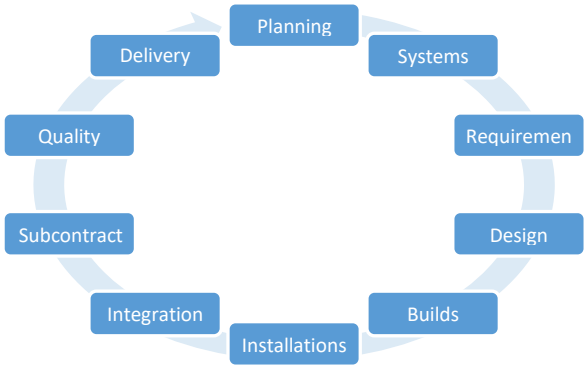
# Chapter 1

## INTEGRATION METHODS

The success of software and systems integration capabilities is dependent upon a major discipline supporting the entire software life cycle.

## SOFTWARE LIFE CYCLE




## THE RIGHT DISCIPLINES

**Methods:** effective methods improve productivity and help better prepare for future challenges that could impact integration environments

**Software:** design, code, plans, and test procedures integrated with applied systems ensure the software developed is done right

**Systems:** for systems to be deemed ready for the combination of software and systems integration they must have accomplished allocation of software design and engineering practices

**Integration:** software, systems, firmware, and hardware must all work together as on

## PROGRAM AND PROJECT PLANNING

**Purpose:** to provide the necessary process steps to plan for systems and software design and development for integration.

**Result:** This type of planning will ensure effective results for performing the disciplines necessary to implement supporting software and systems integration activities.

## SYSTEMS DESIGN

**Method**: analyze customer requirements and develop a software design/development plan for defining the essential elements for a designed system to meet the specified requirements.

**Importance:** provides the disciplines required and implemented during software design/development life cycles.

## SOFTWARE REQUIREMENTS

**Purpose:** the basis for software design and/or development

**Use:** provides a systematic approach to development from multiple resources.

**Method**: used for initial development of software requirements and changes to requirement baselines.

## SOFTWARE DESIGN/DEVELOPMENT

**Purpose:** a systematic approach used to create software design and its development to reflect design and software definitions related to the work product. Provides traceability according to software-defined processes and procedures.

**Requirements:** established between the elements of the design/development. The documented program and project plan.

**Method:** defines details about the product construction, behavior, components, and interfaces.

## SOFTWARE IMPLEMENTATION

**Purpose:** provides assurance that engineering builds function as expected.
Use: enables smooth execution for verification and test activities.
**Method:** incremental software and test approach adds the functions incrementally in a series of engineering builds. As software is tested, build plans are modified for succeeding builds based results previously demonstrated during troubleshooting, and checkout.
**Importance:** requirement for integration testing in a development, integration facilities, or the software systems integration facility (S/SIF).

## SOFTWARE AND SYSTEMS INTEGRATION

**Purpose:** provides a consistent approach to integration to ensure that the software and systems elements are assembled properly.
**Method:** determines if created elements are prepared and subject to verification or validation

## SOFTWARE SUBCONTRACTOR

**Role:**

- to describe how a programs and projects will benefit from outside resources.
- Provides required software/hardware products to be under contract and effective.
- presentation to the customer must be understood from start of the presentation to the finish.

## SOFTWARE AND SYSTEMS INTEGRATION DELIVERY

**Purpose**: to ensure that units tested are complete and documented prior to official delivery.
**Requirement:** integration testing to ensure both software and systems are integrated and working mutually.

## PRODUCT EVALUATION

**Purpose:** provides the necessary process steps to conduct and perform continual evaluations of software products during the design/development life cycle and integration activities.

- evaluation tools and checklists are developed with related scheduled processes to conduct the mandatory audits and evaluations.

## FIX THIS PROBLEM

A FINAL NOTE:
"Quality First" is the most important method. In order to have an impact on the integration and quality of software in addition to meeting scheduled delivery deadlines, hardware and software designers MUST work together to solve issues.

## Chapter 2

### ESSENTIAL ELEMENTS

- Definitions of systems design
- Configuration control
- Subcontractor involvement
- Product quality evaluations
- Software requirements and design
- Systems and software integration
- Deliveries

### PROGRAM PLAN DEVELOPMENT

1. Program objectives are defined/ technical and management disciplines identified.
2. Information outlines a cause for:
   - Cost evaluations
   - Risk management assessments
   - Defined and documented tasks

### EFFECTIVE PROGRAMS

Perform within the scope of defined objectives
Implement:

- Required data
- How the work product performs
- Tasks or functions
- Quantitative mechanisms

### ESTABLISHED FRAMEWORK

- Effective planning entails multiple tasks, scheduled milestones, and quality aspects for everyone involved from management to employees.
- Configuration management personnel monitor the framework process.

### PROJECT GUIDELINES

To eliminate communication issues, guidelines must be established. The following are components of a quality project guideline:

- Daily meetings
- Idea sharing
- Keep project managers informed
- Complaint resolution

### COMMUNICATION PLANNING PRINCIPALS

- Define and understand quality
- Define goals and objectives
- Establish a set of managers who:
  - Understand the technical practices that support systems and software engineering
  - Can clearly define and provide a scope for the team defining the development stages
  - Provide a scope for the team to know what is ahead
  - Involve systems and software teams to help with delivery schedules
  - Can accommodate change and identify potential risks that impact on program and project planning
  - Track the progress daily and adjusting if needed

### SENIOR MANAGEMENT

Role:

- provide the common framework for program and project planning to address engineering tasks

Responsibilities:

- Communicate efficiently and manage a team wisely
- Implement and use reasonable schedules
- Oversee the development of a quality work product that meets the needs of the customer
- Demand the best from designers and developers

## PROGRAM AND PROJECT PLANNING

According to CMMI® for Development the project plan:

- Refers to the overall plan for controlling the project.
- Includes a coherent picture of who does what

## PLANNING ACTIVITIES SHOULD INCLUDE:

- Lessons learned from previous programs and projects
- Cost/schedule estimates and plans for staffing
- Definitions for software and system requirement
- Requirements for safety and security
- Selection of software subcontractors
- Engineering documentation and historical data impacts
- Objectives for program/project
- Contract interpretation of necessary requirements

## PLANNED SCHEDULES

Purpose: defines tasks and processes to be conducted for implementation
Importance: planned schedules affect team capabilities for risk assessment, configuration control, and quality.

## THE THREE CRITICAL FACTORS

- Scope
- Budget
- Quality

## CRITICAL ITEMS IN A DEVELOPMENT PLAN

- Planned schedules
- Engineering information
- Software production direction
- A process consistent with system-level planning
- Consistency in agreement with the steps outlined

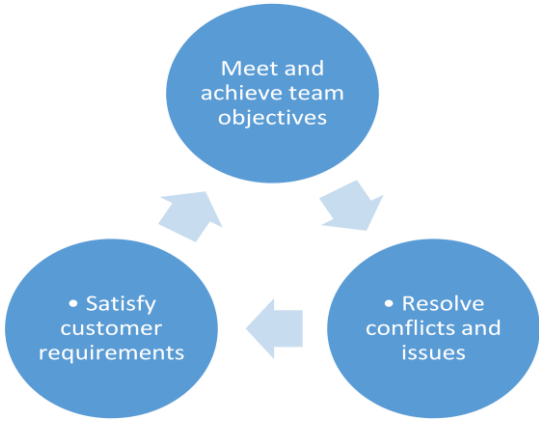
## DEVELOPMENT PLANNING STEPS

- Define entry and exit criteria for the software design/development
- Review and assessment of the work product/task requirements
- Define/update the process for each software activity
- Develop/update the estimating process
- Develop initial cost with schedule estimation and potential risks included
- Prepare detailed implementation plans

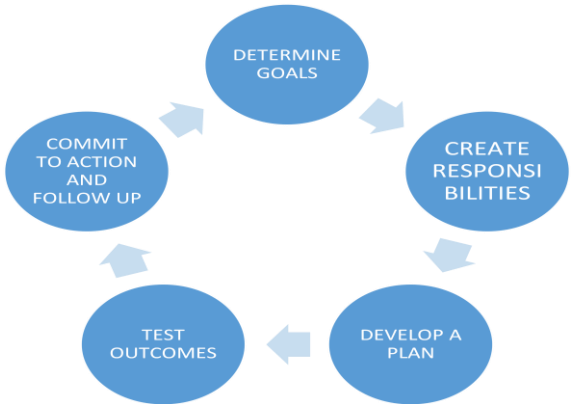
## THE IMPORTANCE OF TEAMWORK

- Energy and consistency influence high-performance goals. Therefore, trust and cohesiveness must be maintained in the work environment.
- A plan is successful when a team delivers a high-quality work product, meets the defined schedule and maintains budget.

### TEAM RESPONSIBILITIES




### TEAM ACTION CYCLE




### EFFECTIVE TEAM MEMBERS

- Know how to manage their own reactivity
- Are curious about what caused the blame
- Let members of a team know how something has an impact on them
- Rely on others' experience and expertise

## Chapter 3

### SYSTEM DESIGN

**Purpose:** to ensure an accurate and complete understanding of the restrictions of a system or subsystem that affect work products.

- The external software interface is defined and verified for completeness.
- External interfaces based on software architecture definitions are identified as part of consequent software requirements.

### SYSTEM ENGINEERING PLAN

**Purpose:** to develop software requirements, analyze the system architecture, design and allocates system requirements.

- A systems engineering plan (SEP) can be written to establish system-level technical reviews

### MAJOR TECHNICAL REVIEWS & AUDITS AFFECTING SOFTWARE AND SYSTEMS INCLUDE:

- Initial requirements (IR)
- Final design meeting (FDM)
- First-article inspection (FAI)
- Physical configuration audit (PCA)
- Incremental design review (IDR)
- Test readiness (TR)
- Functional configuration audit (FCA)

### PURPOSE AND ORGANIZATION

**Purpose:** to address upgraded processes from a systems engineering point of view.

**Organization:** three main sections:

- Systems engineering
- Technical program processes
- Engineering integration

## SYSTEMS ENGINEERING PLAN

**Purpose:** describes an orderly and structured approach to the overall system design, software design/development, required formal reviews, and audits

**Importance of team:**

- documents/provides the technical expertise to execute activities throughout a software design/development life cycle.
- enables performance to be more effective
- enables technical planners to spend more time planning to ensure the customer assurance and satisfaction in addressing the technical challenges

## SOFTWARE ARCHITECTURE EVALUATION

**Purpose**: provides a common approach to developing the work product architecture.
Application: implementation of enhancements for change or corrections to existing software architectures.

- Provides the viability of software architecture definitions to be applied
- Conflicts in requirements, architecture, or program and project plans are reported to product teams for resolution
- Program and project are analyzed to determine the impacts on architecture development.

**Objectives**: operational scenarios and system or subsystem requirements
**Scope:** does use interface requirements to analyze operational designs, software risks, and plans to determine the objectives of the architecture.
**Development:** identified during development and made available to be understood before beginning a software design/development life cycle.

## EVALUATIONS PROVIDE

- Operational scenarios for revision
- Defined system and subsystem requirements for analysis
- Defined system/subsystem interfaces for analysis

## THE SYSTEM/SUBSYSTEM ARCHITECTURE REQUIREMENTS DETERMINE IMPACTS

**Impacts include:**

- Influences to quality
- Functional necessities for determination of the software architecture

## PROCESS RESULTS

- Trade-offs between quality performance and the modifications are prioritized, identified outside system or subsystem requirements reviewed
- Determination of requirements to be modified
- Exhibits how satisfactory the architecture meets objectives, constraints, and quality attributes.
- Determines appropriate design methods to ensure problems are addressed.

## Chapter 4

### Defined software requirements

**Purpose:** provide a systematic approach for program and project development of software requirements delivered by a number of ideas and solutions.

- establish the principals for software design and integration test activities for software and systems integration.
- created as a stand-alone item or as an item embedded in higher-level assemblies.

### DEFINITION OF SOFTWARE REQUIREMENTS

**Stage One:** review of the functional or performance requirements to identify the constraints on software.
Defined into greater detail to define derived software requirements.
**System Requirement:** used to determine accuracy, completeness, and applicability of the requirements for product.
**Tool Purpose:** (dynamic object-oriented requirements system [DOORS], matrix worksheets, etc.) used to understand potential architectures and associated software requirements.
**Work Product**: the execution and the knowledge of what flows from the start of requirements analysis to verification and validation drives software requirements development.

### ANALYSIS

**Include:** a step-by-step process to develop requirements for software work products.
**Use:** fulfillment of high-level user requirements, allocated system requirements, and ideas for system operational concepts.
**Reports:** produced as run procedures verified and validated to support test and evaluations.

### USE CASE

**Purpose:** to describe a flow of operations for the performance of systems and software implementation.

- Defines the limitations/technical considerations established on target computers, work product execution strategy, and operating systems.

**Includes:** functionality, performance, maintenance, and support considerations, in addition to the work product's operational environment

- Incorporates boundaries and constraint

### FUNCTION

**Analysis Purpose:** to guarantee an accurate and thorough understanding of software performance.

- An ongoing activity during the software requirements definition process.

### ARCHITECTURE

Identified/ defined as part of derived software requirements.
**Function:** software design/development life cycle states and modes are established.
**Application:** timing, sequence, conditions, and execution probability define and redefine functional interface requirements for system architectures.

### INTEGRATION

**Purpose:** transforms functional architecture into optimal design solutions.
**Planning Resource Component:** critical for implementation of disciplined interface management principles is critical in order to perform systems build integration activities for the execution.

## VERIFICATION AND VALIDATION

Verification and validation begins with the review of software requirements.

**Requirement Priority Purpose**: determines the extent of verification and validation for each defined requirement.

- Verification and validation is identified, a list of techniques that includes analysis is developed, inspections made, demonstrations run, and software integration tests conducted.

## ACCOMPLISHED SYSTEMS VERIFICATION AND VALIDATION OF REQUIREMENTS

**Performance:** plan, evaluate, and record software work product compliance with established requirements.

**Risk Reduction Assessment:** ensures software design/development activities satisfy user needs in a manner that is efficient and cost-effective for integration of validation and requirement verification.

## REQUIREMENTS DOCUMENTATION

**Includes:** software requirements and related information.

Use cases and derived software requirements are the source of each requirement.

**Definition:** documented based upon development plans, software processes, and product standards.

## REQUIREMENTS TRACEABILITY

Documented according to developing planning, defined processes, and software work product instructions.

Purpose: enters information into the traceability system according to the program/ project for traceability standards.

- Traceable from system requirements or user requirements
- Clearly lead to software architectural component.

## FORMAL REVIEW PREPARATION

**Critical Requirement:** defined and complete software requirements must be in place before formal review.

- FCA Involvement: reviews requirements connected to the release of software documentation and procedures that trace to hardware drawings configured in work products.
- Customer involved in both audits.
    - After customer satisfaction and audit approval the customer has the deliverable work product in possession.

## MANAGING A REQUIREMENTS TOOL

Software requirements tools should:

- Have ability to impose multiple format requirements
- Support traceability and impact analysis
- Support software baselines and releases
- Alert modifications of requirements database

## RELEASED SOFTWARE REQUIREMENTS

**Purpose:** designed to address the areas of software design/development that can affect requirements definitions.

- aligns business goals and objectives
- reduces rework
- increases productivity
- ensures that requirements lead directly to program and project success and effective software delivery

## Chapter 5

### SOFTWARE DESIGN

**Purpose:** develops software requirements in defined designs of a work product.

- Implements details about a software product's architecture, components, and interfaces.
- Used by software designers.
- documented according to program and project plans, ideas, processes, and procedures and applicable internal work instructions.

### DEVELOPMENT PLAN

**Purpose:** a well-defined process useful for implementation and applicable standards.

**Tasks:** identify major software functions (components), functional hierarchy diagrams, and hardware/software interfaces.

### SOFTWARE DESIGN DECISIONS

**Purpose:** provides design concepts and decisions for a work product.

- Analysis and integration of software requirements definition and the software operational concepts identify the capabilities and characteristics required to make key design decisions.
- Software designer uses software design tools for requirements, code development, configuration management (CM), and software documentation.

### SOFTWARE REQUIREMENTS EVALUATION

**Purpose:** defines software operational scenarios to ensure problems affecting software design are identified, evaluated, and resolved.

- A risk analysis using prototype software is performed to support early requirements evaluations and design feasibility.
- If requirement is proven unusable and not to be implemented for use, data from evaluations is fed back into the output of the software requirements development phase.

### SOFTWARE REUSE

**Purpose:** identifies evaluations by software architecture definitions on how to decide on the incorporation of components into the software design.

**Reuse Criteria**: identified in defined software plans

- Determines if the program and project re-use library or existing software work products can be used for near-term software design activities.

### PEER REVIEWS

**Purpose:** to find and correct as many errors as possible before test team integration or customers find problems.

- Starts with requirements, design models, and uninterrupted code and unit tests for the software designer.
- Applied at various stages during the software design/development life cycle
- Creates clean software work products and provides assurance that issues or errors are discovered and resolved.

## EXAMPLE OF PEER REVIEW METHODS

- Inspections
- Structured walk-throughs
- Deliberate refactoring
- Pair programming

## PEER REVIEWS CRITERIA

- Schedule the peer review at a convenient time
- Assign reviewers
- Prepare/update materials
- Provide checklists
- Introduce training materials
- Select software work products
- Provide entry and exit criteria

## SOFTWARE DESIGN/DEVELOPMENT METHODS

### Concurrent Software/Design Development

- Requirement: software design expertise to anticipate where the defined design is going.
- Con: possible to delay commitment until the last moment when failure to make a decision eliminates an important alternative or decision.

### Lean Software Design/Development

- Objective: to move as many changes as possible from the top curve to the bottom curve.
- Delays the freezing of all design decisions as long as possible.
- Emphasizes designing and managing changes throughout the life cycle.
- Provides a better understanding of software engineering and quick delivery to customers.

## AGILE SOFTWARE PROCESSES

- Provides fewer defects.
- Supports numerous initiatives
- Provides a program and project with a manager's approach to emphasize short-term program and project planning.
- Adopts values that are consistently depicts processes and makes decisions that may reject a software design.
- More effective than the traditional models due to perfection versus good-enough concepts for software design practices.
- Provides capability to understand information first before jumping into software design and development.

## FOUR KEY ELEMENTS OF AGILE SOFTWARE ENGINEERING

1. The team has control of work assignments
2. Communication with team members and customers is needed
3. Change is good: "Think outside the box"
4. Customer satisfaction and expectations are achieved

## CONFIGURATION MANAGEMENT

CM methods are a supporting discipline not directly involved in creating executable code. In the Agile process, CM methods are not referenced for specific routines.

**CM Purpose:** trim process and provide more automation in tools

- Brings back focus to configuration control objectives.
- Software tools common to other team members are adapted to the process

• When Agile processes lack configuration control, Lean principles are a waste of time and lead to chaos. As a result, there is no progress in software design/development.

• The ability to control change is the foundation of design/development activities. CM methods should not limit change or it will become a barrier for program and project plans.

## SOFTWARE STANDARDS

**Purpose:** ensures development processes are in accordance with identified process models.

Minimum software standards consist of the following:

- Documented and maintained plans and procedures
- Peer reviews
- Standard software tools

## CAPABILITY MATURITY MODEL INTEGRATION

**Purpose:** provides opportunity to address software design/development with support to customers after delivery.

- Provides a systematic approach to software engineering tasks in programs and projects.
- Enhance the knowledge base for software designers.
- Provides content for performance during the software life cycle.

## CMMI SOFTWARE ENGINEERING TASKS

- Identify internal and external interfaces
- Establish infrastructure abilities with software design
- Develop plans, processes, and procedures
- Reuse capabilities for identified software

## LEAN SIX SIGMA

**Purpose:** reduces process variation, resulting in fewer errors and defects.

**Goal:** Zero defects

**Six Sigma Process:**

- Define • Measure
- Analyze • Improve

## LEAN GOAL: ELIMINATE EIGHT WASTES

| | |
|---|---|
| 1.Defects | 2.Overproduction |
| 3.Waiting | 4.Nonutilized talent |
| 5.Transportation | 6. Inventory |
| 7. Motion | 8. Excess processing |

## SOFTWARE DESIGN /DEVELOPMENT

**Purpose:** secure databases related to software.

- Effective software and systems integration methods create profit from inside the software design/development sector.