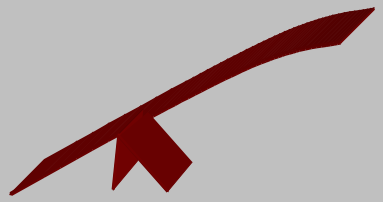


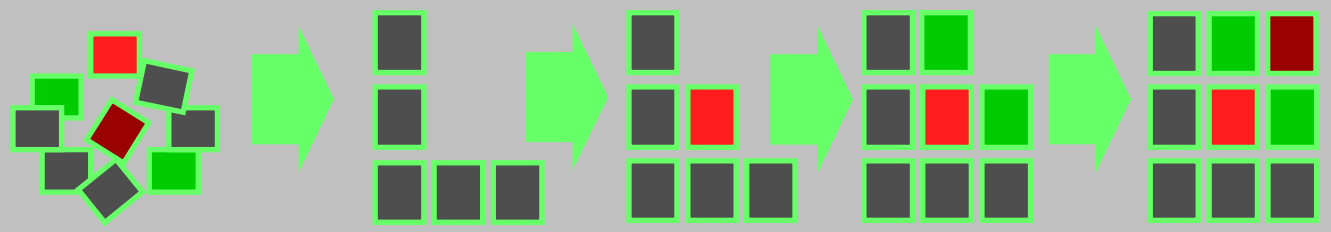
Product Integration Verification Validation

Product Integration Purpose

- Assemble the product from the product components, ensure the product, as integrated, functions properly and deliver the product.

Product Integration Overview

- Product integration may be thought of as a one-time assembly of the product components at the conclusion of design phase but it is generally conducted incrementally
- Product Integration addresses the integration of product components into more complex components or into complete products



Integration Strategy

- The basis for effective product integration is an integration strategy that uses combinations of techniques in an incremental manner
  - An integration strategy should be developed early in the project, concurrently with product development plans and specifications
  - The integration plan should identify a sequence for receipt, assembly, and activation of the various components that make up the product

Integration Strategy - 2

- Establishing the product integration strategy including the following:
  - Integration sequence
  - Work to be done
  - Responsibilities for each activity
  - Resources required
  - Schedule to be met
  - Procedures to be followed
  - Tools required
  - Environment
  - Personnel skills

Integration Strategy - 3

- Review the integration strategy with developers and test and integration teams to confirm its feasibility and revise as necessary
- Document and place under control the rationale used for decisions made and deferred
- Assess the integration strategy on a continuing basis

Considerations for Integration Test Planning

- What modules should be integrated first?
- How many modules should be integrated before integration testing starts?
- What order should be used to integrate the modules?
- Should there be more than one skeleton?
  - How is each skeleton defined?
  - Are there distinct build levels?
- How much testing should be done on each skeleton?

Product Integration Environment

- Establish and maintain the environment needed to support the integration of the product components
- The product integration strategy may identify needs for an environment that must be acquired or developed
- The product integration environment may include the reuse of existing organizational resources

Product Integration Environment - 2

- The environment required at each step of the product integration may include:
  - Test equipment
  - Simulators
  - Pieces of real equipment
  - Recording devices

Detailed Product Integration Procedures

- Detailed procedures for the integration of the product components include such things as:
  - The number of incremental iterations to be performed
  - The details of the expected tests
  - Other evaluations to be carried out at each stage

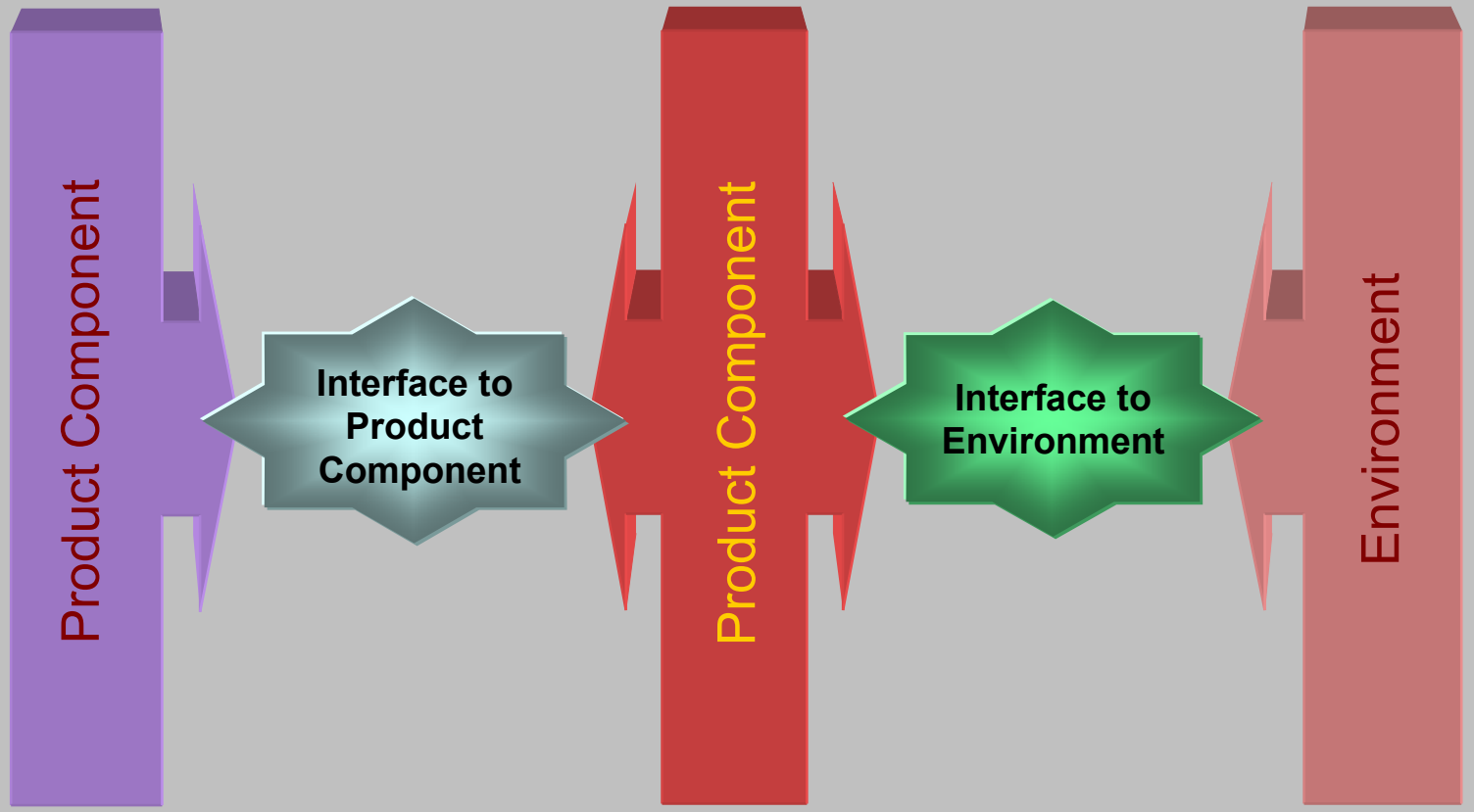
Detailed Product Integration Procedures - 2

- Detailed criteria
  - Can include criteria indicating the readiness of a product component for integration or its acceptability
  - Can be defined for how the product components are to be verified and the functions they are expected to have
  - May also include the degree of simulation permitted for a product component to pass a test
  - May describe the environment for the integration test
- The details include how the assembled product components and final integrated product are to be validated and delivered

Ensure Interface Compatibility

- Product component interface requirements, specifications, and designs must be managed effectively to help ensure that all implemented interfaces will be complete and compatible
- The interfaces should include, in addition to product component interfaces, all the interfaces with the environment as well as other environments for verification, validation, operations, and support

Ensure Interface Compatibility - 2



Review Interface Descriptions for Completeness

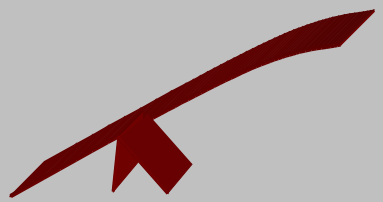
- Review all interface data for completeness
- Ensure that product components and interfaces are marked to ensure easy and correct connection to the joining product component
- Review the adequacy of interface descriptions on a periodic basis to ensure no deviation between the existing descriptions and the products being developed, processed, produced or bought

Manage Internal and External Interface Descriptions

- Management of the interfaces includes:
  - Maintaining the consistency and compatibility of the interfaces throughout the development cycle
  - Resolving conflict, noncompliance, and change issues
  - Maintaining a repository for interface data that is accessible to project participants

Confirm Readiness of Product Components for Integration

- Confirm that each product component is compliant with its interface requirements
  - Ensure that the product components are delivered to the product integration environment in accordance with the planned product integration strategy
  - Verify the receipt of each product component
  - Verify the configuration status of the product component against the expected configuration
  - Verify the configuration status of the accompanying interface documentation against the expected configuration
  - Perform pre-checks of all physical interfaces before connecting product components together



Assemble and Checkout Product Components

- Assemble and conduct product or product component **checkout** using an **iterative approach** moving from the initial product components through the interim assemblies of product components to the product as a whole
- Checkout includes examining and evaluating the assembled product components for performance, suitability, and readiness
- Ensure that the actual product checkout results are compared against the expected results
- Verify and validate assembled and checked out product components per the integration and verification strategies

Apply Verification & Validation Activities Prior to Packaging

- Use verification and validation techniques to:
  - Ensure that the integrated product meets the specified requirements
  - Ensure the project has confidence that the as-built product will perform its intended functionality in its intended operational environment
- Verification techniques include inspections, testing, analyses, and demonstration
- Verification methods commonly applied prior to packaging and delivery include:
  - Load, stress, and performance testing
  - Functional decomposition based testing
  - Operational scenario testing

Apply Verification & Validation Activities Prior to Packaging – 2

- Configuration audits should also be conducted prior to packaging and delivery to ensure that:
  - The product or product component that is in final checkout satisfies the customer and product requirements and all approved change requests and nothing more
  - The documentation that is to be delivered to the customer/end user matches the delivered product or product component
- It is recommended that verification and validation results that have been conducted throughout the development lifecycle be used as input to this final configuration audit

Packaging and Delivery

- Review the requirements, design, product, test results, and documentation to ensure that issues affecting the packaging and delivery of the product are identified and resolved
- Prepare the operational site for the installation of the product
- Deliver the product and related documentation and verify receipt
- Install the product at the operational site and verify correct operation

Graphic of Package – Present with Bow

Acceptance Testing (Final Verification)

- The purpose of Acceptance Testing is to confirm that a product or product component is ready for operational use
- The Acceptance Test is performed for or in conjunction with someone else to demonstrate that the confidence is justified
- The primary issue is usability and reliability – will the product or product component support operational use?
- Acceptance criteria should be discussed and agreed upon in advance of the actual acceptance testing

Summary

- Product Integration presents the concepts to achieve complete product integration through progressive assembly of product components, in one stage or in incremental stages, according to a defined integration strategy
- The integration plan should identify a sequence for receipt, assembly, and activation of the various components that make up the product

Summary - 2

- Product Integration presents the idea of applying (Product Integration, Verification, and Validation) in successive triplets until the product is ready for packaging and delivery
- Product Integration stresses the effective management of all interfaces to ensure that all interfaces will be complete and compatible

Summary - 3

- Verification is used to assure that selected work products meet their specified requirements
- Verification assures "You built it right"
- Validation is used to demonstrate that a product or product component fulfills its intended use when placed in its intended operational environment
- Validation assures "You built the right thing"