The Benefits of
Agile Systems Engineering
in Program Management

Case Study: Developing a Concept of Operations (ConOps) for a Power Control Center System Upgrade

National Defense Industrial Association [NDIA]
19th Annual Systems Engineering Conference
Track 5 Agile [Session 18912]
Springfield, VA – October 26, 2016

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AGENDA

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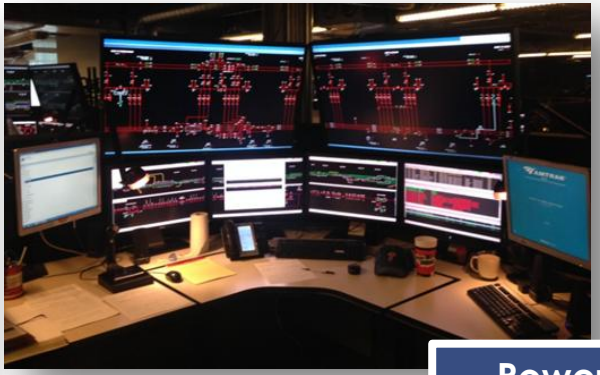
- **Practical Example**
  - Project Background, Challenges & Objectives
  - Project Management Approach
  - Project Implementation
  - Project Accomplishments & Benefits
- **Applicability to DoD Acquisitions**
- **Summary**

PRACTICAL EXAMPLE
PROJECT BACKGROUND



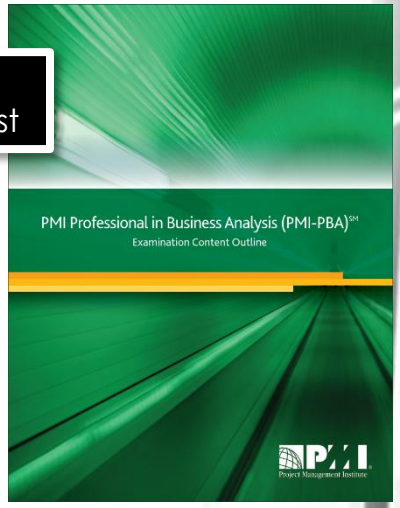
Power Control Center (Examples)

PROJECT SCOPE:

- Facilitate and Support Development of Concept of Operations (ConOps) for a Power Control System
- ConOps to Serve as Agreement between Operators & Maintainers and Designers & Implementers
- Mix of Experienced Systems Engineers and Industry & Technology Subject Matter Experts
- Guide Client & Make Recommendations based on Domestic & International Best Practices

PRACTICAL EXAMPLE
CONCEPT OF OPERATIONS

Professional Business Analyst

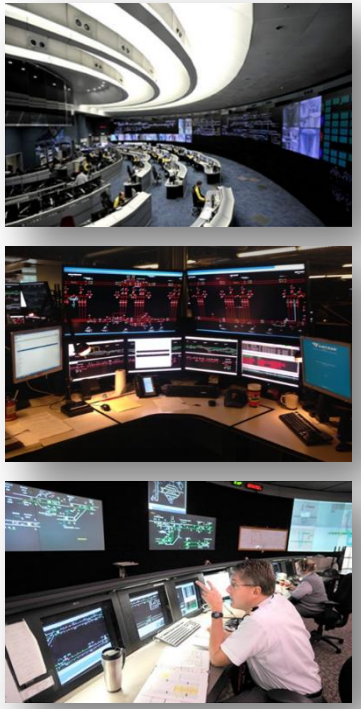


A **concept of operations** (abbreviated CONOPS, CONOPs, or ConOps) is a document describing the characteristics of a proposed system from the viewpoint of an individual who will use that system. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders.

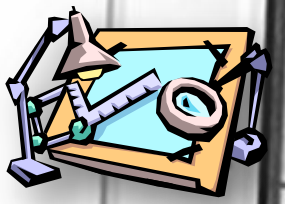
Concept of operations - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/**Concept_of_operations** Wikipedia

Stakeholder Requirements	Current **"As-Is"** System	**Alternative** System Reviews	Planned **"To-Be"** System	**Gap Analysis** "As-Is" vs. "To-Be"	ConOps (SDLC) **Output**

People
Processes
Products

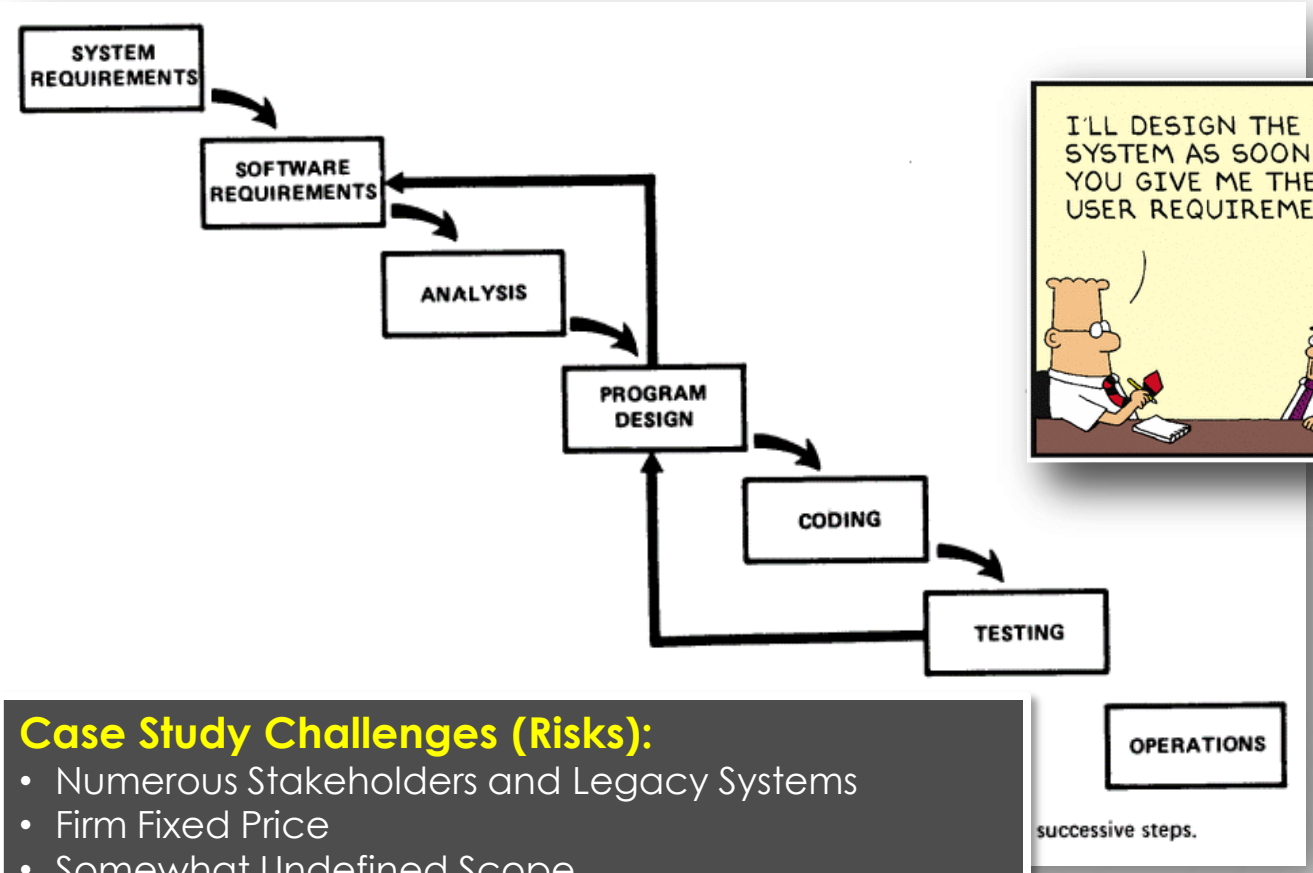


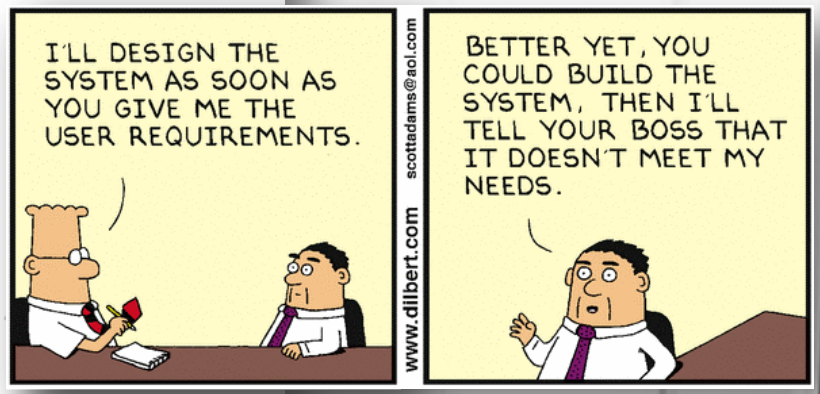
People
Processes
Products



PRACTICAL EXAMPLE
PROJECT CHALLENGES

Waterfall Approach with Potential Late Surprises & Rework





Case Study Challenges (Risks):

- Numerous Stakeholders and Legacy Systems
- Firm Fixed Price
- Somewhat Undefined Scope
- Demanding 14 Week Timeline
- Stovepiped Client Organization
- Distributed Project Team (2 Continents, 8 Time Zones)

Source: Royce, W. W. 1970. *Managing the Development of Large Software Systems*. Proceedings, IEEE WESCON. Figure 2, 3, and 4.

PRACTICAL EXAMPLE
OBJECTIVES (RISK MITIGATIONS)

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- Satisfy the Client through **early and often delivery** of ConOps, **avoiding late surprises** common to the waterfall approach
- **Incorporate changes** from ConOps reviews and walk-throughs ('sprint reviews') into each new revision of the ConOps **before next release**
- **Deliver 'shippable' versions**, with an average of three weeks between sprints, keeping the team focused and the Client apprised of the progress
- **Work together with the Client** in frequent stakeholder meetings throughout the project and meet in person whenever possible
- **Use released versions** of the ConOps **as a measure of progress** (demonstrating earned value)
- Provide continuous attention to technical excellence, **using best practices** and building trust with the Client

Source: Adapted from *Principles behind the Agile Manifesto* - http://agilemanifesto.org/principles.html

PROGRESS

- **Practical Example**
  - Project Background, Challenges & Objectives
  - **Project Management Approach**
  - Project Implementation
  - Project Accomplishments & Benefits
- **Applicability to DoD Acquisitions**
- **Summary**

PRACTICAL EXAMPLE
MANAGEMENT CONSIDERATIONS

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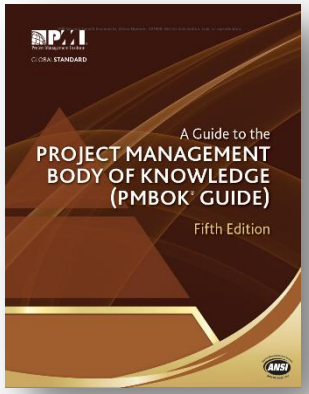
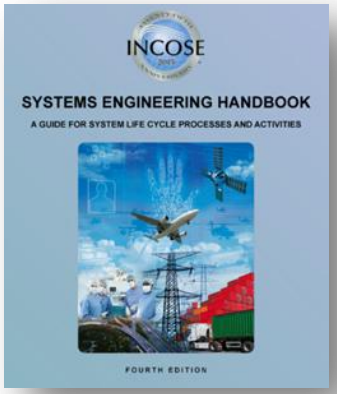
Project Management



- Request for Proposal
- Scope Management
- Cost Management
- Schedule Management
- Risk Management
- Other

Systems Engineering



- Systems Development
- Concept of Operations
- Stakeholder Mgmt.
- Legacy Products & Procedures
- Other

Agile Product Development

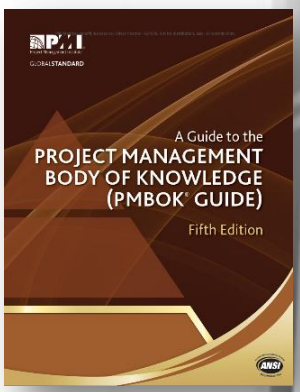
Scrum Alliance®

- Early & Often Delivery
- Shippable Product
- Increment (Sprint) Reviews
- Avoid Late Surprises
- Progress Demonstration
- Other

Lean Product Development Flow

- Continuous Work Flow
- Individual "Takt Periods"
- Regular Integration
- Lean Principles (i.e. Pull, Value, etc.)
- Other

PRACTICAL EXAMPLE
PROJECT MANAGEMENT CONSIDERATIONS



Scope Management

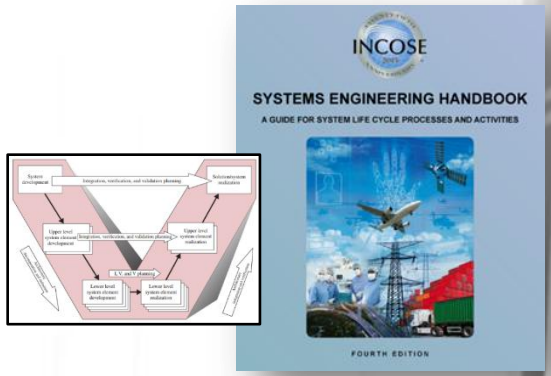
	Resource	PV	Period 1	Period 2	Period n
Work Breakdown Structure					
(D) Deliverable #1					
(A) Activity #1	Res. #1	1d	100%		
(A) Activity #2	Res. #2	1d		80%	
(A) Activity #n	Res. #n	1d			
(D) Deliverable #2					
(D) Deliverable #n					

Cost Management

Time Management

Cost & Schedule Performance

PRACTICAL EXAMPLE
SYSTEMS ENGINEERING CONSIDERATIONS



Stakeholder Requirements

System Requirements

System

System Element

System Element

System Element

System Architecture

Interfaces & Interaction

System Element

System Element

System Element

Detailed Design

Concept of Operations

Project Definition

Requirements and Architecture

Detailed Design

Implementation

Integration, Test, and Verification

Verification and Validation

System Verification and Validation

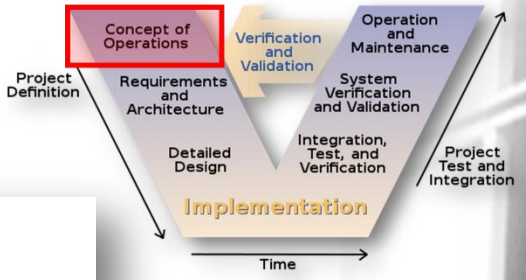
Operation and Maintenance

Project Test and Integration

Time

Source: https://en.wikipedia.org/wiki/V-Model#/media/File:Systems_Engineering_Process_II.svg

PRACTICAL EXAMPLE
TYPICAL CONOPS OUTLINE



ConOps Structure

IEEE 1362 Outline

1. Scope
2. Referenced Documents
3. The Current System or Situation
4. Justification for and Nature of Changes
5. Concepts for the Proposed System
6. Operational Scenarios
7. Summary of Impacts
8. Analysis of the Proposed System

1.0 SCOPE
- 1.1 STAKEHOLDER REQUIREMENTS

2.0 REFERENCED DOCUMENTS

3.0 THE CURRENT SYSTEM OR SITUATION — Current "**As-Is**" System
- 3.1 PEOPLE
- 3.2 PROCEDURES
- 3.3 PRODUCTS

4.0 BEST PRACTICE REVIEW — **Alternative** System Reviews
- 4.1 ALTERNATIVE #1
- 4.2 ALTERNATIVE #2
- 4.3 ALTERNATIVE #N

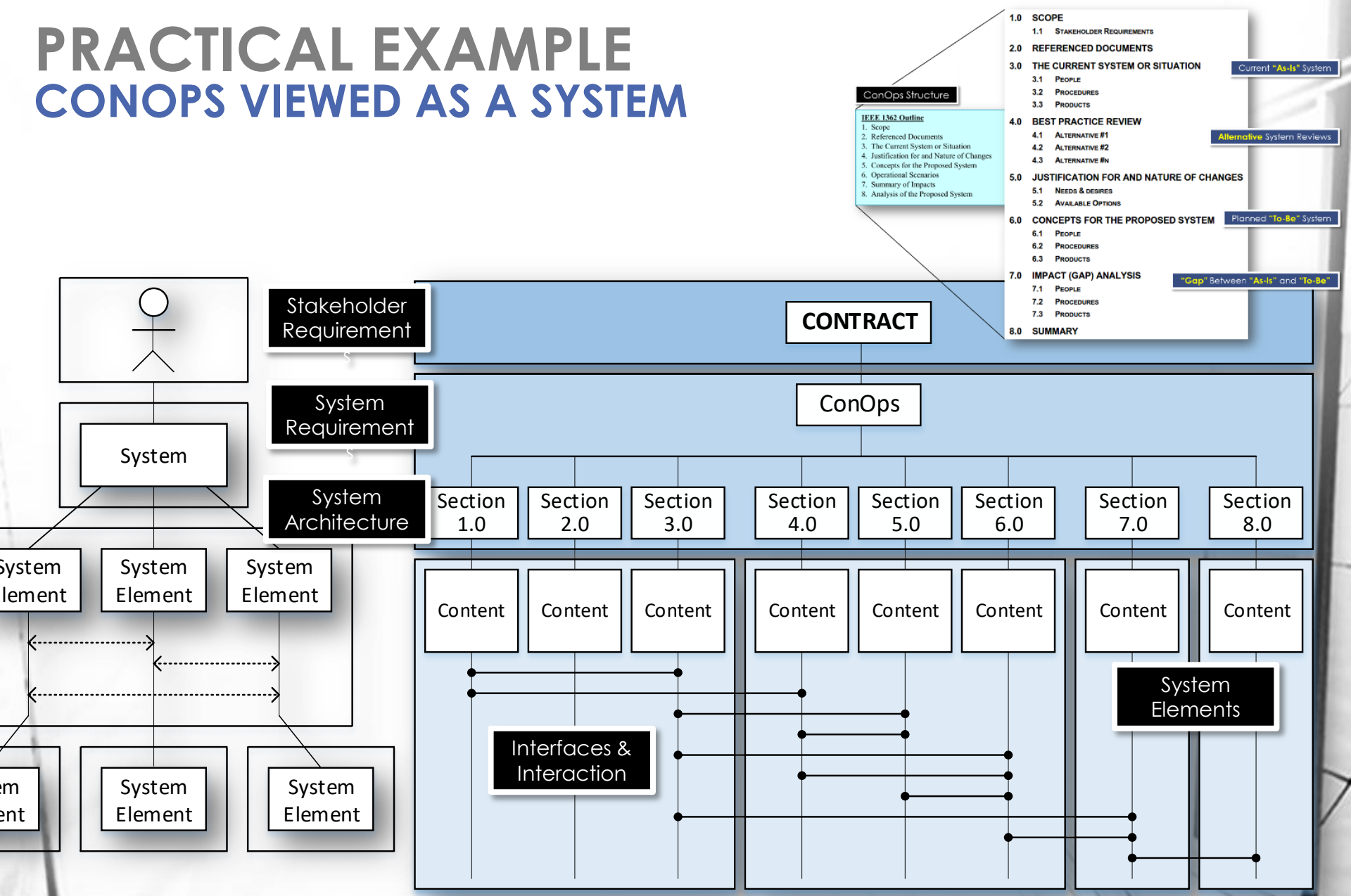
5.0 JUSTIFICATION FOR AND NATURE OF CHANGES
- 5.1 NEEDS & DESIRES
- 5.2 AVAILABLE OPTIONS

6.0 CONCEPTS FOR THE PROPOSED SYSTEM — Planned "**To-Be**" System
- 6.1 PEOPLE
- 6.2 PROCEDURES
- 6.3 PRODUCTS

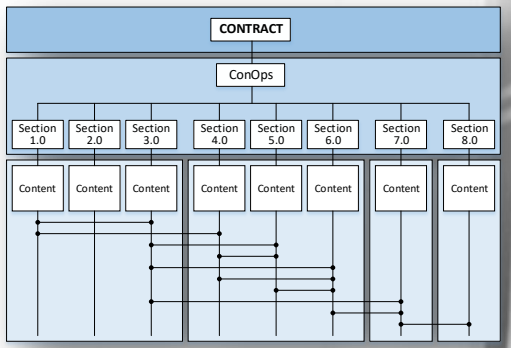
7.0 IMPACT (GAP) ANALYSIS — "**Gap**" Between "**As-Is**" and "**To-Be**"
- 7.1 PEOPLE
- 7.2 PROCEDURES
- 7.3 PRODUCTS

8.0 SUMMARY

PRACTICAL EXAMPLE
CONOPS VIEWED AS A SYSTEM



PRACTICAL EXAMPLE
ORGANIZATIONAL STRUCTURE



Stakeholder Manager

Systems Engineer

Project Manager

Subject Matter Expert(s)

Best Practice Outreach

Stakeholder Requirements

System Requirements

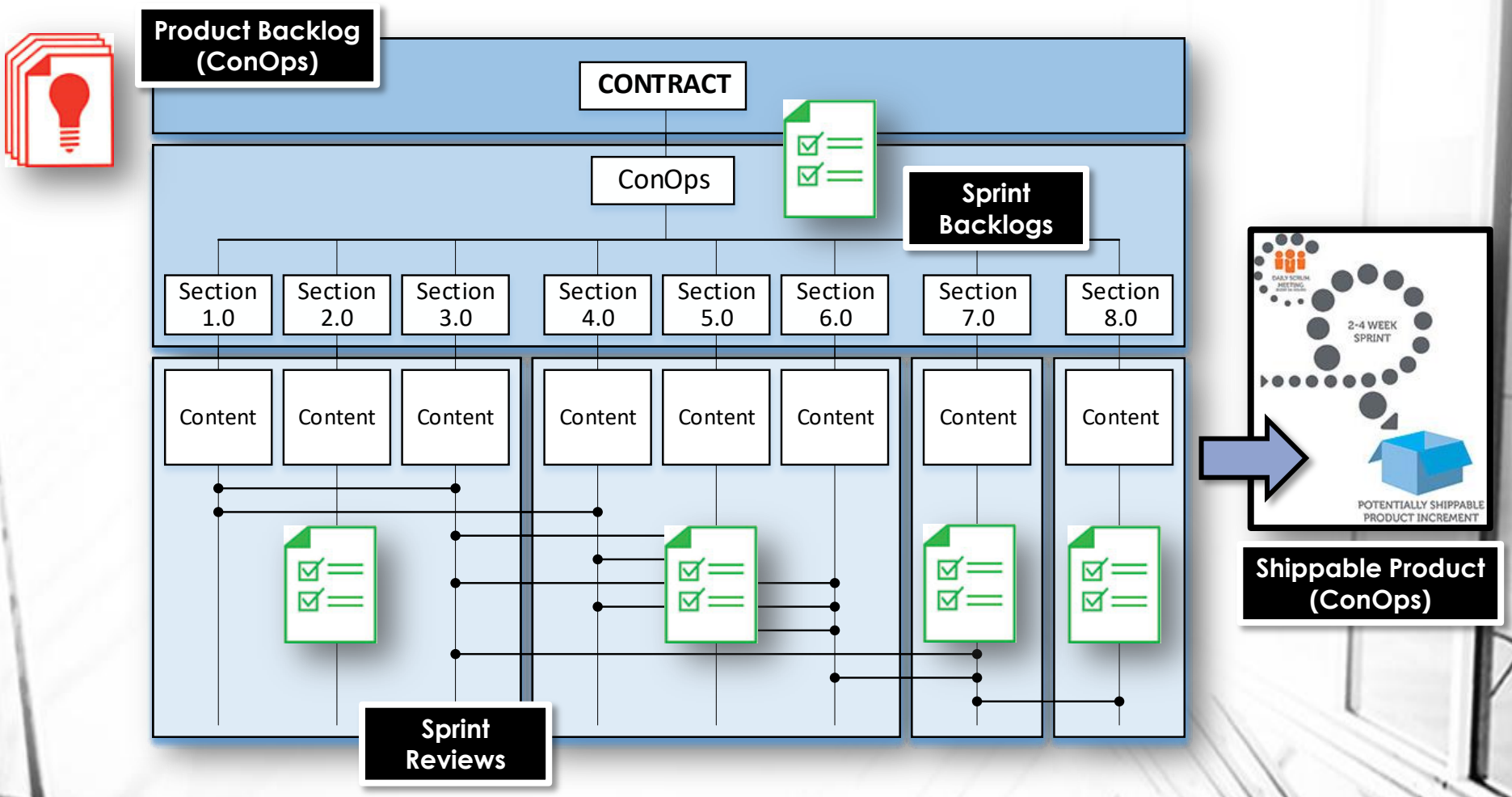
System Architecture

System Elements

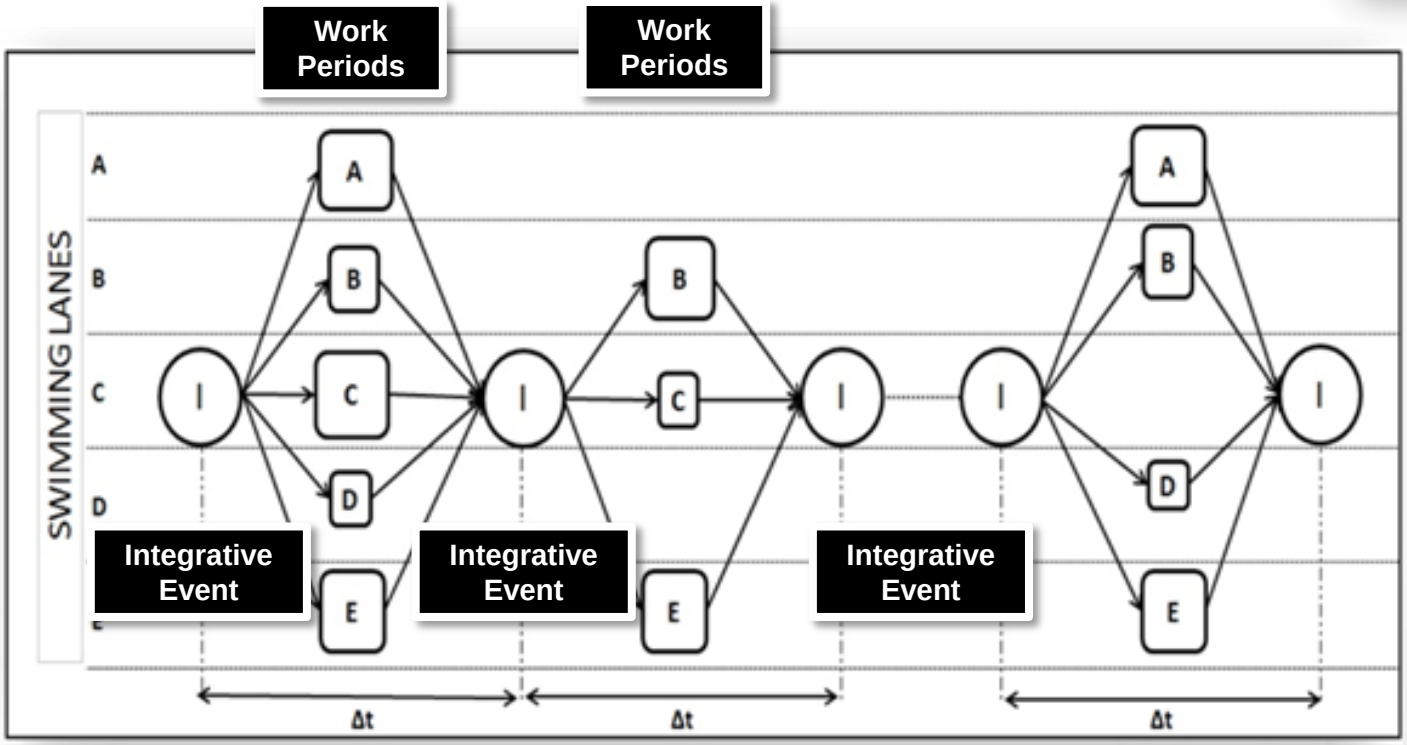
Interfaces & Interaction

PRACTICAL EXAMPLE
AGILE PRODUCT DEVELOPMENT CONSIDERATIONS

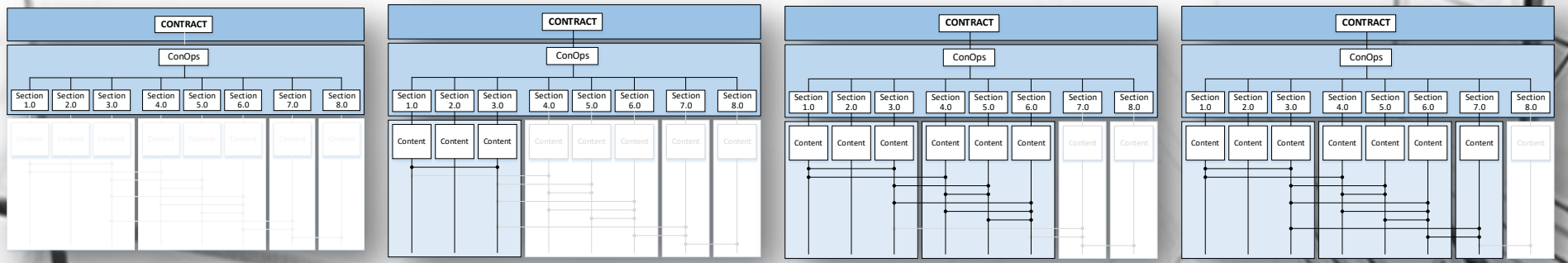
PRACTICAL EXAMPLE
AGILE PRODUCT DEVELOPM. APPLIED TO CONOPS



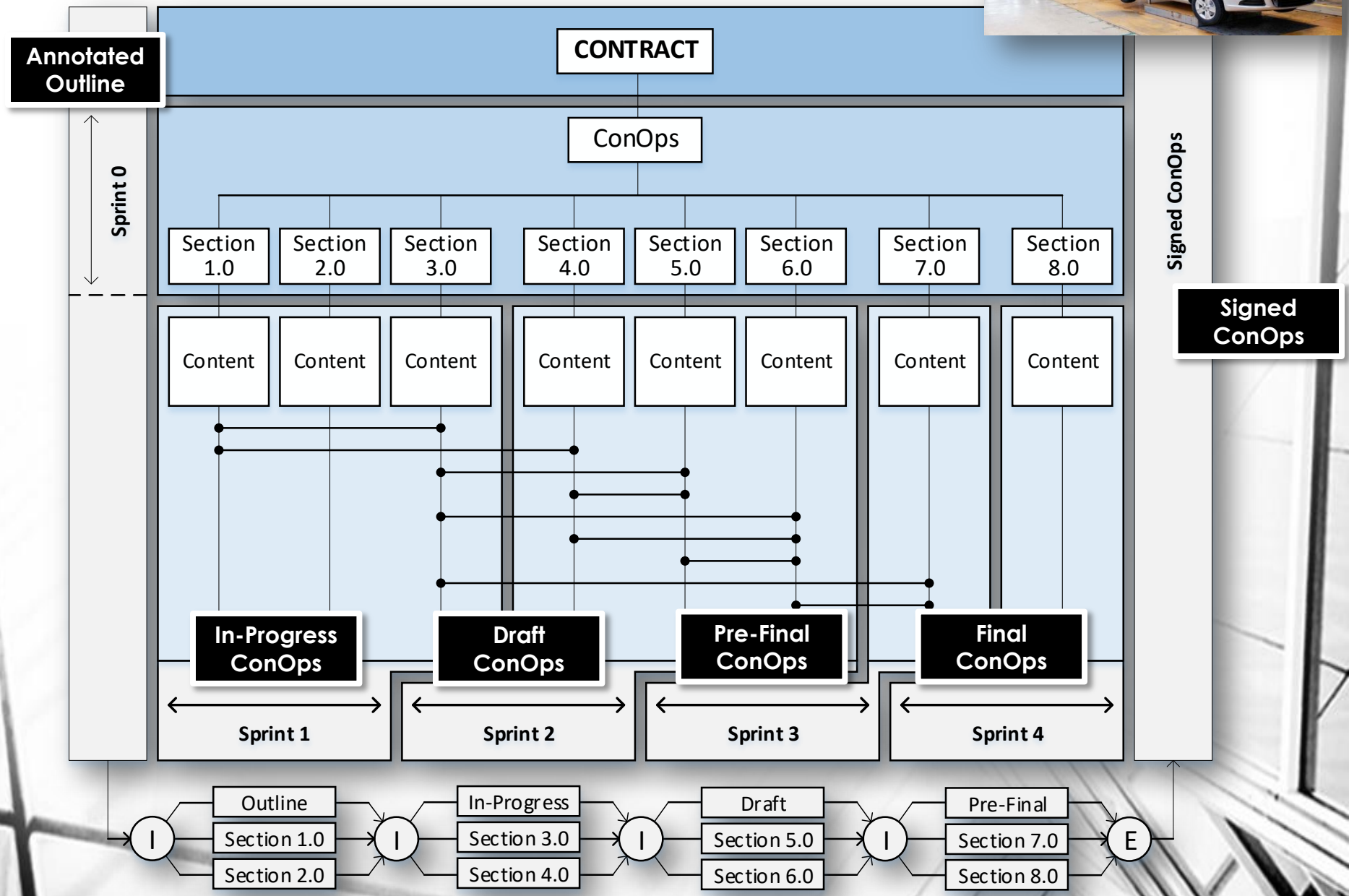
PRACTICAL EXAMPLE
LEAN PRODUCT DEVELOPMENT FLOW CONS.



Source: Oppenheim, Bohdan W. 2015. *Lean Management of Complex Programs*. INCOSE IW Transportation WG



PRACTICAL EXAMPLE
LEAN PRODUCT DEV. APPLIED TO CONOPS



PRACTICAL EXAMPLE
PUTTING IT ALL TOGETHER

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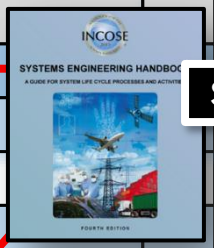
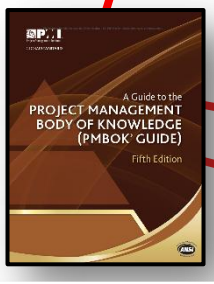
Scope

Work Breakdown Structure	Resource	PV	Period 1	Period 2	Period 3	Period 4	Period 5
(D) Concept of Operations							
(D) Annotated Outline							
(A) …			100%				
(D) In-Progress Revision							
(A) Incorporate Comments	SE	2d					
(A) Prepare Section 1.0	SM	6d					
(A) Prepare Section 2.0		2d					
(A) Integrate & Submit	SE	1d					
(D) Draft Revision							
(D) Pre-Final Revision							
(D) Signed Revision							
(D) Other Deliverables							
(D) …							



Systems Engineering



Project Management

Time

AC/EV

Agile SE/PM

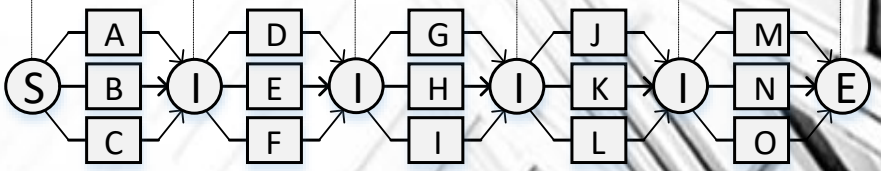
Scrum Alliance®

Agile SE/PM

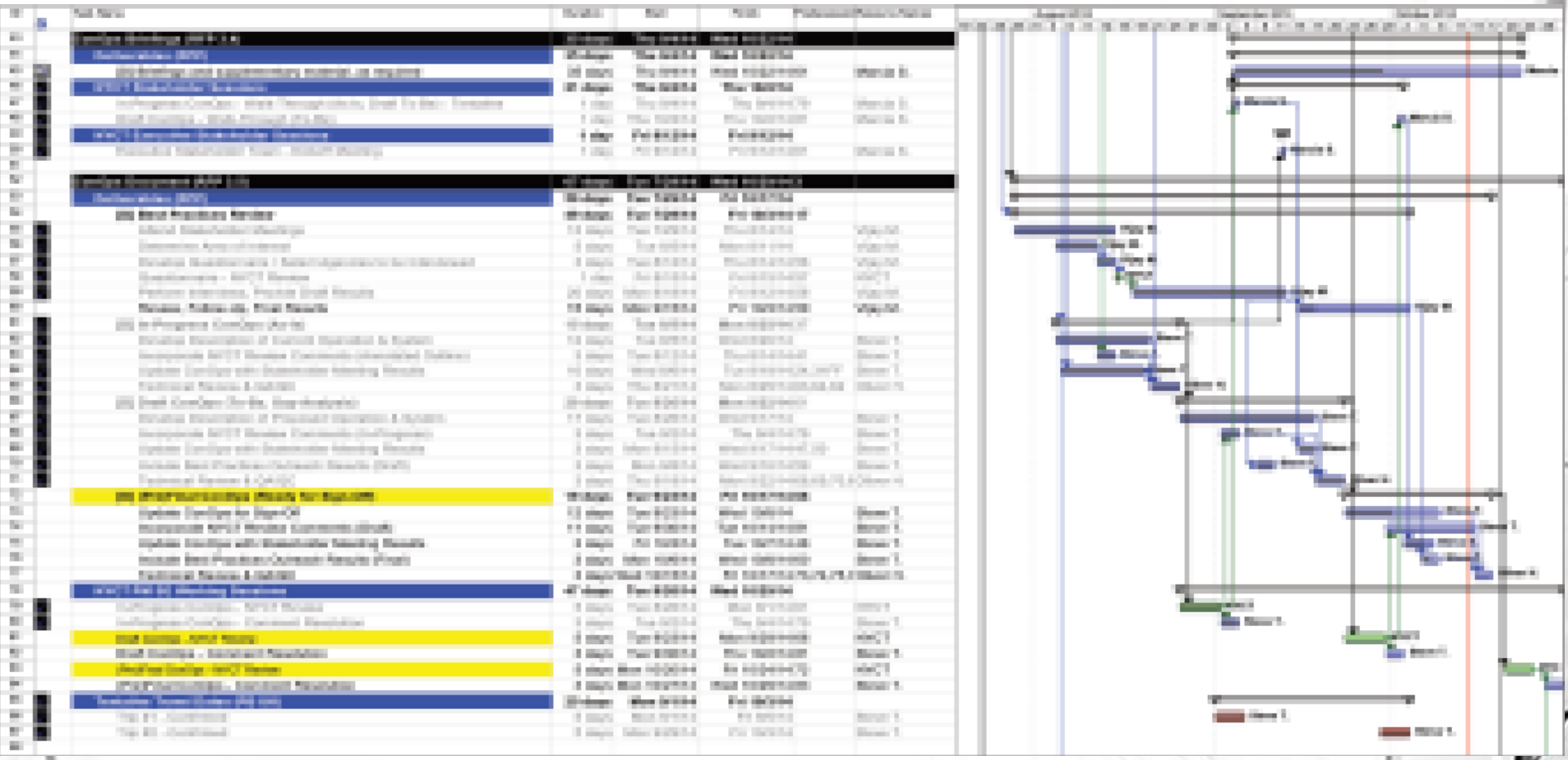
Scrum Alliance®

Lean SE/PM

Sprint 0	Sprint 1	Sprint 2	Sprint 3	Sprint 4



PRACTICAL EXAMPLE
PUTTING IT ALL TOGETHER (CONT'D)



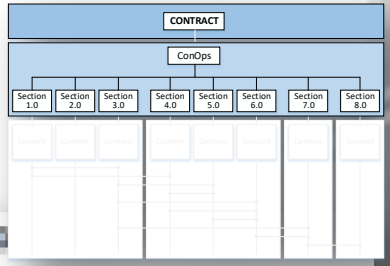
Follow Standard Project Management Practices

PROGRESS

- **Practical Example**
  - Project Background, Challenges & Objectives
  - Project Management Approach
  - **Project Implementation**
  - Project Accomplishments & Benefits
- **Applicability to DoD Acquisitions**
- **Summary**

PRACTICAL EXAMPLE

SPRINT #0 – ANNOTATED OUTLINE



1.0 SCOPE 11

1.1 IDENTIFICATION AND PROJECT PURPOSE 11
1.2 OBJECTIVES OF THE CONOPS DOCUMENT 11
1.3 DOCUMENT OVERVIEW/STRUCTURE 11
1.4 [redacted] PROJECT BACKGROUND 11
1.5 [redacted] BUSINESS REQUIREMENTS 11

2.0 REFERENCE DOCUMENTS 14

3.0 THE CURRENT SYSTEM OR SITUATION 16

3.1 BACKGROUND AND OVERVIEW 16
3.2 OPERATIONAL POLICIES AND CONSTRAINTS 16
3.3 DESCRIPTION OF THE CURRENT SYSTEM 16
3.4 USER CLASSES AND OTHER PERSONNEL 26
3.5 MODES OF OPERATION FOR THE CURRENT SYSTEM 28
3.6 SUPPORT ENVIRONMENT 28

4.0 BEST PRACTICES REVIEW 30

4.1 CONCLUSIONS AND COMMON THEMES 30

5.0 JUSTIFICATION AND NATURE OF CHANGES 36

5.1 DESCRIPTION AND JUSTIFICATION OF DESIRED CHANGES 36
5.2 REVIEW OF OPTIONS AVAILABLE FOR [redacted] 36

6.0 CONCEPTS FOR THE PROPOSED SYSTEM 40

6.1 BACKGROUND AND OVERVIEW 40
6.2 OPERATIONAL POLICIES AND CONSTRAINTS 40
6.3 DESCRIPTION OF THE PROPOSED SYSTEM 49
6.4 USER CLASSES AND OTHER INVOLVED PERSONNEL 53
6.5 MODES OF OPERATION 55
6.6 SUPPORT ENVIRONMENT 58

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7.2 IMPACTS TO THE CURRENT SYSTEM 58
7.3 IMPACTS TO USER CLASSES AND OTHER INVOLVED PERSONNEL 59
7.4 IMPACTS TO OPERATIONS 59
7.5 IMPACTS TO THE SUPPORT ENVIRONMENT 59
7.6 PHASING AND TRANSITIONING 59

8.0 SUMMARY 61

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8.2 ALTERNATIVES AND TRADE OFFS CONSIDERED 65

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9.1 [redacted] (AS-IS) 66
9.2 BEST PRACTICE OUTREACH QUESTIONNAIRE 69
9.3 BEST PRACTICE REVIEW 72
9.4 SPECTRUM OF OPTIONS AVAILABLE FOR [redacted] 89

Mobilization & Planning

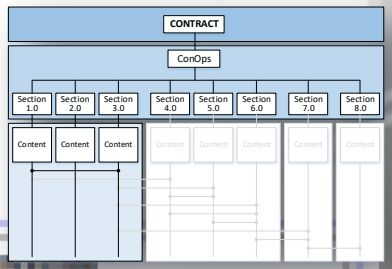
Project Kick-Off Meeting

Management Plan(s)

Annotated ConOps Outline (15 Pages)

PRACTICAL EXAMPLE

SPRINT #1 – IN-PROGRESS CONOPS



Incorporate Sprint Review

Current System or Situation

Stakeholder Interviews

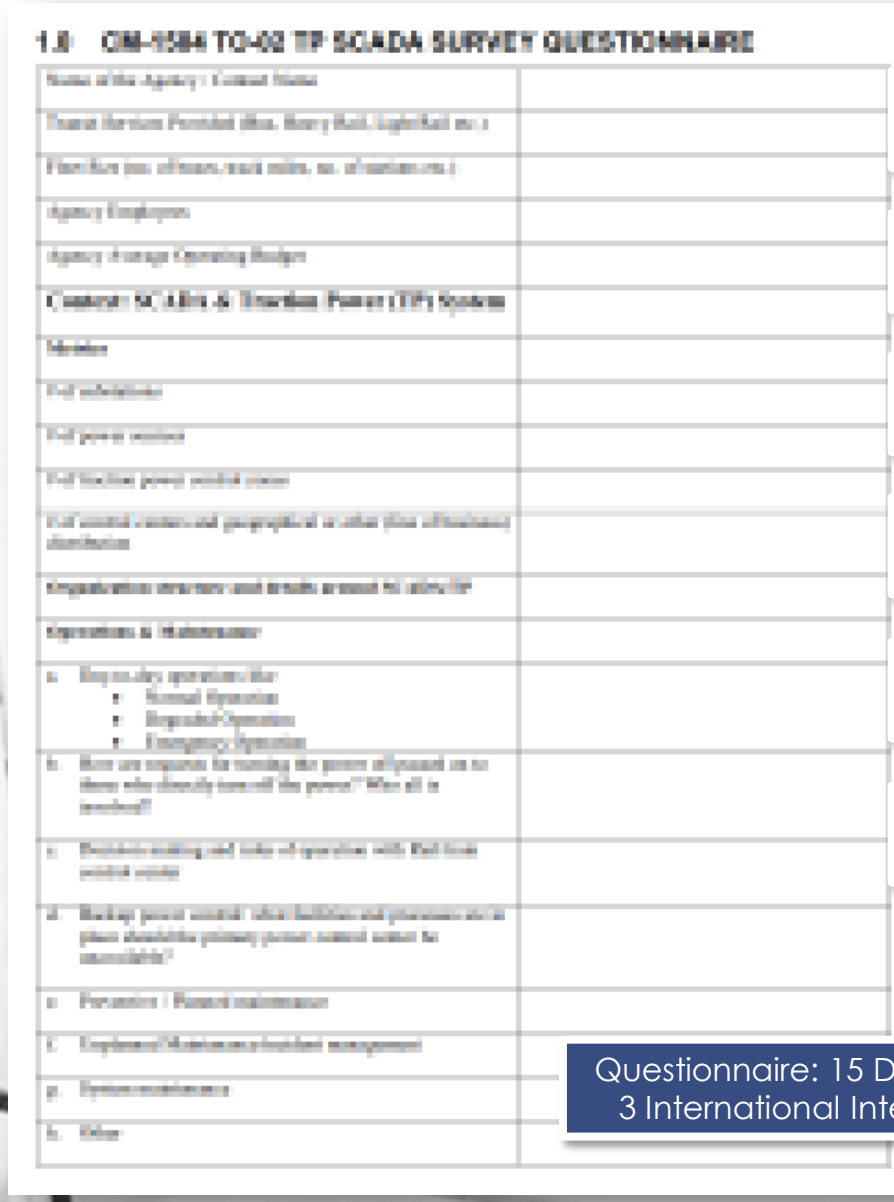
Operators & Maintainers

Operating Procedures

Systems & Interfaces

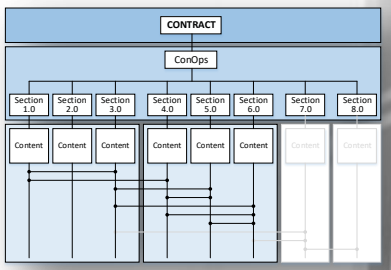
ConOps Walk-Through

PRACTICAL EXAMPLE
SPRINT #2 – DRAFT CONOPS


1.0 CM-1584 TO-02 TP SCADA SURVEY QUESTIONNAIRE

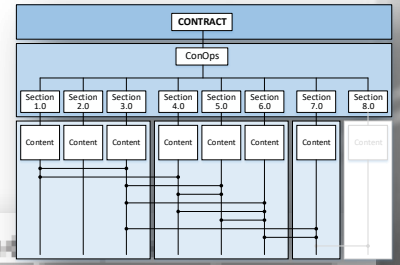
- Incorporate Sprint Review
- Stakeholder Requirements
- Best Practice Analysis
- Alternatives Analysis
- Planned System or Situation
- ConOps Walk-Through

Questionnaire: 15 Domestic, 3 International Interviews



PRACTICAL EXAMPLE

SPRINT #3 – PRE-FINAL CONOPS



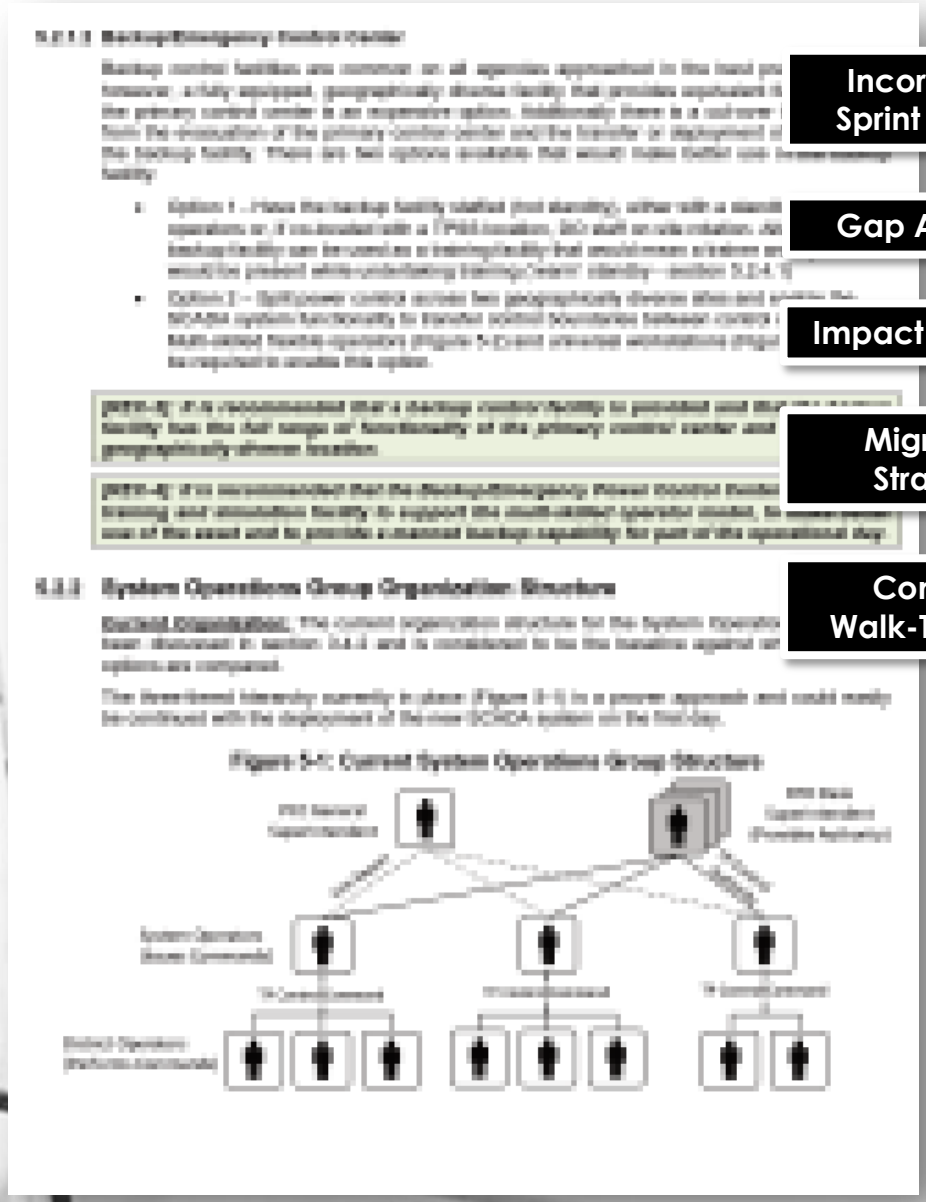
Incorporate Sprint Review

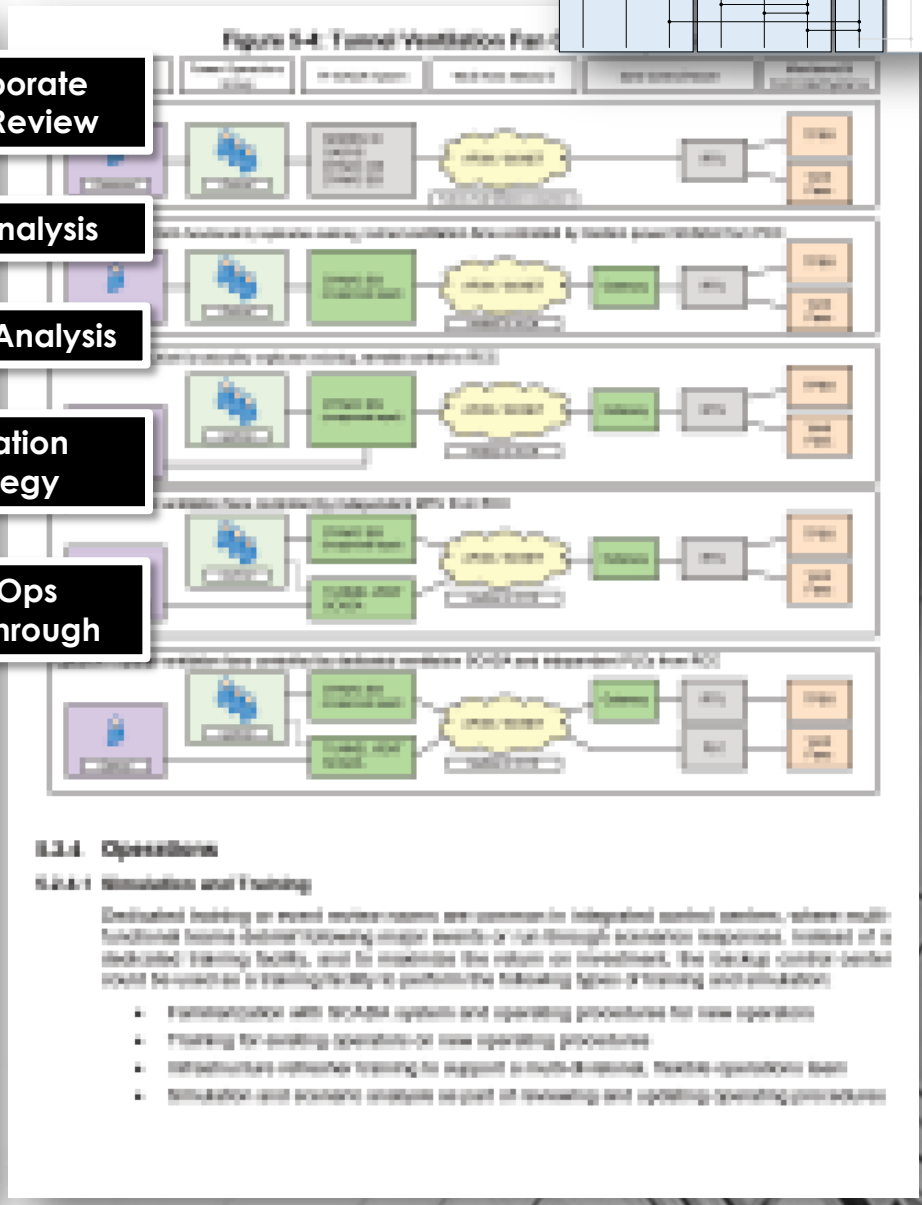
Gap Analysis

Impact Analysis

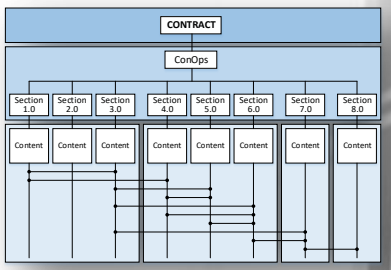
Migration Strategy

ConOps Walk-Through





PRACTICAL EXAMPLE
SPRINT #4 – FINAL CONOPS



Incorporate Sprint Review

Summary & ConOps Output

Circulate for Signatures

PROGRESS

- **Practical Example**
  - Project Background, Challenges & Objectives
  - Project Management Approach
  - Project Implementation
  - **Project Accomplishments & Benefits**
- **Applicability to DoD Acquisitions**
- **Summary**

PRACTICAL EXAMPLE
ACCOMPLISHMENTS & BENEFITS

National Defense Industrial Association

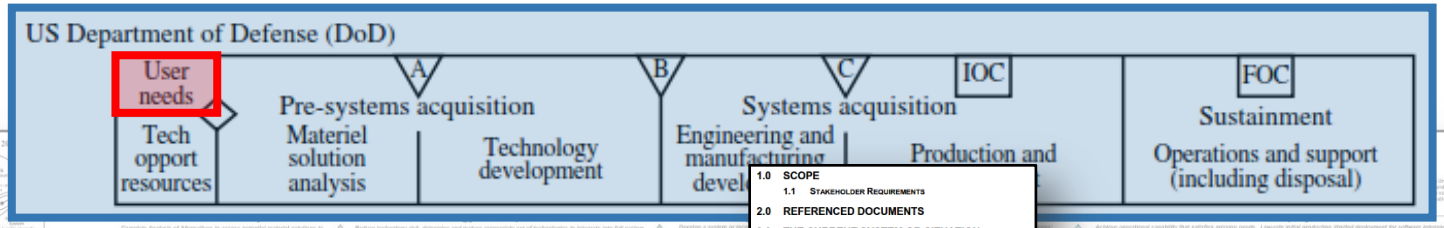
- Systems Engineering helped significantly **defining the project scope** such as project phases, deliverables, activities, etc.
- Delivering the ConOps **early and often** helped **avoiding late surprises** that could have potentially resulted in rework, delays, and cost overruns
- **Sprints** with an average length of three weeks kept the team focused and did not allow for distractions
- Performing regular integration of new content into **'shippable' ConOps 'architecture'** distributed the integration work load and risk
- **Spring reviews** were valuable opportunity to validate stakeholder requirements
- **Released versions** of the ConOps served very well **as a measure of progress** (demonstrating earned value)
- Frequent **stakeholder meetings** and **sprint reviews** kept the client engaged
- Project resulted in high-quality product, satisfied client, **delivered** on-time and **20% under budget**

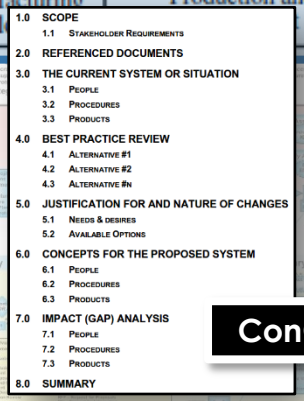
PROGRESS

- **Problem Statement**
- **Practical Example**
  - Project Background
  - Project Management Approach
  - Project Implementation
  - Project Accomplishments & Benefits
- **Applicability to DoD Acquisitions**
- **Summary**

APPLICABILITY TO DOD ACQUISITIONS

USER NEEDS





User Needs

ConOps

Acquisition Framework

A (Program Initiation) B C IOC FOC

Materiel Solution Analysis	Technology Development	Engineering and Manufacturing Development	Production and Deployment	Operations and Support
Materiel Development Decision	PDR or PDR or PDR Pre-EMD Review Post-PDR Assessment	Post-CDR Assessment	LRIP/IOT&E FRP Decision Review	
Pre-Systems Acquisition		Systems Acquisition		Sustainment

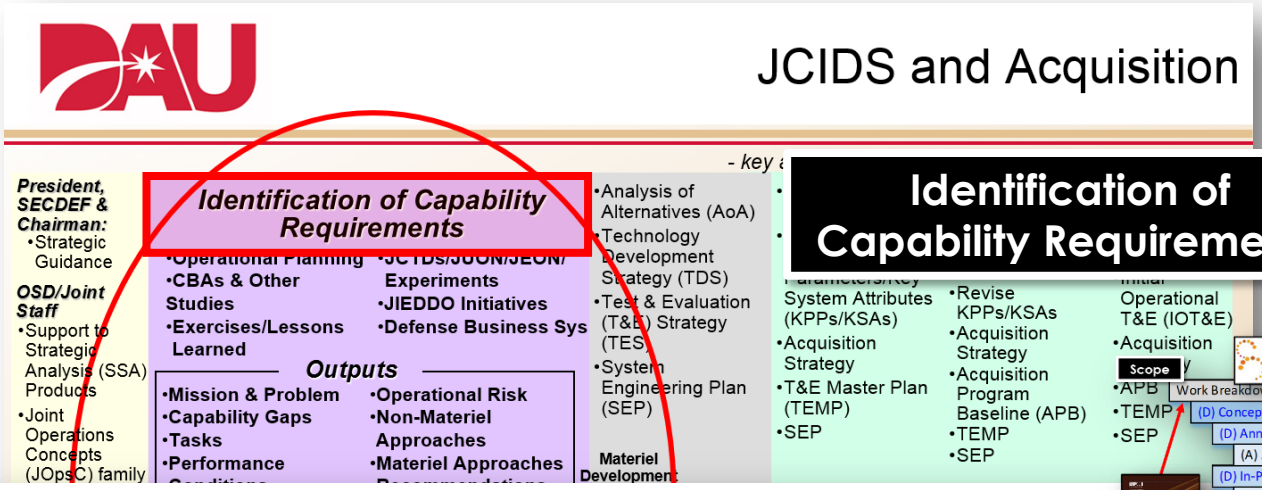
Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System

Source: http://cimsec.org/wp-content/uploads/2015/08/atl_wall_chart.jpg

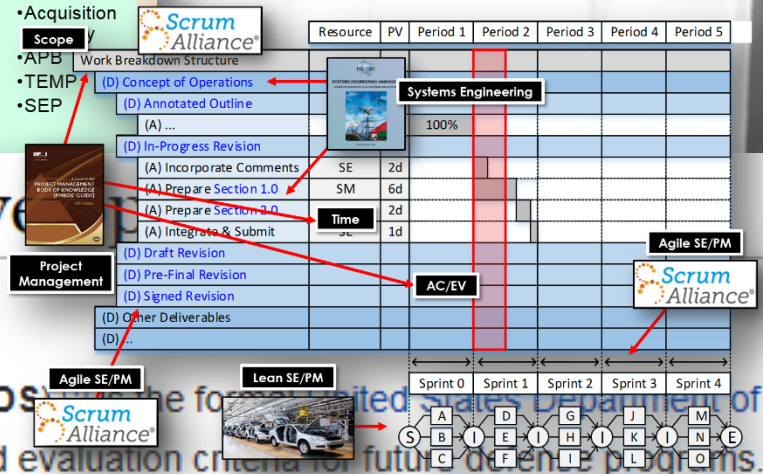
APPLICABILITY TO DOD ACQUISITIONS

JOINT CAPABILITIES INTEGRATION DEVELOPMENT SYSTEM

Defense Acquisition University



Identification of Capability Requirements

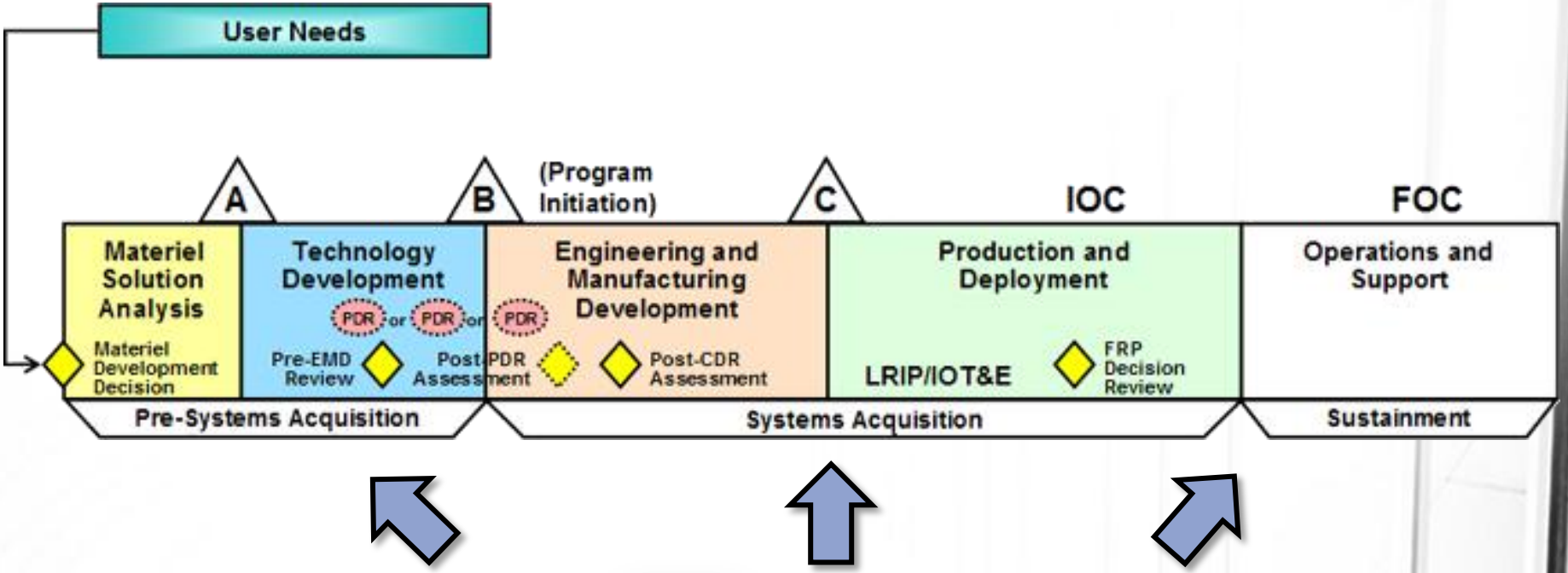


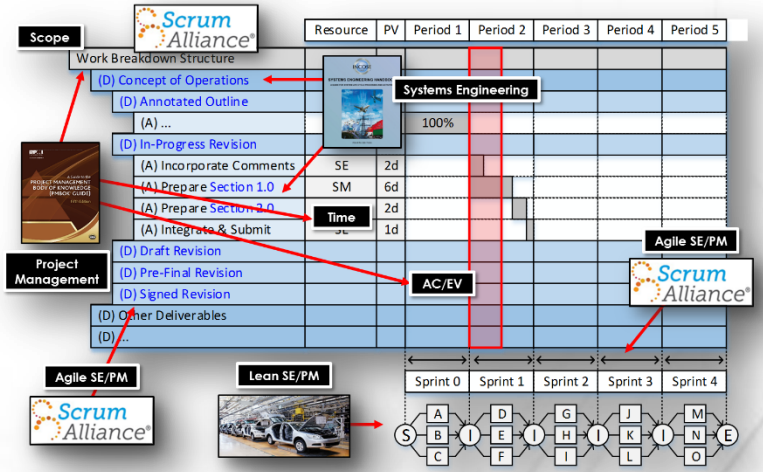
Joint Capabilities Integration Deve

From Wikipedia, the free encyclopedia

The **Joint Capabilities Integration and Development System** (JCIDS) is the fo ited States Department of Defense (DoD) procedure which defines acquisition requirements and evaluation criteria for future defense programs. JCIDS was created to replace the previous service-specific re ments generation system, which created redundancies in capabilities and failed to meet the combined needs of all US military services. In order to correct these problems, JCIDS is intended to guide the development of requirements for future acquisition systems to reflect the needs of all four services (Army, Navy, Marines, and Air Force) by focusing the requirements generation process on needed *capabilities* as requested or defined by one of the US combatant commanders. In the JCIDS process, regional and functional combatant commanders give feedback early in the development process to ensure that their requirements are met.

APPLICABILITY TO DOD ACQUISITIONS
INTEGRATED ACQUISITION FRAMEWORK





PROGRESS

- **Problem Statement**
- **Practical Example**
  - Project Background
  - Project Management Approach
  - Project Implementation
  - Project Accomplishments & Benefits
- **Applicability to DoD Acquisitions**
- **Summary**

AGILE SYSTEMS ENGINEERING
SUMMARY

National Defense Industrial Association

PRACTICAL EXAMPLE
PROJECT BACKGROUND

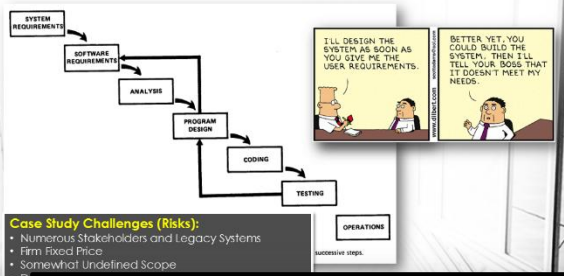
Power Control Center (Examples)

PROJECT SCOPE:

- Facilitate and Support Development of Concept of Operations (ConOps) for a Power Control System
- ConOps to Serve as Agreement between Operators & Maintainers and Designers & Implementers
- Mix of Experienced Systems Engineers and Industry & Technology Subject Matter Experts
- Guide Client & Make Recommendations based on Domestic & International Best Practices

PRACTICAL EXAMPLE
PROJECT CHALLENGES

Waterfall Approach with Potential Late Surprises & Rework



Case Study Challenges (Risks):
- Numerous Stakeholders and Legacy Systems
- Firm Fixed Price
- Somewhat Undefined Scope

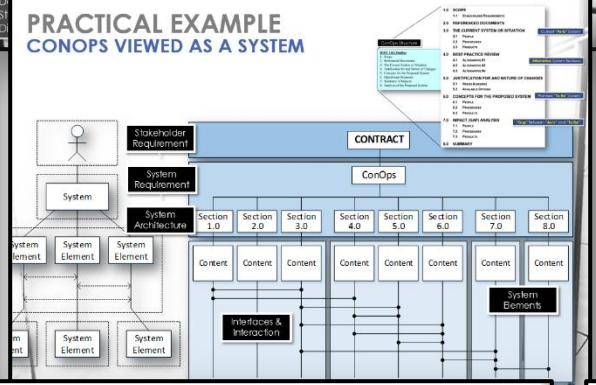
PRACTICAL EXAMPLE
OBJECTIVES (RISK MITIGATIONS)

- Satisfy the Client through **early and often delivery** of ConOps, **avoiding late surprises** common to the waterfall approach
- **Incorporate changes** from ConOps reviews and walk-throughs ('sprint reviews') into each new revision of the ConOps **before next release**
- **Deliver 'shippable' versions**, with an average of three weeks between sprints, keeping the team focused and the Client apprised of the progress
- **Work together with the Client** in frequent stakeholder meetings throughout the project and meet in person whenever possible
- **Use released versions** of the ConOps **as a measure of progress** (demonstrating earned value)
- Provide continuous attention to technical excellence, **using best**

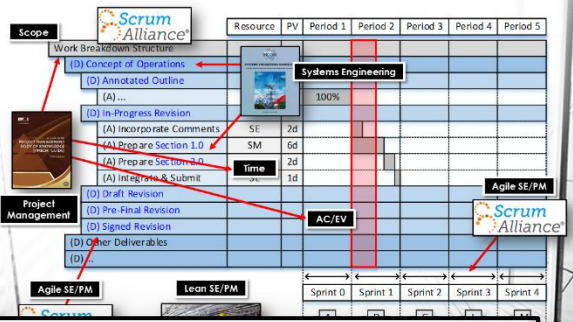
PRACTICAL EXAMPLE
MANAGEMENT CONSIDERATIONS

Project Management	Systems Engineering	Agile Product Development	Lean Product Development Flow
		Scrum Alliance®	
➢ Request for Proposal ➢ Scope Management ➢ Cost Management ➢ Schedule Management ➢ Risk Management ➢ Other	➢ Systems Development ➢ Concept of Operations ➢ Stakeholder Mgmt. ➢ Legacy Products & Procedures ➢ Other	➢ Early & Often Delivery ➢ Shippable Product ➢ Increment (Sprint) Reviews ➢ Avoid Late Surprises ➢ Progress Demonstration ➢ Other	➢ Continuous Work Flow ➢ Individual "Takt Periods" ➢ Regular Integration ➢ Lean Principles (i.e. Pull, Value, etc.) ➢ Other

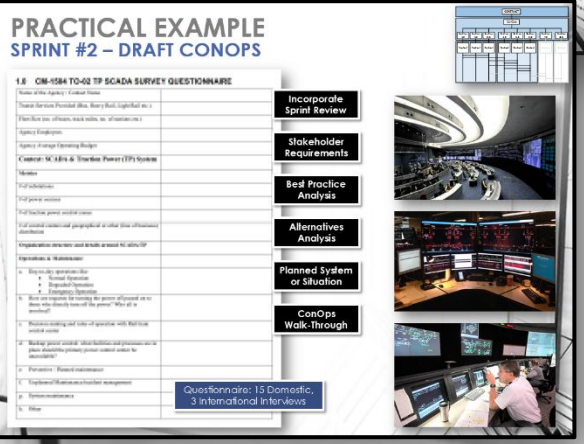
PRACTICAL EXAMPLE
CONOPS VIEWED AS A SYSTEM



PRACTICAL EXAMPLE
PUTTING IT ALL TOGETHER



PRACTICAL EXAMPLE
SPRINT #2 – DRAFT CONOPS

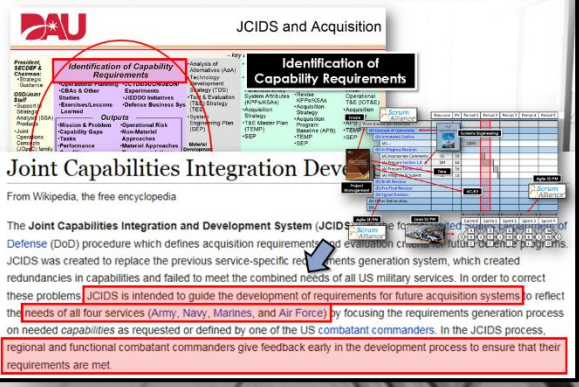


PRACTICAL EXAMPLE
ACCOMPLISHMENTS & BENEFITS

- Systems Engineering helped significantly **defining the project scope** such as project phases, deliverables, activities, etc.
- Delivering the ConOps **early and often** helped **avoiding late surprises** that could have potentially resulted in rework, delays, and cost overruns
- **Sprints** with an average length of three weeks kept the team focused and did not allow for distractions
- Performing regular integration of new content into **'shippable' ConOps 'architecture'** distributed the integration work load and risk
- **Spring reviews** were valuable opportunity to validate stakeholder requirements
- **Released versions** of the ConOps served very well **as a measure of progress** (demonstrating earned value)
- Frequent **stakeholder meetings** and **sprint reviews** kept the client engaged
- Project resulted in high-quality product, satisfied client, **delivered** on-time and **20% under budget**

APPLICABILITY TO DOD ACQUISITIONS
JOINT CAPABILITIES INTEGRATION DEVELOPMENT SYSTEM

DAU Defense Acquisition University



CONCLUSIONS & SUMMARY
QUESTIONS & ANSWERS

Thank You for Your Attention!

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