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Brownfield Systems Development: Moving from the Vee Model to the N Model for Legacy Systems



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Topics

- **Purpose/Introductions**
- Definitions
- Greenfield Systems Development and the “Vee”
- Brownfield Systems Development and the “N”
- Examples of N Model Usage
- Wrap-up/Summary

Purpose/Introductions

- Most systems engineering standards, references, and textbooks consider systems development from a “**greenfield**” (i.e., clean-sheet, new development) perspective. (ISO/IEC/IEEE 15288, 2015) (INCOSE SEHv4, 2015)
- There are several development (or life cycle) models used for greenfield developments, with the “**Vee**” **model** being a popular choice. (Rook, 1986) (Forsberg, et al., 2005)
- Many development efforts are better considered from a “**brownfield**” perspective (i.e., improving upon or replacing legacy systems). (Baley and Belcham, 2010) (Seacord et al., 2003)
- This paper proposes an extension of the Vee model, called the **N model**, which adds a site survey and various reconstruction processes to help move from the as-is system to the to-be system for brownfield development efforts.

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Greenfield vs. Brownfield

“**Greenfield** land is undeveloped land in a city or rural area either used for agriculture, landscape design, or left to evolve naturally.”



“**Brownfield** land means places where new buildings may need to be designed and erected considering the other structures and services already in place.”
“The land may be contaminated ... and has the potential to be reused once it is cleaned up.”



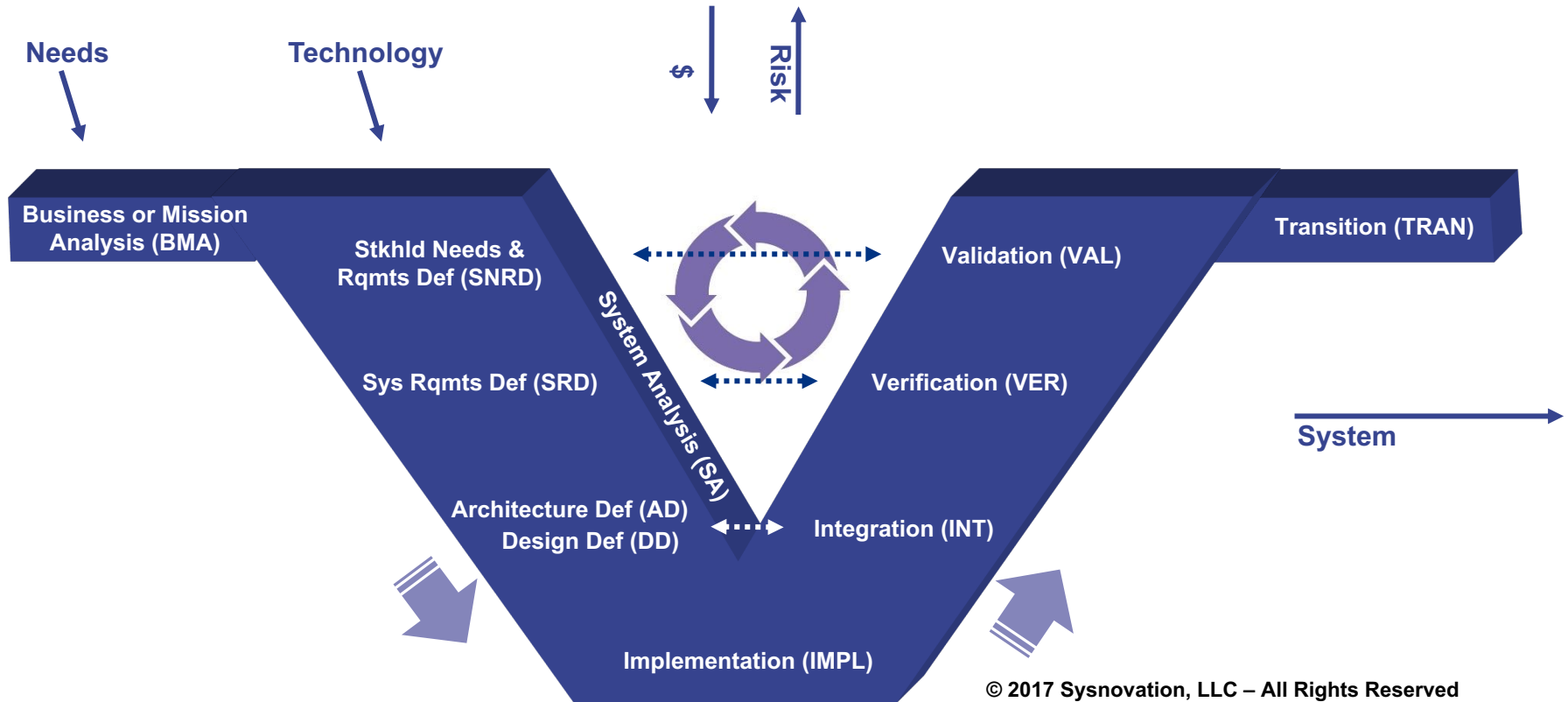
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Greenfield Systems Engineering

- Usually have no or limited legacy system constraints, other than system interfaces.
- Typically have no, or limited, continuity considerations.
- Also known as “clean-sheet” systems engineering.

V - The “Vee” Model



Pros and Cons of the Vee Development Model

- Pros:

- Depicts top-down definition and bottom-up realization
- Shows the horizontal relationship between definition and realization
- Well-defined phases
- Well-defined handoffs between phases
- Most suitable for projects of moderate complexity in familiar domains

- Cons:

- Reflects a serial view of projects similar to the Waterfall model
- Not easy to account for feedback or changes in the up-front information (need to go “off the Vee”)
- Required abstraction to multiple Vee instances for each level of the system hierarchy

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Brownfield Systems Engineering

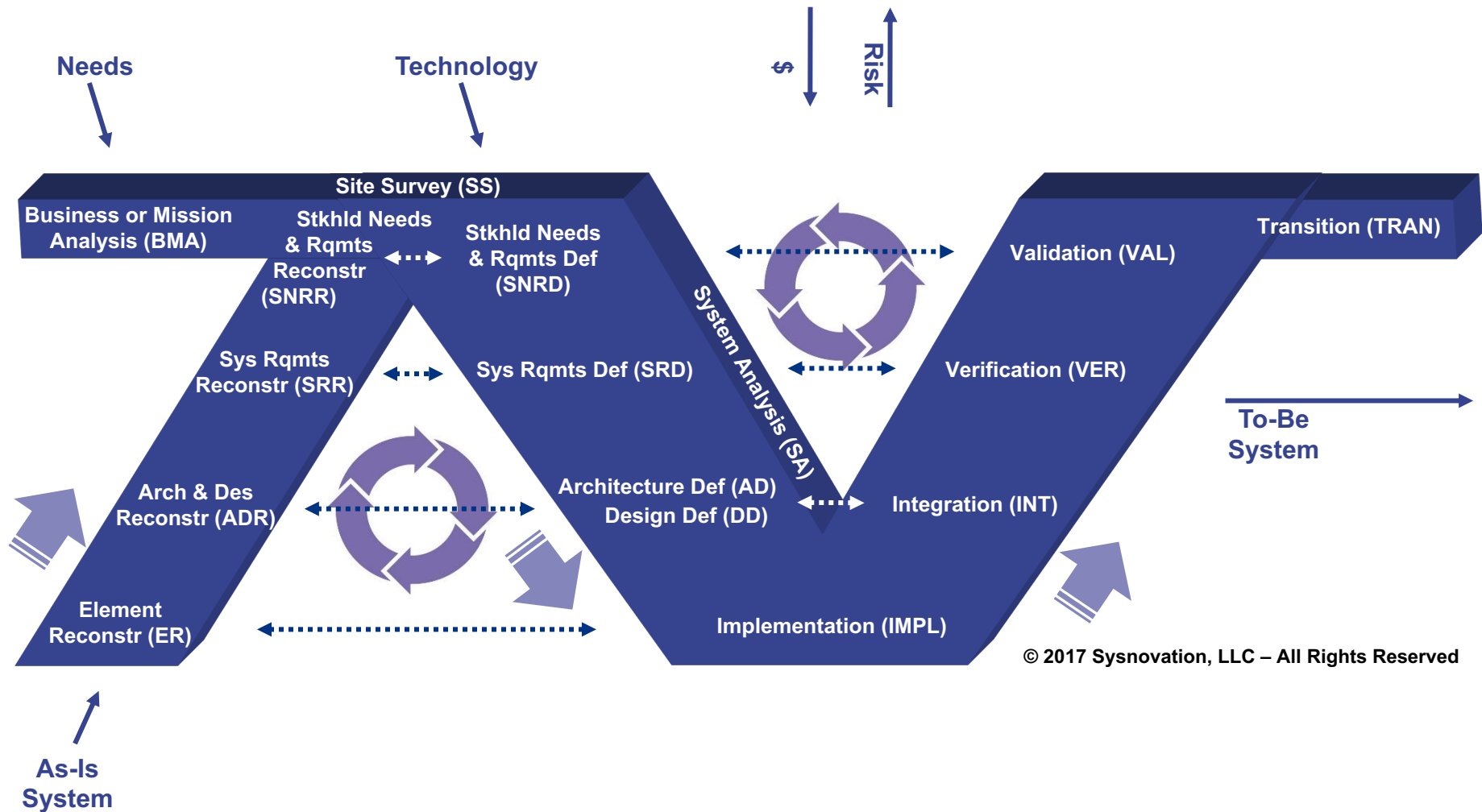
- Usually involve significant modification, extension, or replacement of an existing system in an existing environment.
- Typically have explicit continuity requirements.
- A key aspect of brownfield development efforts is moving from the “as-is” initial legacy system to the “to-be” updated legacy system
- Also known as “legacy” or “in-service” systems engineering.

**“Brownfield is much, much harder than Greenfield, whether [systems] or house remodeling.”
Fred Brooks**

Drivers for Brownfield

Reason for Change	Description
Perfective	<ul style="list-style-type: none">• Changes made to improve the system• Also called enhancements• Represents approximately 48% of changes
Adaptive	<ul style="list-style-type: none">• Changes made to keep pace with changing environments• Represents approximately 29% of changes
Corrective	<ul style="list-style-type: none">• Changes made to repair defects in the system• Represents approximately 19% of changes
Preventive	<ul style="list-style-type: none">• Changes made to improve future maintainability and proactively seek to simplify future evolution• Represents approximately 4% of changes

N – The “N” Model for Brownfield



Pros and Cons of the N Development Model

- Pros:

- Adds up-front site survey & as-is system reconstruction activities
- Depicts bottom-up reconstruction, top-down definition, and bottom-up realization
- Shows the horizontal relationship between reconstruction and definition and realization
- Well-defined phases
- Well-defined handoffs between phases
- Most suitable for Brownfield projects of moderate-to-high complexity in familiar domains

- Cons:

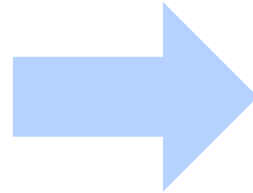
- Reflects a serial view of projects similar to the Waterfall and Vee models
- Not easy to account for feedback or changes in the up-front information (need to go “off the N”)
- Required abstraction to multiple N instances for each level of the system hierarchy

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Example 1

Minor Feature Updates with Mature SE

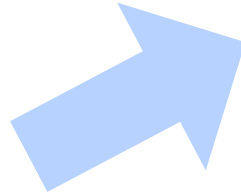


Example 2

System Replacement Updates with Immature SE



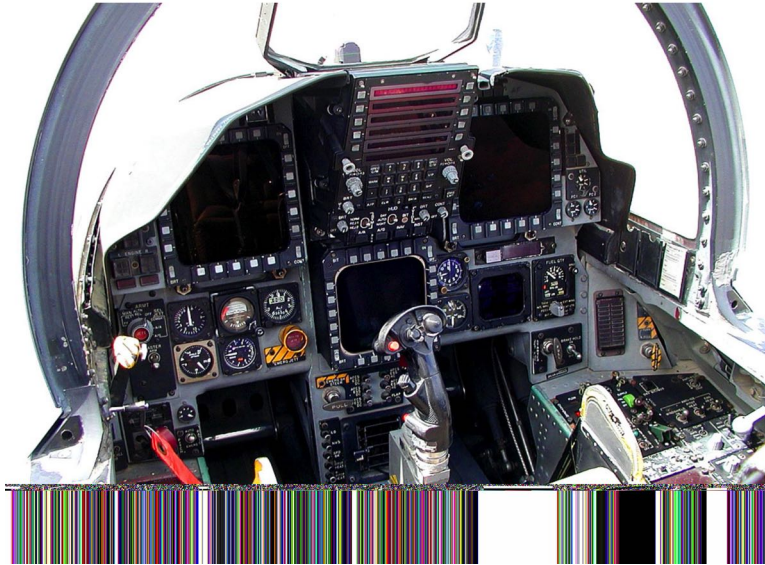
Albatross



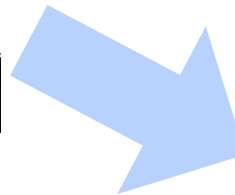
Eagle

Example 3

Major Updates by a Different Organization



F-123



F-123+



Photo Source: worldwarwings.com)

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Wrap-up/Summary

- This paper proposed an extension of the Vee model, called the N model, which adds a site survey and various reconstruction process areas to help move from an as-is system to a to-be system in brownfield development efforts.
- Three examples were provided to demonstrate how the N model can be applied in different situations.
- Topics for future research have also been identified (see paper).

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Comments?
Questions?



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