Systems Engineering at NASA

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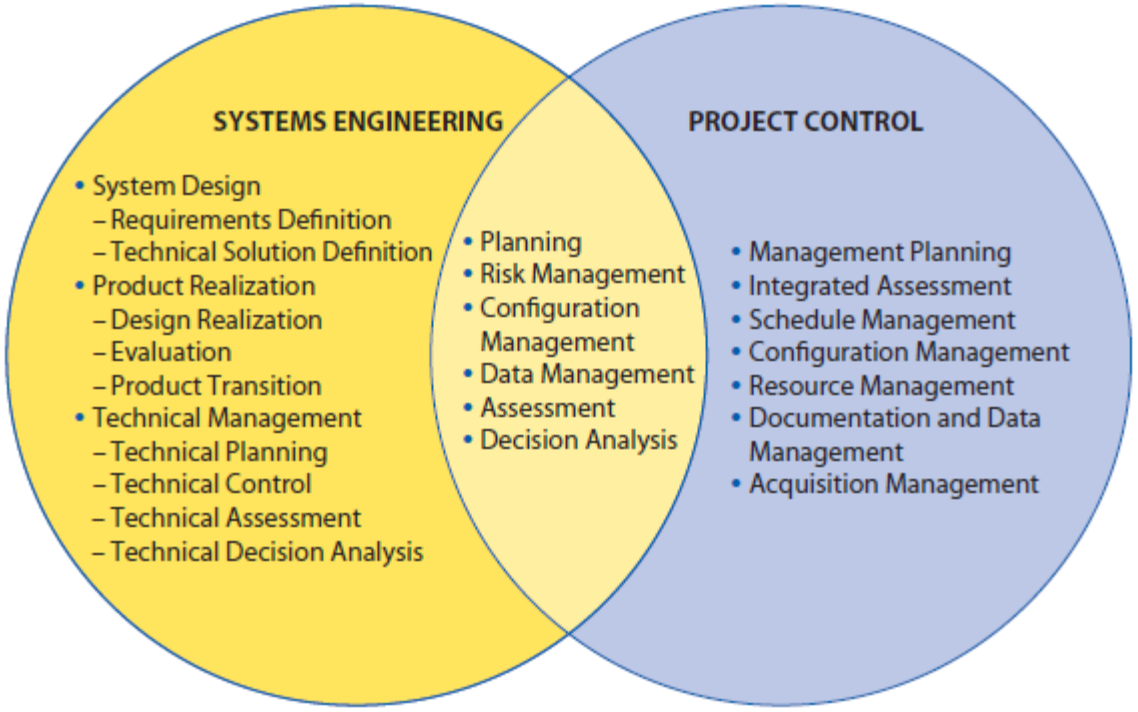

Figure 2.0-1 SE in context of overall project management

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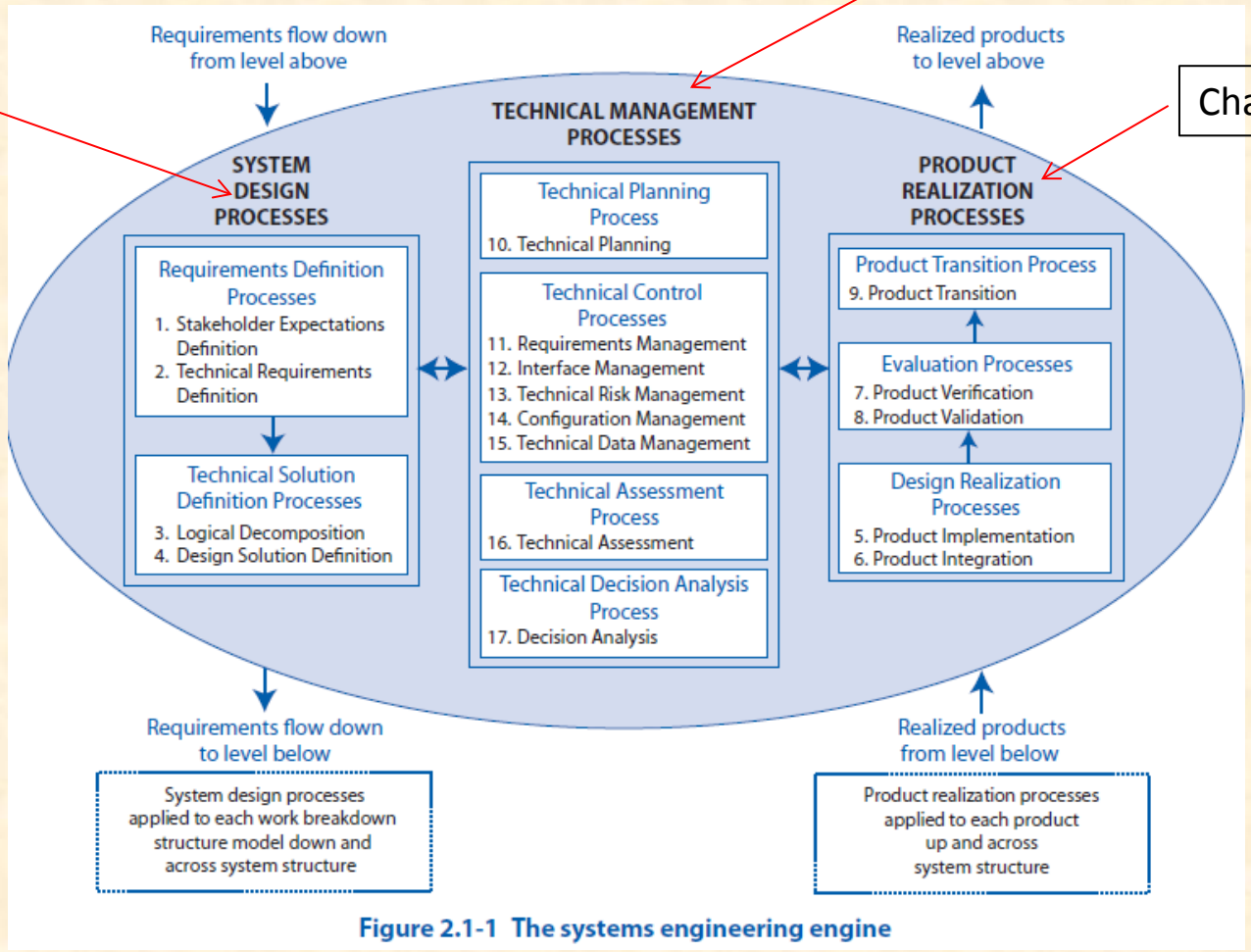

Figure 2.1-1 The systems engineering engine

- Steps 1 through 9 indicated in Figure 2.1-1 represent the *tasks in execution of a project.*
- Steps 10 through 17 are *crosscutting tools for carrying out the processes*.

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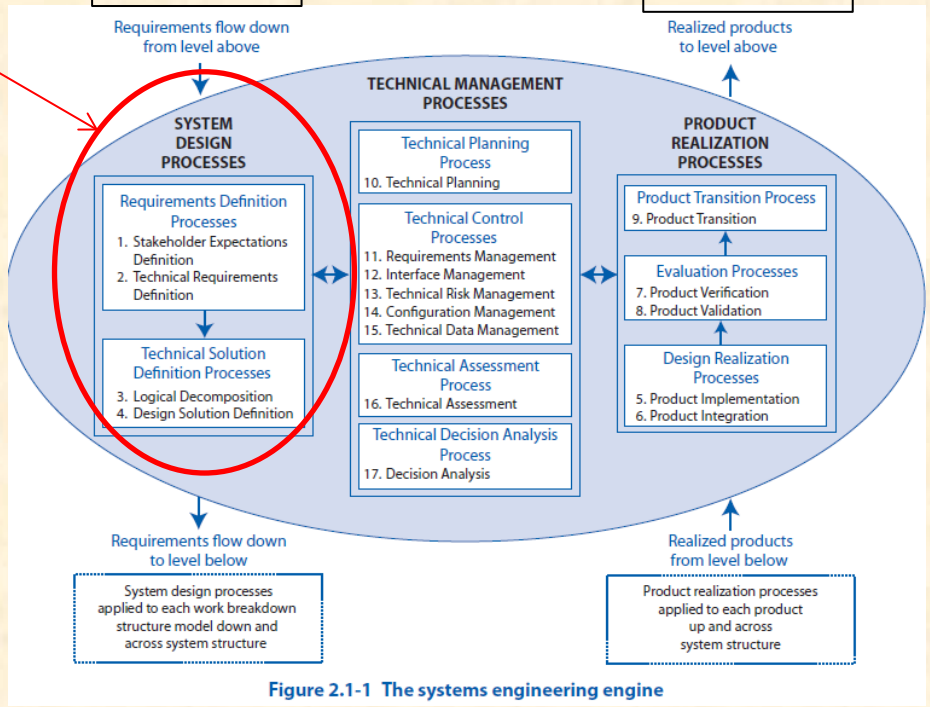
- **System Design Processes:** The four system design processes shown in Figure 2.1-1 are used to define and baseline stakeholder expectations, generate and baseline technical requirements, and convert the technical requirements into a design solution that will satisfy the baselined stakeholder expectations. These processes are applied to each product of the system structure from the top of the structure to the bottom until the lowest products in any system structure branch are defined to the point where they can be built, bought, or reused. All other products in the system structure are realized by integration. Designers not only develop the design solutions to the products intended to perform the operational functions of the system, but also establish requirements for the products and services that enable each operational/mission product in the system structure.



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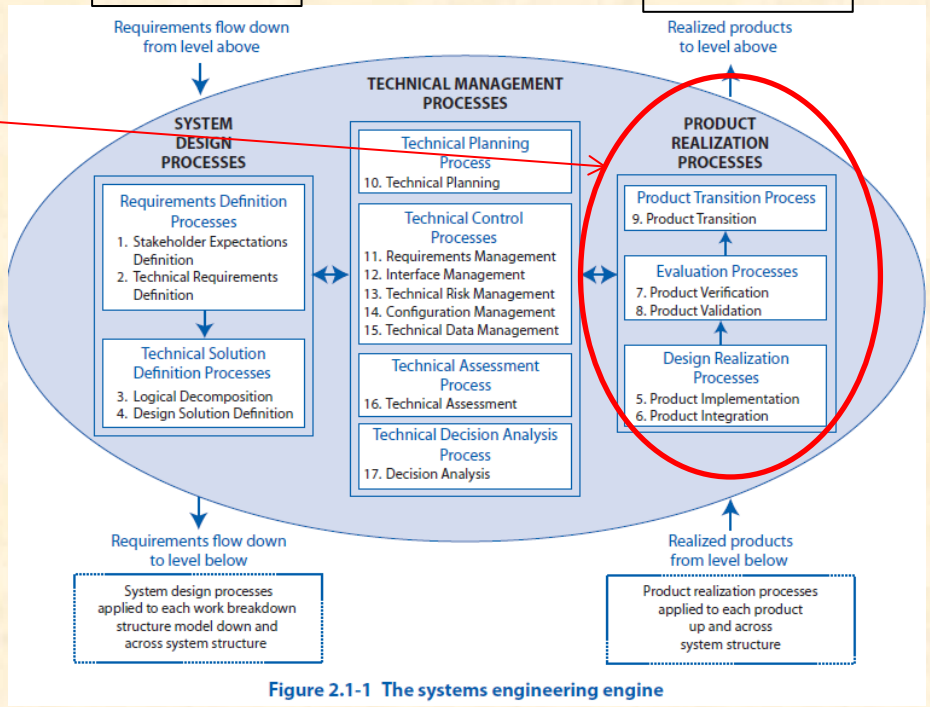
- **Product Realization Processes:** The product realization processes are applied to each operational/mission product in the system structure starting from the lowest level product and working up to higher level integrated products. These processes are used to create the design solution for each product (e.g., by the Product Implementation or Product Integration Process) and to verify, validate, and transition up to the next hierarchical level products that satisfy their design solutions and meet stakeholder expectations as a function of the applicable life-cycle phase.



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- **Technical Management Processes:** The technical management processes are used to establish and evolve technical plans for the project, to manage communication across interfaces, to assess progress against the plans and requirements for the system products or services, to control technical execution of the project through to completion, and to aid in the decisionmaking process.

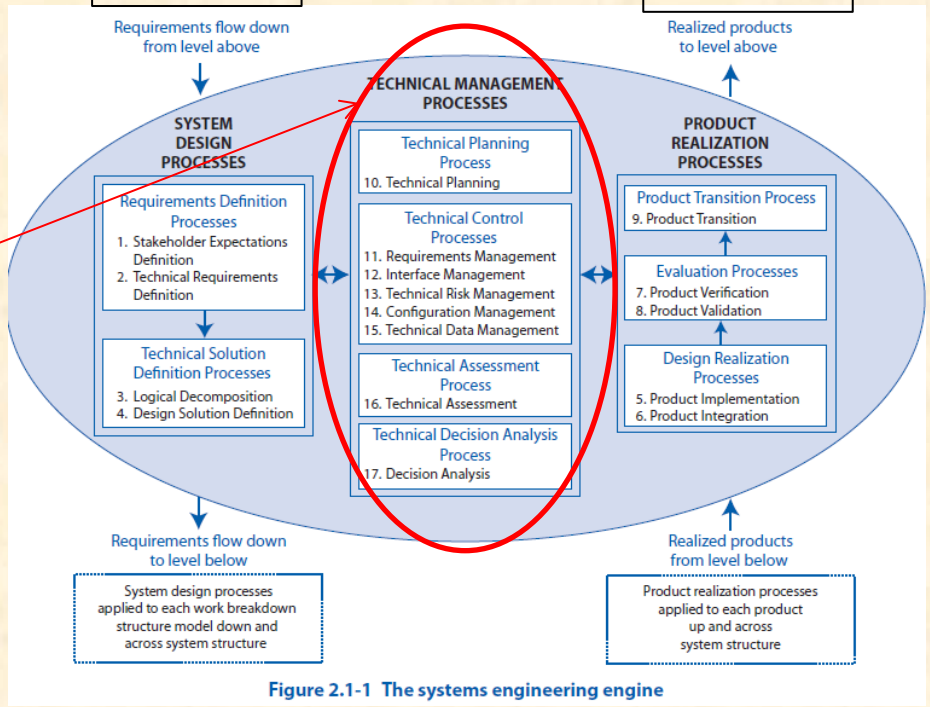

Figure 2.1-1 The systems engineering engine

The SE "Engine"

- Steps 1 through 9 indicated in Figure 2.1-1 represent the *tasks in execution of a project.*
- Steps 10 through 17 are *crosscutting tools for carrying out the processes*.

SE by NASA: Life Cycle Phases

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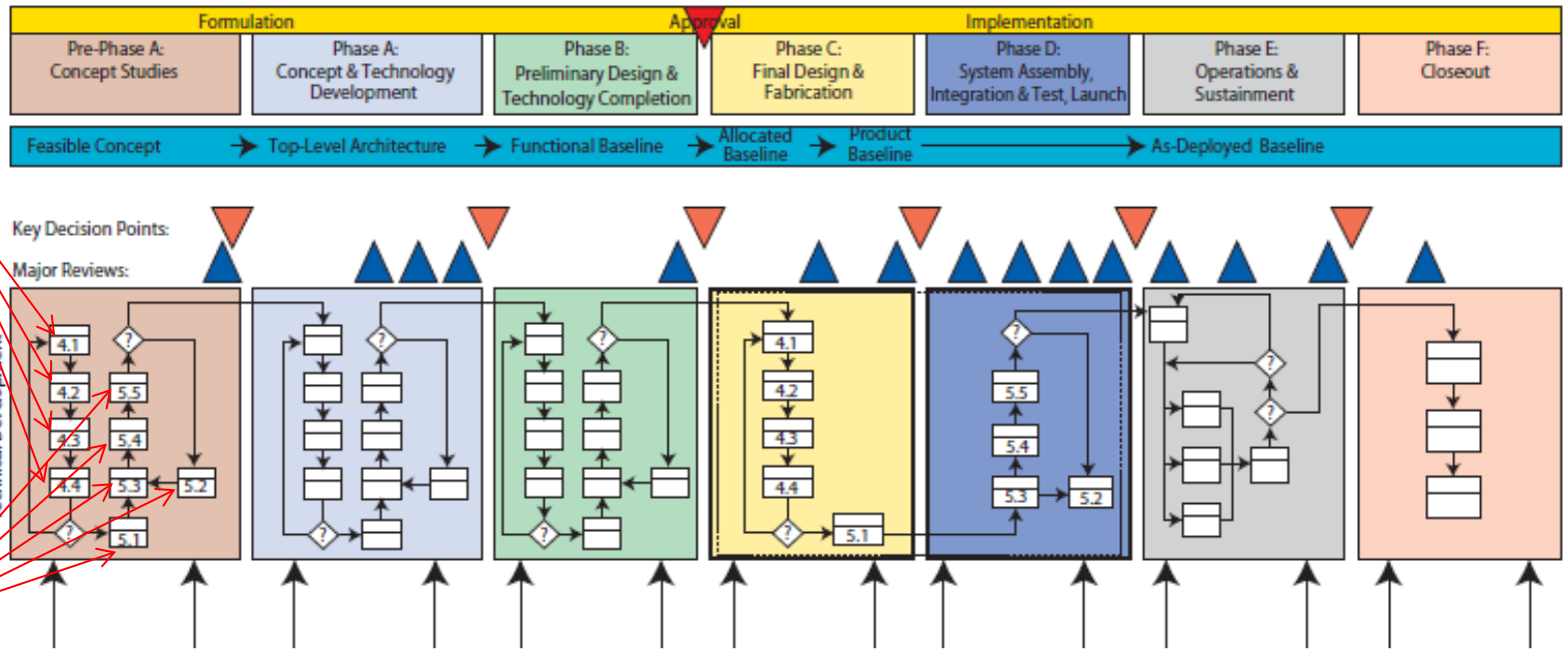

Figure 2.2-1 A miniaturized conceptualization of the poster-size NASA project life-cycle process flow for flight and ground systems accompanying this handbook

- Apply "steps 1 to 9" of the SE Engine to each "Phase" in the "Technical Development"

SE by NASA: Life Cycle Phases

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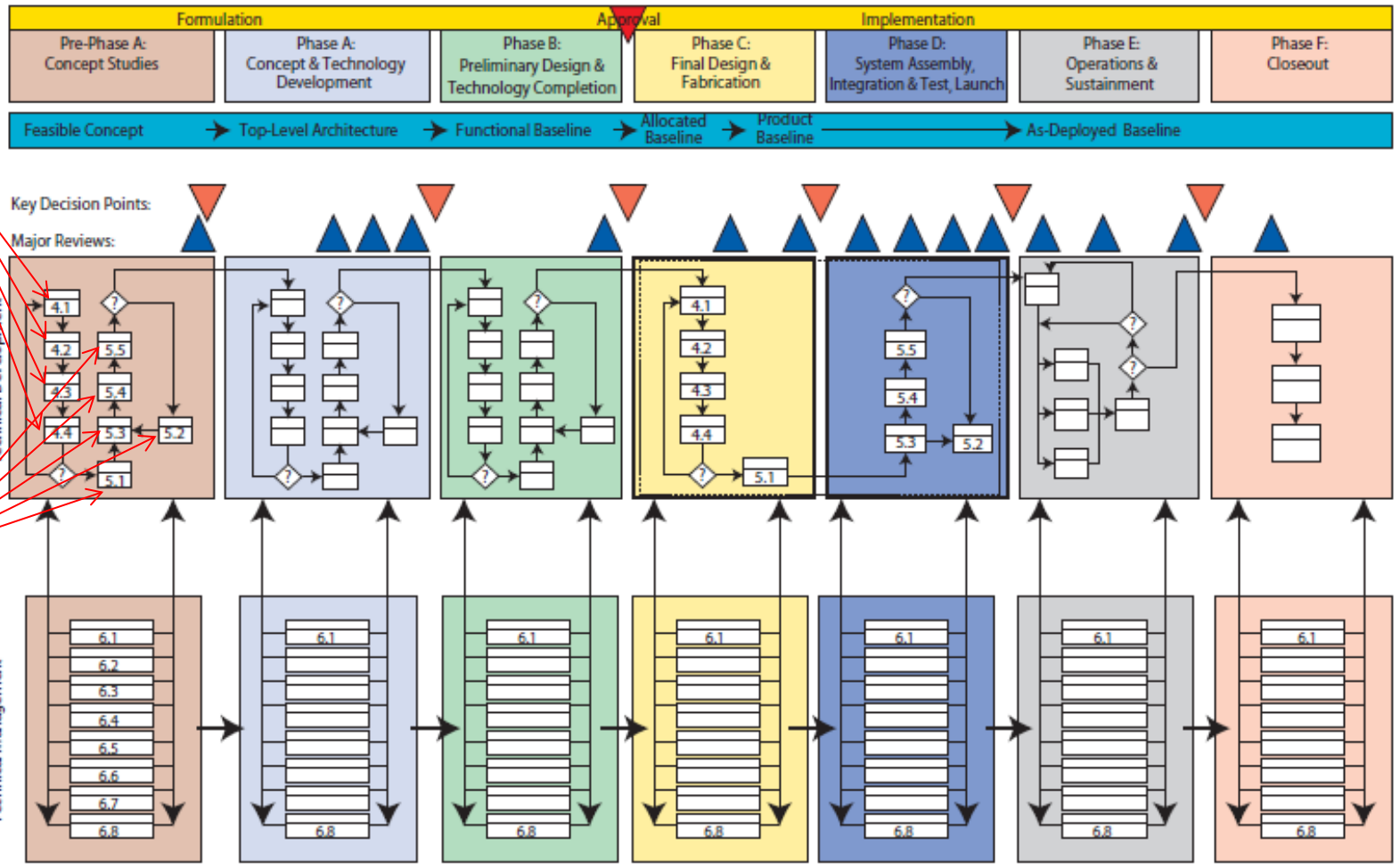

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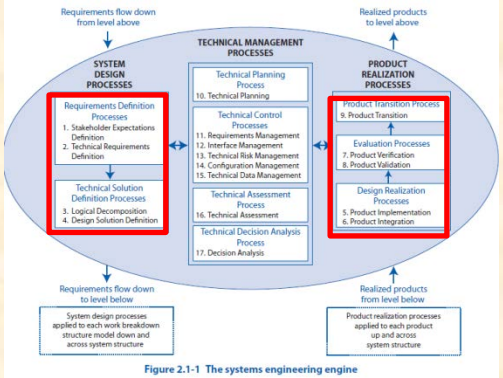
- Apply "steps 1 to 9" of the SE Engine to each "Phase" in the "Technical Development"
- Apply "steps 10 to 17" of the SE Engine to each "Phase" in the "Technical Management"

SE by NASA: Life Cycle Phases



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Apply "**steps 1 to 9**" of the SE Engine to ***each*** "Phase" in the "Technical Development"

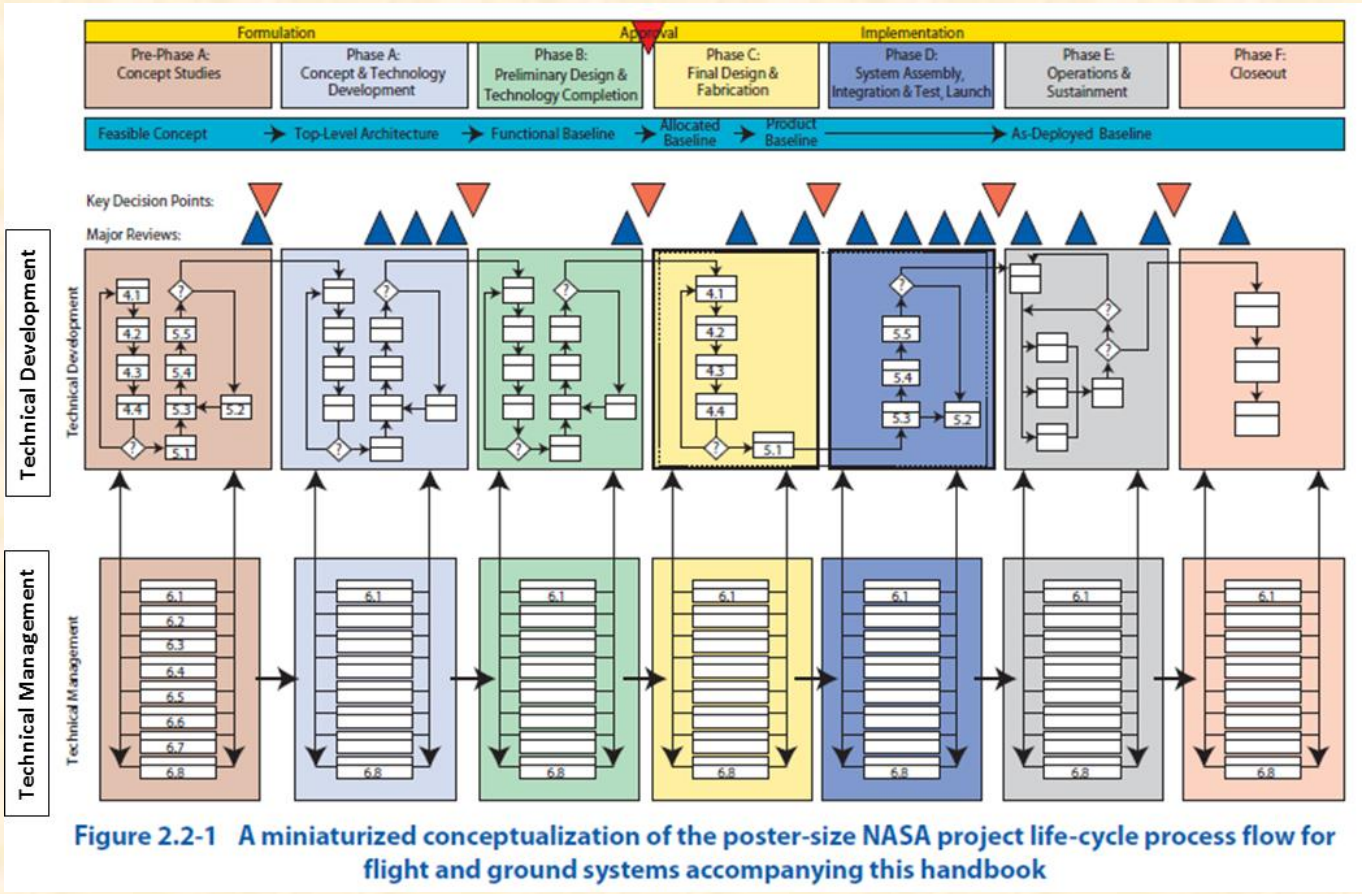

Figure 2.2-1 A miniaturized conceptualization of the poster-size NASA project life-cycle process flow for flight and ground systems accompanying this handbook

The SE Engine cycles five times from Pre-Phase A through Phase D

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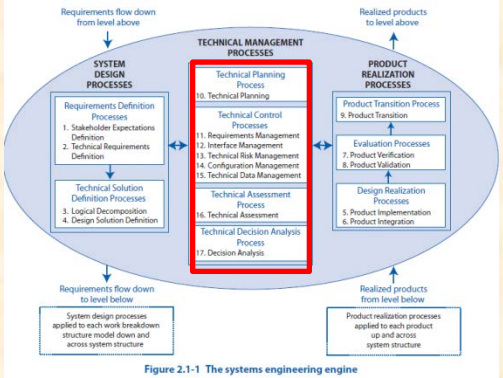


Figure 2.1-1 The systems engineering engine

Apply "**steps 10 to 17**" of the SE Engine to ***each*** "Phase" in the "Technical Development"

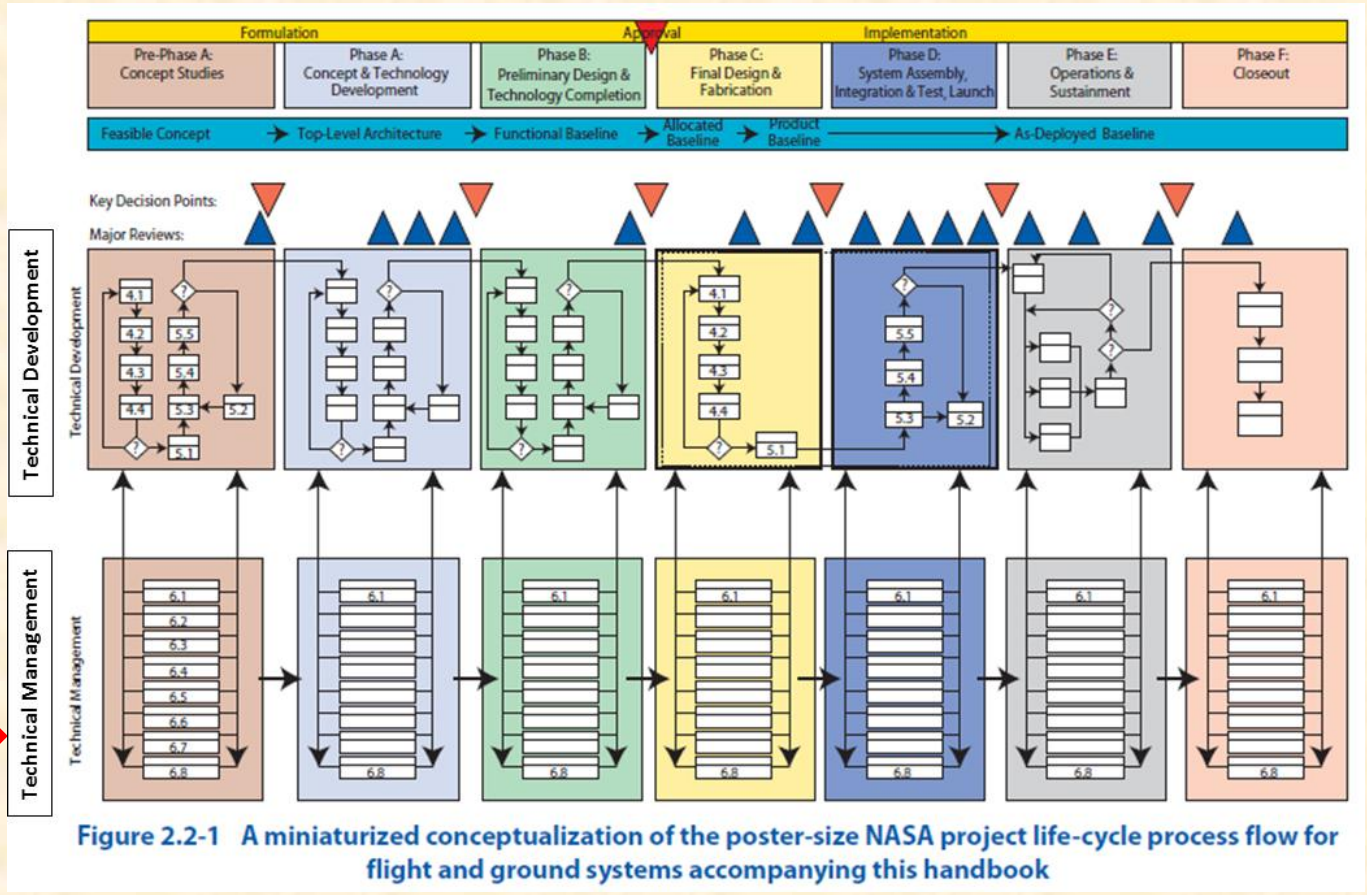


Figure 2.2-1 A miniaturized conceptualization of the poster-size NASA project life-cycle process flow for flight and ground systems accompanying this handbook

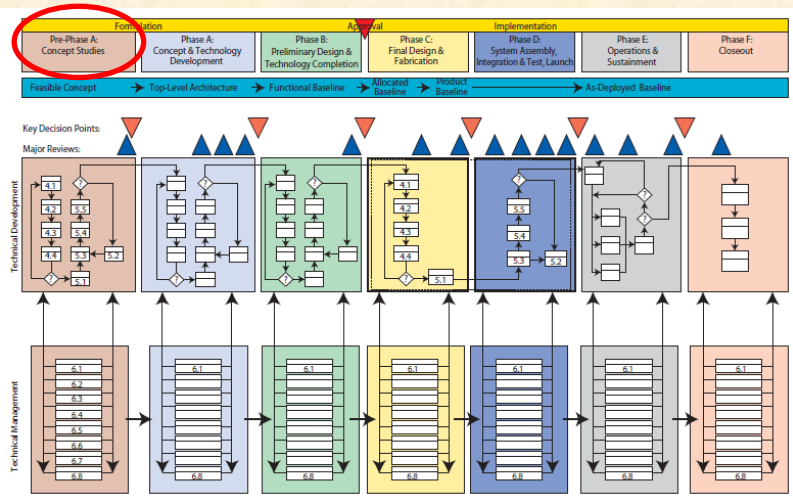
The SE Engine cycles seven times from Pre-Phase A through Phase D

SE by NASA: Life Cycle Phases

Table 2.3-1 Project Life-Cycle Phases

Phase	Purpose	Typical Output
Pre-Phase A Concept Studies	To produce a broad spectrum of ideas and alternatives for missions from which new programs/projects can be selected. Determine feasibility of desired system, develop mission concepts, draft system-level requirements, identify potential technology needs.	Feasible system concepts in the form of simulations, analysis, study reports, models, and mockups

Formulation



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SE by NASA: Life Cycle Phases

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Formulation	Phase A Concept and Technology Development	To determine the feasibility and desirability of a suggested new major system and establish an initial baseline compatibility with NASA's strategic plans. Develop final mission concept, system-level requirements, and needed system structure technology developments.	System concept definition in the form of simulations, analysis, engineering models, and mockups and trade study definition

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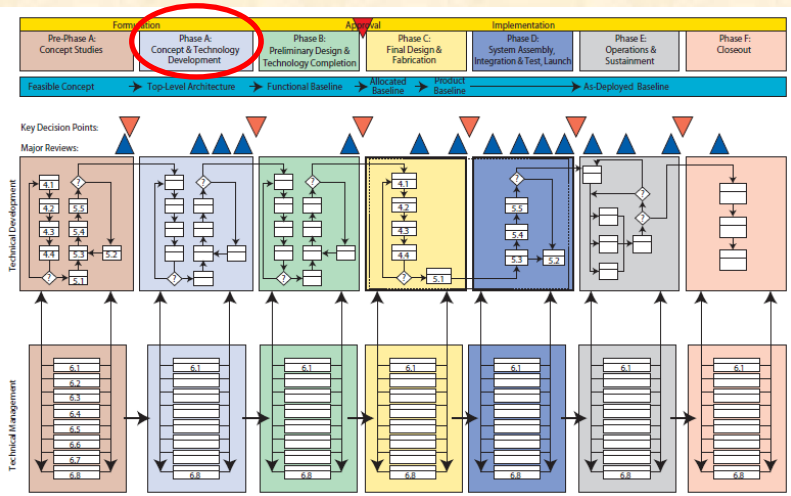

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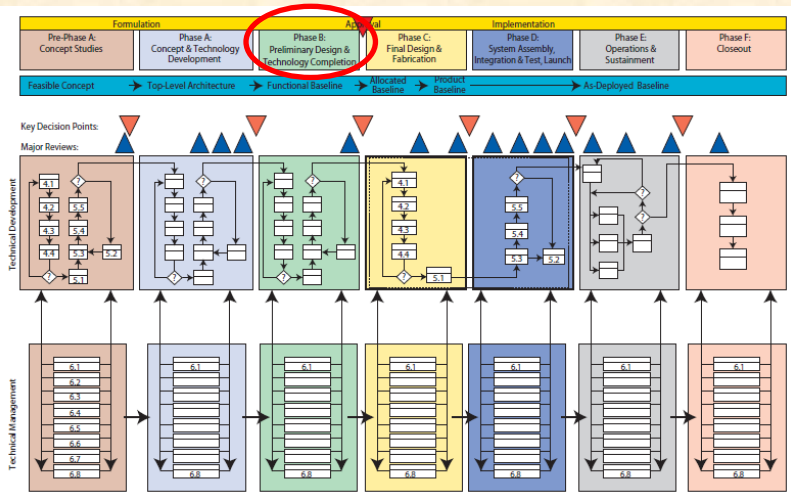
Formulation



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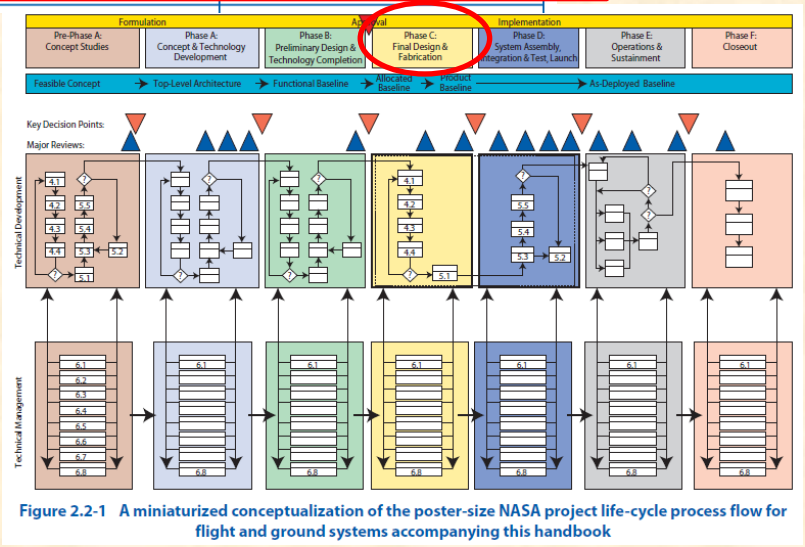
	Phase C Final Design and Fabrication	To complete the detailed design of the system (and its associated subsystems, including its operations systems), fabricate hardware, and code software. Generate final designs for each system structure end product.	End product detailed designs, end product component fabrication, and software development



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SE by NASA: Life Cycle Phases

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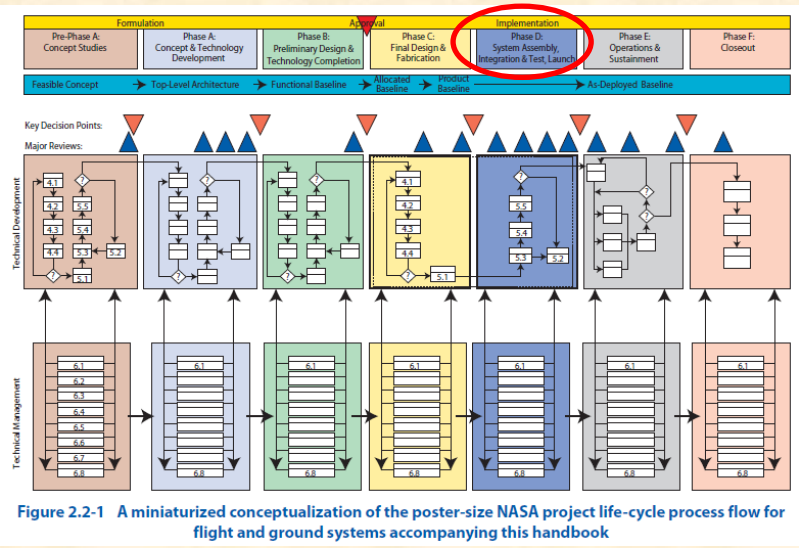
	Phase	Purpose	Typical Output
Implementation	Phase D System Assembly, Integration and Test, Launch	To assemble and integrate the products to create the system, meanwhile developing confidence that it will be able to meet the system requirements. Launch and prepare for operations. Perform system end product implementation, assembly, integration and test, and transition to use.	Operations-ready system end product with supporting related enabling products



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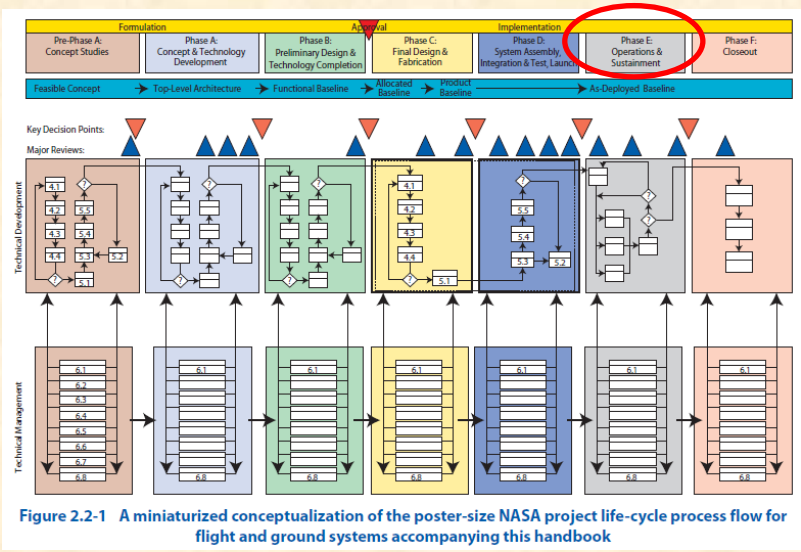
Implementation



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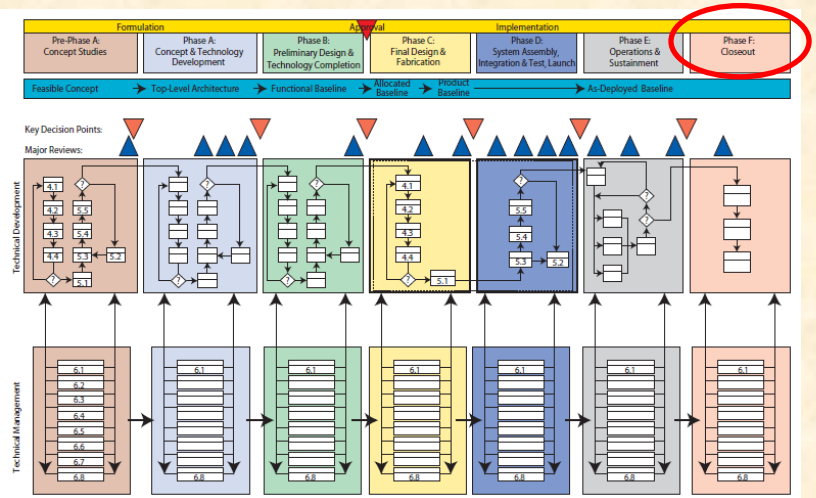
		Phase F Closeout	To implement the systems decommissioning/disposal plan developed in Phase E and perform analyses of the returned data and any returned samples.	Product closeout



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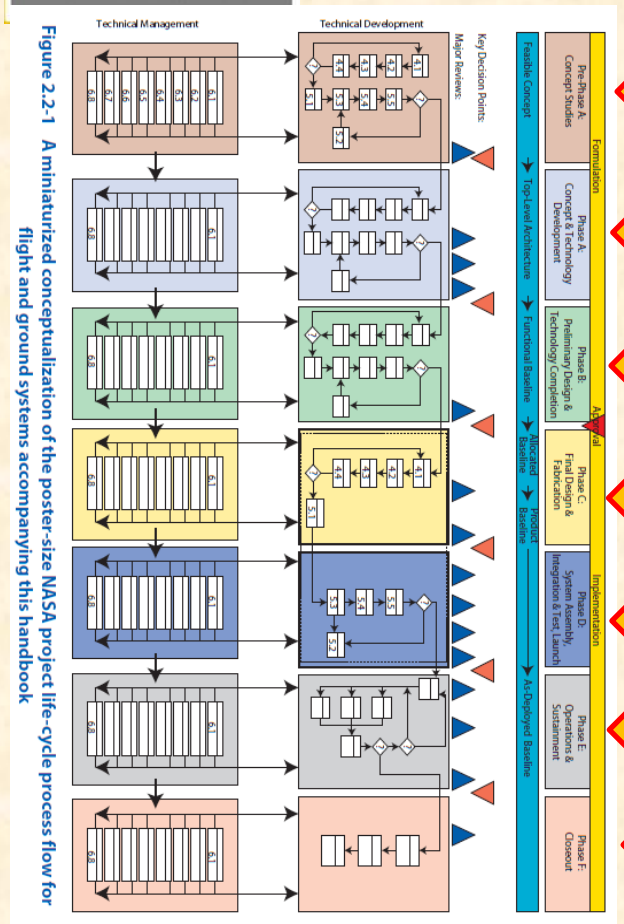

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