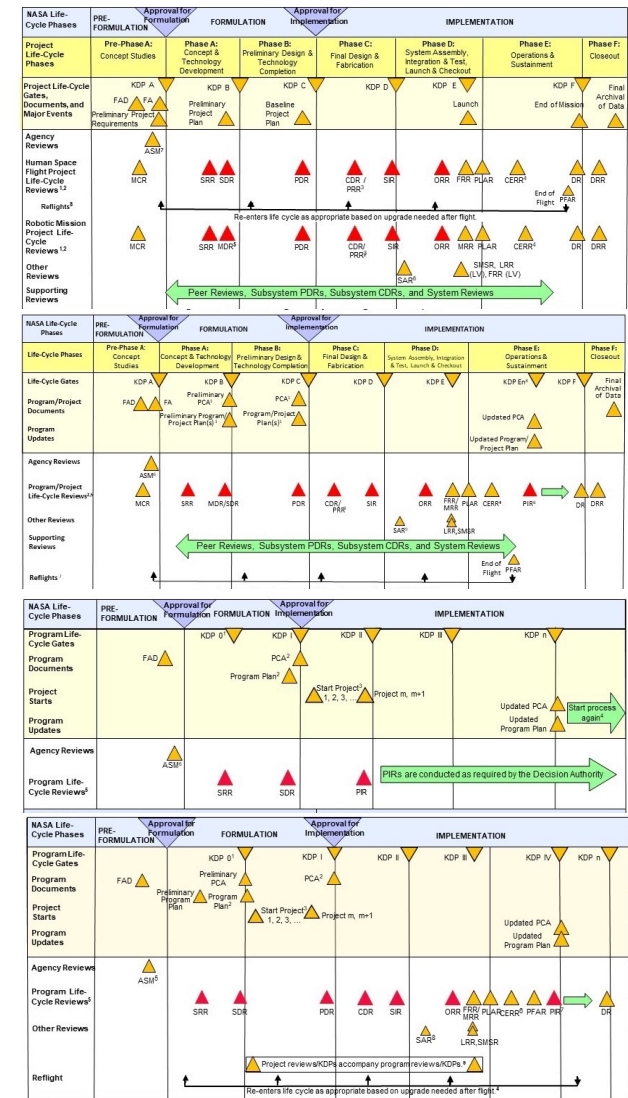
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FINDINGS & RECOMMENDATIONS

Assess Lifecycles

- NASA currently has numerous lifecycles
- Data-centric views allow for assessment of:
 - Complexity vs. Flexibility
 - Codified vs. Guidance
 - Traceability to Centers vs. Program/Project
 - Missing details/allocations
- Recommendations for changes based on:
 - Accuracy and consistency
 - Efficiency
 - Risk management
 - Data patterns and trends
- Enable attribute-based customizations



Data-Centric Views of Common Items



Terminology

Consistent terminology across all processes. Method for extending definitions.



Roles & Responsibilities

Role expectations are consistent across all processes. Views created based on roles.



Milestone Reviews

Integrated data-centric views are tailorable and directly inform decisions.



References

Defined metadata necessary for reference data. References are current and linked.



Data/Deliverable Hierarchy

Deliverables are broken into the required data elements which allows for re-use and traceability.

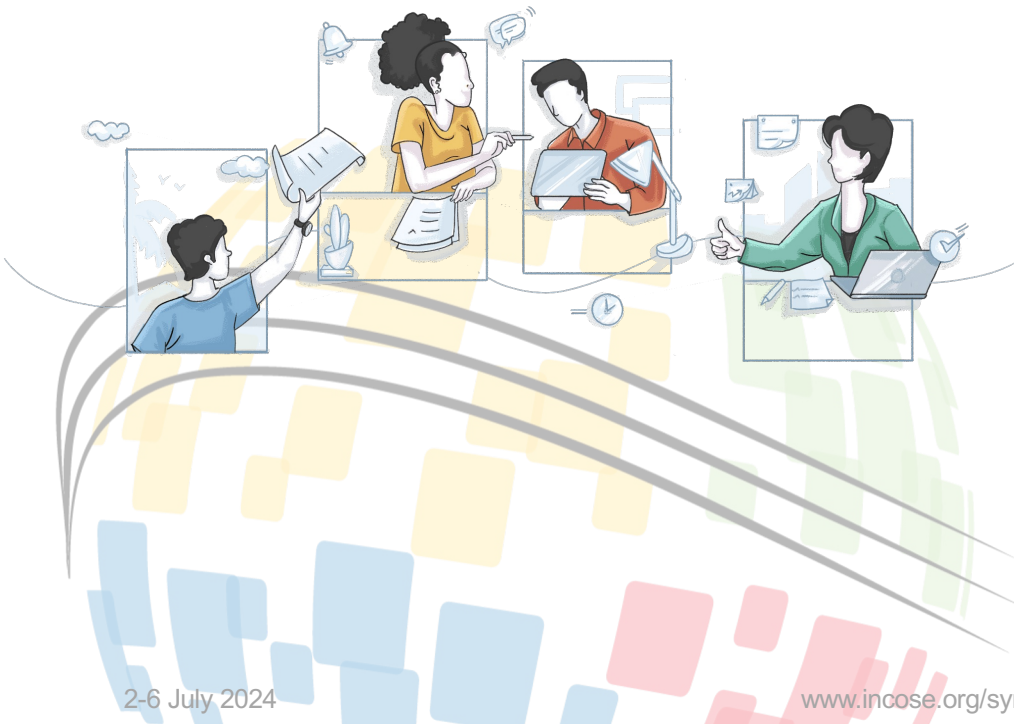


Requirements

Defined metamodel which breaks text into data elements and process flows allows orchestration of large/complex processes.



Document-Centric to Data-Centric Milestone Reviews



Data-Centric Review Process Pattern



Data/Deliverable hierarchy and consistent terminology along with consistent processes make this easier to produce

Accurate data collection and management ensure the data is available and at the appropriate maturity

Data from various source can be integrated and standardized into views for various Stakeholders
Allows the ability to drill into available data/information

Evaluations rely on data and information, increasing objectivity

Risk-informed decisions are made



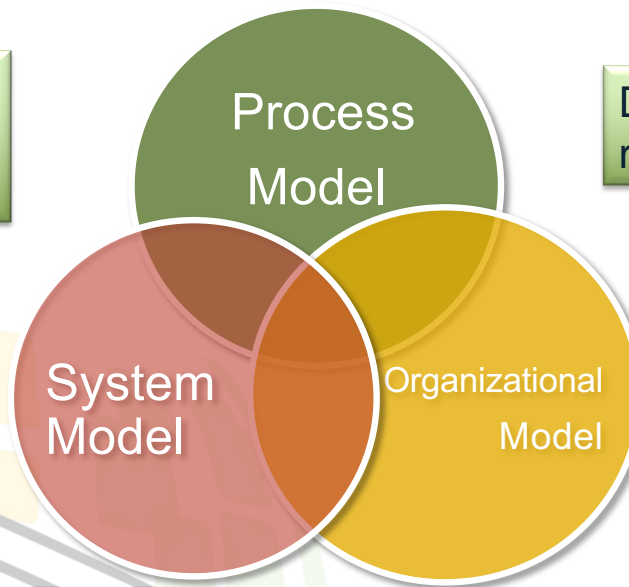
Summary

Digital Engineering – Next Steps

Continue to Simplify
& Streamline

Data-centric views that focus
on collection, integration, and
management of data

Data-centric views to focus on
roles and responsibilities



Integrate and align
input/outputs

Familiarization of data-centric
views and models

Data-centric views that support design,
development, and operations

Questions?



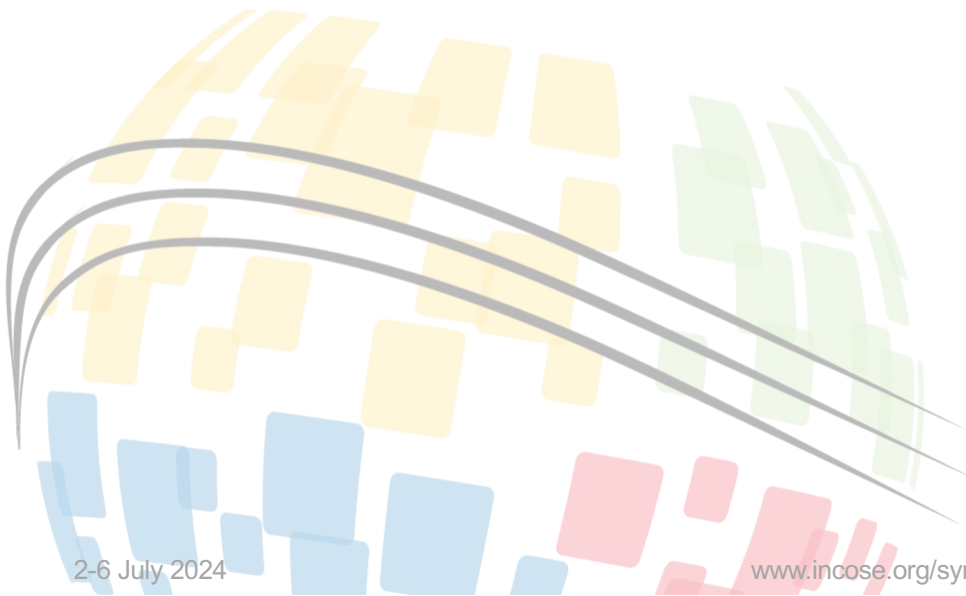
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