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Seilevel

What do the terms Verification and Validation really mean?

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Lou Wheatcraft
louw@reqexperts.com
www.reqexperts.com/blog

RequirementsExperts
Training and Services for Project Success

Lou Wheatcraft

- Senior Product Manager for Seilevel/Requirements Experts (RE)
- Has taught over 190 requirement seminars over the last 18 years.
- 22 years in the US Air Force
- Heavy involvement in space systems (DoD launch vehicles and spacecraft, NASA Space Shuttle, International Space Station)
- Worked in the Astronaut Office at Johnson Space Center for 6 years.
- Works with both government and industry clients.
- Chair of the INCOSE Requirements Working Group
- Member of PMI, the Software Engineering Institute (SEI), the World Futures Society, International Institute of Business Analysis (IIBA), and the National Honor Society of Pi Alpha Alpha.
- Has a BS degree in Electrical Engineering, MA degree in Computer Information Systems, MS degree in Environmental Management, and has completed the course work for an MS degree in Studies of the Future
- Author of numerous papers and presentations concerning requirement development and management
- Is the primary contributor to RE's blog on requirements best practices. The blog can be assessed at: http://www.reqexperts.com/blog .

Background

The terms verification and validation:

- **are often used interchangeably**
- **the meaning of the concepts are often misunderstood**
- **the context of their use is not made clear (requirement, design, or product)**
- **both terms are ambiguous unless a modifier is included in front of the word**
- **both terms can refer to either an activity or a process**

This presentation addresses the use of the terms verification and validation and identifies their various meanings in terms of the context in which they are used.

IV&V??????

- **What is the difference between:**
  - IV&V (as defined by INCOSE SE HB)
  - IV&V (as defined by NASA SE HB)

INCOSE SE HB v4

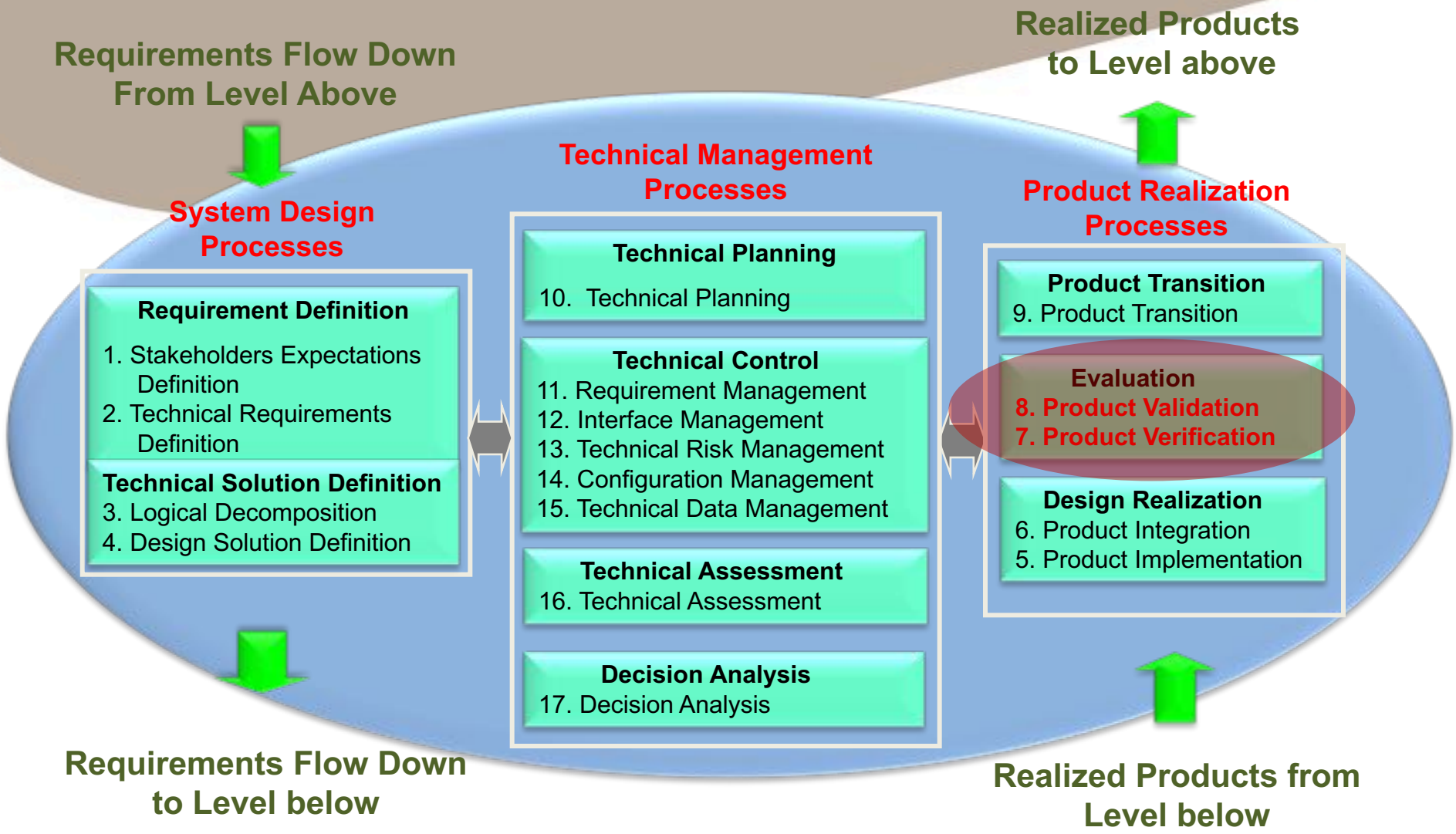
Verification process—Evidence is provided that the system, the system elements, and the work products in the life cycle meet the specified requirements.

- Provide objective evidence that a system or system element fulfils its specified requirements and characteristics.
- Ensure that the "product is built right,"
- Can verify a requirement, architecture, design, or system.

Validation process—Evidence is provided that the system, the system elements, and the work products in the life cycle will achieve their intended use in the intended operational environment.

- Provide objective evidence that the system fulfills its business or mission objectives and stakeholder requirements, achieving its intended use in its intended operational environment.
- Ensure that the "right product is built."
- Can validate a requirement, architecture, design, or system.

NASA Systems Engineering Engine



System Design Processes applied to each product layer down through system structure

Product Realization processes applied to each product layer up through system structure

From SE NPR 7123.1B

ISO/IEC 15288 (2015)

Verification: "confirmation, through the provision of objective evidence, that specified requirements have been fulfilled [ISO 9000: 2000]

- set of activities that compares a product of the system life cycle against the required characteristics for that product.
- This may include, but is not limited to, specified requirements, design description, and the system itself."

Validation: "confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled [ISO 9000: 2000]

- set of activities ensuring and gaining confidence that a system is able to accomplish its intended use, goals and objectives."

CMMI® for Development, Version 1.3

Verification:

- The purpose of Verification is to ensure that selected work products meet their specified requirements.
- Includes verification of the product and intermediate work products against all selected requirements, including customer, product, and product component requirements.
- Is inherently an incremental process because it occurs throughout the development of the product and work products, beginning with verification of requirements, progressing through the verification of evolving work products, and culminating in the verification of the completed product.

CMMI® for Development, Version 1.3

Validation:

- Demonstrate that a product or product component fulfills its intended use when placed in its intended environment.
- Validation activities can be applied to all aspects of the product in any of its intended environments, such as operation, training, manufacturing, maintenance, and support services.
- The work products (e.g., requirements, designs, prototypes) should be selected on the basis of which are the best predictors of how well the product and product component will satisfy end user needs and thus validation is performed early (concept/exploration phases) and incrementally throughout the product lifecycle (including transition to operations and sustainment).

PMBOK Definitions

Verification: The evaluation of whether or not a [*process*], product, service, or system complies with a regulation, requirement, specification, or imposed condition.

Validation: The assurance that a [*process*], product, service, or system meets the needs of the customer and other identified stakeholders.

PMBOK Definitions

- **Control Quality**: The process of monitoring and recording results of executing the quality activities to assess performance and recommend changes.
  - Validating that project deliverables and work meet the requirements specified by key stakeholders necessary for final acceptance
  - Verify that the delivered output will meet the requirements
  - Used during the project executing and closing phases to formally demonstrate, with reliable data, that the sponsor and/or customer's acceptance criteria have been met.

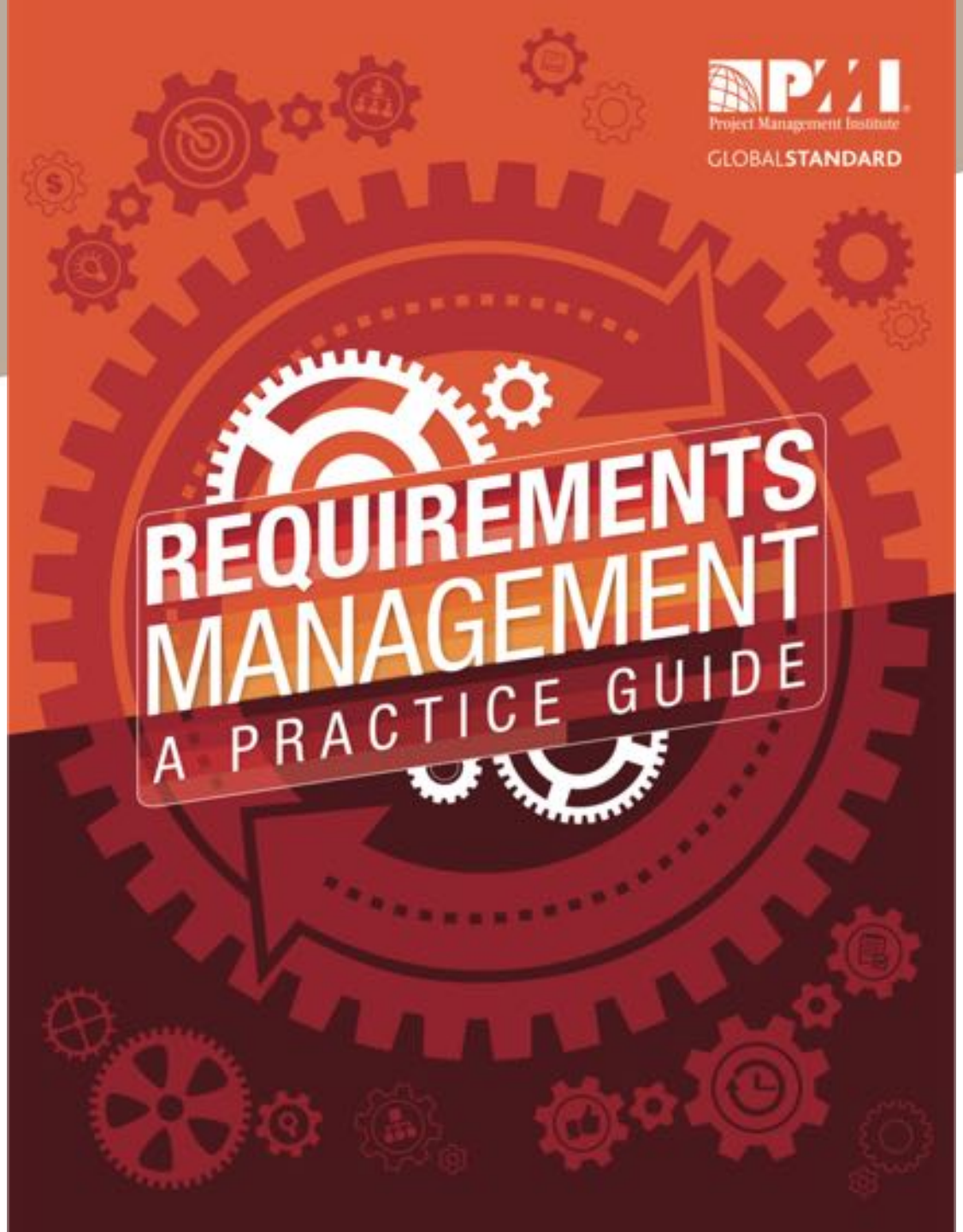
PMBOK Definitions

- **Verify Scope (4th edition):** The process of formalizing acceptance of the completed project deliverables.
- **Validate Scope (5th edition):** The process of formalizing acceptance of the completed project deliverables.
  - Increases the chance of the final project, service, or result acceptance by validating each deliverable
  - Assumes verified deliverable: Completed project deliverables that have been checked and confirmed for correctness through the **Control Quality** process

- Change made to add emphasis that this process is not solely about accepting deliverables but validating the deliverables will deliver value to the business and and confirms the deliverables, as provided will fulfill the project objectives, as well as their intended use to the project stakeholders *[in the operational environment].*

PMBOK Definitions

- **Control Quality** is primarily concerned with the correctness of the deliverables and meeting the quality requirements specified for the deliverables.
- **Validate Scope** is primarily concerned with acceptance of the deliverables


PMI
Project Management Institute
GLOBALSTANDARD
REQUIREMENTS MANAGEMENT
A PRACTICE GUIDE

PMI Requirements Management – A Practice Guide

- **Solution Evaluation:** the domain of the business analysis concerned with the activities performed to validate a solution that is about to be or that has already been implemented.
  - Determines how well a solution meets the business needs expressed by the stakeholders
  - Testing, analysis, and other means are used to demonstrate:
    - The agree-upon requirements have been met (solution verification) – "Did we do it correctly?"
    - The suitability of the solution for its intended purpose (solution validation) – "Did we do the right thing?"

PMI Requirements Management – A Practice Guide

- **Requirement verification:** the process of reviewing requirements to ensure the requirements are constructed properly and are error free.
  - Requirements are compared to a set of requirement quality characteristics which serve as a guideline for writing high quality requirements.
- **Requirement validation:** the process used to evaluate that all requirements accurately reflect the intent of the stakeholder, thereby ensuring requirements meet stakeholder expectations.

ISO/IEC FDIS 29148 (2011)

***Requirements verification**:*

- Confirmation by examination that requirements (individually and as a set) are well formed
- This means that a requirement or a set of requirements has been reviewed to ensure the characteristics of good requirements are achieved.

***Requirements validation**:*

- confirmation by examination that requirements (individually and as a set) define the right system as intended by the stakeholders.

CFR Title 21 FDA: PART 820 Quality System Regulation

- ***Design input:*** The physical and performance requirements of a device that are used as a basis for device design.
  - Each manufacturer shall establish and maintain procedures to ensure that the design requirements relating to a device are appropriate and address the intended use of the device, including the needs of the user and patient.
  - The procedures shall include a mechanism for addressing incomplete, ambiguous, or conflicting requirements.

Design Requirements = Design-to (what) requirements

CFR Title 21 FDA: PART 820 Quality System Regulation

- ***Design output:*** The results of a design effort at each design phase and at the end of the total design effort.
  - Each manufacturer shall establish and maintain procedures for defining and documenting design output in terms that allow an adequate evaluation of conformance to design input requirements.
  - Design output procedures shall contain or make reference to acceptance criteria and shall ensure that those design outputs that are essential for the proper functioning of the device are identified.

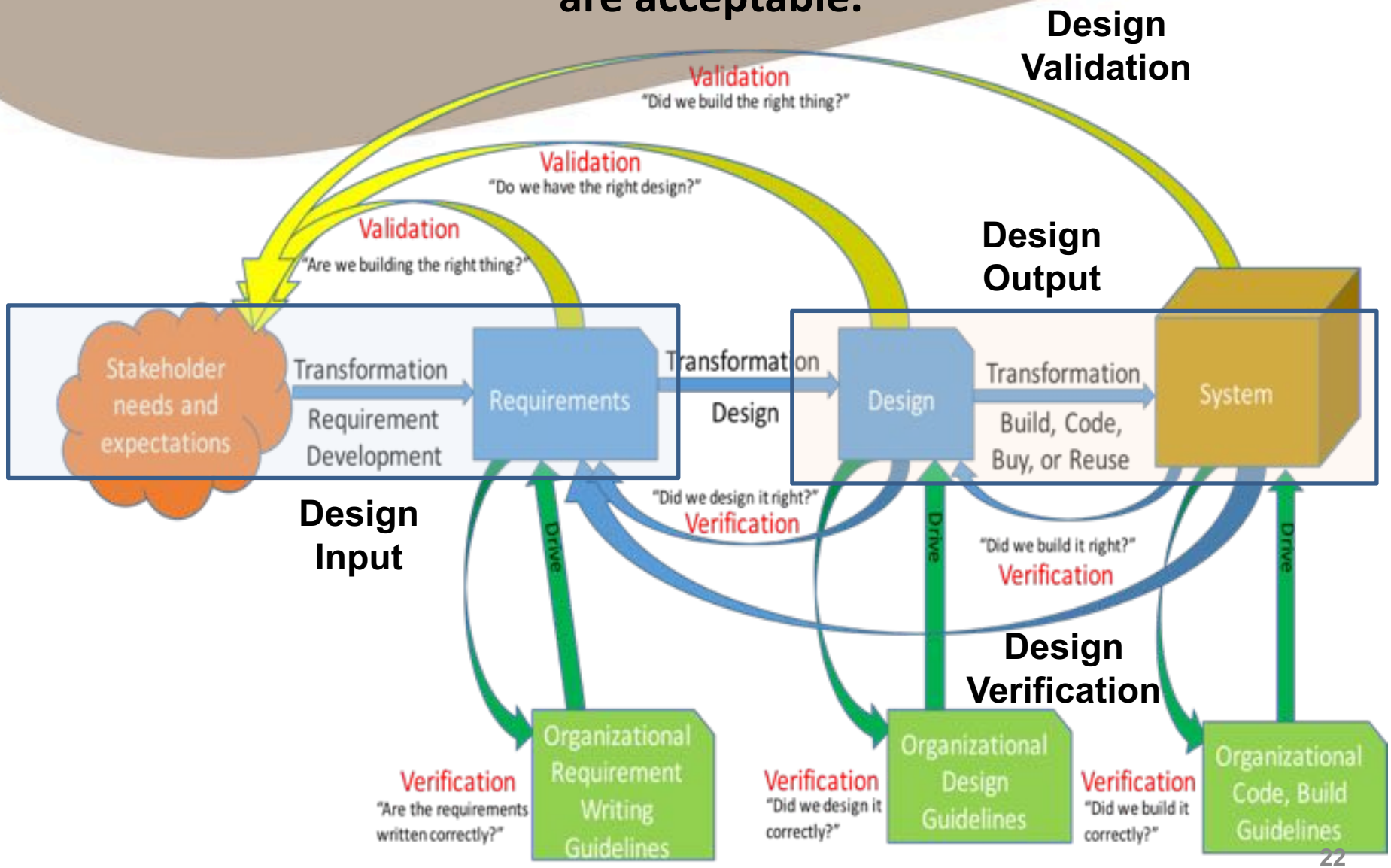
CFR Title 21 FDA: PART 820 Quality System Regulation

- ***Verification:*** means confirmation by examination and provision of objective evidence that specified requirements have been fulfilled**.**
- ***Design verification****:* Each manufacturer shall establish and maintain procedures for verifying the device design.
  - Design verification shall confirm that the design output meets the design input requirements.

CFR Title 21 FDA: PART 820 Quality System Regulation

- ***Validation:*** means confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use can be consistently fulfilled.
- ***Design validation:*** means establishing by objective evidence that device specifications conform with user needs and intended use(s).
  - Each manufacturer shall establish and maintain procedures for validating the device design.
  - Design validation shall be performed under defined operating conditions on initial production units, lots, or batches, or their equivalents.
  - Design validation shall ensure that devices conform to defined user needs and intended uses and shall include testing of production units under actual or simulated use conditions.

Verification and validation are the processes of confirming that artifacts generated during the transformation processes are acceptable.



Verification levels

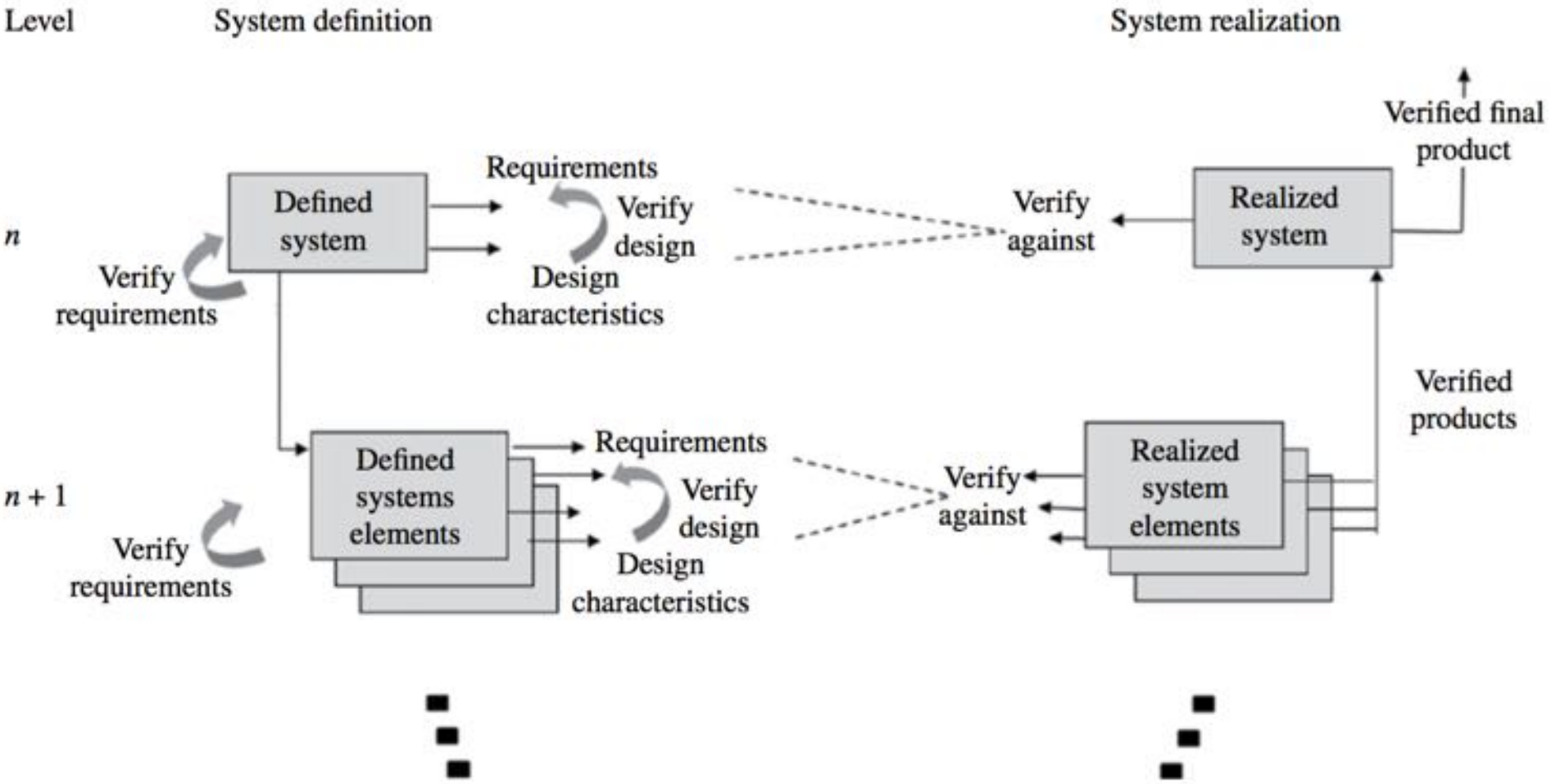
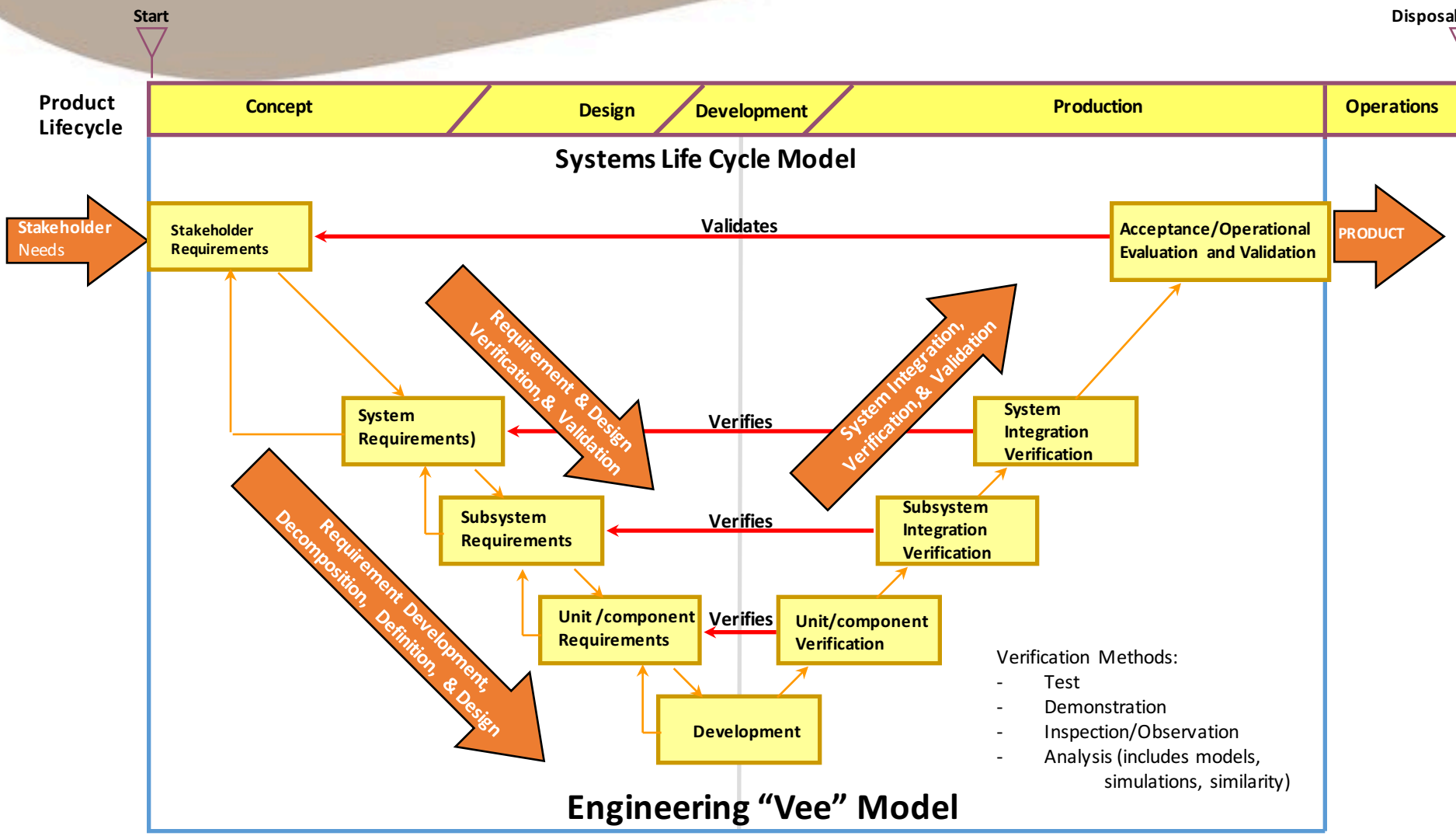


FIGURE 4.15 Verification level per level. Reprinted with permission from Alain Faisandier. All other rights reserved.

Systems Engineer “V” Model



For more detailed information, sign the sign-in sheet and I will send you a copy of the paper”

“On the Use of the Terms Verification and Validation”

from which this presentation was derived.

I will also send you a copy of my paper:

“Thinking Ahead to Verification and Validation”