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Advanced Information Services Inc.

Experiences Integrating PSP and TSP with Six Sigma

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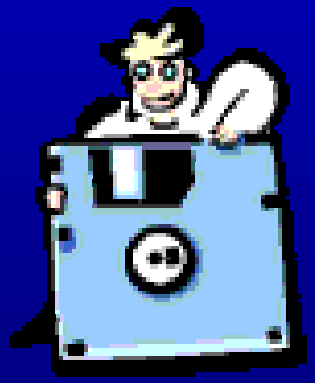
Agenda

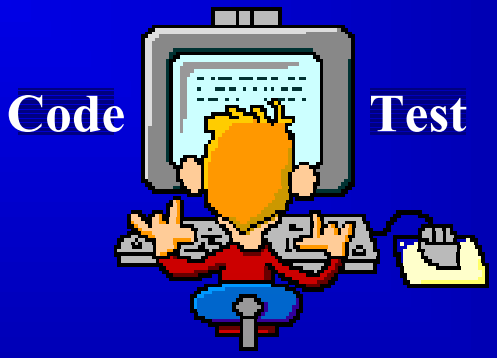
- Purpose & Background
- A Few Words about Six Sigma and TSP
- Deploying TSP as part of the Six Sigma Initiative at Honeywell
- Lessons Learned

Oh Those Initiatives!

"XYZ"
SQA
FDD
XP
UML
CMMI
Scrum
SDLC
Agile
PSP/TSP
6σ



Makes You Just Want To…



Presentation Purpose

Discuss *one* example of an approach taken for integrating TSP into a Six Sigma (6σ) initiative

- Large company
- Software not a "core competency" (even though most products depend on it)
- 6σ was an organization with experience primarily outside of development engineering

Many other valid approaches certainly exist

My Background

Currently with AIS as a full-time TSP coach and PSP instructor, supporting Microsoft IT organization

11,045,160 minutes in software engineering, first 6,837,480 as a software development engineer, last 4,207,680 in software process and quality

6σ: Green Belt certified in DMAIC in 1998, Black Belt certified in DMAIC in 2003, Green Belt certified in DFSS in 2003

PSP/TSP: Authorized as PSP instructor in 1999; Authorized as a TSP launch coach in 2002

A Few Words about Six Sigma—1

Six Sigma (6σ) is (as I see it, anyway)

- A term
  - Six standard deviations away from the mean of a normal distribution -> 3.4 defects per million "opportunities"
- A philosophy
  - Moving products and processes to optimal target values, and reduction of variation around those targets
  - Defect prevention over (late) defect detection
  - Continuous improvement

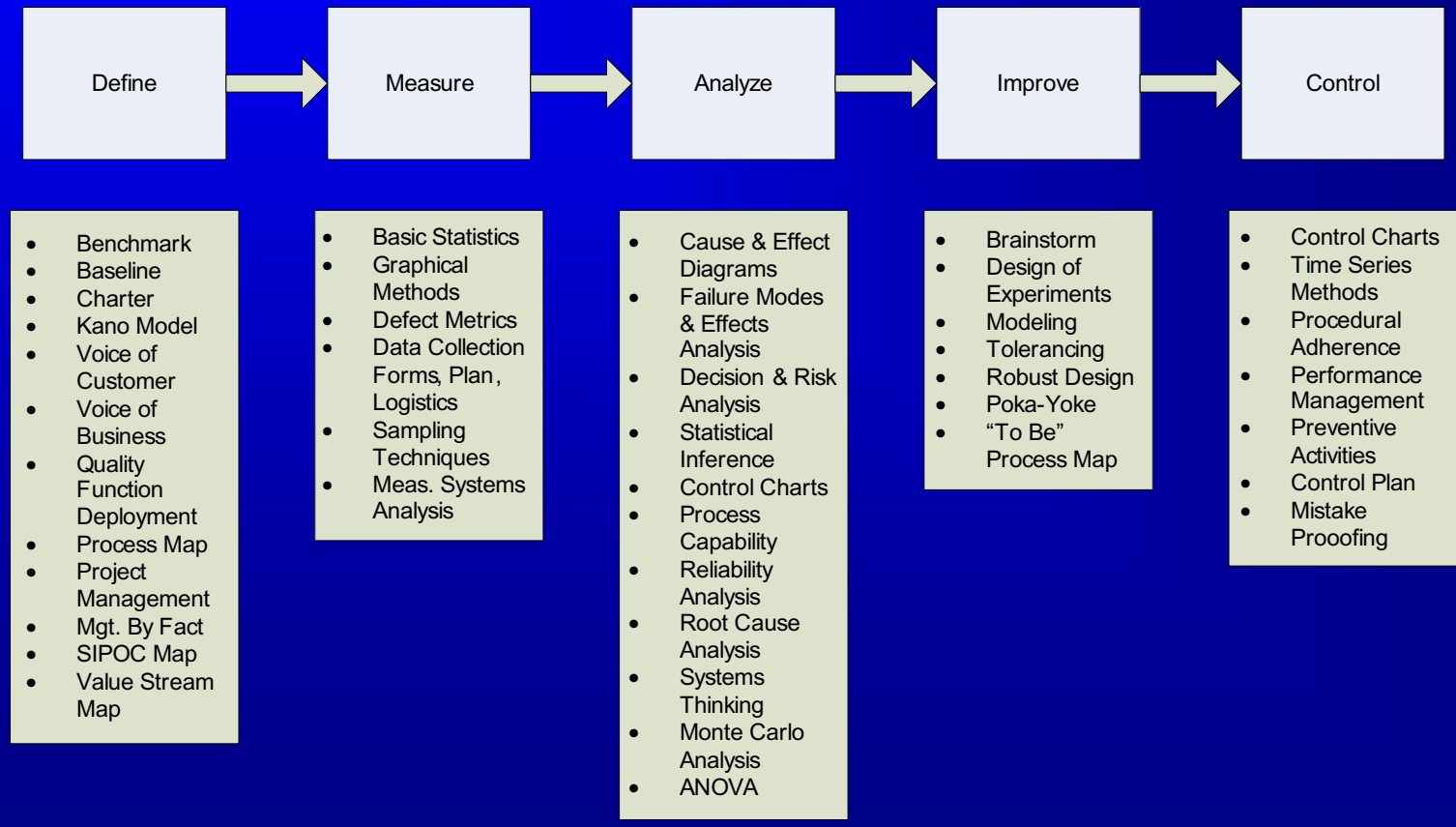
A Few Words about Six Sigma—2

6σ is implemented with

- One or more approaches (or strategies), e.g.,
  - "DMAIC" (Define, Measure, Analyze, Improve, Control)
  - "Lean" ("Manufacturing" or "Enterprise")
  - "DFSS" (Design For Six Sigma—most recent)
  - Approach used depends on context
- One or more toolsets (methods and techniques)
  - Statistical and other methods for analyzing product and process data, and for making improvements to processes and controlling them
  - Many tools are "soft"
  - No standard toolset—toolsets vary by approach, company, organization, wind speed, …

A Few Words about Six Sigma—3

An example *partial* 6σ toolset



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A Few Words About PSP/TSP

The PSP/TSP philosophy (adapted from the "PSP book")

- Plan and manage your work
- Use effective methods
- Recognize strengths and weaknesses
- Practice, practice, practice
- Learn from history
- Find and learn new methods

Some key PSP/TSP "tools" (methods)

- Use of process data for fact-based decision-making
- PROBE (PROxy Based Estimating)
- Earned Value Tracking

} 6σ: Reduce Variation

- Structured Personal Reviews and Team Inspections
- Verifiable Designs and Design Verification techniques

} 6σ: Defect Prevention

- Postmortems and Improvement Proposals

} 6σ: Continuous Improvement

Consistent with 6σ philosophy!

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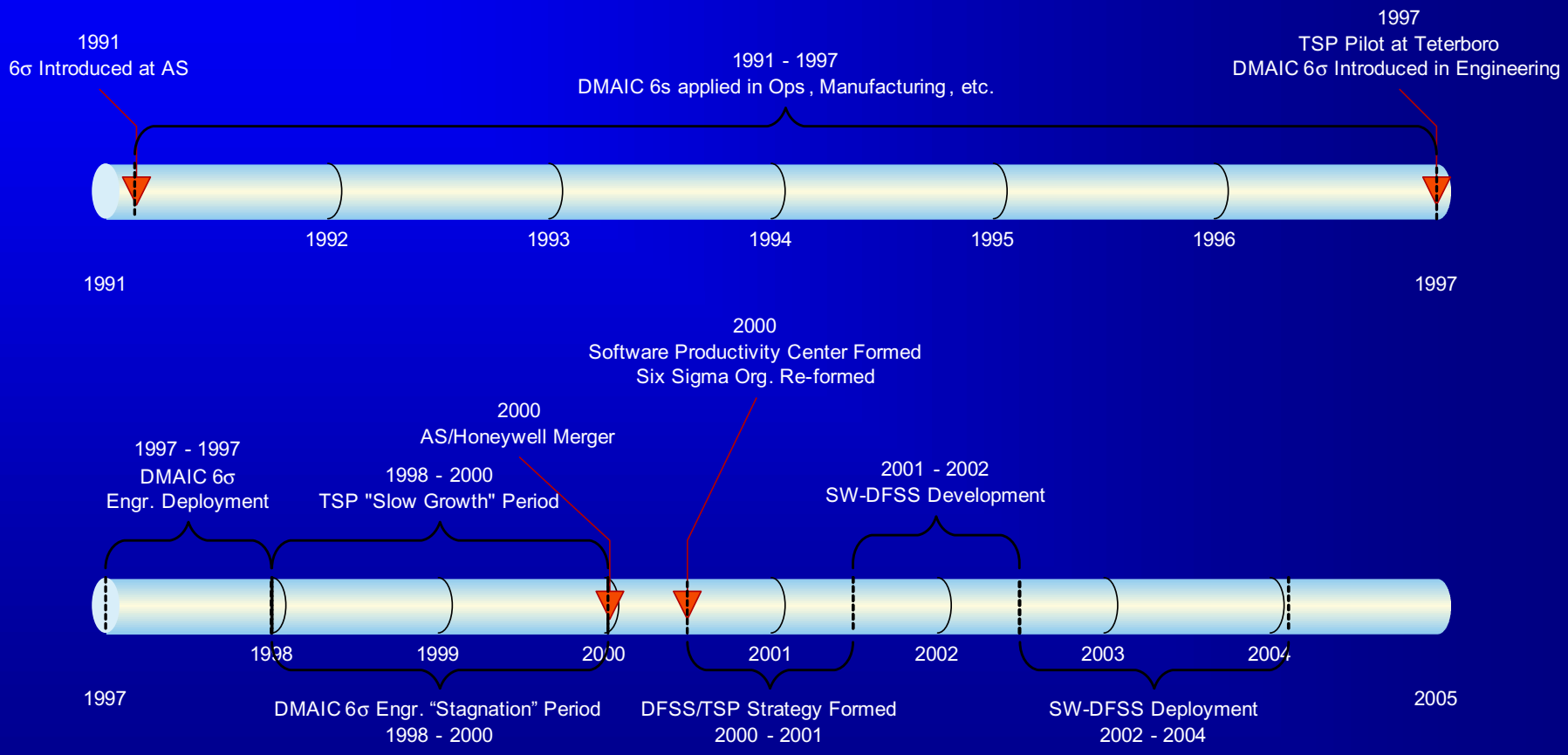
Evolution of TSP and Six Sigma at AlliedSignal/Honeywell



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Honeywell SW DFSS Strategy

Strategy, Take 1: PSP/TSP *is* 6σ for Software

- Good start, but not sufficient

Refined Strategy: Build a SW DFSS toolset from

- PSP and TSP
- Existing 6σ tools most useful for software development
  - QFD, Process Map, FMEA, SPC, Control Plan,…
  - Provide software-specific usage examples
- Existing software development methods consistent with 6σ philosophy
  - Software Inspections, Software Scorecard, DFT, DFR,…

Six Sigma and the TSP Launch—1

Meeting	Primary Six Sigma Tools
1: Allow management to review business and product needs, explain project constraints, and ensure team understands these needs and constraints	
2: Define team goals and roles	Quality Function Deployment (QFD)
3: Produce the project conceptual design and strategy, identify major deliverables, and produce the process and support plans	QFD Process Mapping (PMAP) Measurement System Evaluation (MSE)
4: Produce an overall team-level project plan	PMAP (update)
5: Produce the Quality Plan	Design For Reliability (DFR) Scorecard Lean Principles
6: Produce the bottom-up next phase plan for each engineer and consolidated next-phase plan	PMAP (update)
7: Identify project risks and produce the risk management plan	Failure Mode and Effects Analysis (FMEA)
8: Prepare the plan presentation for the management meeting	
9: Present team plan to management and obtain approval of the plan	
PM: Identify what went well during the launch and what could be improved	Lessons Learned

Six Sigma and the TSP Launch—2

Quality Function Deployment

- Structured method used to identify/prioritize customer's needs and development activities, mapping the What's and Why's from meetings 1 and 2 into How's and Who's in meetings 2 through 4

Process Mapping

- Used during Meeting 3 to document development strategy & processes
- "Big Y" is determined in meetings 1 and 2
- Process map x's can be used as inputs to the FMEA used in Meeting 7

Kappa MSE

- Used during Meeting 3 to determine appropriate defect type categorization

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Six Sigma and the TSP Launch—3

Design for Reliability (DFR) and the (Software) Scorecard

- Extensions to the Quality Plan used to set quality goals in order to actively manage the process to meet the goals
- Scorecard includes Quality Plan "defect leakage matrix" actuals plus other typical TSP quality data such as DLRs, COQs & A/FRs

Lean Principles

- Used in Meeting 5, which focuses on removing defects where it is most efficient

FMEA

- Extension of the Risk Analysis and Management Plan, using data from Process Maps to identify and prioritize risks, and to develop risk plans

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Example QFD

Calculator House of Quality (HoQ)

Technical Response
Voice of the Developer (Hows)

Technical Correlations

	Software				Hardware				
Batteries	0	0	0	0	0	0	+	-	0
Keypad Buttons	+	0	0	0	+	0	+	+	
Weight	0	0	0	0	0	-	-		
Dimensional Envelope	0	0	0	0	+	-			
Display Size	0	+	0	0	+				
Material Cost	0	0	0	0					
Perform Arithmetic	0	0	+						
Store Input Characters	0	0							
Write To Display	0								
Read and Debounce Button									

Customer Needs
Voice of the Customer (Whats)

1st Level	2nd Level	3rd Level	Target Values: Units	Dir	Goal	UTL	LTL	Read and Debounce Button	Write To Display	Store Input Characters	Perform Arithmetic	Material Cost	Display Size	Dimensional Envelope	Weight	Keypad Buttons	Batteries	Importance to customer (1-5)	Customer satisfaction with current performance (1-5)	Competitive satisfaction performance (1-5)	Goal (1-5)	Improvement ratio (goal / current satisfaction performance)	Sales point (1, 1.2, 1.5)	Raw weight (importance to cust. X improvement ratio X sales point)	Normalized raw weight (%)	Overall importance ranking
Does what I want it to do	Supports basic numbers	Standard radix	Base	TB	10	10	10		3	1	3					3		5	5	5	5	1	1	5	7.2	5
		Integer and floating point						1	1		3					9		4	5	5	5	1	1	4	5.8	7
		Positive and negative numbers						1	1	1	3			1		9		4	5	5	5	1	1	4	5.8	7
		High accuracy	Digits	MTB	10		9		1	3	3		9	1				5	3	3	5	1.67	1.5	12.5	18.0	2
	Supports basic functions	Add, Subtract, Multiply, Divide						1	1	1	9			1		9		5	5	5	5	1	1	5	7.2	5
Easy to use	Edit	Delete input characters						1	1	9			1	1		9		3	1	3	5	5	1.2	18	25.9	1
	Easy to handle	Fits in shirt pocket	Inches	LTB	3x5x0.5	4x6x0.5						3		9		1	3	5	3	3	4	1.33	1.2	8	11.5	3
		Light-weight	Oz.	LTB	3	4						1		9	9	1	9	4	3	3	4	1.33	1.2	6.4	9.2	4
	Easy to buy and maintain	Low cost	$	LTB	5	8						9	3	3	1	3	1	2	3	4	3	1	1.5	3	4.3	10
		Uses inexpensive power source	$	LTB	1	1.5	0					3	3	3	1	1	9	3	3	4	3	1	1.2	3.6	5.2	9

Technical Impacts

	Read and Debounce Button	Write To Display	Store Input Characters	Perform Arithmetic	Material Cost	Display Size	Dimensional Envelope	Weight	Keypad Buttons	Batteries
Raw Contribution to Overall Customer Satisfaction	44.6	84.2	307	175	98.1	216	272	92.4	462	168
Normalized Contribution to Customer Satisfaction (%)	2.3	4.4	16.0	9.1	5.1	11.3	14.2	4.8	24.1	8.8
Ranked Contribution to Overall Customer Satisfaction	10	9	2	5	7	4	3	8	1	6

Software Development Targets

	Read and Debounce Button	Write To Display	Store Input Characters	Perform Arithmetic	Material Cost	Display Size	Dimensional Envelope	Weight	Keypad Buttons	Batteries
Measurement Units	Milliseconds	Milliseconds	Number	Milliseconds	$	Digits	WxLxH	Ounces	Number	Size
Direction of Goodness	LTB	LTB	MTB	LTB	LTB	MTB	LTB	LTB	LTB	LTB
Goals	50	50	10	200	4	10	3x5x0.5	3	20	AA
Upper Spec Limit (USL)	100	100	10	300	4.2	12	4x6x0.5	4	22	C
Lower Spec Limit (USL)			9			9			18	AAA

Hardware Performance Measures

Measurement Units	
Direction of Goodness	
Goals	
Upper Spec Limit (USL)	
Lower Spec Limit (LSL)	

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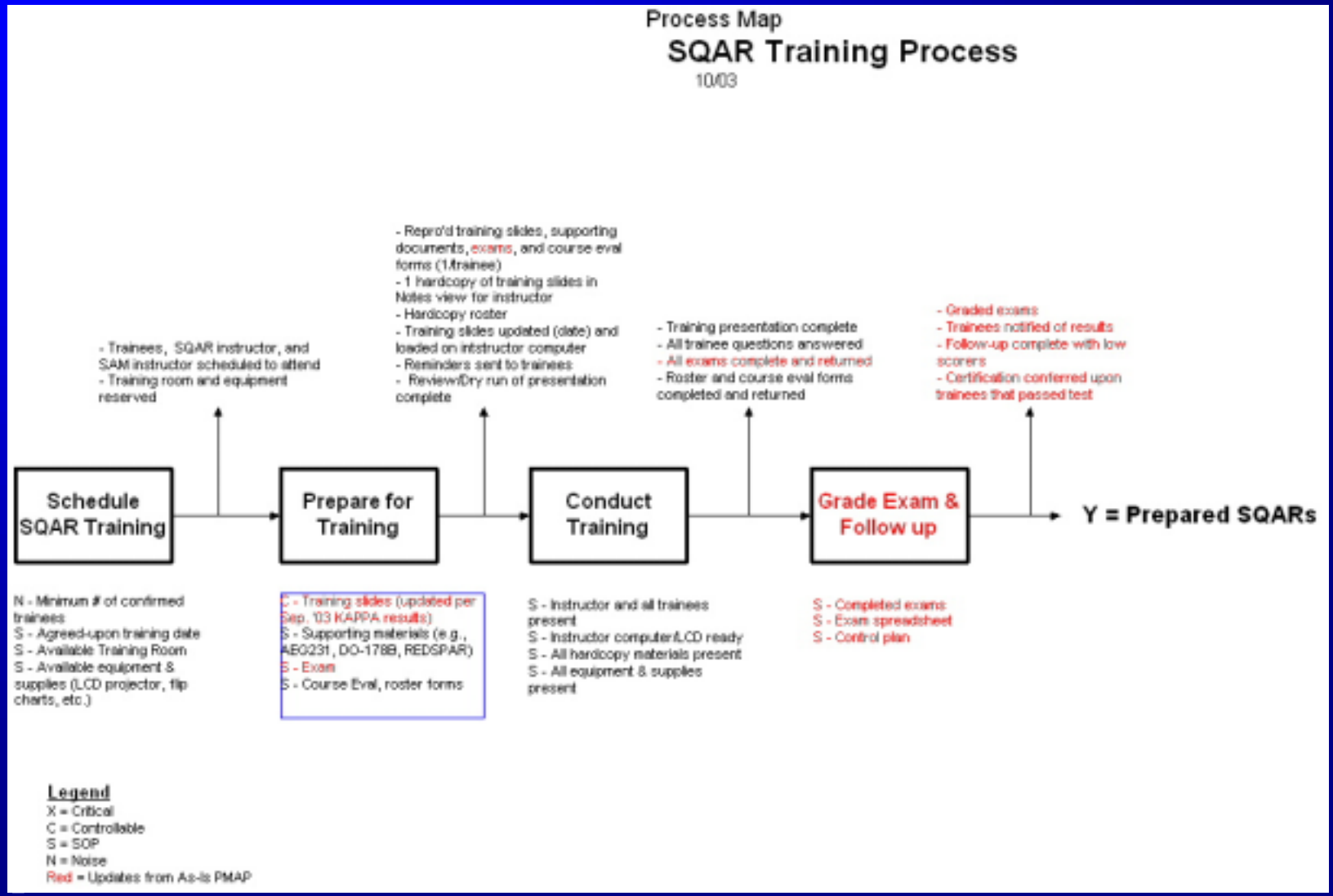
Example Process Map



Example Partial FMEA

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN
What is the process step/input?	What can go wrong with the process step/input?	What is the impact on the customer (output variables) or internal requirements?		What are the root cause reasons for the process step/input to go wrong?		What are the existing controls that prevent or detect either the cause or the FM prior to leaving the process step?		
Conduct Training	SQAR does not adequately understand SQAR responsibilities	SQAR does not enforce AEW309 requirements to produce designs for changes	10	Trainee doesn't pay attention	4	None	10	400
Conduct Training	SQAR does not adequately understand SQAR responsibilities	SQAR does not enforce AEW309 requirements to produce designs for changes	10	Training material does not adequately cover all areas of responsibility	10	None	10	1000
Conduct Training	SQAR does not adequately understand SQAR responsibilities	SQAR does not enforce AEW309 requirements to produce designs for changes	10	Trainee misses part of class	1	Theoritically, if a trainee missed enough of the class, the SQE can withhold certification	7	70

Example Scorecard

Project: ______________________

Date: ______________
note: data in shaded cells is calculated v12

Process Step Where Defect Injected	SW Requirements	SW Design	SW Implementation	SW I&T	System Test	SW Certification	Post-Release	Unresolved		Total Defects Injected	Quality Escapes (Phase)	Leakage (Phase)	Yield
	Process Step Where Defect Removed												
System Requirements	5	2	0	2	1	0	0	0		10	10	100.0%	0.0%
SW Requirements	15	10	8	4	4	4	3	2		50	35	70.0%	33.3%
SW Design		75	65	22	10	7	2	2		173	98	56.6%	40.8%
SW Implementation			210	90	70	4	6	1		381	171	44.9%	53.8%
SW I&T				12	10	3	0	0		25	13	52.0%	50.2%
System Test					15	2	8	0		25	10	40.0%	71.4%
SW Certification						6	0	0		6	0	0.0%	52.0%
Post-Release							0	0		0	0		79.2%
Total Number of Defects	20	87	273	130	110	20	19	5		660			

Effort (Hours):								Other	Total
Failure Cost (Rework)	10	20	120	80	500	240	700	0	1670
Appraisal Cost (Inspections)	8	16	18	15	0	0	0	0	57
Prevention Cost (Causal Analysis)								20	20
Total Software Cost	38	206	338	195	620	280	700	20	2517

24	Total Defects in Delivered Product
96.4%	Overall Process Yield

Cost of Quality (COQ)	18.4%	13.5%	40.8%	48.7%	80.6%	85.7%	100.0%	100.0%	69.4%	
Defect Removal Effort (Hours/Defect)	0.9	0.4	0.5	0.7	4.5	9.2	36.8		2.6	<--- Avg. Defect Removal Effort
Defect Removal Leverage	5.1	11.0	5.0	6.2	1.0	0.5	0.1			
Appraisal/Failure Ratio (A/FR)	0.80	0.80	0.15	0.19	0.00	0.00	0.00	-	0.03	

Other Measures:		Units			
Size (Developed)	7000	LOC	→ Defect Injection	0.094	Defects / Developed LOC
			→ Productivity (Process)	2.8	Developed LOC / Hour
Size (Delivered)	10	KSLOC	→ Productivity (Product)	0.0040	Delivered KSLOC / Hour
			→ Defect Density	2.4	Delivered Defects / KSLOC
Software Requirements	260	count	→ "Mega-Metric"	726	$ / Software Requirement
Average Labor Rate	75	$ / hour			
Opportunities	10000	count	→ Sigma	4.3	

Notes:

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Six Sigma and TSP Operation

Control Plans

- Used in 6σ to ensure improvement gains are sustained and to ensure process consistency; intent is fulfilled with the TSP weekly meeting

Basic Statistics and Graphical Methods

- Used routinely in TSP to analyze and control the process and to make process improvements

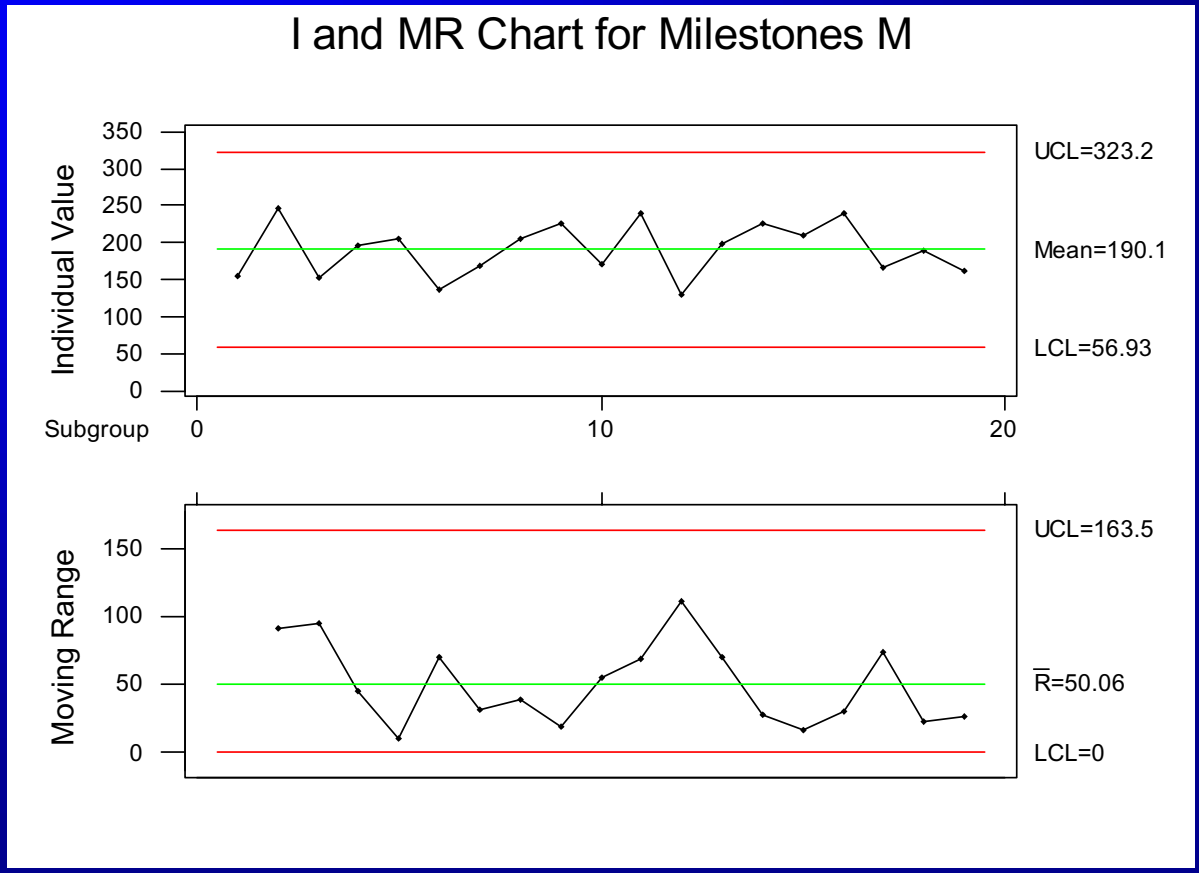
Statistical Process Control (SPC)

- Used for extra rigor in determining statistically whether a process is under control and to identify special cause variation

Appraisals (Inspections)

- Used to remove defects efficiently

Example SPC Control Chart



Six Sigma and PSP—1

Regression, Basic Statistics, and Graphical Methods

- Used in PROBE to provide statistically-sound estimates, and to interpret PROBE values and select the appropriate method

Design For Testability (DFT)

- Incorporated by using the PSP Design Templates

Functional Maps

- A Process Map extension used during DLD to graphically depict flow & function of a logical sequence of actions & events

Six Sigma and PSP—2

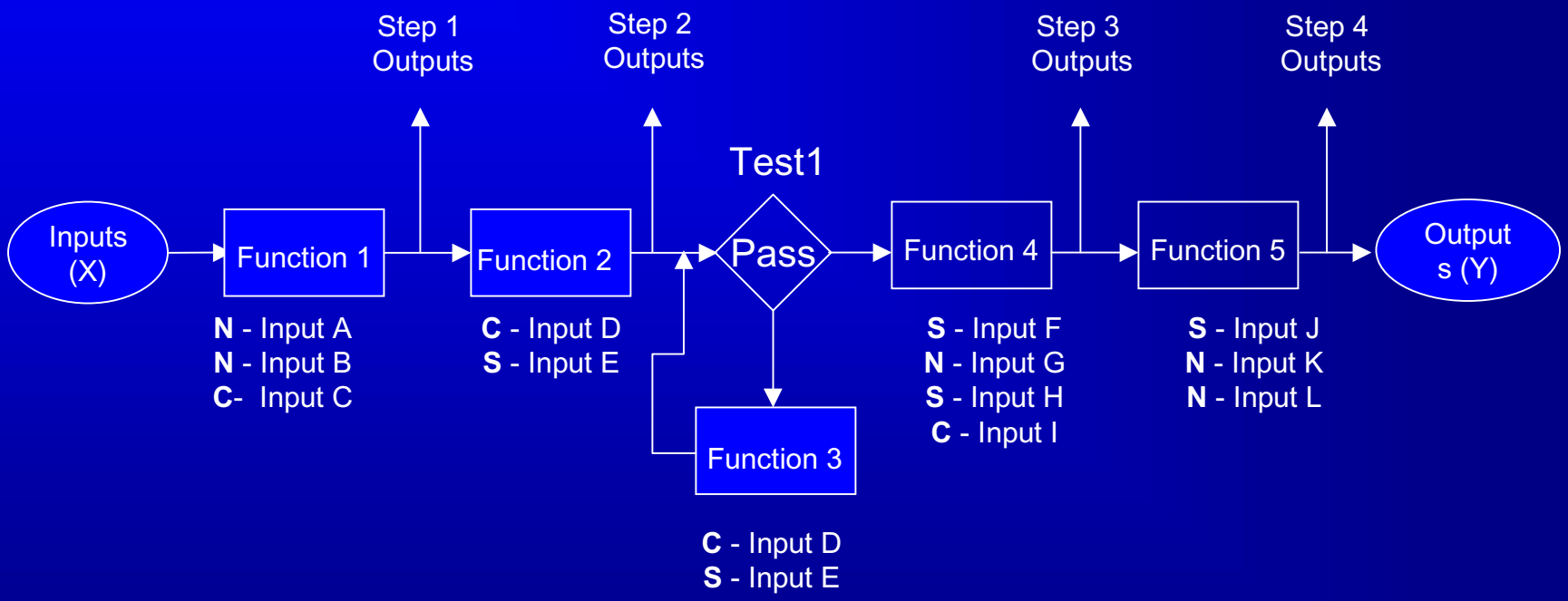
(Personal) Appraisals

- Used to remove defects efficiently; Personal Reviews are essentially software inspections applied at the personal level

Monte Carlo Simulation

- Used during design to select a design approach among several options by providing a potential range of outcomes, probability of reaching specific targets, most likely outcomes, etc.

Example Functional Map



Green Belt Certification Considerations

A typical 6σ initiative requirement is certification

- Training and application of (a subset of) toolset on a 6σ project

Before SW-DFSS, a typical complaint of 6σ was that engineers on development teams had to "make up projects" to use the tools and get certified

By making the natural connection between TSP & 6σ, it became realistic to complete a 6σ project as part of one's normal work

- No problem applying tools!
- PSP, TSP, Regression, Inspections, FMEA (risk analysis), DFR (Quality Plan), Graphical Methods, Basic Stats, Control Plan (weekly meeting), …

The only extra work for certification was to organize personal and/or project data into a report—much like the PSP Final Report

Lessons Learned Integrating TSP into a 6σ Initiative—1

TSP experts should be familiar with the philosophy and standard toolset(s) of the 6σ organization

Map PSP and TSP methods to company-standard 6σ toolset (not all methods will map, but enough should)

For PSP/TSP methods that don't map directly to 6σ tools, but meet the 6σ philosophy, document how they do so

Engage the 6σ organization in validating the mappings

Lessons Learned Integrating TSP into a 6σ Initiative—2

Focus on the 6σ *philosophy* and not just the *tools*

Developing a SW 6σ curriculum—even with existing SEI PSP training—is a significant undertaking and should be treated as a product development effort

Training time may be an issue

Compromises may be necessary

Summary

TSP can be integrated into a 6σ program

There are significant synergies among TSP, 6σ, and other software methods not traditionally associated with either TSP or 6σ

Keep the goals in mind—don't get overwhelmed by initiatives and tools

As a first approximation, it may be best to start with TSP as your 6σ program, then extend

Contact Information

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