Project Life Cycle – The "V" Model within Construction

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Contents

Introduction

- Developed by NASA (60s)
  - Aerospace Projects
  - Performance and Reliability Problems
- Used for Software development
- Few applications in Construction

"V" Model - Concept

"This depiction is requirements-driven, and starts with identification of user requirements. When these are understood and agreed-to, they are then placed under project control, and through decomposition the system concepts and system specification are developed. The decomposition and definition process is repeated over and over until, ultimately, lines of code and piece parts are identified. Agreement is reached at each level, and the decisions are placed under project configuration management before proceeding to the next level. When the lowest level is defined, we move upward through the integration and verification process on the right leg of the Vee to ultimately arrive at the complete verified and validated system. At each level there is a direct correlation between activities on the left and right sides of the Vee – the rationale for the shape. Everything on the left and right legs of the Vee are sequentially placed under configuration control, and hence this has been designated the "core" of the Vee." (Forsberg and Mooz, 1998)

Principles and Objectives

- Iteration among disciplines and
- Decision gates
- High level of detail at the beginning
- Early involvement of the team
- Continuous improvement
- Change Control regimen
- Analysis (on the right) Synthesis (on the left)

- To reduce risk within the project
- Reduce Cycle Time
- To reduce uncertainty (may establish meaning for reduce waste in lean design)

The "V" Model

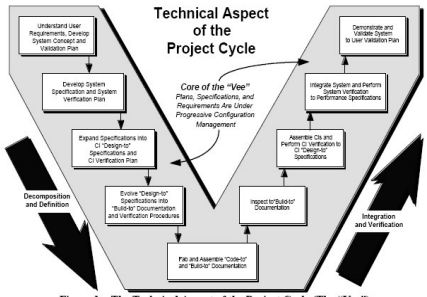
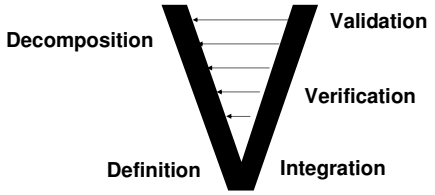


Figure 1 – The Technical Aspect of the Project Cycle (The "Vee")

Source: Forsberg and Mooz (1998)

The "V" Model



Concepts

- **Decomposition**: the hierarchical functional and physical partitioning of the system (Forsberg et al., 1996)
- **Definition**: documentation that defines the functional and physical content of each entity (Forsberg et al., 1996)

Concepts

- **Integration**: the successive **combining** and **testing** to demonstrate the performance and compatibility (Forsberg et al., 1996)
- **Verification**: the process of determining that the system meets all specified requirements and survives its intended environment (Forsberg et al., 1996)
  - **Validation**: is the process of demonstrating (as opposed to proving) that the product satisfies the user needs, regardless of what the system specifications require (Forsberg et al., 1996)

Development Approaches

- **Evolutionary Development**

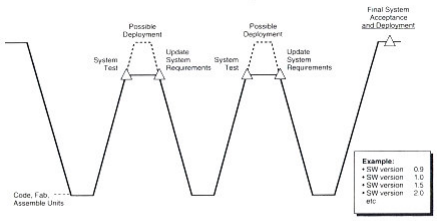


FIGURE 6.8 Evolutionary development: used for incomplete requirements—incremental releases.

Source: Forsberg and Mooz (1998)

Development Approaches

- **Incremental Development (One product in the end)**

All requirements can be specified up front, but incremental development is desired, resulting in either a single or incremental delivery.

Baselines Control gates: agreement between costumer and provider to proceed:

technical issues
business issues

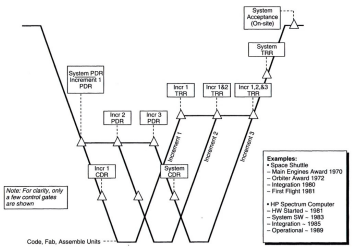


FIGURE 6.9 Incremental development—single delivery.

Source: Forsberg and Mooz (1998)

Development Approaches

- **Incremental Development (multiple products in the end)**

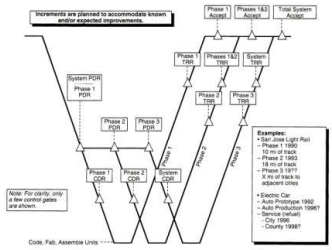


FIGURE 6.10 Incremental development—incremental delivery.

Source: Forsberg and Mooz (1998)

The Ancient Method of Analysis and Synthesis

- **Six features within the ancient method of Analysis and Synthesis**
  - **The starting and end points of analysis qualitatively different**
  - **Unity of two directions of inferences: backwards for solution and forwards for proof**
    - **Regressive inferences: analysis (resolution)**
    - **Inferences forwards: synthesis (composition)**
  - **Does not ensure that the solution can be found: iterative**
  - **Two types of analysis: theoretical and problematical**
  - **Decompositional (configurational) analysis**
  - **Transformative (interpretive) analysis**

Analysis and Synthesis within the "V" Model

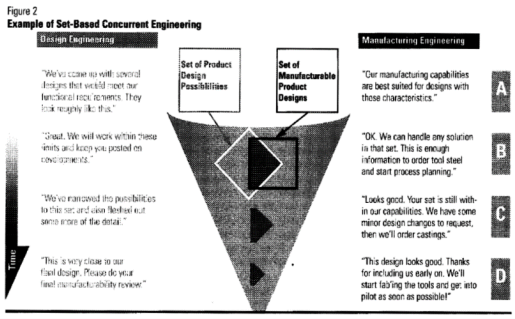
"This depiction is requirements-driven, and starts with identification of user requirements. When these are understood and agreed-to, they are then placed under project control, and through **decomposition** the system concepts and system specification are developed. The decomposition and definition process is **repeated over and over** until, ultimately, lines of code and piece parts are identified. Agreement is reached at **each level**, and the decisions are placed under project configuration management before proceeding to the next level. When the lowest level is defined, we **move upward** through the integration and verification process on the right leg of the Vee to ultimately arrive at the **complete verified** and **validated system**. At each level there is a direct correlation between activities on the left and right sides of the Vee – the rationale for the shape. Everything on the left and right legs of the Vee are sequentially placed under configuration control, and hence this has been designated the "core" of the Vee." (Forsberg and Mooz, 1998)

Project Life Cycle Models

- **Set-Based Concurrent Engineering – Toyota's "V"**
  - **1. Map the design space**
    - **Define feasible regions**
    - **Explore trade-offs by designing alternatives**
    - **Communicate sets of possibilities**
  - **2. Integrate by Intersection**
    - **Look for intersections of feasible sets**
    - **Impose minimum constraint**
    - **Seek conceptual robustness**
  - **3. Establish feasibility before commitment**
    - **Narrow sets gradually while increasing detail**
    - **Stay within sets once committed**
    - **Control by managing uncertainty at process gates**

Source: Sobek et. all (1999)

Set-Based Concurrent Engineering



Source: Sobek et. all (1999)

Process Protocol – "Left leg of the V"

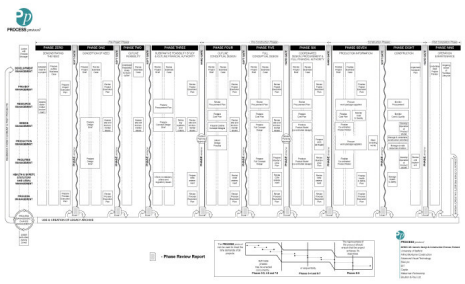
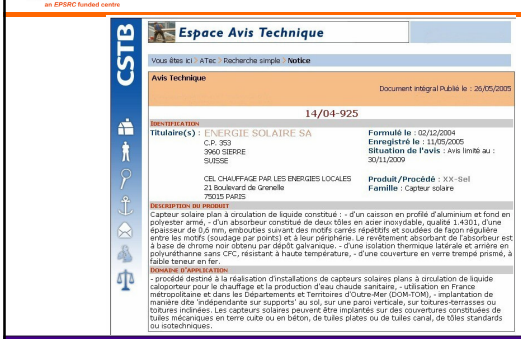


Figure 6.1. The Generic Design and Construction Process Protocol Model

Source: www.processprotocol.com

Avis Technique – "Right leg of the V"



Source: www.cstb.fr

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Lessons

- The application of the "V" model should be investigated in Construction;
- Testing should be considered more systematically in Construction Project Life Cycle
- To reduce uncertainty may establish meaning for waste reduction in Lean Design

EPSRC Engineering and Physical Sciences Research Council

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Thank you!!!

Q & A

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