



# *An Executive Introduction to CMM<sup>ò</sup> -Based Software Process Improvement*

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<sup>SM</sup> Capability Maturity Model Integration, CMMI, IDEAL, Personal Software Process, PSP, Team Software Process, and TSP are service marks of Carnegie Mellon University.

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# *Topics to Be Covered*

**Why should an executive care about the “software process?”**

**What is the Capability Maturity Model<sup>0</sup> for Software (CMM)? A mature process?**

**Is software process improvement just another fad? Does it really *work*?**

**What about the future?**

- **CMM integration?**
- **ISO/IEC 15504 (SPICE)?**



# *Why Should Executives Care About “Software Process?”*

**Are you unhappy with the status quo with respect to software in your organization?**

**Are your customers dissatisfied?**

**Is the competition using software superiority to gain competitive advantage?**

***If you answer “No,” it is unlikely that***

- your behavior will change***
- your “sponsorship” will inspire change in others***



# *Standish Group - CHAOS Study*

**\$250 billion / year spent on information technology**  
**• 175,000 software projects**

<u>Co Size</u>	<u>\$M</u>	<u>Imp %</u>	<u>Chall %</u>	<u>Succ %</u>	<u>Fcn %</u>
Large	2.322	30	62	9	42
Medium	1.331	37	47	16	65
Small	.434	22	50	28	74

*Large is > \$500M    Medium is \$200-500M    Small is \$100-200M*

Imp is “impaired” (cancelled)

Chall is “challenged” (cost and/or schedule overruns)

Succ is “successful”

Fcn is “functionality” delivered for challenged + successful projects



# *Capers Jones - Project Outcomes*

Project outcome	<i>Project size in function points</i>			
	<100	100-1K	1K-5K	>5K
<b>Cancelled</b>	<b>3</b>	<b>7</b>	<b>13</b>	<b>24</b>
<b>Late &gt; 12 months</b>	<b>1</b>	<b>10</b>	<b>12</b>	<b>18</b>
<b>Late &gt; 6 months</b>	<b>9</b>	<b>24</b>	<b>35</b>	<b>37</b>
<b>Approx on time</b>	<b>72</b>	<b>53</b>	<b>37</b>	<b>20</b>
<b>Early</b>	<b>15</b>	<b>6</b>	<b>3</b>	<b>1</b>



# *Conditions for Change*

**if  $D * V * F > R$   
then “change will occur”**

***where***

***D = dissatisfaction with status quo***

***V = vision of a future state***

***F = first steps towards the vision***

***R = resistance to change***



# *What Is the Software CMM?*

A **common-sense** application of process management and quality improvement concepts to software development and maintenance

A **community-developed** guide

A model for **organizational** improvement

The underlying structure for **reliable and consistent** CMM-based appraisal methods



## *Why CMM?*

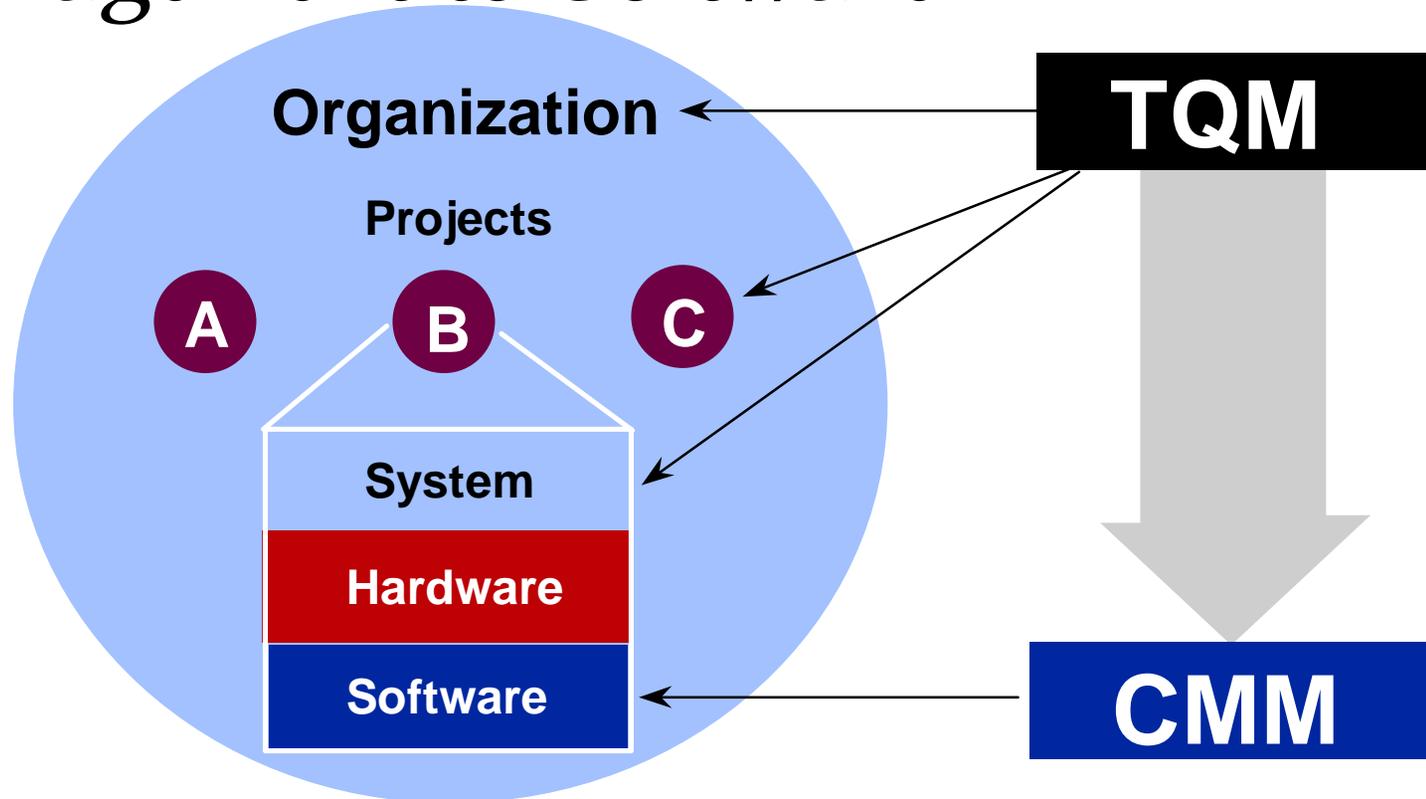
**Why was the Software CMM and the associated software process improvement program initiated?**

- massive cost and schedule overruns
- less functionality delivered than promised
- lower quality than desired
- *unpredictability*

**.... the “chronic” software crisis**



# *Applying Total Quality Management to Software*



**Process improvement fits in an overall business context—CMM applies to software.**



# Software CMM v1.1 Key Process Areas

Level	Focus	Key Process Areas	
5 Optimizing	<i>Continuous process improvement</i>	Defect Prevention Technology Change Management Process Change Management	Quality Productivity
4 Managed	<i>Product and process quality</i>	Quantitative Process Management Software Quality Management	
3 Defined	<i>Engineering processes and organizational support</i>	Organization Process Focus Organization Process Definition Training Program Integrated Software Management Software Product Engineering Intergroup Coordination Peer Reviews	
2 Repeatable	<i>Project management processes</i>	Requirements Management Software Project Planning Software Project Tracking & Oversight Software Subcontract Management Software Quality Assurance Software Configuration Management	
1 Initial	<i>Competent people and heroics</i>		



## *“What” Versus “How To”*

**Software CMM is intended to be**

- **descriptive** of software engineering and management practices
- **prescriptive** for process improvement priorities

**Key process areas describe “what” not “how.”**

- **ignorance of “how” to implement processes can lead to “ticking off” CMM practices**
- **particularly a problem for technical people promoted to management positions**
  - **different skill set than what they excel at**

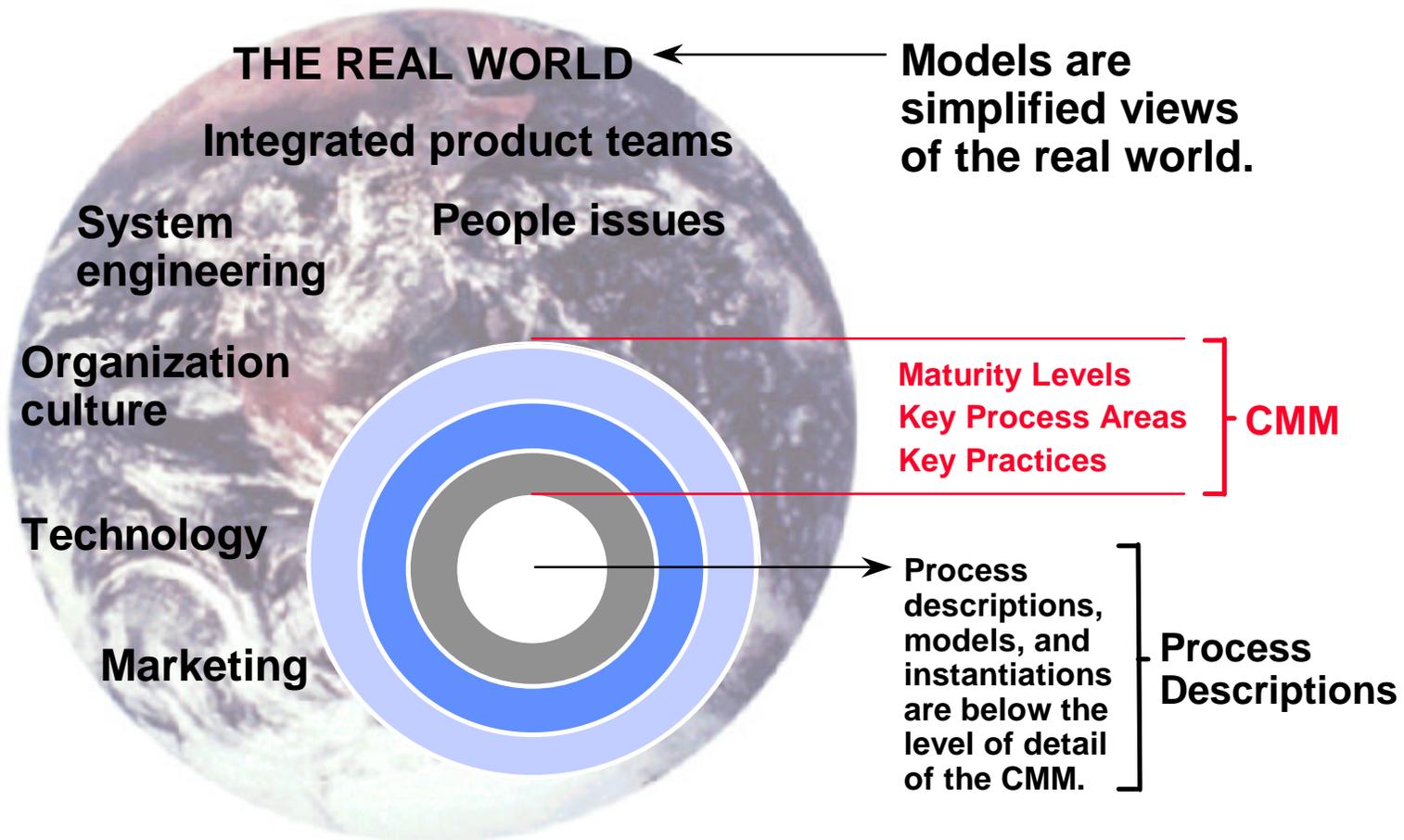


# *Evolution of Process Capability*

Level	Process Characteristics	Predicted Performance
5 Optimizing	Process improvement is institutionalized	
4 Managed	Product and process are quantitatively controlled	
3 Defined	Software engineering and management processes defined and integrated	
2 Repeatable	Project management system in place; performance is repeatable	
1 Initial	Process is informal and unpredictable	



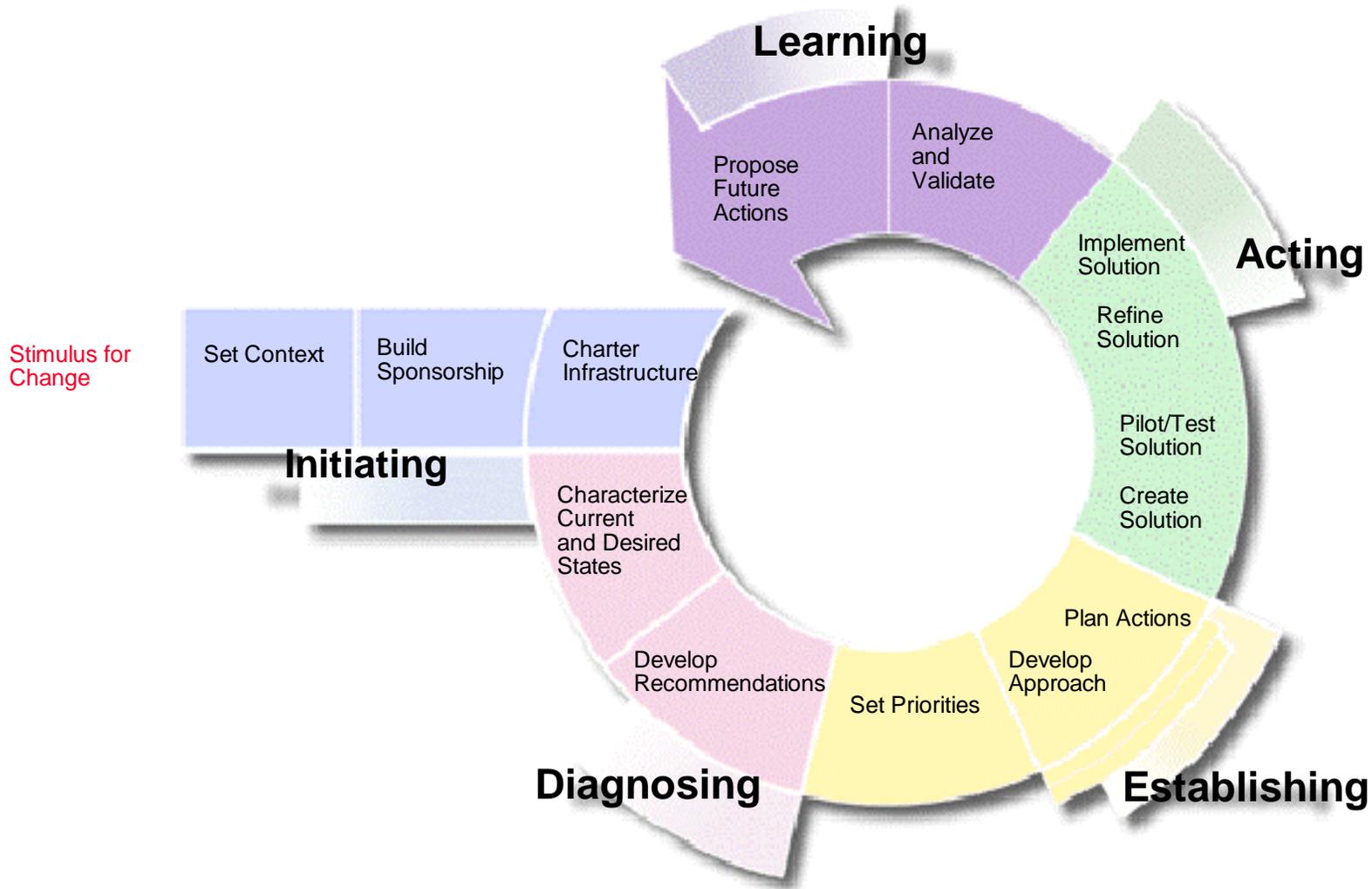
# “M” is for Model



**“All models are wrong; some models are useful.” George Box**



# SEI's IDEAL<sup>SM</sup> Approach





# *Assess the Current Process*

## ***Chinese Proverb:***

**If you don't know where you are going,  
any road will do.**

## ***Humphrey's Proverb:***

**If you don't know where you are,  
a map won't help.**



# *Applying the CMM*

## **Assessments by industry**

- **self improvement**

## **Evaluations by government**

- **source selection**
- **contract monitoring**

***The Capability Maturity Model is the underpinning of both assessments and evaluations.***



# A Comparison

## Evaluations

- For customer use in source selection or contract monitoring
- Results known to the customer
- Substantiate current practice
- Assess supplier commitment to improve
- Analyze supplier performance potential

*Identify risks and motivate changes in suppliers' software management and engineering practices. Select qualified suppliers.*

## Assessments

- For the use of the organization
- Results are confidential
- Assess current practice
- Act as catalyst for improvement
- Provide input for improvement action plan

*Characterize an organization's current software engineering process. Identify the most critical process issues. Facilitate the initiation of process improvement actions.*





# *Process Improvement Is A Lifestyle Change*

## ***Silver Bullet = Diet***

**95% of all dieters regain the weight they have lost... and more... within one year of a diet**

## ***Process Improvement = Lifestyle Change***

**60% of those who change their lifestyle to eat less and exercise more maintain their weight loss**



# *What Are the Benefits of Model-Based Improvement?*

**Establish a common language**

- **forge a shared vision**

**Build on a set of processes and practices developed with input from a broad section of the software community**

**Provide a framework for prioritizing actions**

**Provide a framework for performing reliable and consistent appraisals**

**Support industry-wide comparisons**



# *What Are the Risks of Model-Based Improvement?*

**Models are simplifications of the real world.**

**Models are not comprehensive.**

**Interpretation and tailoring must be aligned to  
business objectives.**

**Judgement is necessary to use models correctly  
and with insight.**



# *Business Value*

**Goals, objectives, strategies, and plans in all organizations are based on two fundamental needs.**

- 1. providing competitive products or services in terms of functionality, time-to-market, quality, and cost**
- 2. meeting commitments to customers with respect to products and services**

**Success in meeting commitments means that commitments must be achievable. This implies the need to predict outcomes.**



# *What Should You Expect From A High Maturity Organization?*

## **Predictability**

- **the ability to predict cost, schedule, and defects based on past performance**
- **upper and lower boundaries on expected performance (intervals, not point estimates!)**

## **Recognition of the “unknown”**

- **requirements change!**
- **software management = risk management**

**Willingness to work with the customer/end user to understand needs**



# *Characteristics of High Maturity Organizations -1*

**Defined, standardized processes**

**Common measures and historical data**

- **operational definitions in terms of the standardized process**

**Data analysis tools, e.g., trend charts, Pareto charts, control charts, prediction intervals**

**® process insight into the possible**



# *Characteristics of High Maturity Organizations -2*

**An understanding of what business the organization is in**

- **software projects aligned with strategic business plans**

**Product assets, e.g., product lines, product families, systematic reuse**

**® product insight into the feasible**



# *Characteristics of High Maturity Organizations -3*

## **Process insight + product insight**

® **predictable performance for known factors**  
- quantitative (statistical) control

® **identification of unknown factors**  
- risk management

**The calculations that go with the calculated risk!**

- “management by fact”



## *Does SPI Work?*

**Initial acceptance of the Software CMM based on “face validity”**

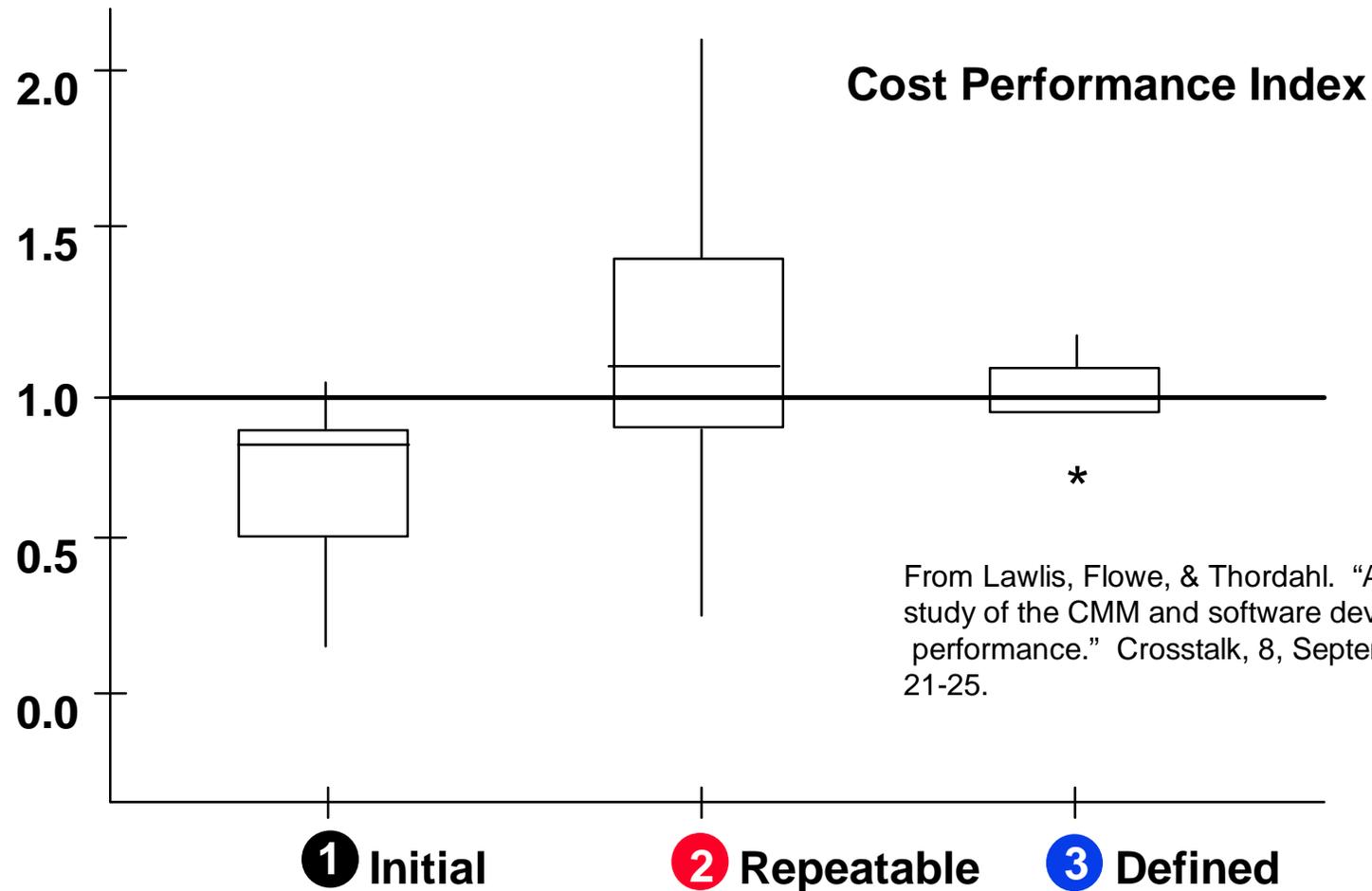
- **the maturity model was plausible**

**Many case studies and research in recent years indicate that maturity levels correlate with improved**

- **productivity**
- **cycle time**
- **quality**
- **predictability**

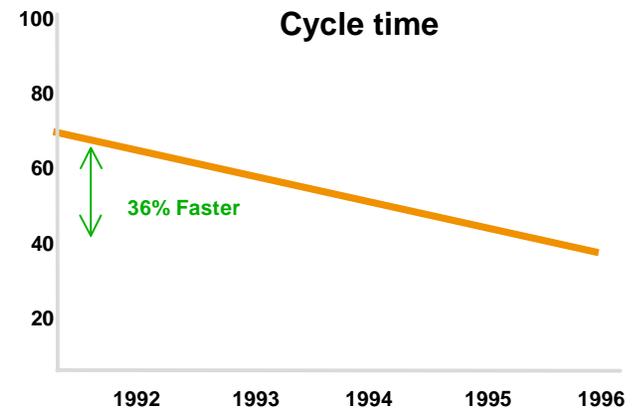
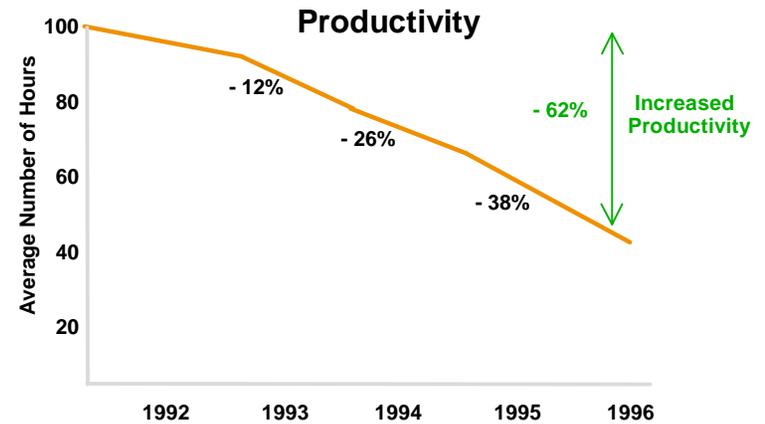
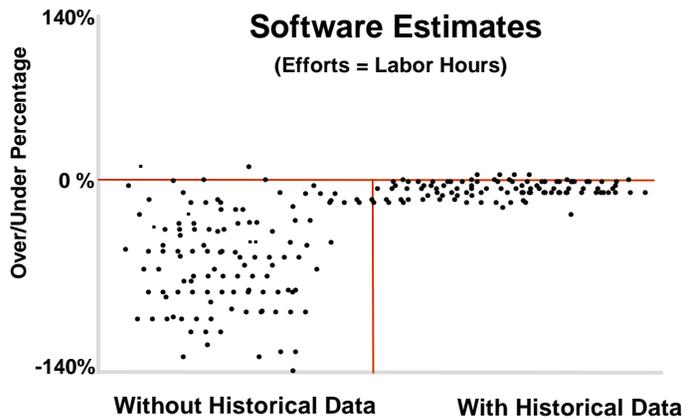


# *AFIT Study*





# Impact of Software Process Improvement: Boeing Data



John Vu, Boeing, keynote talk at SEPG '97, "Software Process Improvement Journey (From Level 1 to Level 5)"



# *“Trends” in Quality Results*

<b>Maturity Level</b>	<b>Design Faults / KSLOC (Keene)</b>	<b>Delivered Defects / FP (Jones)</b>	<b>Shipped Defects / KSLOC (Krasner)</b>	<b>Relative Defect Density (Williams)</b>	<b>Shipped Defects (Rifkin)</b>
<b>5</b>	<b>0.5</b>	<b>0.05</b>	<b>0.5</b>	<b>0.05</b>	<b>1</b>
<b>4</b>	<b>1</b>	<b>0.14</b>	<b>2.5</b>	<b>0.1</b>	<b>5</b>
<b>3</b>	<b>2</b>	<b>0.27</b>	<b>3.5</b>	<b>0.2</b>	<b>7</b>
<b>2</b>	<b>3</b>	<b>0.44</b>	<b>6</b>	<b>0.4</b>	<b>12</b>
<b>1</b>	<b>5-6</b>	<b>0.75</b>	<b>30</b>	<b>1.0</b>	<b>61</b>

Samuel Keene, “Modeling Software R&M Characteristics.” Unpublished report.

Capers Jones, “Software Benchmarking,” IEEE Computer, October 1995, pp. 102-103.

Herb Krasner, “Self-Assessment Experience at Lockheed,” Third Annual SEPG Workshop, 7 November 1990.

Karl D. Williams, “The Value of Software Improvement... Results! Results! Results!” SPIRE97, 4 June 1997.

Stan Rifkin, “The Business Case for Software Process Improvement,” Fifth SEPG National Meeting, 26-29 April 1993.



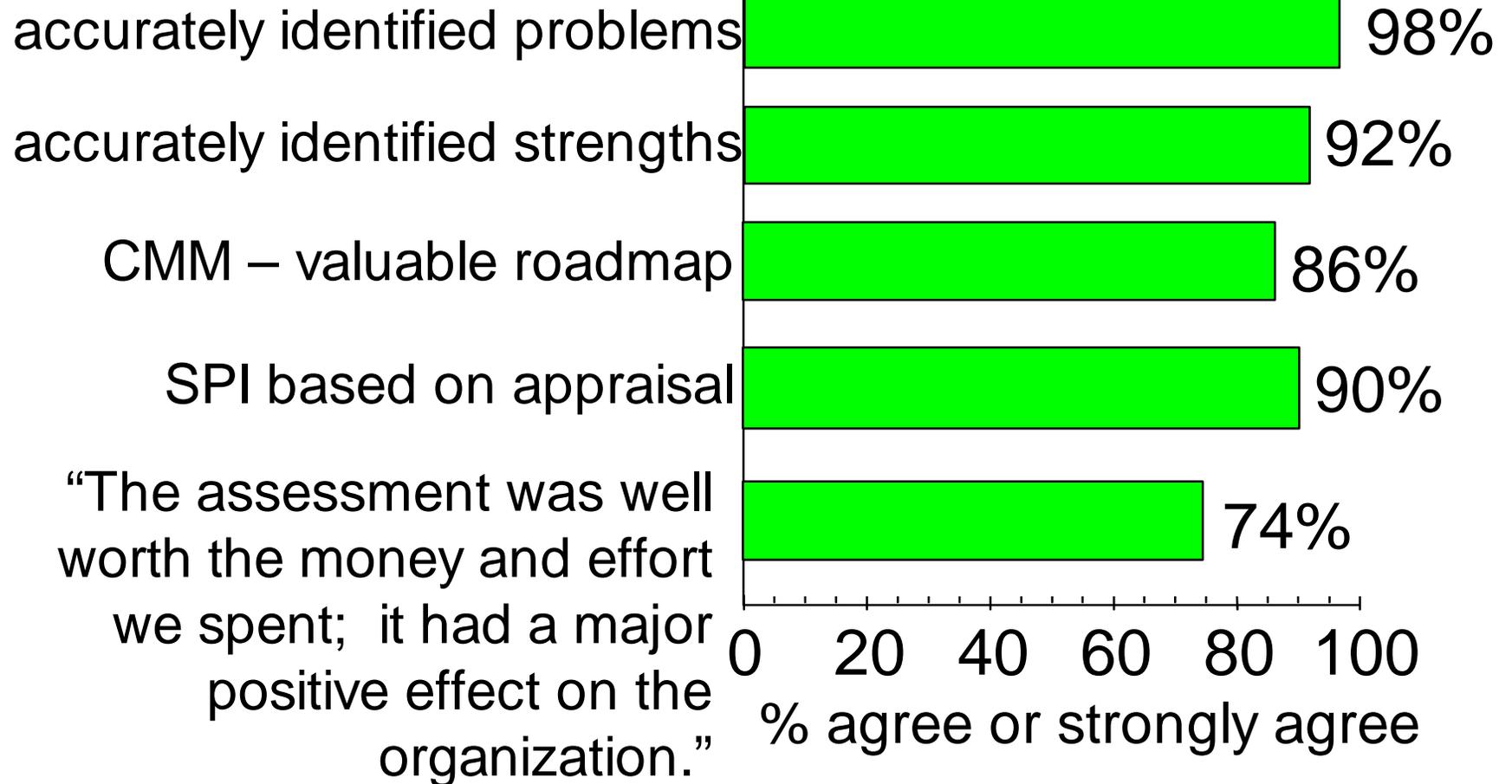
# *A Need for Improvement?*

## **Why is the organization interested in using the Software CMM?**

- **desire to improve process**
  - direct tie to business objectives
  - willingness to invest in improvement
- **flavor of the month**
  - prescription for disaster!
- **customer concerns about process performance**
  - leading to collaborative improvement?
- **concern about software capability evaluations**
  - cost-effective for small organizations?



# *Appraisal Worthwhile?*

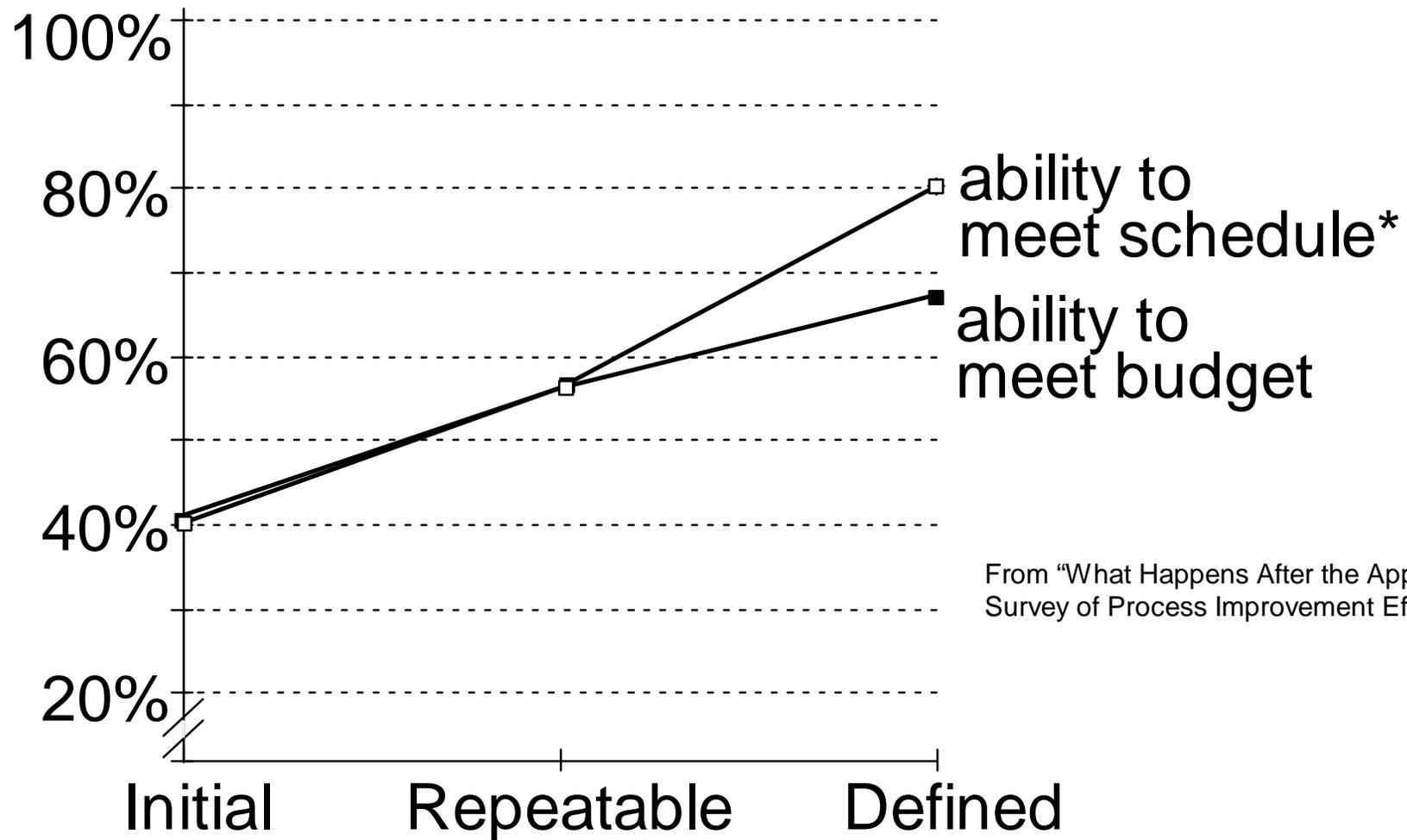


From “What Happens After the Appraisal? A Survey of Process Improvement Efforts”



# *Predictability*

Percent of Respondents Reporting “Excellent” or “Good”

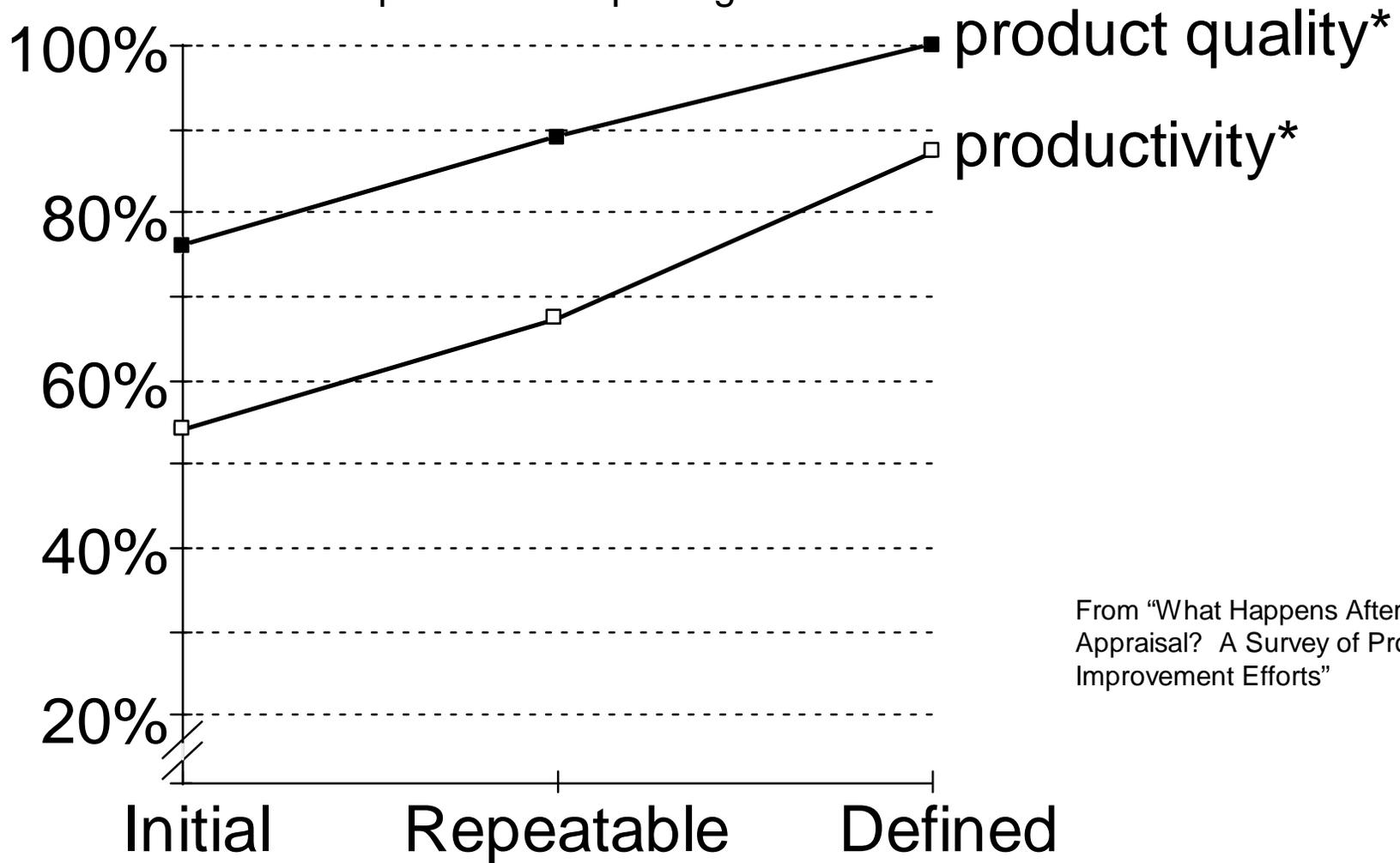


From “What Happens After the Appraisal? A Survey of Process Improvement Efforts”



# Performance

Percent of Respondents Reporting “Excellent” or “Good”

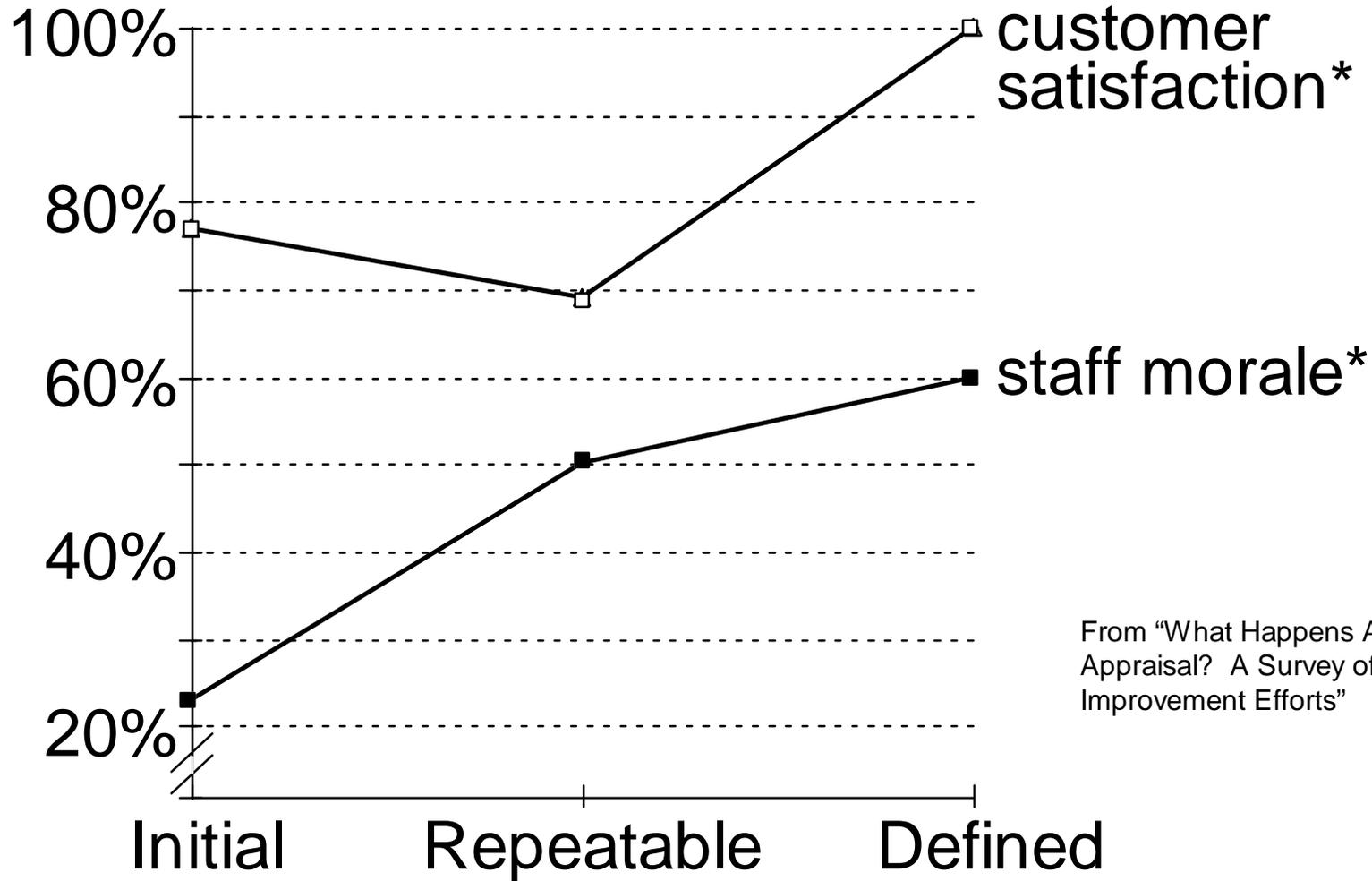


From “What Happens After the Appraisal? A Survey of Process Improvement Efforts”



# *Intangibles*

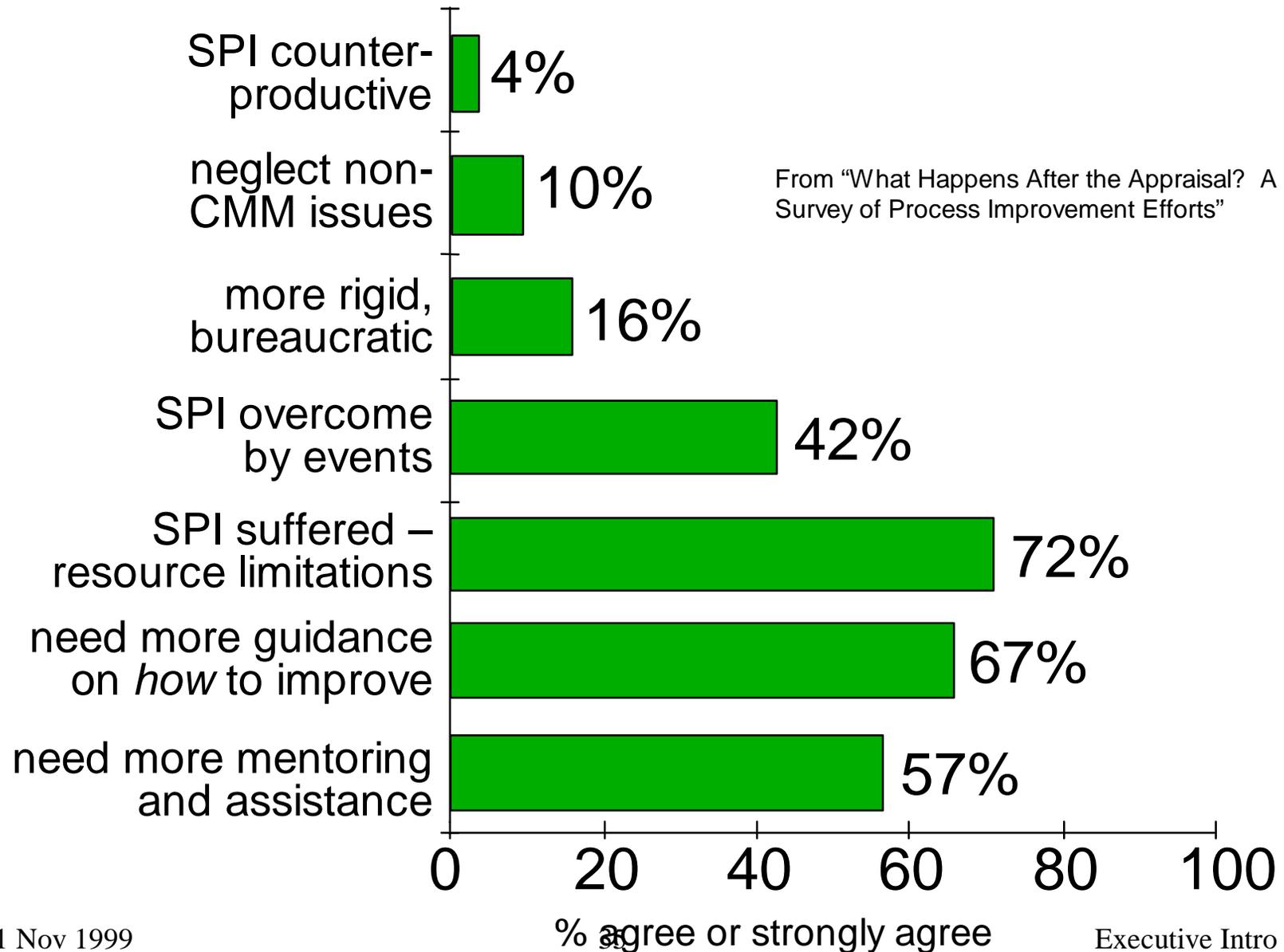
Percent of Respondents Reporting “Excellent” or “Good”



From “What Happens After the Appraisal? A Survey of Process Improvement Efforts”

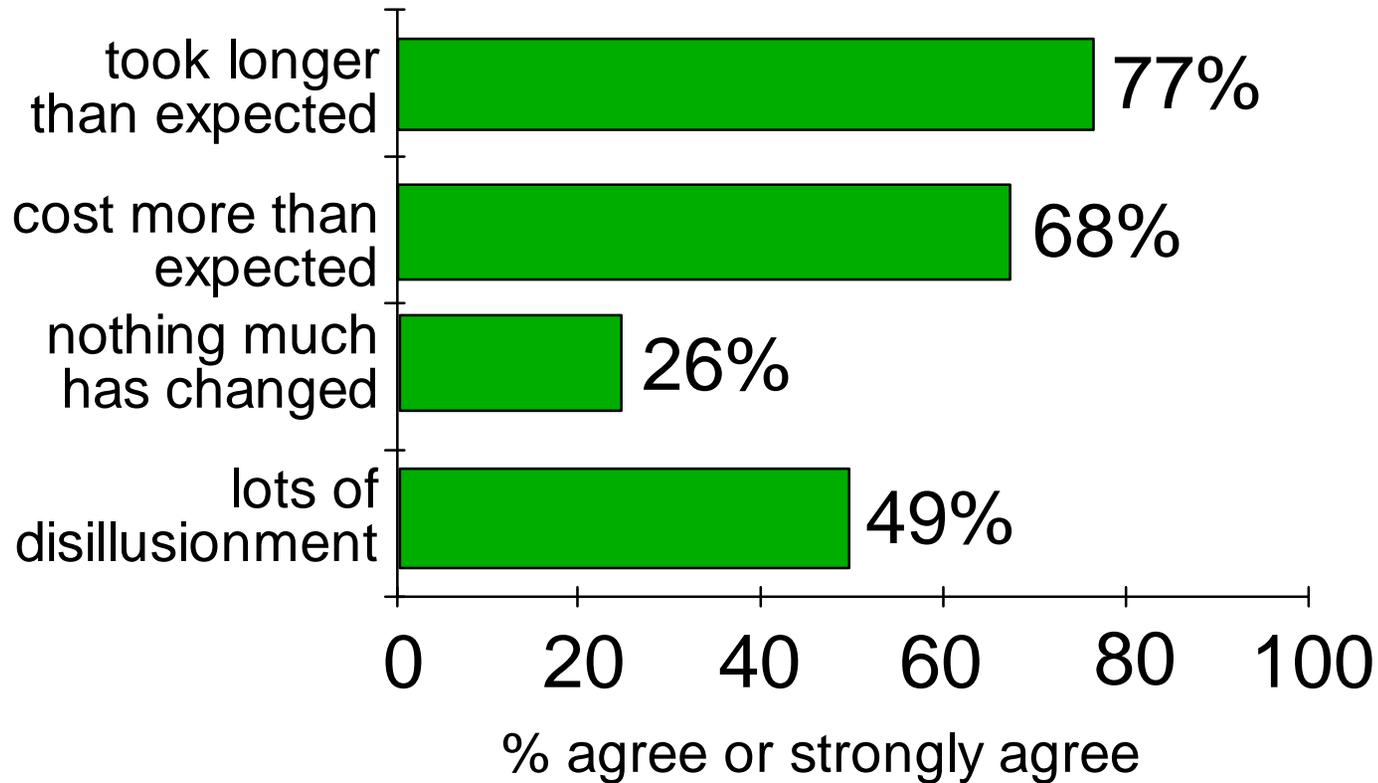


# Potential SPI Problems





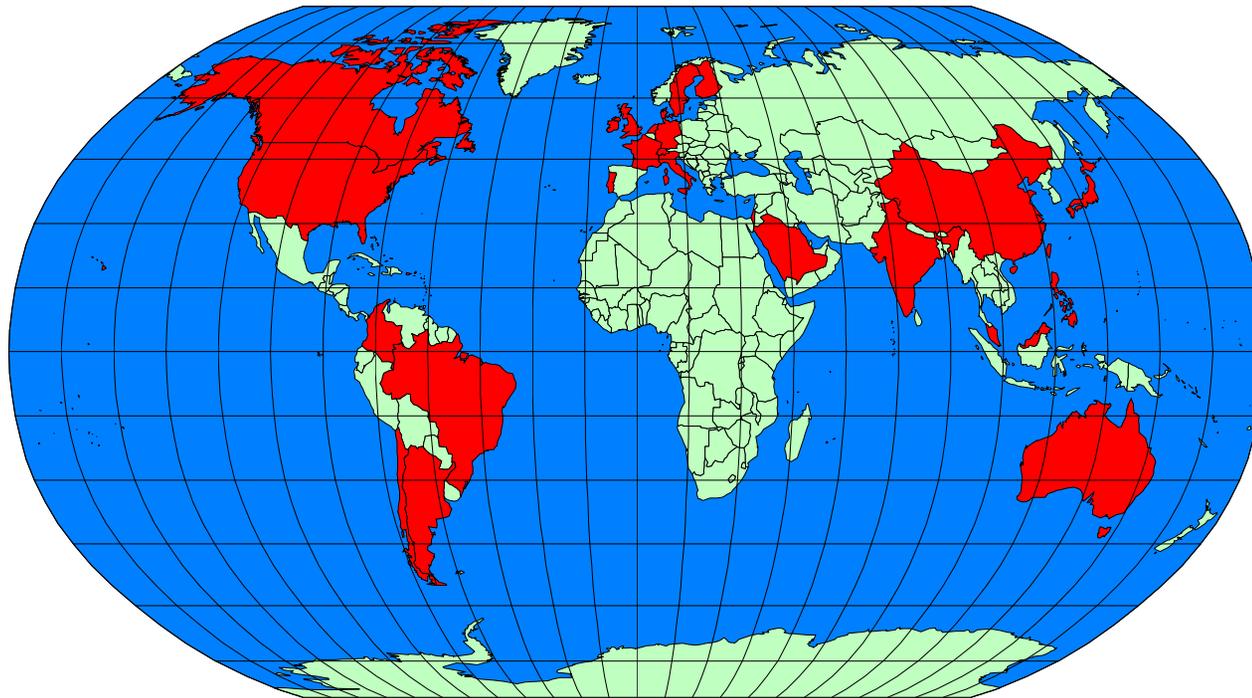
# *Setting Expectations*



From "What Happens After the Appraisal? A Survey of Process Improvement Efforts"



# *Global Impact of CMM Usage*



<b>Argentina</b>	<b>Australia</b>	<b>Brazil</b>	<b>Canada</b>	<b>Chile</b>	<b>China</b>	<b>Colombia</b>	<b>Denmark</b>
<b>Finland</b>	<b>France</b>	<b>Germany</b>	<b>Hong Kong</b>	<b>India</b>	<b>Ireland</b>	<b>Israel</b>	<b>Italy</b>
<b>Japan</b>	<b>Malaysia</b>	<b>Netherlands</b>	<b>Philippines</b>	<b>Portugal</b>	<b>Puerto Rico</b>	<b>Saudi Arabia</b>	<b>Singapore</b>
<b>Sweden</b>	<b>Switzerland</b>	<b>Taiwan</b>	<b>United Kingdom</b>	<b>United States</b>			



## *What Does the Future Hold?*

**Release of Software CMM v2 halted in favor of CMM integration (CMMI) work**

- **prototype of CMMI model released Aug 1999**
- **v1 of CMMI model planned for June 2000**

**ISO 9001 certification required in many environments**

- **major revision planned for 2000**

**ISO/IEC 15504 as emerging standard for software process assessment planned for 2001**

- **integrated with ISO 12207 (software) and ISO 15288 (systems)**



# *The Current Situation for CMMI*

## **Explosion of CMMs and CMM-like models**

- **systems engineering**
- **software acquisition**
- **people**
- **integrated product development**
- **etc.**

## **Multiple models within an organization**

- **multiple assessments**
- **multiple training**
- **multiple expenses**



# *What Problem Is CMMI Addressing?*

**Similar process improvement concepts, but...**

**Different model representations (e.g. staged, continuous, questionnaire, hybrid)**

**Different terminology**

**Different content**

**Different conclusions**

**Different appraisal methods**



# *Source Models for CMMI*

**Capability Maturity Model for Software V2,  
Draft C**

**EIA Interim Standard 731, System Engineering  
Capability Model**

**Integrated Product Development Capability  
Maturity Model, draft V0.98**



# *ISO 9000 and Software*

**The ISO 9000 series of standards can be used to certify/register the quality management systems of suppliers.**

**ISO 9001 covers**

- **design**
- **development**
- **production**
- **installation**
- **servicing**

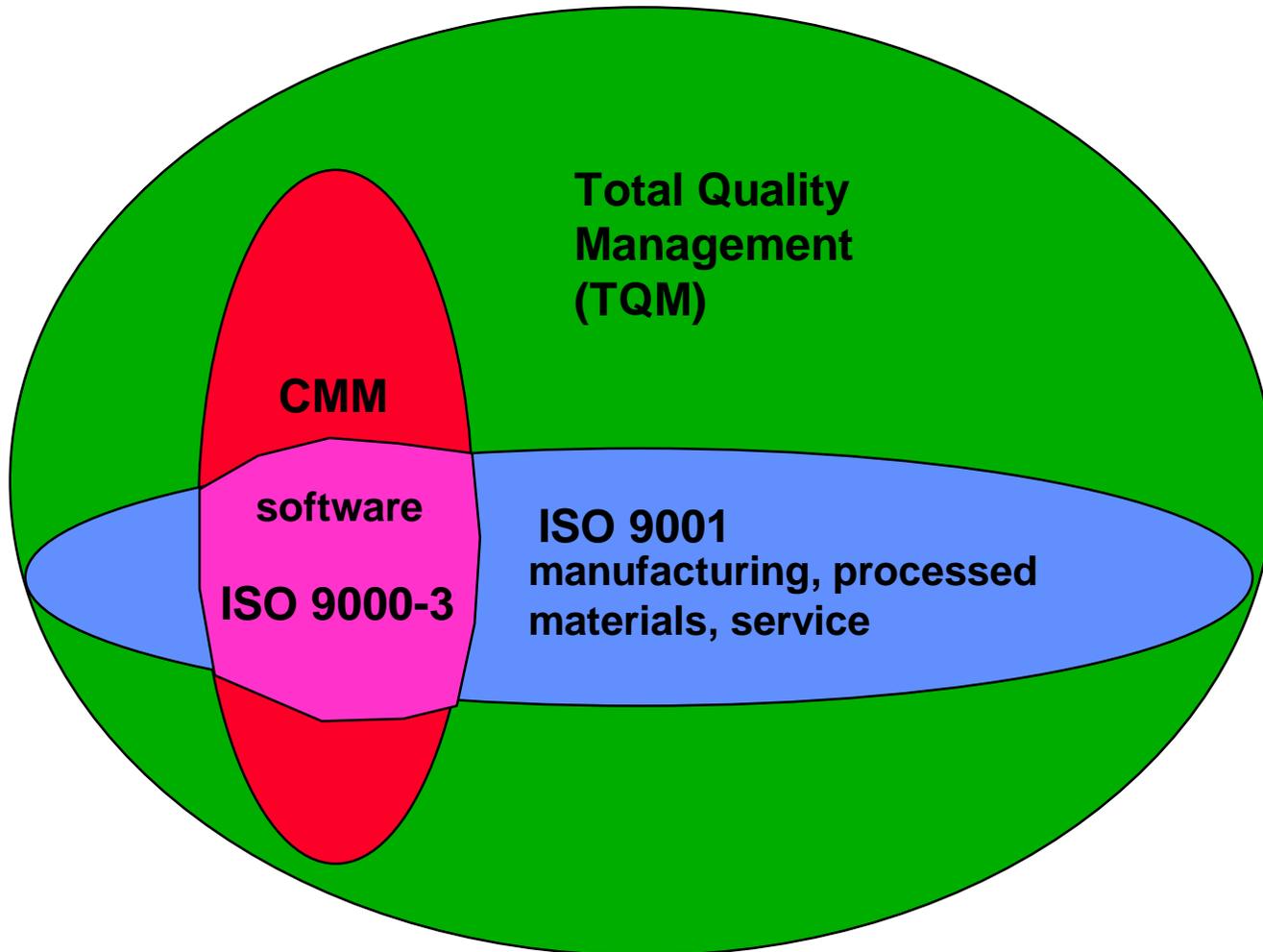


# *KPA Profile for an ISO 9001 Compliant Organization*

CMM Key Process Areas	Not Satisfied	Fully Satisfied
Process Change Management	25%	75%
Technology Change Management	40%	60%
Defect Prevention	75%	25%
Software Quality Management	25%	75%
Quantitative Process Management	45%	55%
Peer Reviews	75%	25%
Intergroup Coordination	35%	65%
Software Product Engineering	75%	25%
Integrated Software Management	35%	65%
Training Program	65%	35%
Organization Process Definition	55%	45%
Organization Process Focus	45%	55%
Software Configuration Management	75%	25%
Software Quality Assurance	75%	25%
Software Subcontract Management	45%	55%
Software Project Tracking & Oversight	45%	55%
Software Project Planning	45%	55%
Requirements Management	75%	25%



# *TQM, CMM, and ISO 9001*





## *ISO 9000:2000 Revision*

**Major revision of ISO 9000 set of standards planned for 2000**

- **this comparison is based on ISO 9001:1994**

**Four primary standards:**

- **ISO 9000: Quality management systems - Concepts and vocabulary**
- **ISO 9001: Quality management systems - Requirements**
- **ISO 9004: Quality management systems - Guidelines**
- **ISO 10011: Guidelines for auditing quality systems**



# *ISO 9001:2000 Major Clauses*

## **Management responsibility**

- **policy, objectives, planning, quality management system, management review**

## **Resource management**

- **human resources, information, facilities**

## **Process management**

- **customer satisfaction, design, purchasing, production**

## **Measurement, analysis, and improvement**

- **audit, process control, continual improvement**



# *ISO 9004:2000 Principles*

**ISO 9001 should address effectiveness; ISO 9004 should address both efficiency and effectiveness**

**Quality management principles of ISO 9004:**

- **customer focus**
- **leadership**
- **involvement of people**
- **process approach**
- **system approach to management**
- **continual improvement**
- **factual approach to decision making**
- **mutually beneficial supplier relationships**



# *ISO/IEC 12207 -- “Software Life Cycle Processes”*

**A common framework for software life cycle processes**

- **with well-defined terminology**

**Contains processes, activities, and tasks that are to be applied during the acquisition of**

- **a system that contains software**
- **a stand-alone software product**
- **software service**
- **during the supply, development, operation, and maintenance of software products**



# *ISO/IEC 15504 -- “Software Process Assessment”*

**Proposed international standard for software process assessment (and improvement)**

- **type 2 technical reports completed**
- **intended to harmonize the many different approaches to software process assessment**
- **for use in both process improvement and capability determination**
- **international standard planned for 2001 timeframe**

**SPICE = Software Process Improvement and Capability dEtermination**



# *Concluding Thoughts*

**Using the CMM improperly**

**Processes and the unknown**

**SEI contact info**

**Acronyms list**



# *Using the CMM Improperly*

Improper uses of the CMM include

- checking off (sub)practices for conformance
- mandating processes from above: not involving the true process owners – the workers
- riding roughshod over reasonable concerns
- confusing

*Value judgments are embedded in the terminology you use to describe your processes!*

<b>documented</b>	<b>detailed</b>
<b>guidance</b>	<b>onerous</b>
<b>disciplined</b>	<b>law</b>
<b>measured</b>	<b>inflexible</b>
	<b>bureaucracy</b>
	<b>judgmental</b>



## *Drivers for CMM Abuse*

**Unwillingness or inability to interpret, tailor, or apply judgment within organization**

- **easy to mandate the key practices**
- **judgment is needed even for large projects and organizations!**
- **paranoia about customer intentions and competence**

**Ignorance by the customer**

- **software capability evaluation (SCE) teams?**
  - **judgments may differ!**
- ® risk profile rather than maturity level**



# *Process Management and the Known*

Management must deal with both known and unknown factors.

- **process management** focuses on the known, on controlling repeatable (if not repetitive) processes
- **risk management** focuses on controlling the unknown
  - superior life cycle models: incremental, evolutionary, etc.
  - identifying and tracking risks



# Let Common Sense Prevail!

		Documented Process	
		Yes	No
Common Sense	Yes	<b>Quality</b>	<i>Creative Chaos</i>
	No	<i>Mindless Bureaucracy</i>	<b>Mindless Chaos</b>

With thanks to Sanjiv Ahuja, President and COO of Bellcore.



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# *Internet Access to SEI*

## SEI Web pages

- [www.sei.cmu.edu](http://www.sei.cmu.edu)
- [www.sei.cmu.edu/cmm/](http://www.sei.cmu.edu/cmm/)
- [www.sei.cmu.edu/cmm/cmm.articles.html](http://www.sei.cmu.edu/cmm/cmm.articles.html)

