INCOSE 2008 Case Study:

Product Life-Cycle Modeling Utilizing SysML Modeling

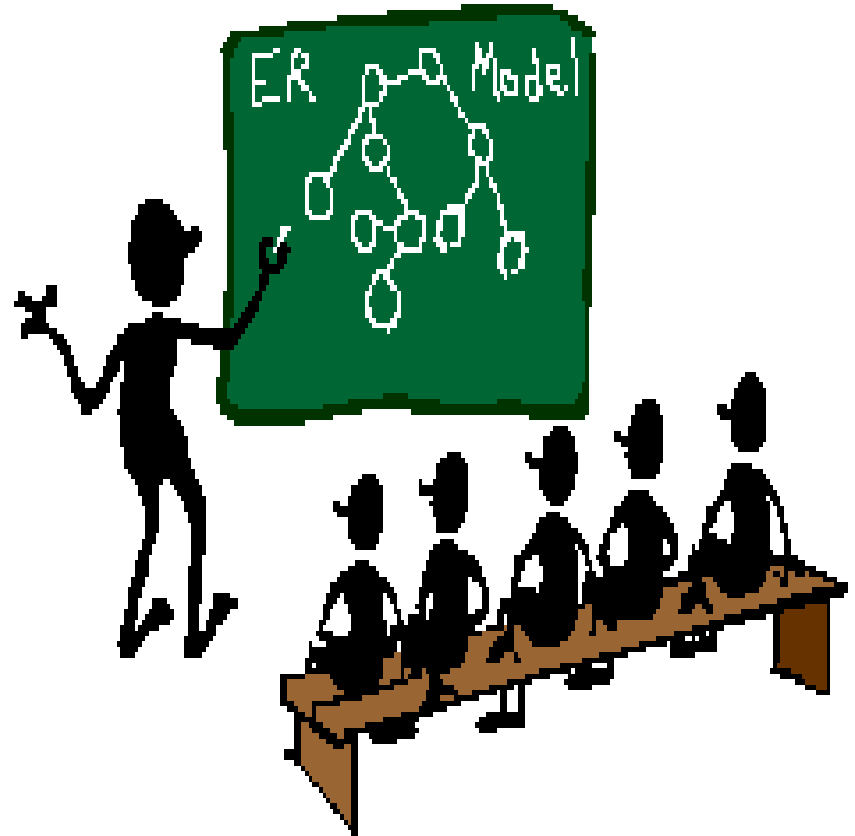## Georgia Artery

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Outline

- Purpose of Case Study

- Business Background

- Process Background

- Modeling Approach

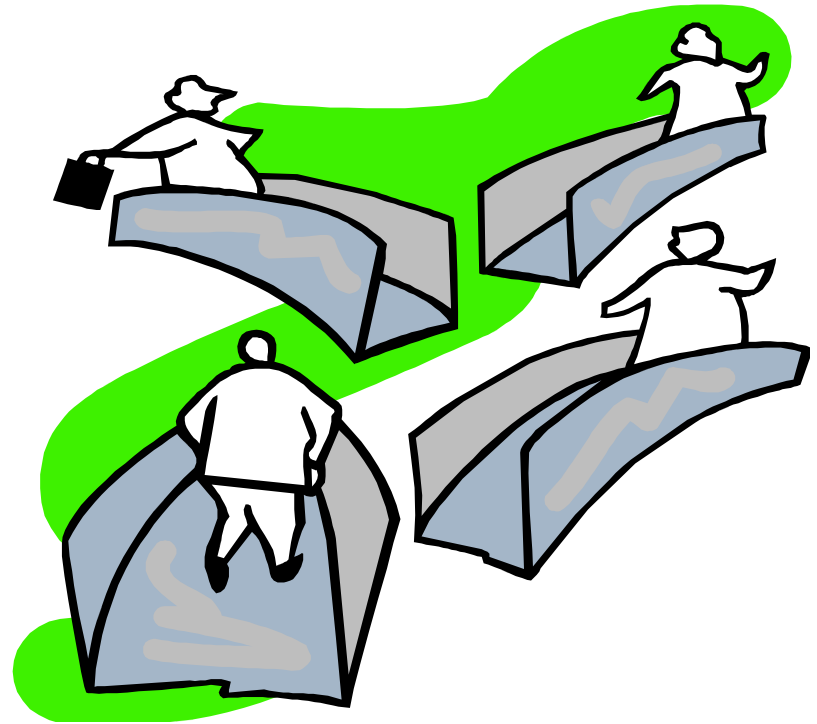- Behavioral and Structural Model Elements

- Conclusions

Purpose of Case Study

- Use of functional modeling can help organizations more readily accept the use of systematic modeling for developing Product Realization Process

- Understand the value of using SysML/UML over functional modeling in order to completely specify process and process artifacts
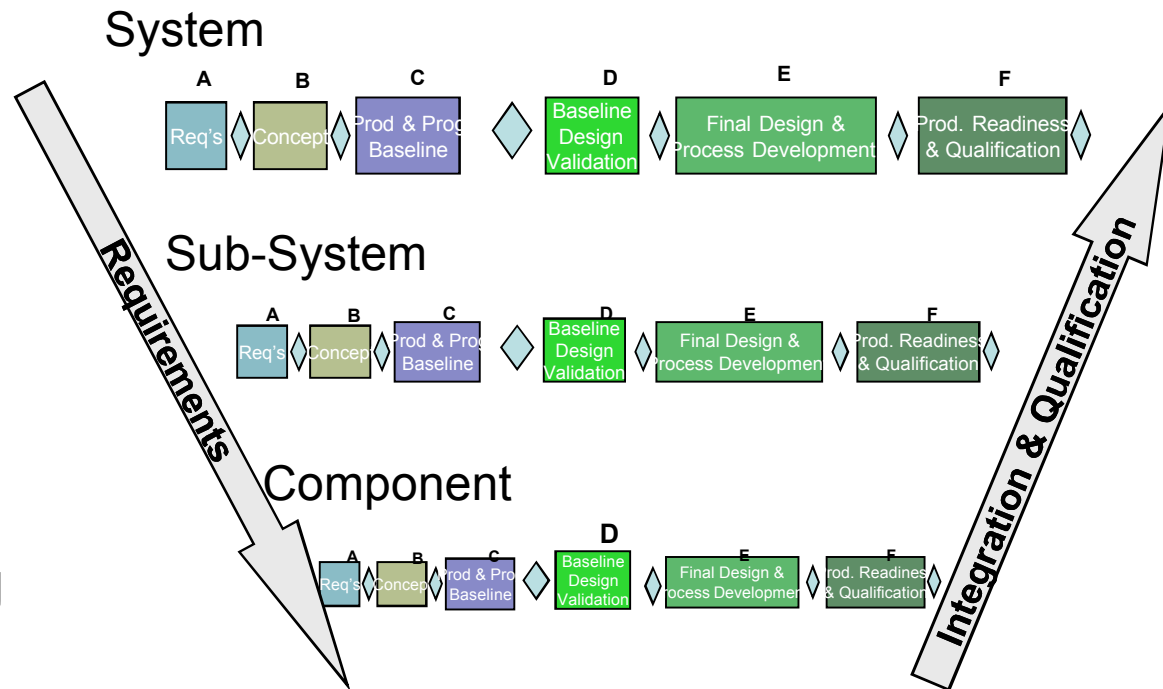
Business Background

- Large, complex business utilizing legacy product realization process
- Multiple sites/organizations trying to utilize one process
  - Many handoffs
  - Changing roles and responsibilities
  - Various interpretations of process
- NNSA initiative to revitalize technical business practices
- Sandia named as Systems Integration support

Differing domains by multiple agencies need to work in partnership to develop, deploy, maintain, & dismantle highly complex product

Process Background

- Business need to improve current product realization process

- Applied the System Engineering "Vee Model" to create process

- Utilized phase-gating methodology to imbedded rigor, accountability and system integration

Using System Engineering methods to develop new Product Realization Process
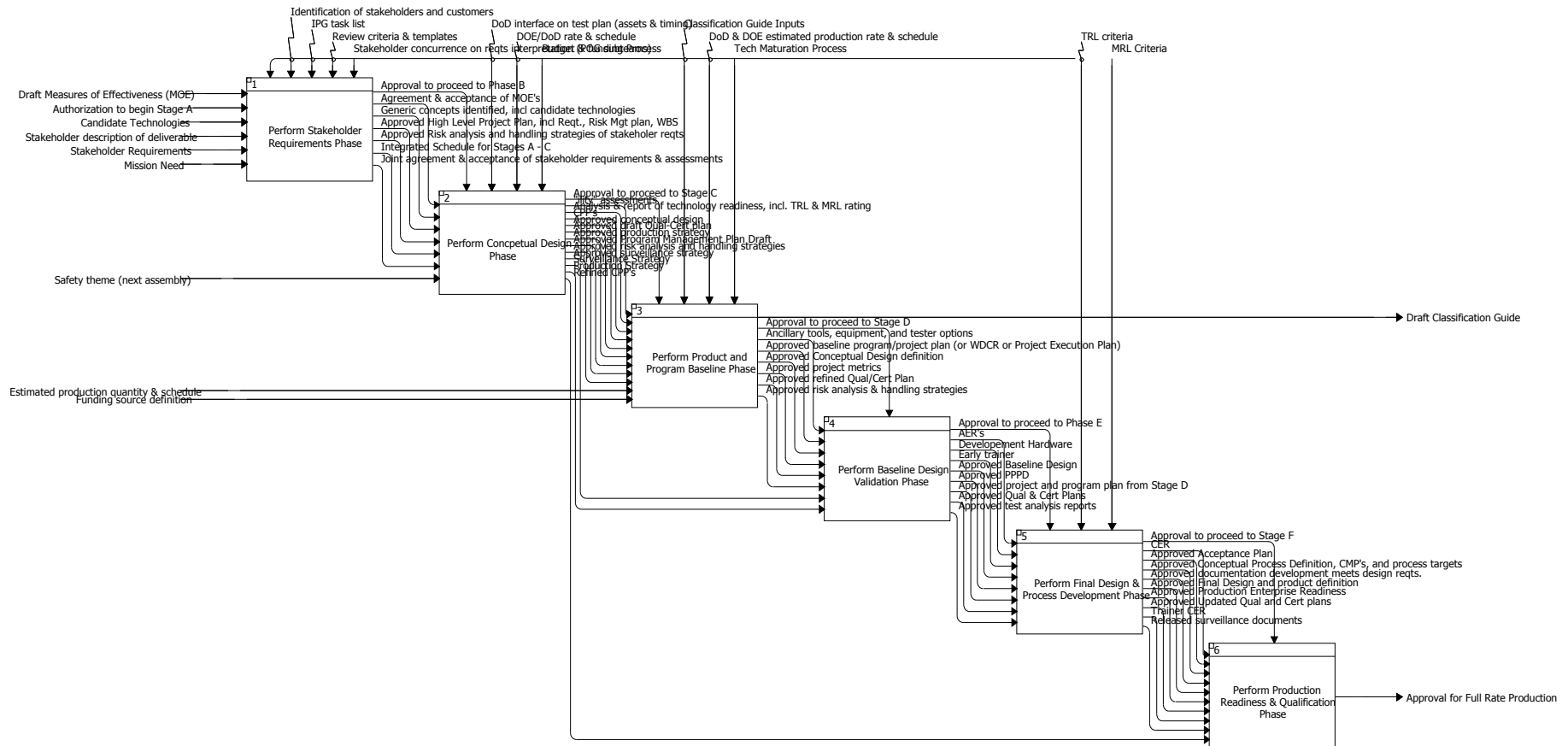
Process Modeling Approach

- Developed process using IGOE charts, depicting inputs-tasks-outputs of each phase in the process
- Created functional model for 1st phase to socialize a better approach to specifying the process
- Developed parallel approach to look at behavior models
  - IDEF0 diagrams and use case diagrams
- Created structural and behavioral elements of the process using SysML
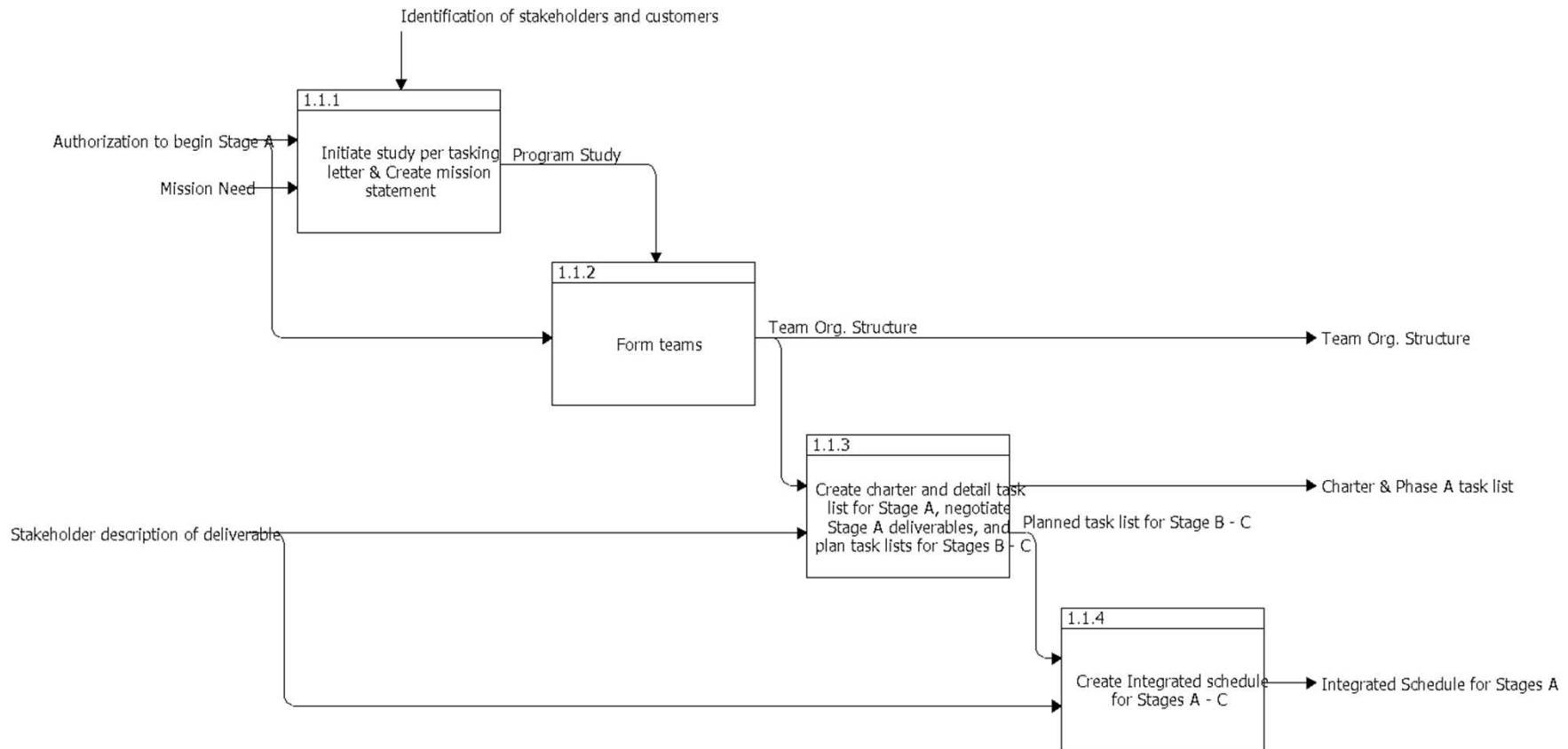 - Structural views were used to specify the process more completely

Rigorous modeling to developing & deploying common process is critical to fully understand the structure and behavior of teams

Functional Model – A1 Level

- *Functional modeling helped to better understand and specify the process*
- *IDEF0 diagrams represent how critical taking a System Engineering approach to process development using modeling*

Functional Model – A2 Level

Identification of stakeholders and customers

1.1.1 Initiate study per tasking letter & Create mission statement

Authorization to begin Stage A

Mission Need

Program Study

1.1.2 Form teams

Team Org. Structure → Team Org. Structure

1.1.3 Create charter and detail task list for Stage A, negotiate Stage A deliverables, and plan task lists for Stages B - C

Charter & Phase A task list

Planned task list for Stage B - C

Stakeholder description of deliverable

1.1.4 Create Integrated schedule for Stages A - C

Integrated Schedule for Stages A

Decomposing the next level to further specify the connectivity of the process elements & identify inefficiencies in the process
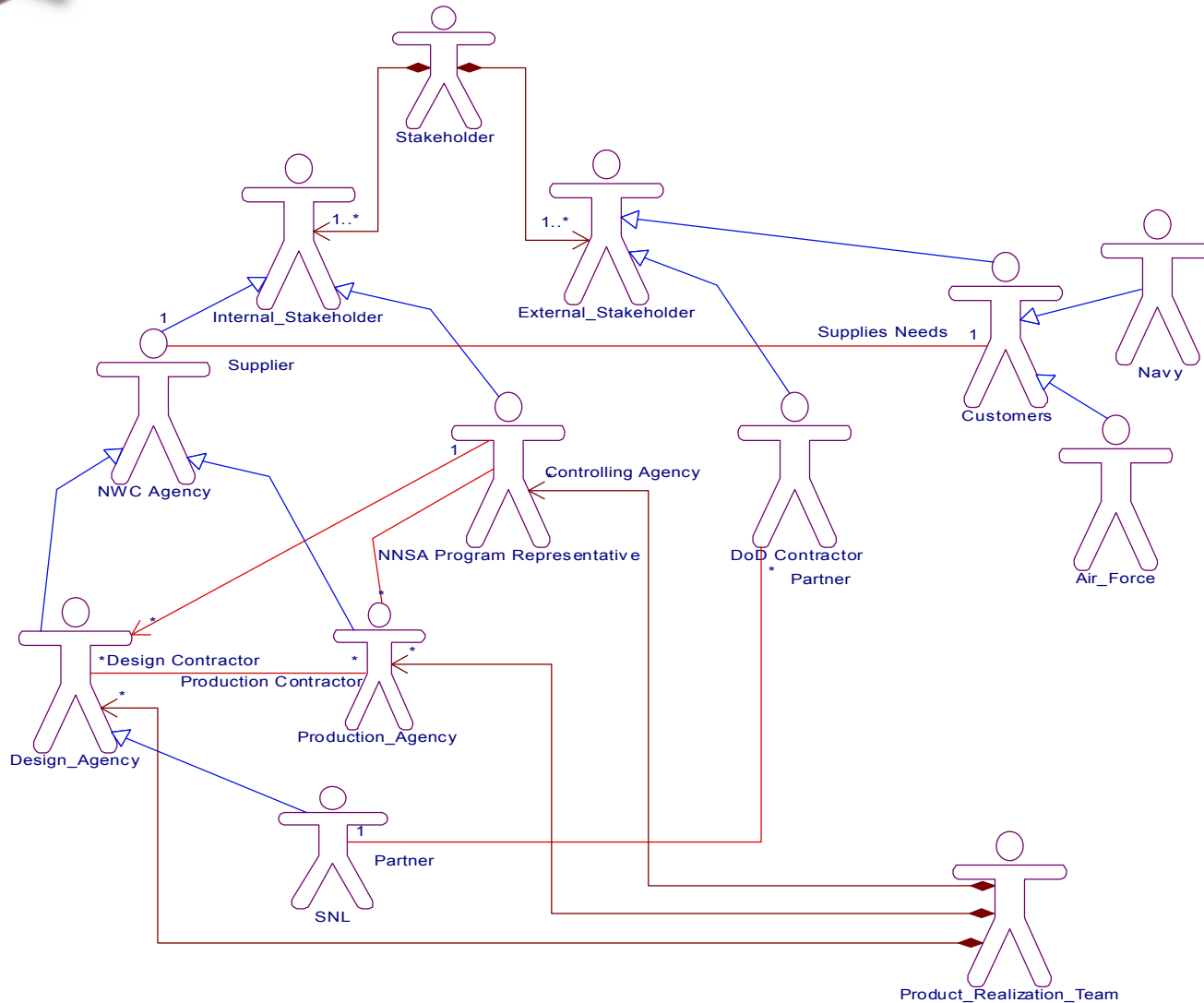
SysML Model

- Identify stakeholders and their relationships (structural view)
- Create highest use case architecture (behavioral view)
- Create structural view of artifacts (nouns) identified in the use cases & functional model
- Optimize behavioral specification in use case architecture by embedding behavior in the structural elements
- Realize the use cases or operations within the artifacts with activity diagrams or state diagrams
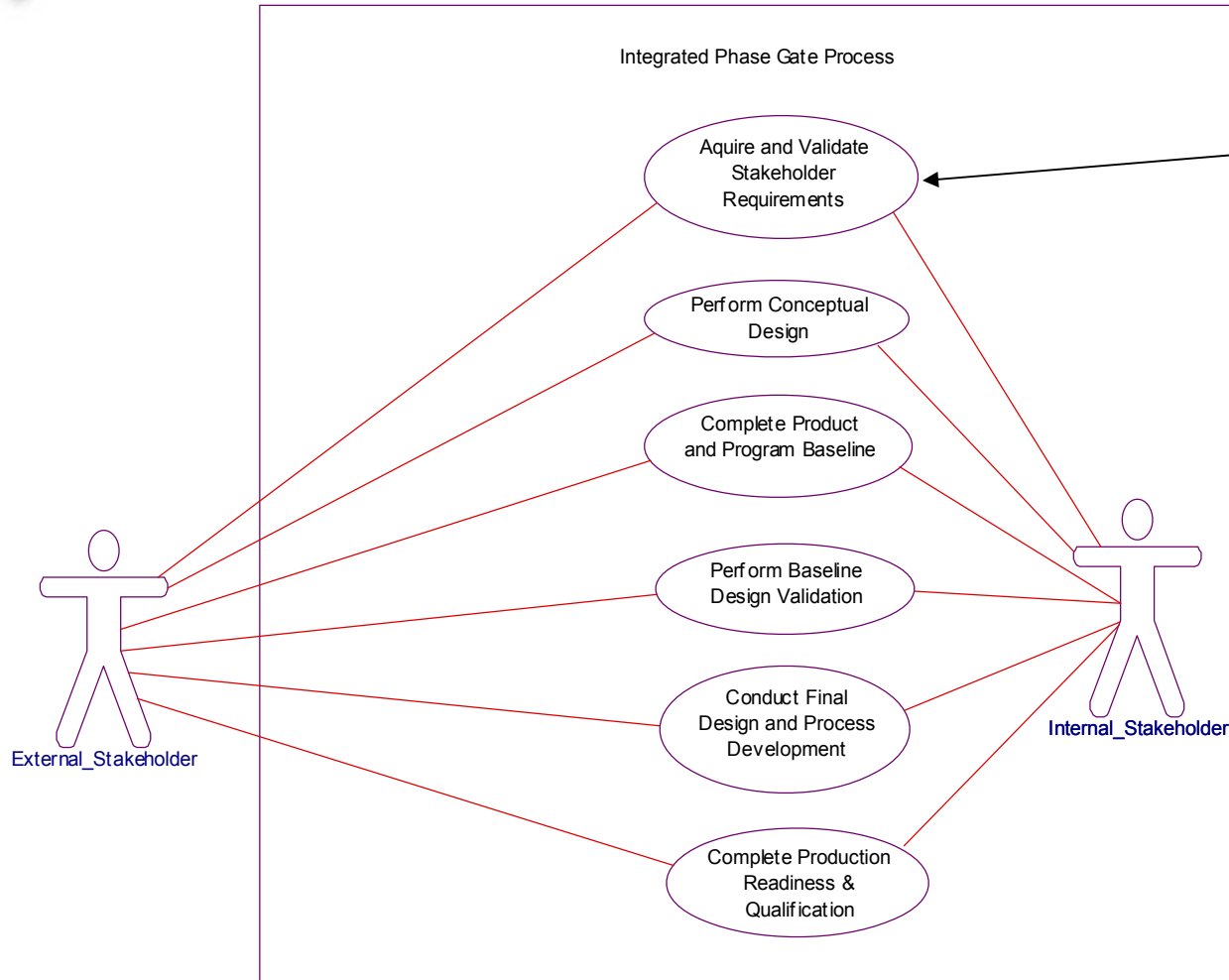 - Develop process procedures from the behavioral specification

SysML instrumental to achieve full specification of structural and behavioral elements of the process

Stakeholder Relationships

Developing stakeholder relationships allows for clearer association of responsibilities in the process
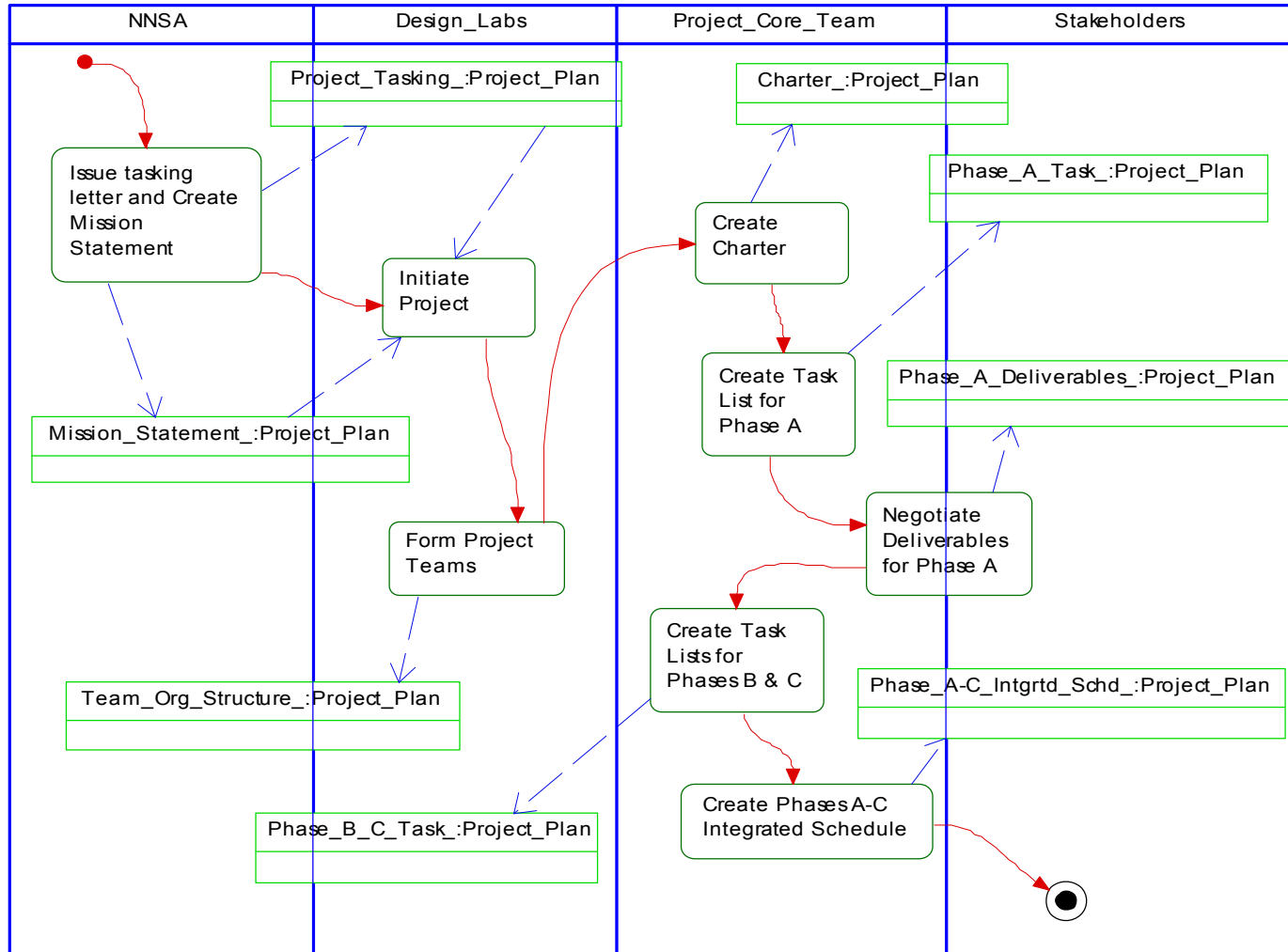
Use Case Architecture

Integrated Phase Gate Process

- Aquire and Validate Stakeholder Requirements
- Perform Conceptual Design
- Complete Product and Program Baseline
- Perform Baseline Design Validation
- Conduct Final Design and Process Development
- Complete Production Readiness & Qualification

External_Stakeholder

Internal_Stakeholder

Each use case can be further specified to the next level down as was done in the functional model decomposition

Use Case diagrams created to describe the high level process architecture

Activity Diagrams

NNSA	Design_Labs	Project_Core_Team	Stakeholders
Issue tasking letter and Create Mission Statement	Project_Tasking_:Project_Plan	Charter_:Project_Plan	Phase_A_Task_:Project_Plan
Mission_Statement_:Project_Plan	Initiate Project	Create Charter	Phase_A_Deliverables_:Project_Plan
Team_Org_Structure_:Project_Plan	Form Project Teams	Create Task List for Phase A	Phase_A-C_Intgrtd_Schd_:Project_Plan
	Phase_B_C_Task_:Project_Plan	Negotiate Deliverables for Phase A	
		Create Task Lists for Phases B & C	
		Create Phases A-C Integrated Schedule	

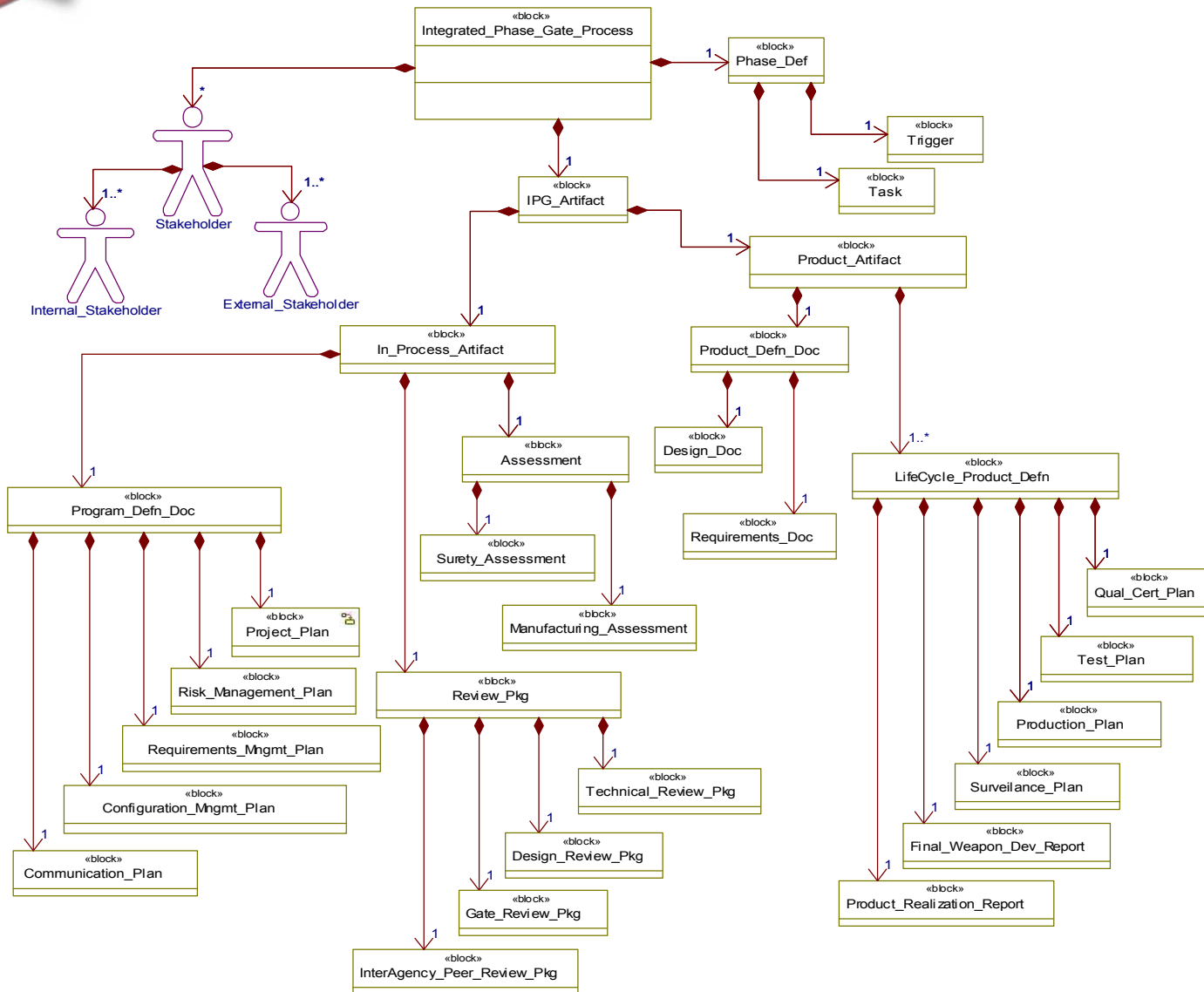*Activity diagrams specifies the tasks to complete & instances of the artifacts*

Requirements Document

Requirements:	- Design Lead shall jointly create mission statement for the project to guide and project scope - Design Project Lead shall form a Product Realization Team (PRT) with representatives from design and production to manage the technical and planning aspects of the project. - Design Project Lead shall negotiate Phase A deliverables with stakeholder - Project Core Team shall create charter for the project - PRT shall develop a list of tasks needed to meet the Phase A deliverables - Project Core Team shall create an integrated schedule for Phases A – C - Design shall obtain and analyze stakeholder requirements and document in Requirements Management Plan - Design shall define subsystems and their capabilities, characteristics, and interfaces - Design shall define and option trades and option requirements - Project Core Team shall begin project plan and initiate program management activities - Project Core Team shall prepare and conduct Phase A Gate Review and document actions items and recommendations

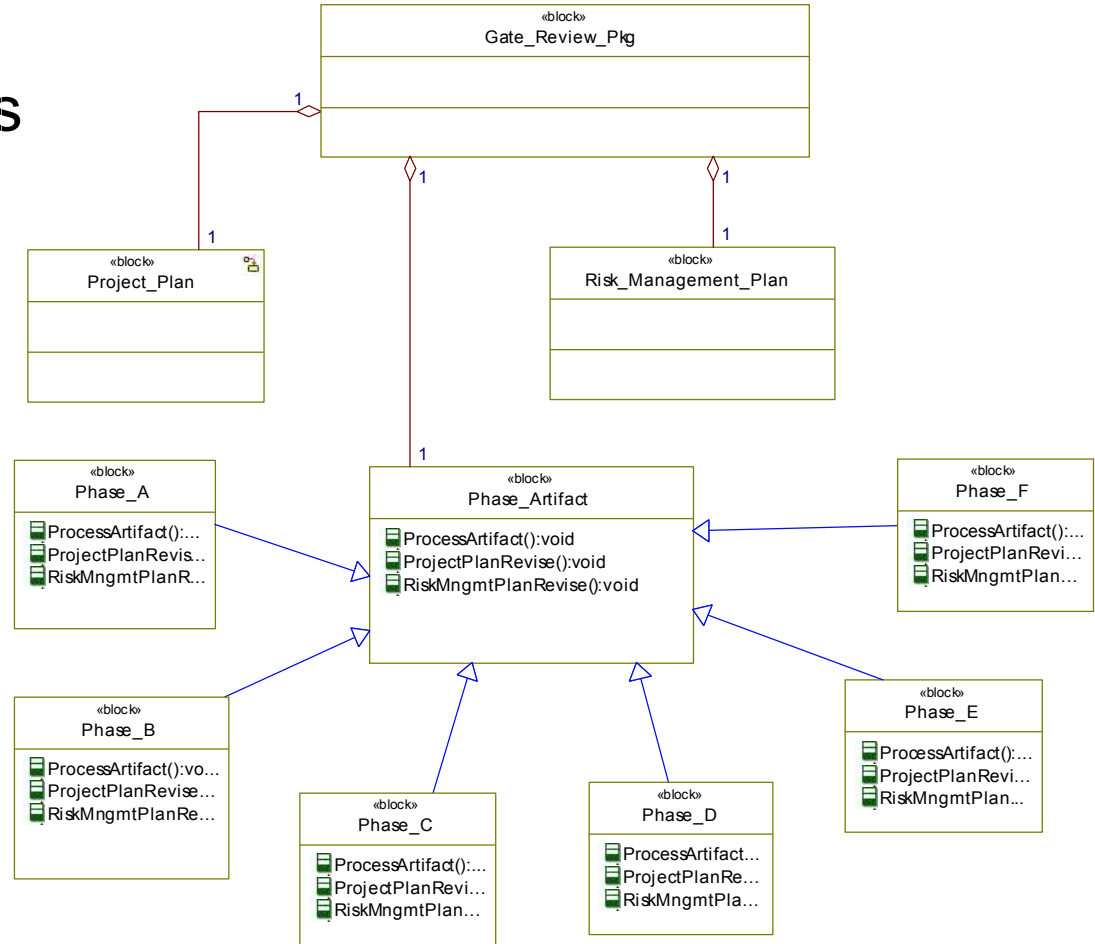*Requirements documents created from Activity diagrams*
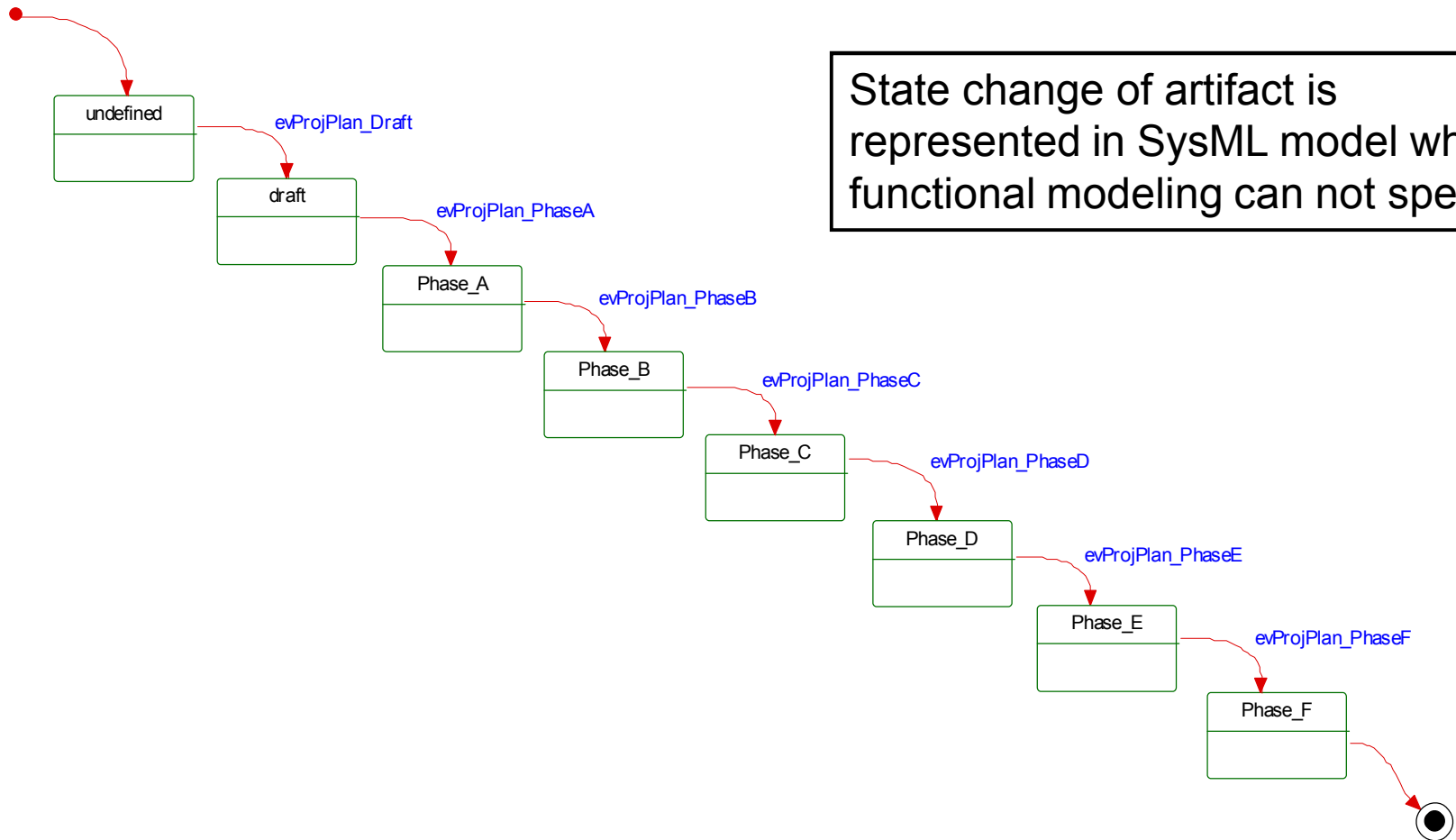
Structure View of Artifacts

Structural models used to understand the artifact architecture, connections, and ontology

Common Elements

- Gate package is a common element across all phases

- Factoring out common process elements is absent from functional model

- External block diagram helps to elaborate & further represent associations of the artifact

Artifact Behavior

State change of artifact is represented in SysML model where functional modeling can not specify

State diagrams in the structural models helped to see artifact behavior

Conclusions

- Behavioral and structural models presented to team as a standard by which to develop business processes

- Functional modeling helped to identify the gaps and the connectivity of the process elements

- SysML modeling is helping to further specify the artifact behavior and relationships in the process which is needed for completeness

- Provided a more comprehensive view and link of behavioral and structural elements in the process that can not be seen by functional modeling alone