REFLECTIONS ON THE JOURNEY TO WORLD-CLASS SOFTWARE QUALITY

by George Yamamura
Boeing Information, Space & Defense Systems

NASA Mission

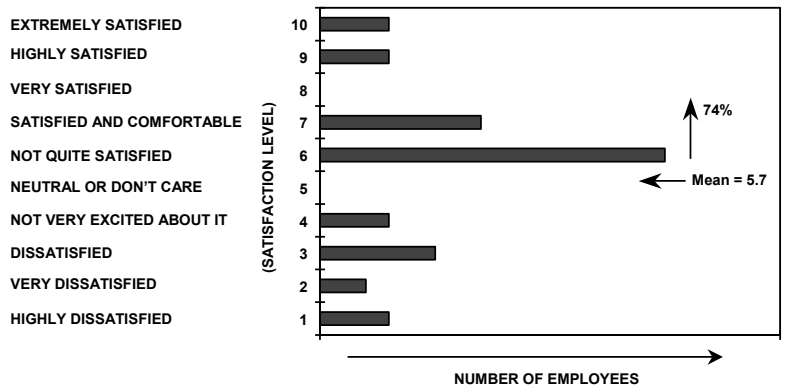
Ad Hoc Environment

- Many interface problems, misunderstandings, repeated mistakes
- Processes thought-up on the fly, reinventing the wheel
- Too busy with project work, no time to work improvements, just get the product out
- Little senior management sponsorship for process improvement, in tiger-team mode
- No extra budget for process improvement, did not want to pay for next project benefits

Manage With Facts & Data

- Conduct a survey
  - What is important to the workforce
  - What should be improved
  - What is the current satisfaction level
- Analyze the situation
  - Ad hoc environment
  - Employee inputs
- Develop a strategy

Employee Satisfaction



Before Process Improvement Activities

Actions

- Document most used processes
- Define most helpful metrics
- Analyze data
- Define goals

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Processes
Tools
Research
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Process Improvement History

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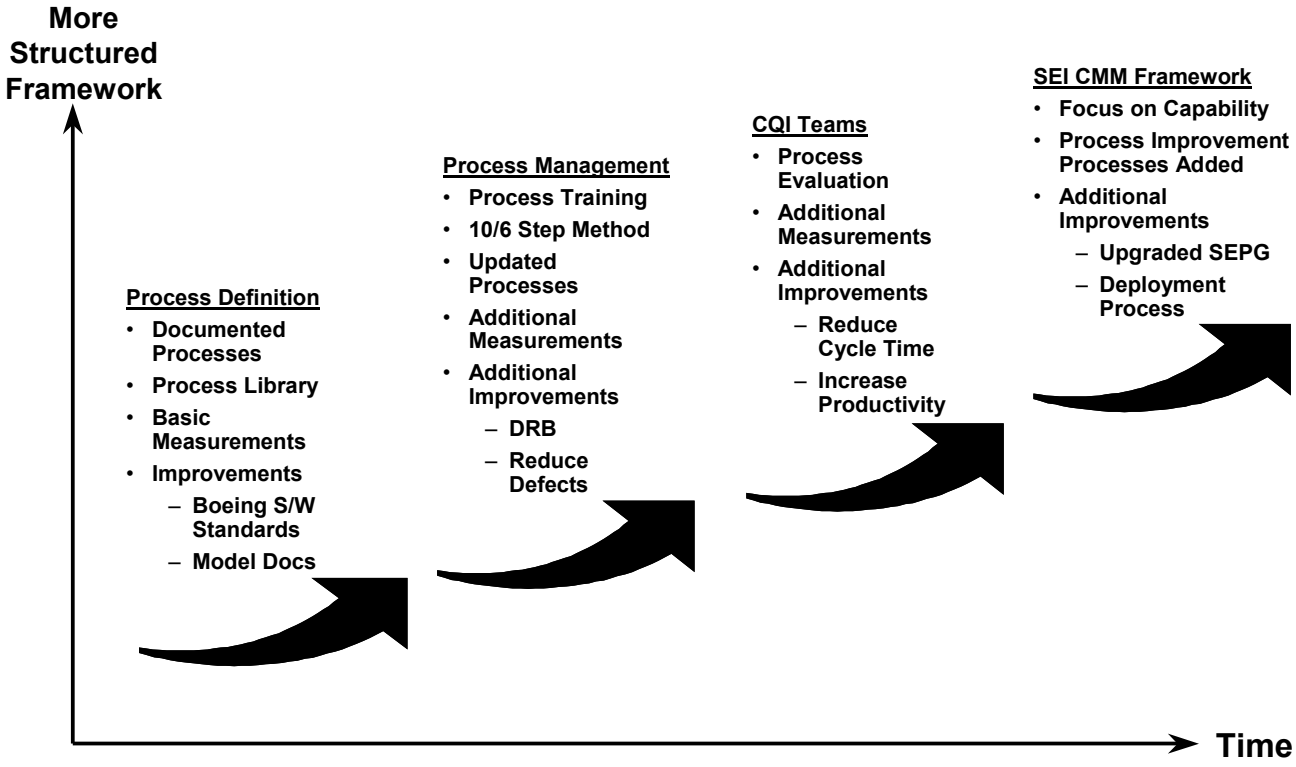

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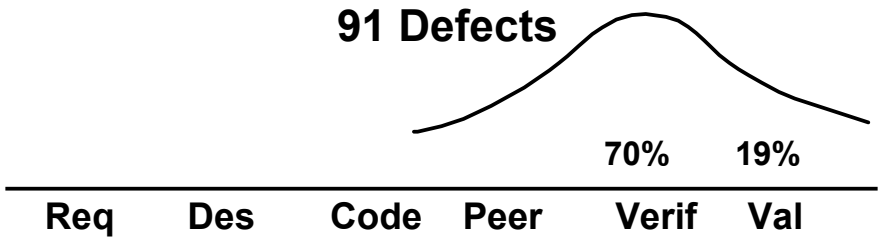
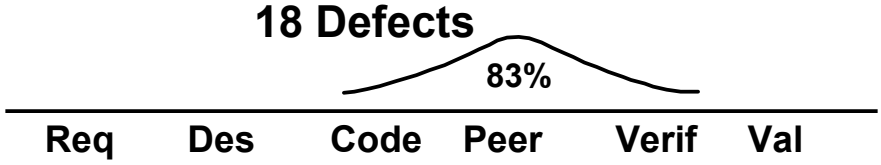
Defect Analysis

BOEING

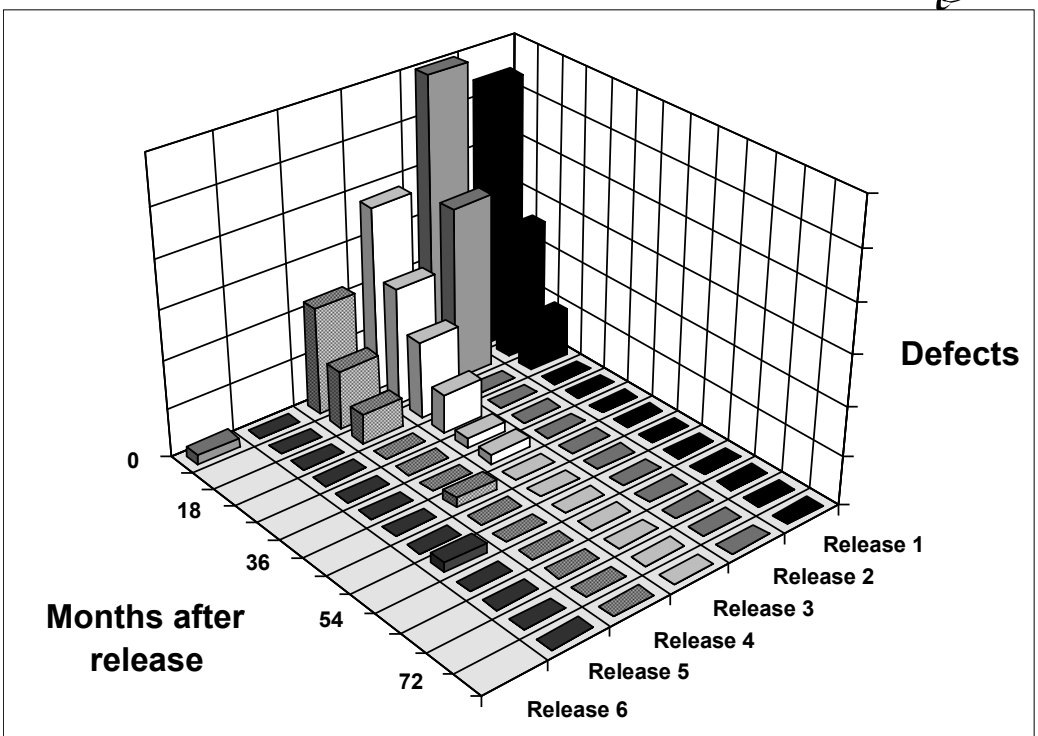
- Defect rate was 5.3%
- Correlated to periods of high activity
  - 3 or more tasks per individual
  - 10 or more tasks per group
  - Fixes greater than 100 words of memory
- Correlated to personnel turnover
  - Coefficient of correlation = .918
- Probability of inducing a defect = 2.6×10^{-3}

Defect Detection

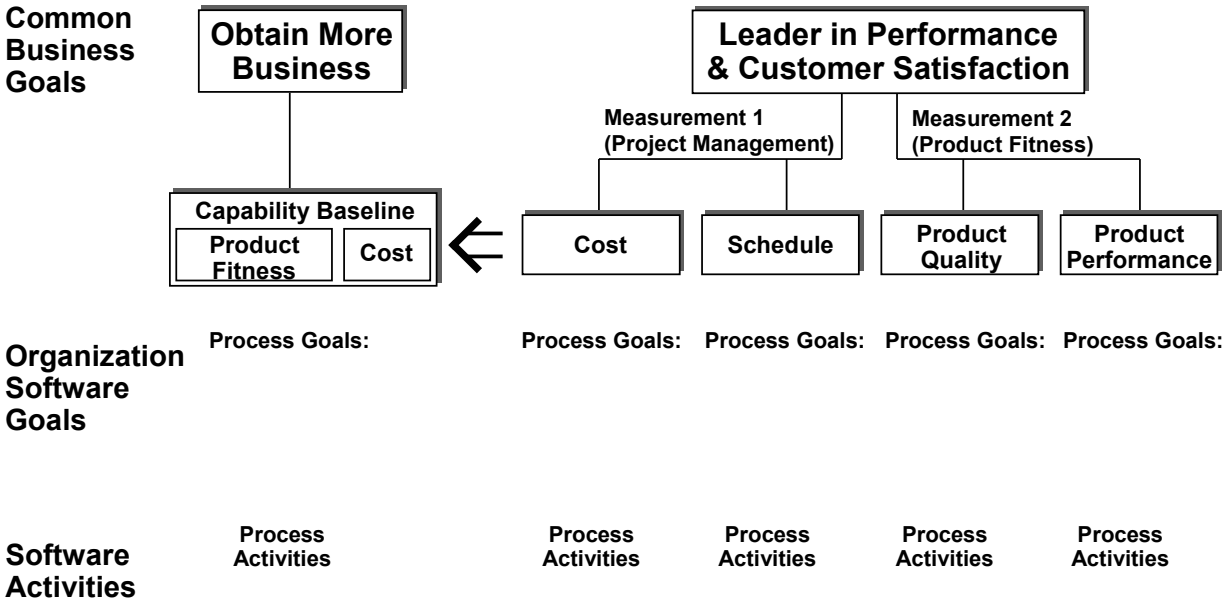




Defect History



Goal Management Framework



Process Focus

Process improvement is a human issue

- Addresses resistance to change
- Requires up-front investment
- Driven by motivation

Institutionalized

Defined:

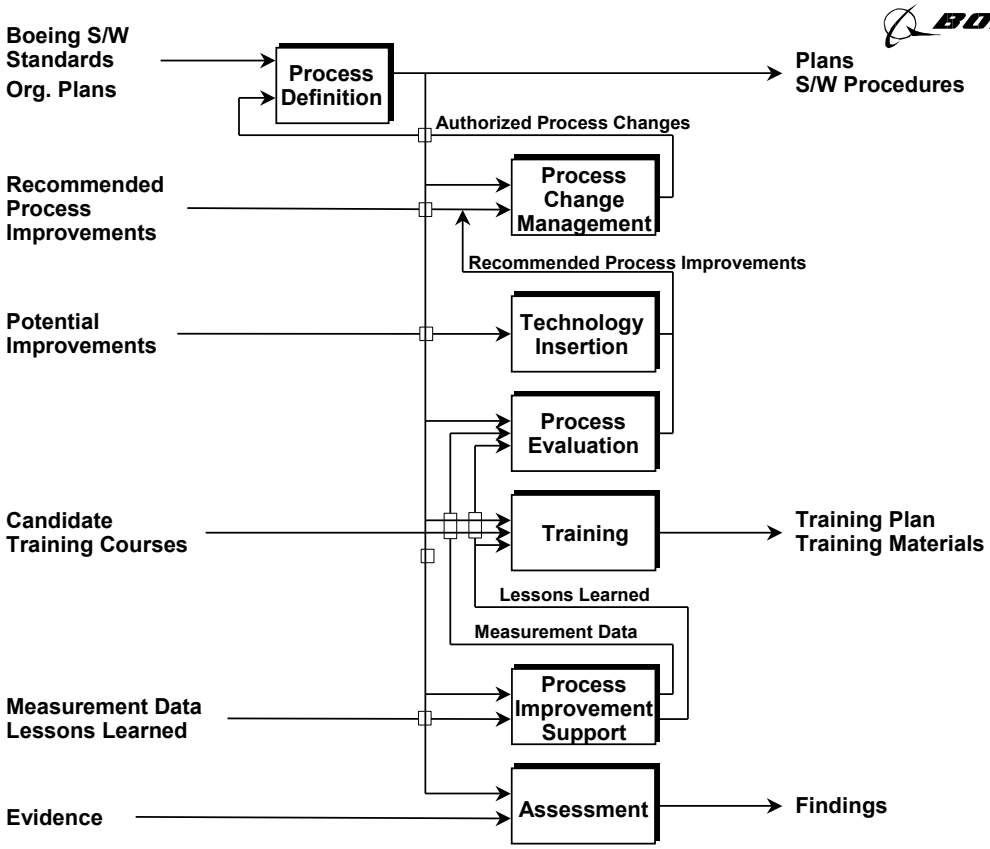
- Documented
- Trained
- Practiced
- Maintained

Established:

- Own
- Believe
- Pride
- Promote

(Motivated & Sustained)

SEPG Tasks



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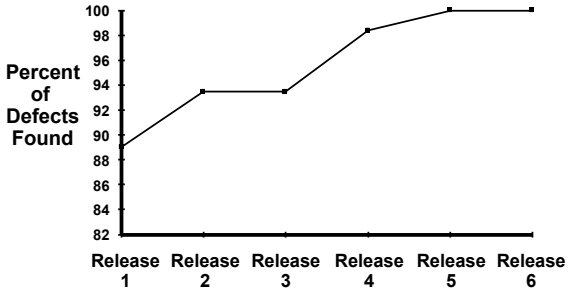
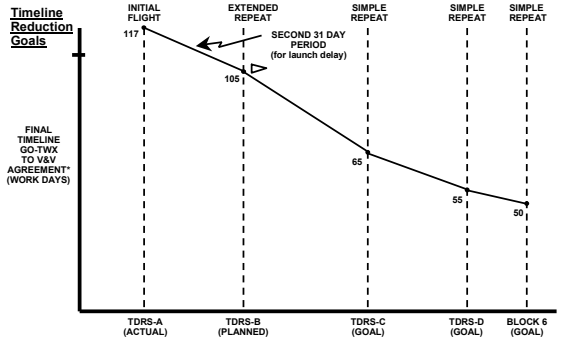
STS Significant Results

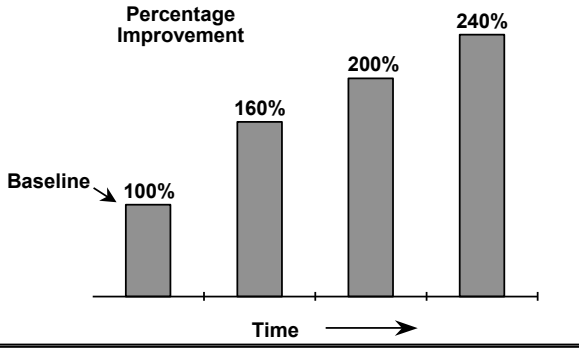
Quality



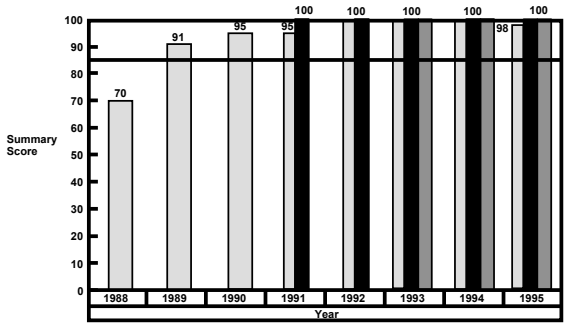
Cycle Time Reduction



Productivity



Customer Satisfaction



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IUS Is Accurate

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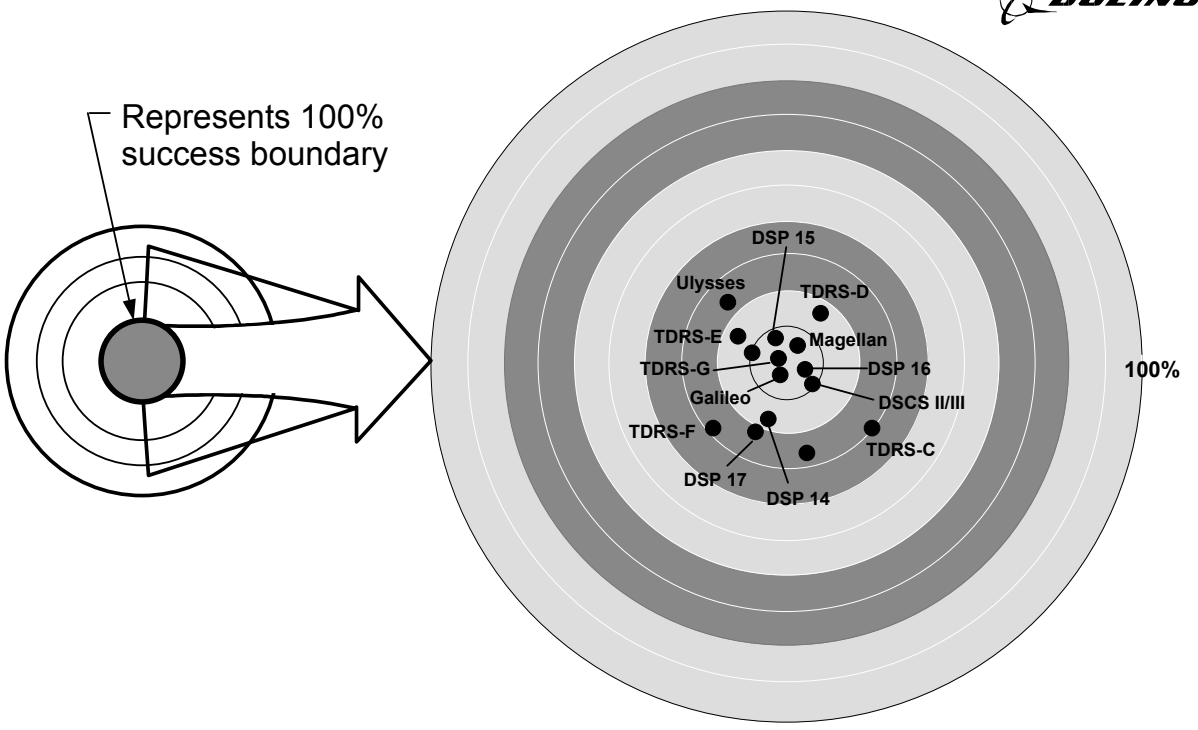
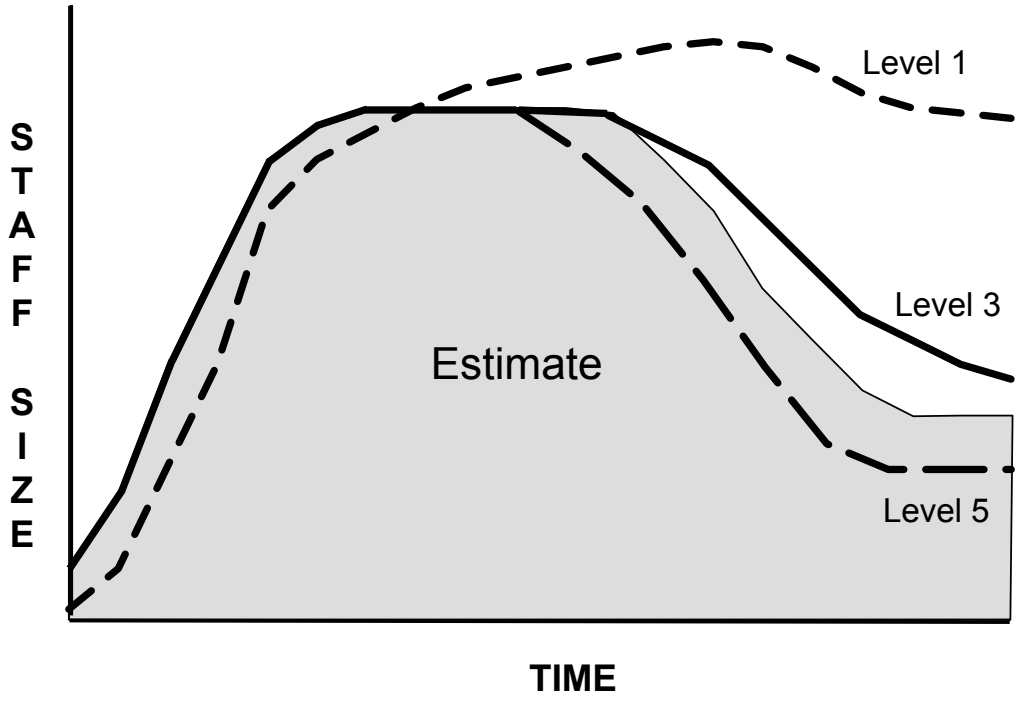
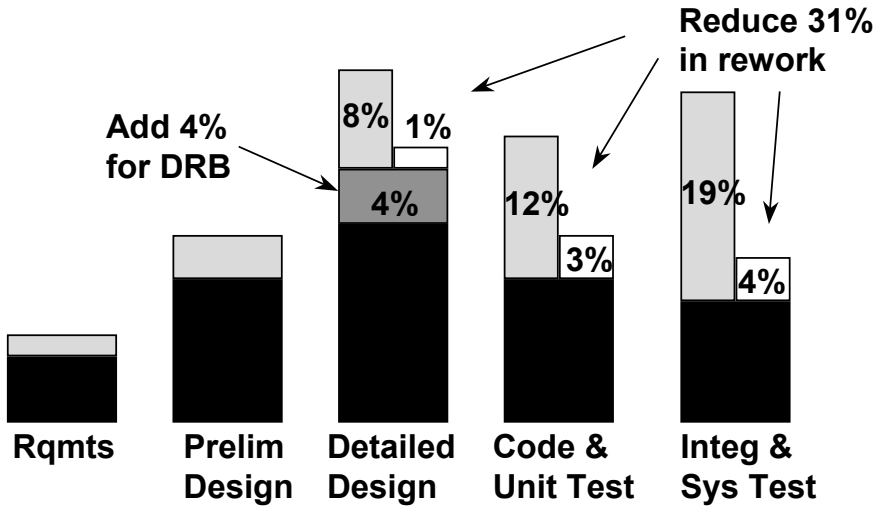


IUS accuracy extends spacecraft mission life

Staffing Profile



IUS Cost:Benefit Ratio

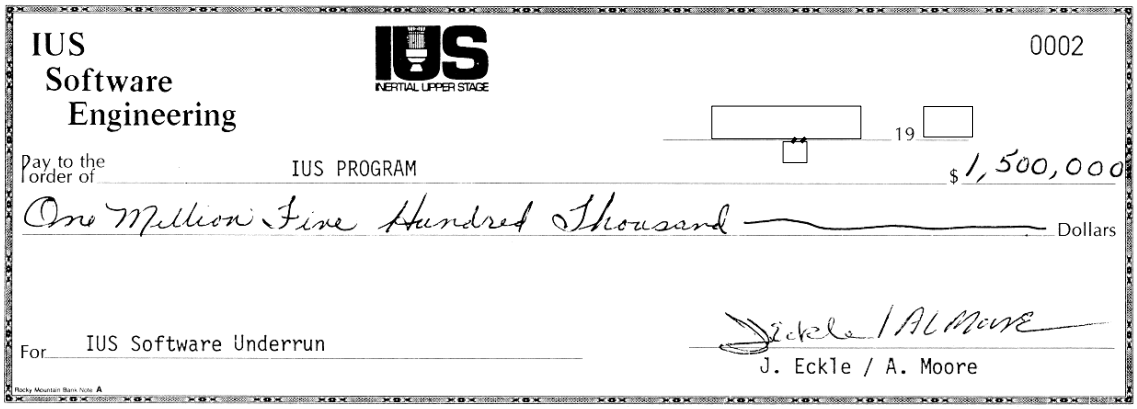


Implementing DRB increased design effort by 4%

Rework effort was reduced in Verif from 64 to 7 defects = 7%
Valid from 17 to 4 defects = 9%
Oper from 10 to 2 defects = 15%
31%

Cost:Benefit ratio is 4% : 31% or 1 : 7.75

IUS Software Award



IUS
Software
Engineering

IUS
INERTIAL UPPER STAGE

0002

19

Pay to the order of IUS PROGRAM $1,500,000

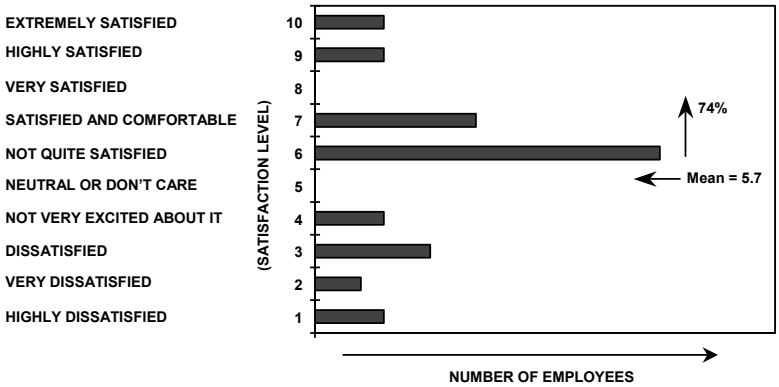
One Million Five Hundred Thousand Dollars

For IUS Software Underrun

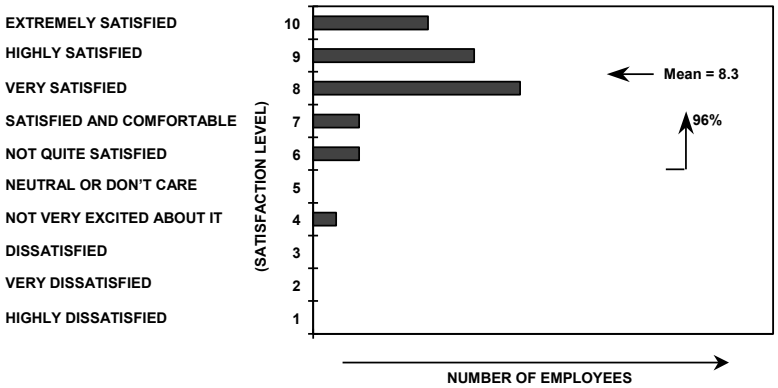
J. Eckle / A. Moore

Rocky Mountain Bank Note

Employee Satisfaction

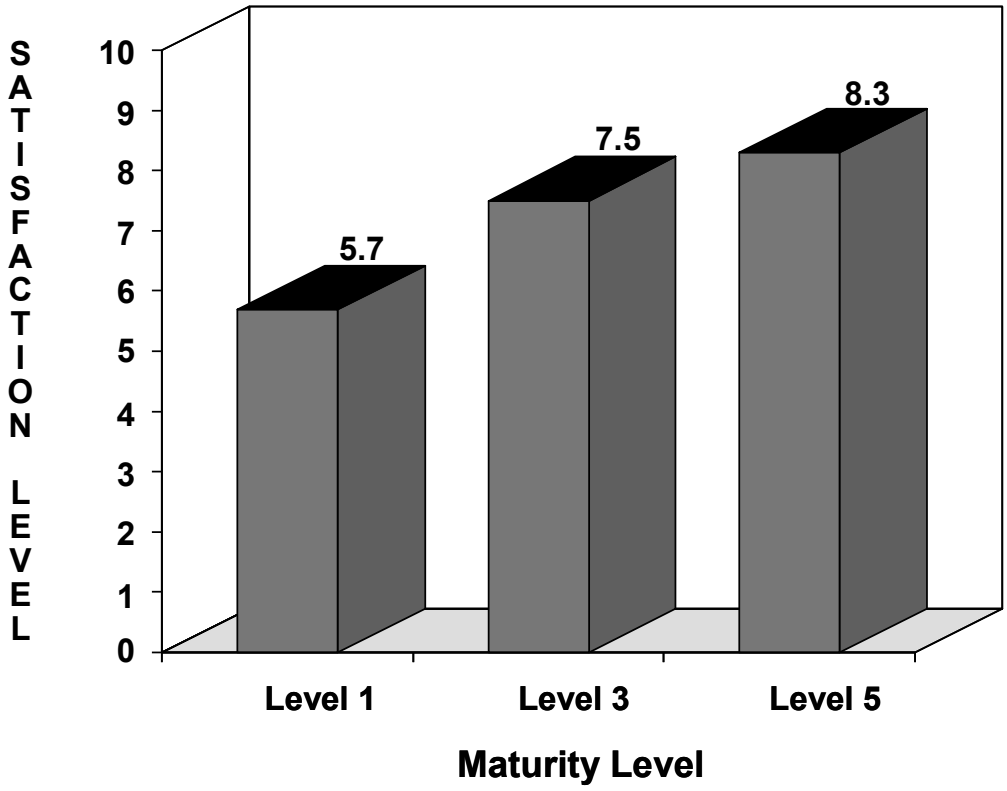


Before Process Improvement Activities



After Process Improvement Activities

Employee Satisfaction Vs Maturity Level



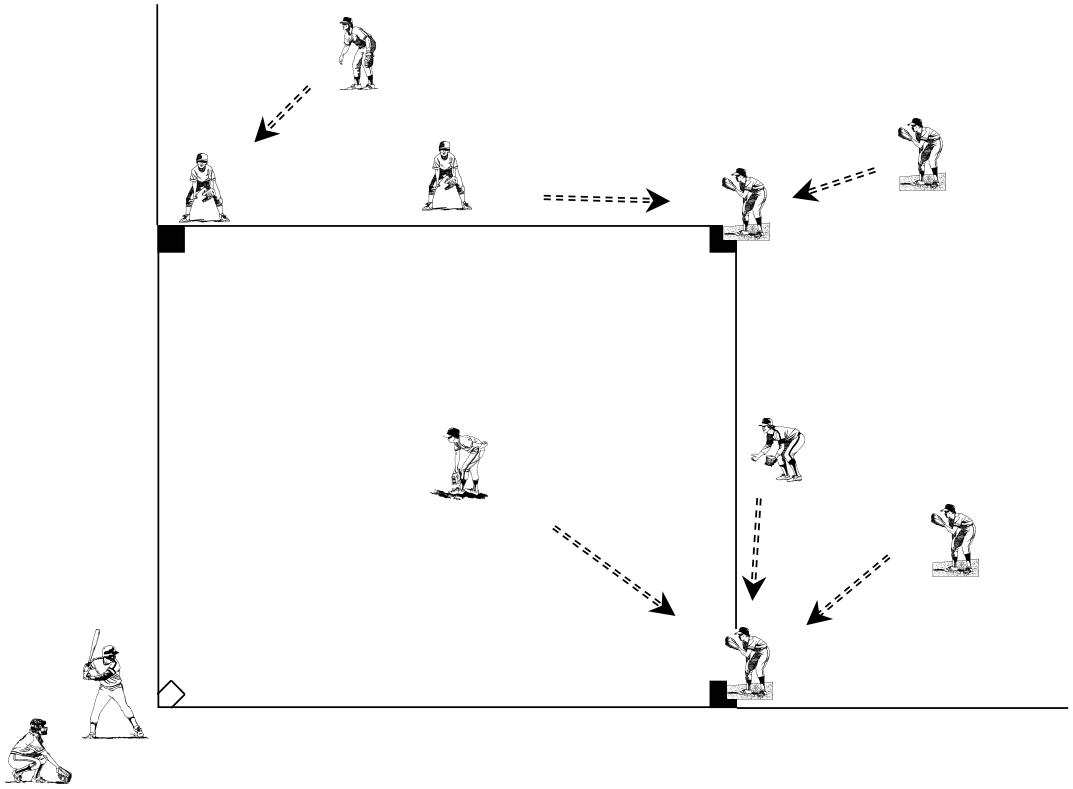
Employee Needs

- Achievement & Recognition
- Work Assignment & Responsibility
- Advancement & Growth
- Security
- Salary
- Work Environment
- Relationships
- Supervision

Yamamura Formula for Success

- **Apply *RSST*:**
  - **Right Thing - Do the right thing for the situation, understand the problem/capability**
  - **Small Steps - Take small, do-able steps, get a success, look for highest value item to change**
  - **Simple - Keep it simple, look for the simple solution, use common sense, don't just follow the trend**
  - **Timing - Right timing is critical, when environment is right, able to apply right strategy**

Minimize Decisions Example



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Curve Spread Example

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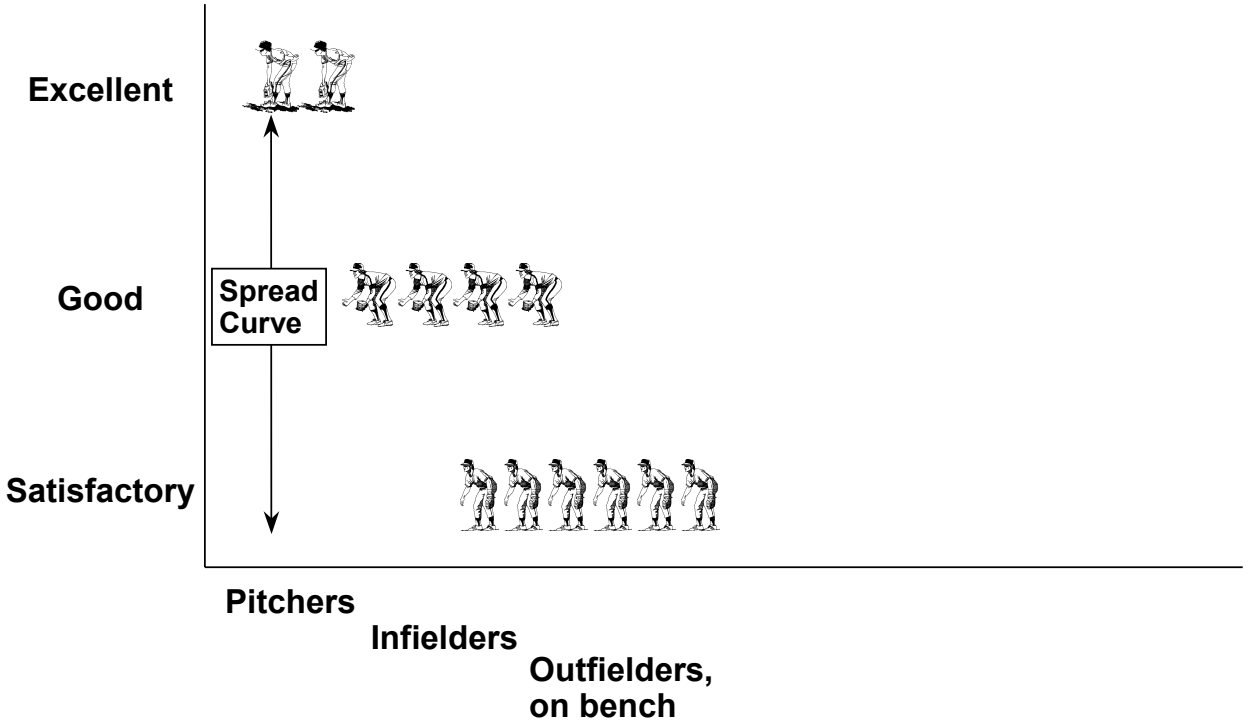

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Curve Spread Example (Cont.)

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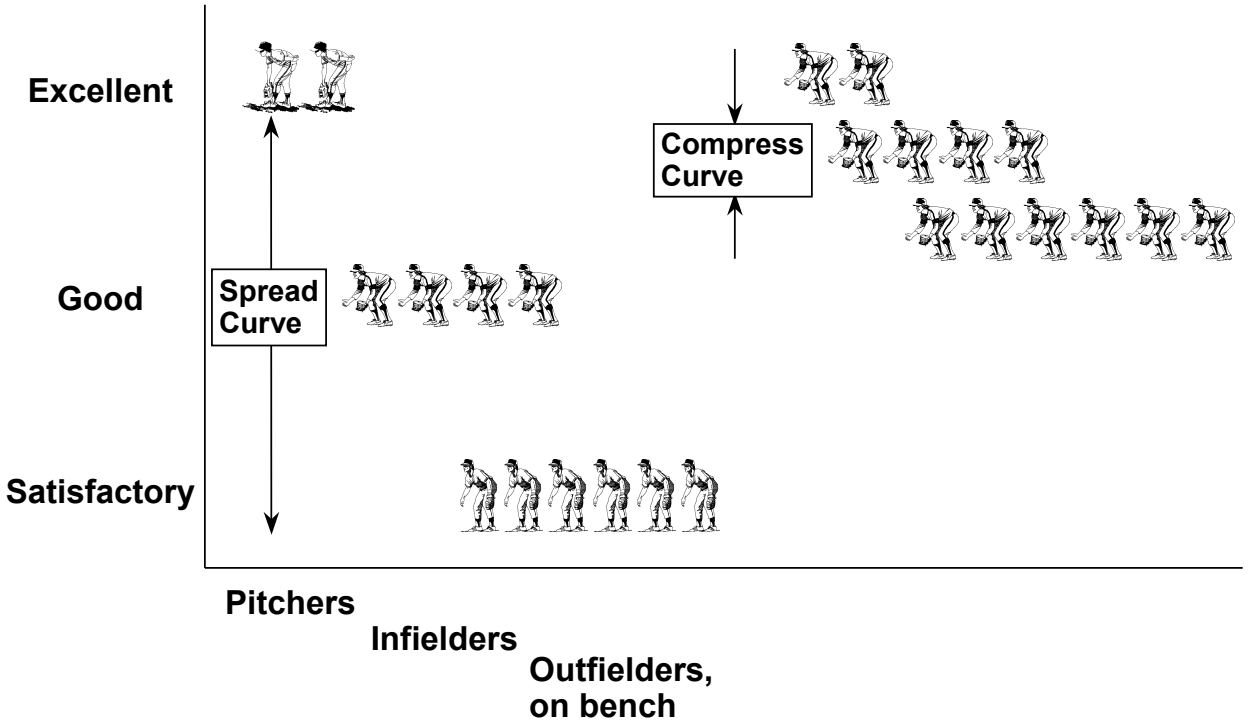

Making A Difference

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"It is not as important to know more than others, as it is to make a difference with what we do know."

- George Yamamura

STS Deployment Process

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Comprehensive Software Development for Space Transportation Systems Programs

Common processes across all STS programs reduce cost and risk. Programs start with mature processes in-place. Trained engineers provide domain expertise.

Mature Processes

Space Transportation Systems takes advantage of many years of software process development and improvements to provide a highly successful and proven engineering methodology. Processes are the key to a well defined and disciplined approach for predictable performance, high quality products and excellence in customer satisfaction.

Mature processes define a predictable organization capability for the "big four": cost, schedule, quality and performance

Benefits New Start Programs

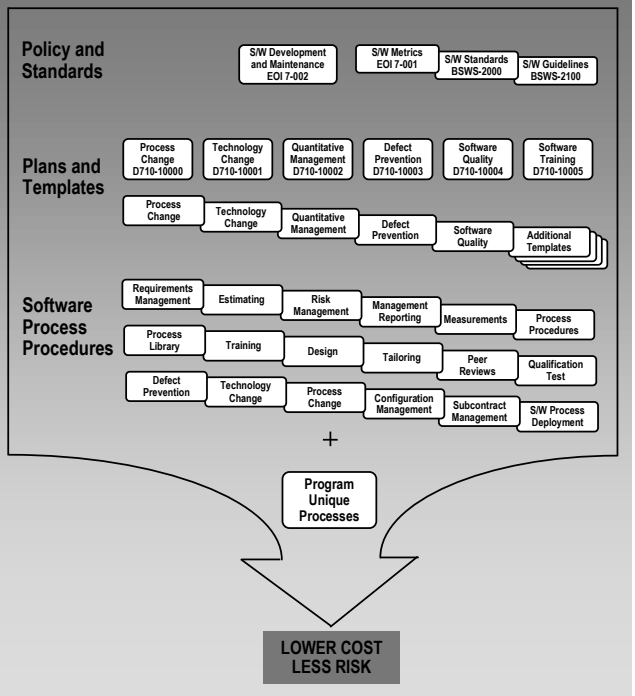
Approximately 70% of policies, standards, plans and process procedures are in- place for managing a successful software program. Programs start with mature processes, minimizing cost and risk.

Software Process Library

The STS Software Process Library, along with other existing program libraries, provide a complete set of documents to benefit existing and new start programs.

Software Center of Excellence

A team, trained in the software processes, provide the expertise for deployment. Engineers are experienced in multiple program applications. Orientation and training programs are applied for all engineers. The organization has attained a record of excellent performance.



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Organization Maturity Profile

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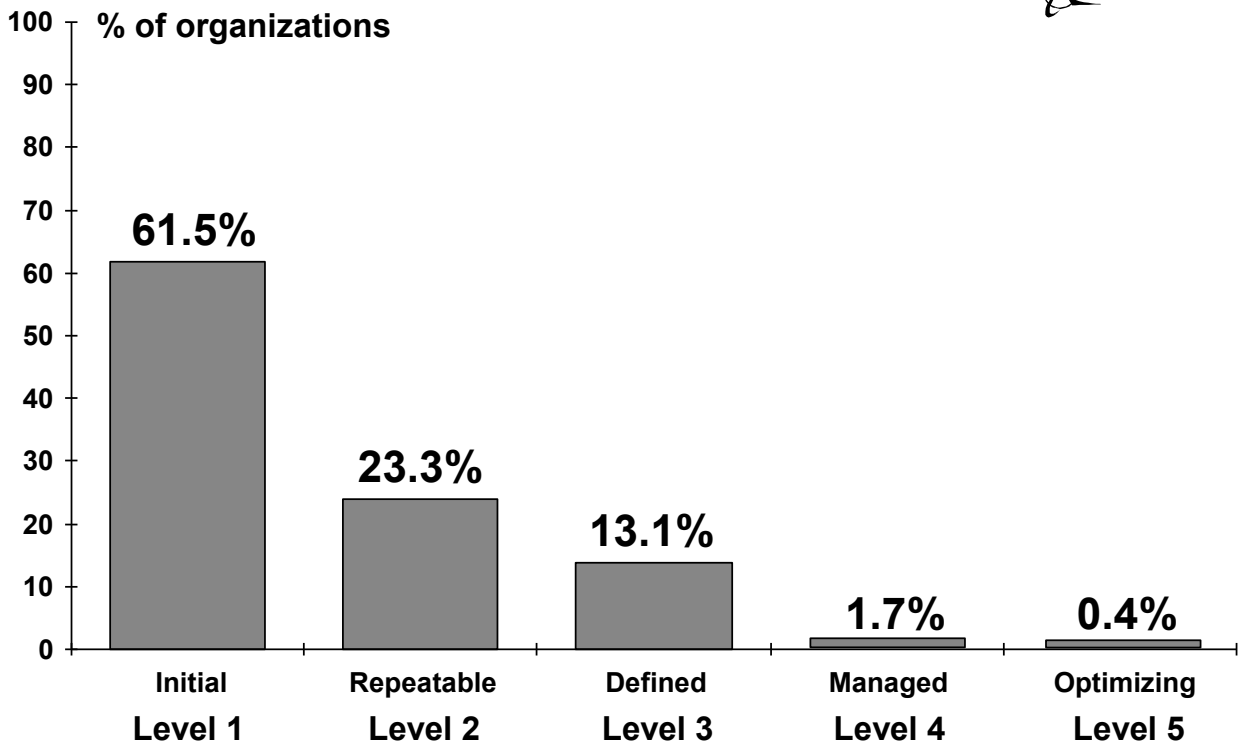

Based on more than 700 organizations - April 1997

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World Class Achievement

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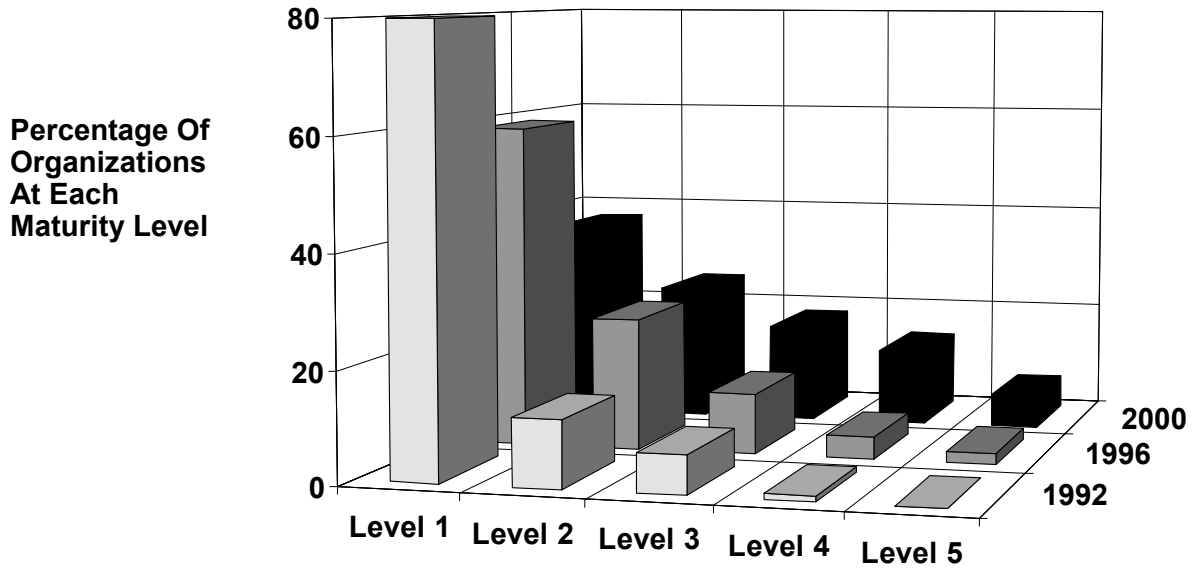
Boeing's STS organization is among the "number one software development organizations in the world", as certified by the DoD's Software Engineering Institute (SEI)

	Published Maturity Levels		
Company	**Level**	**Source**	**Date**
1) Boeing Defense & Space Group	5	PRNewswire	Aug 6, 1996
2) IBM Federal Systems Company	5	IBM Systems Journal, v 33	Nov 1, 1994
3) Motorola Electronic India Ltd. (MEIL)	5	IEEE Software, v11, No. 2	Mar, 1994
4) CITL (Citicorp Information Technology Industries Limited)	4	Software Engineering Symposium	Sep 1, 1996
5) Loral Federal Systems	4	CrossTalk	Nov, 1995
6) Oklahoma City ALC Directorate of Aircraft Management S/W Division Test S/W and Industrial Plant Equipment Branches	4	Tinker Take Off	Nov 22, 1996
7) Tinker Air Force Base, Oklahoma	4	Air Force News, News Service	Jan 25, 1997
8) Bellcore, Morristown, NJ	3	Bellcore	Feb 5, 1997
9) Defense Systems and Electronics Group, Texas Instruments	3	Texas Instruments Technical	Mar, 1995
10) GDE Systems (subsidiary of Tracor, Inc.)	3	CrossTalk	Nov, 1995

Continuing To Improve

IF YOU'RE NOT IMPROVING, THEN YOU'RE LOSING GROUND

Predicted Process Maturity Improvement for U.S. Organizations



Most Common Questions

- How long did it take to get to Level 5?
- What is the size of your organization?
- What is your productivity rate?
- How many SLOCs are produced?

Focus is on getting to a level!

Most Helpful Questions

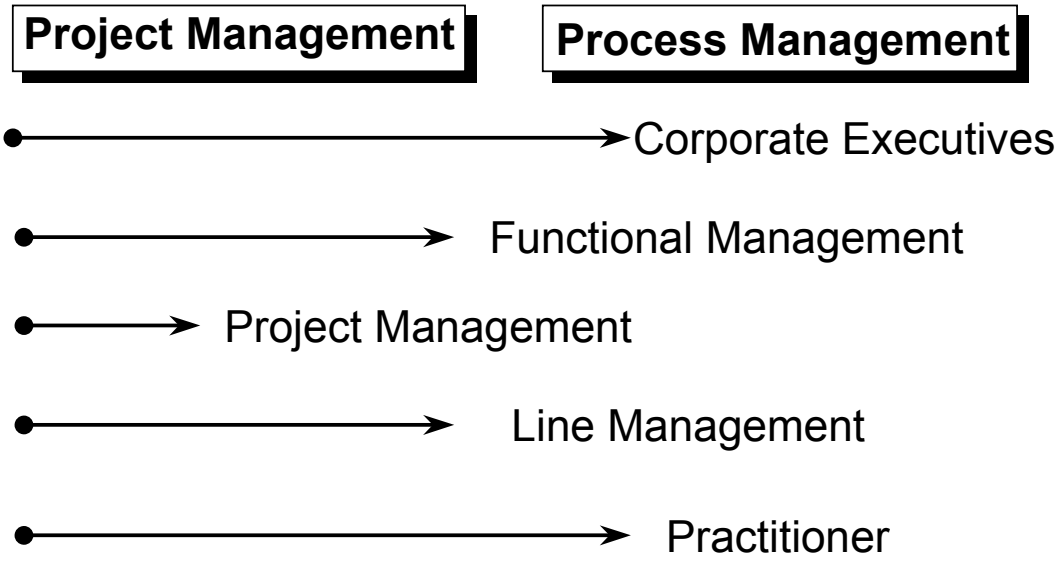
- What was your process improvement strategy?
- What were the barriers?
- How did you get sponsorship?
- How did you motivate the employees?
- What were the benefits?

Focus is on process improvement!

Thought Provoking Question

What would happen to your organization process improvement activities if there were no pressure to achieve a SW-CMM level?

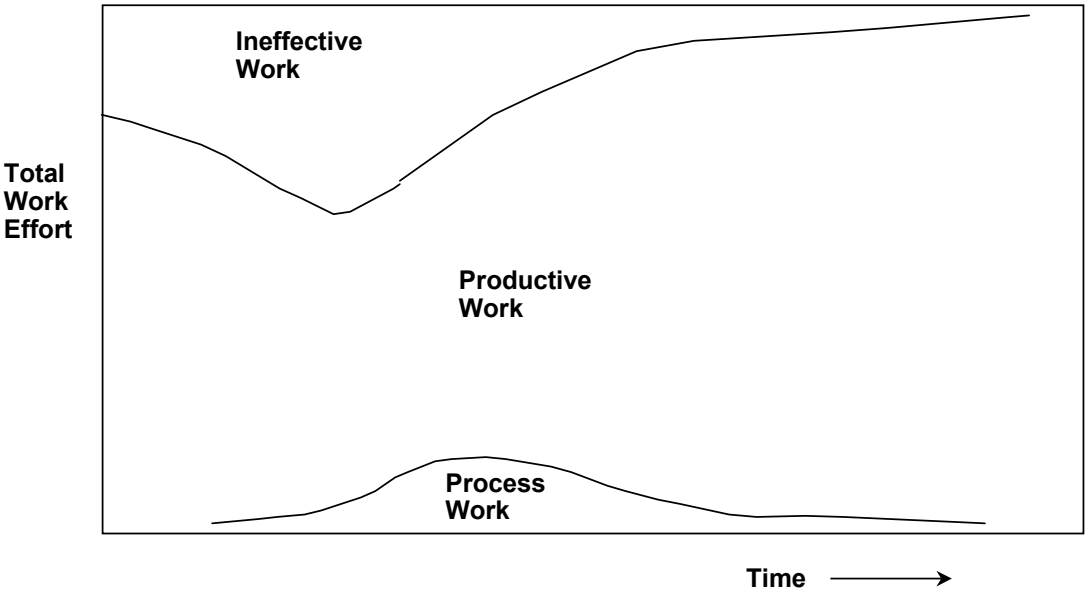
The Sponsorship Curve



Implementation Mechanism

- **Strong process champion**
  - **Line management**
- **Effective process improvement network**
  - **Ownership**
  - **Coordinate across organizations**
  - **Promote commonality**
  - **Promote communication**

Process Effort Profile



Summary

- Manage with facts and data
- Apply goal management
- Recognize human issues
  - Institutionalization
- Need process champions
- Implement an effective PI network
- Keep senior management aware
  - Be own sponsor first, use facts and data
- Apply RSST

DoD CrossTalk Journal

- **SEI CMM Level 5 - for the Right Reasons**
  www.stsc.hill.af.mil/CrossTalk/1997/aug/seicmm5.html
- **SEI CMM Level 5 - A Practitioner's Perspective**
  www.stsc.hill.af.mil/CrossTalk/1997/sep/seicmm5.html
- **A Level 5 Organization Looks at PSP**
  www.stsc.hill.af.mil/CrossTalk/1997/oct/level5.html
- **Practices of a SEI SW-CMM Level 5 SEPG**
  www.stsc.hill.af.mil/CrossTalk/1997/nov/cmm5sepg.html

A Level 5 Dream

Imagine what it would be like to work in an environment rich in well-coordinated and tested processes: everyone is trained and you could accurately estimate a job, finish it on time, within budget, and with exceptionally high quality. Nobody argues over who is at fault for a problem or who is responsible for a particular task. While you are dreaming, toss in some well-pleased managers and many proud employees. This is not a dream --- I am describing (our organization)...

Kimsey M. Fowler Jr.
CrossTalk, The Journal of Defense Software Engineering
Sep 1997