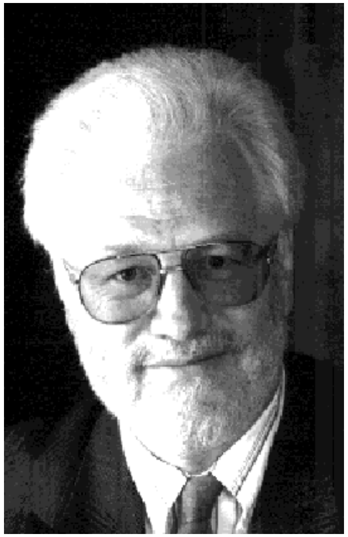
"The Ten Most Powerful Principles for Quality in [Software and] Software Organizations"



Prague SQAM

September 6 2006 1030-1130

ABSTRACT:
Software knows it has a problem. Solutions abound. But which solutions work? What are the most fundamental underlying principles we can observe behind those successful solutions? Can these principles guide us to select successful solutions and avoid time wasters? One hint: in Observing successful software organizations in the US, the dominant principle seems to be feedback and control.

By Tom Gilb, Result Planning Limited

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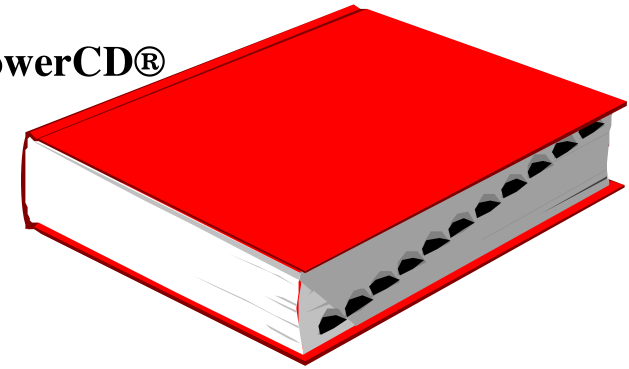
Version 1.21 : Feb 12 2001

Full detailed set of slides

"Principle" is ...



Webster's New World™ College Dictionary (Third Edition) on PowerCD®

prin•ci•ple (prinse pel)

n.

1 the ultimate source, origin, or cause of something

2 a natural or original tendency, faculty, or endowment

3 a fundamental truth, law, doctrine, or motivating force, upon which others are based [moral principles]

4 a) a rule of conduct, esp. of right conduct b) such rules collectively c) adherence to them; integrity; uprightness [a man of principle]

5 an essential element, constituent, or quality, esp. one that produces a specific effect [the active principle of a medicine]

6 a) the scientific law that explains a natural action [the principle of cell division] b) the method of a thing's operation [the principle of a gasoline engine is internal combustion]

in principle

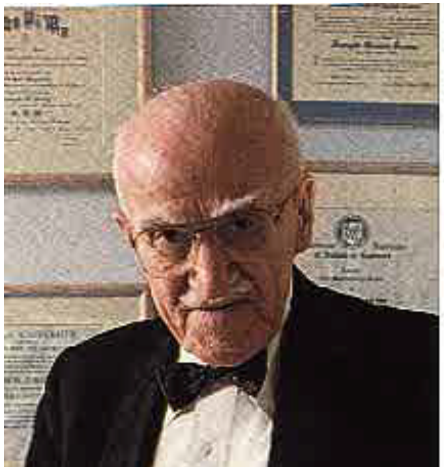
theoretically or in essence

on principle

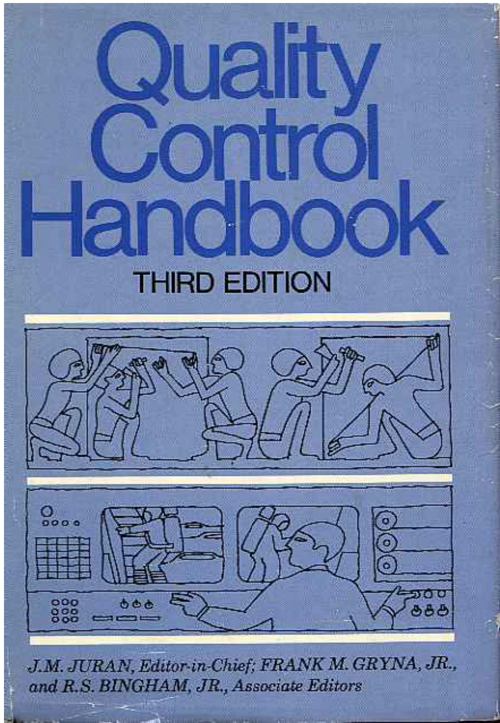
because of or according to a principle

1. Feedback

- Rapid feedback allows rapid correction.
  - Methods using rapid feedback succeed, those without seem to fail.
    - Methods:
      - **Defect Prevention Process** (CMM 5, Mays, IBM 1985)
      - **Inspection** (Fagan, IBM 1975) *
      - **Evolutionary Project Management** (Mills, IBM, Cleanroom, 1970) *
      - **Statistical Process Control** (SPC): Shewhart, Deming, Juran (1920’s)

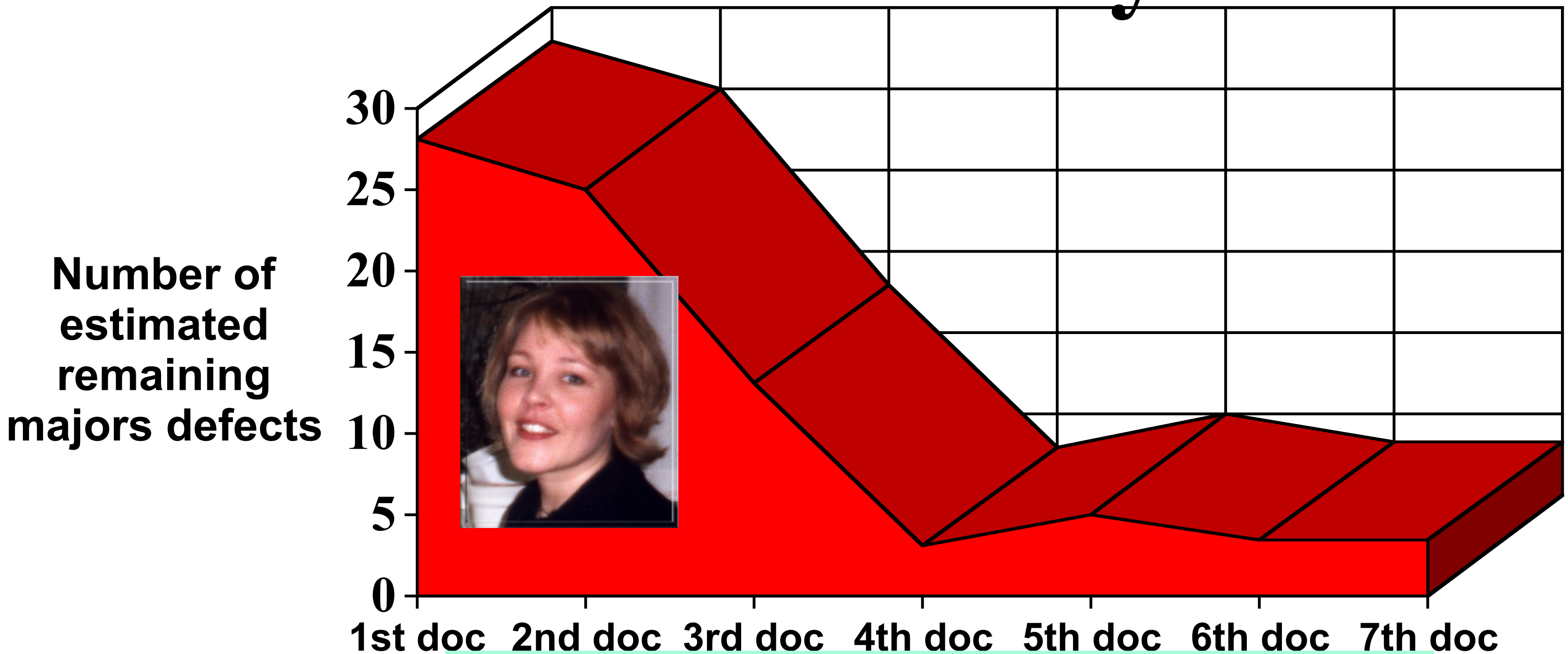


Dr. Juran (1904-)



* reprints are in IBM Systems Journal, 2&3 1999

Marie’s Learnability Curve



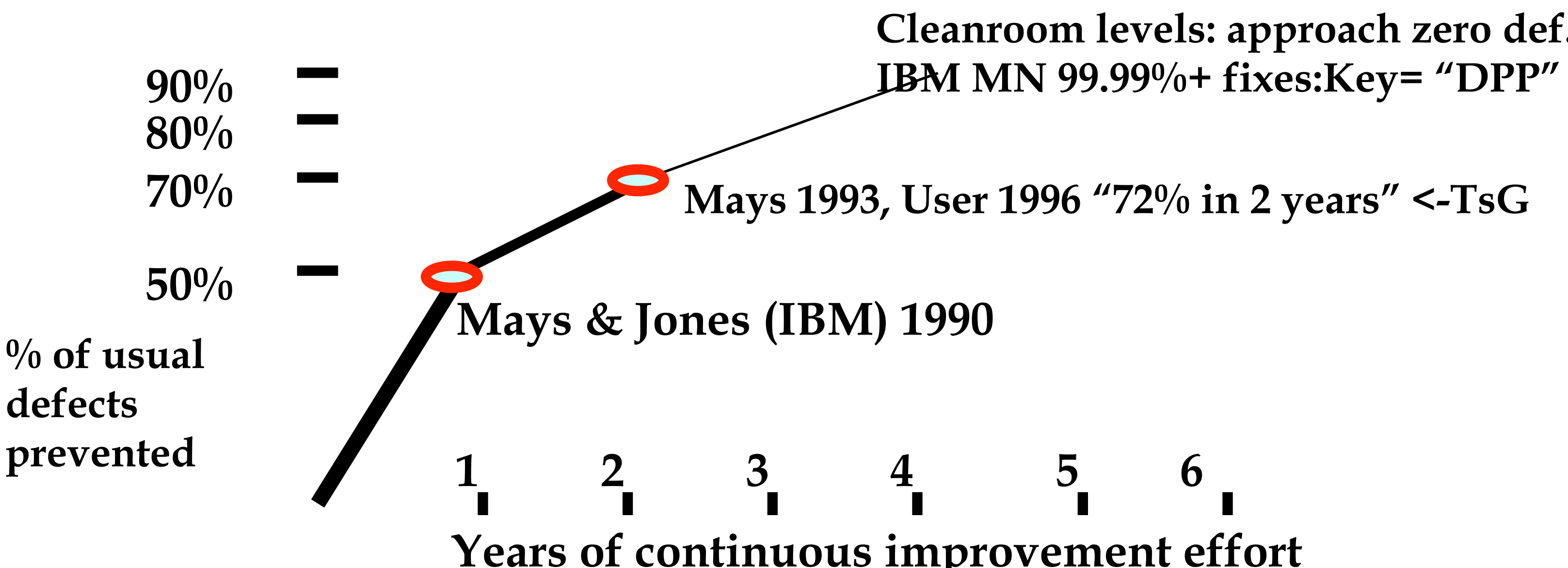
The number of Document Inspections where she got useful **feedback** about quality and rules.

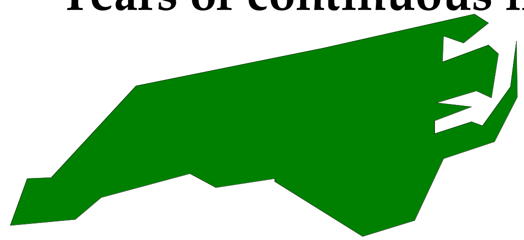
Feedback reduces INJECTION of engineering specification defects

Defect **Prevention** Experiences:

(CMM5) Most defects can be prevented from getting in there *at all, e v e r!*

This works by daily *feedback* from development defects.

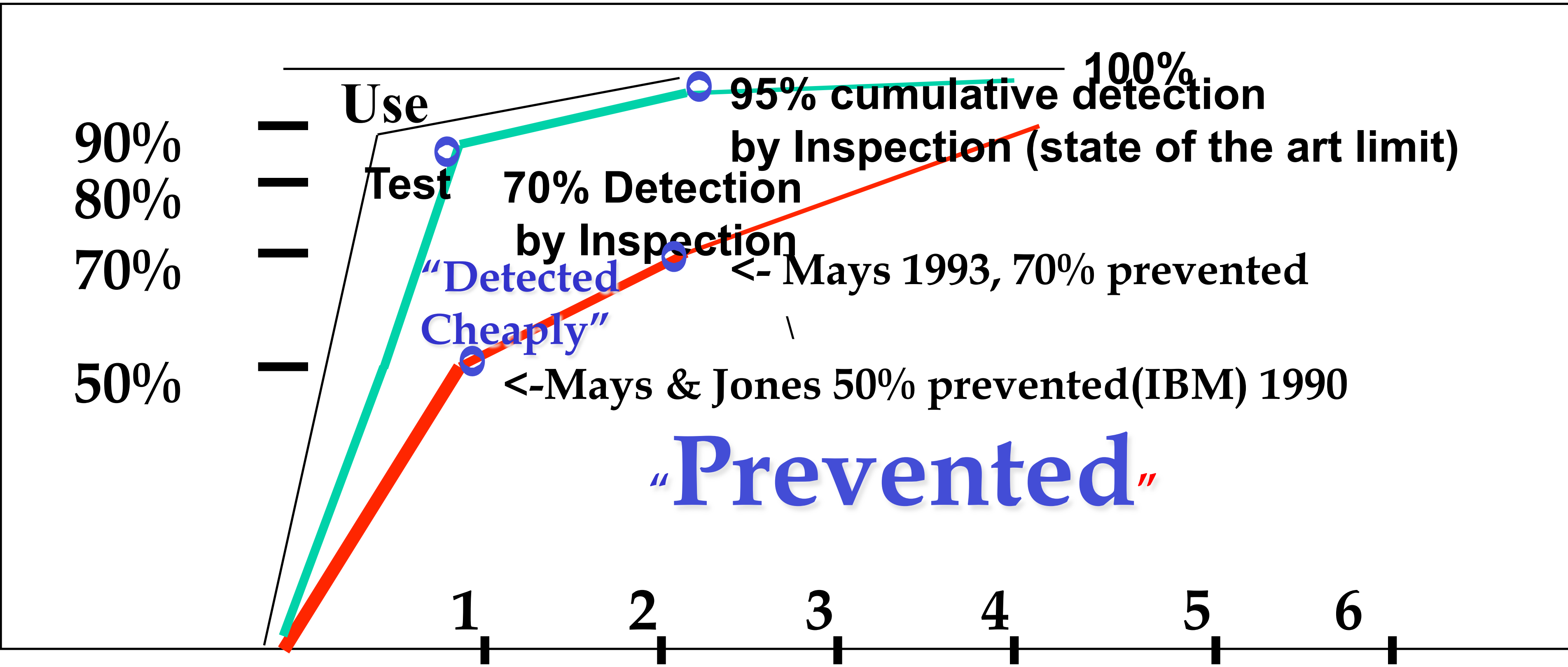




North Carolina

IBM Research Triangle Park Networking Laboratory

Prevention + Pre-test Detection is the most effective and efficient



- Prevention data based on state of the art prevention experiences (IBM RTP), Others (Space Shuttle IBM SJ 1-95) 95%+ (99.99% in Fixes)
- Cumulative Inspection detection data based on state of the art Inspection (in an environment where prevention is also being used, IBM MN, Sema UK, IBM UK)

IBM MN & NC DPP Experience.

High quantity feedback leads to real change.

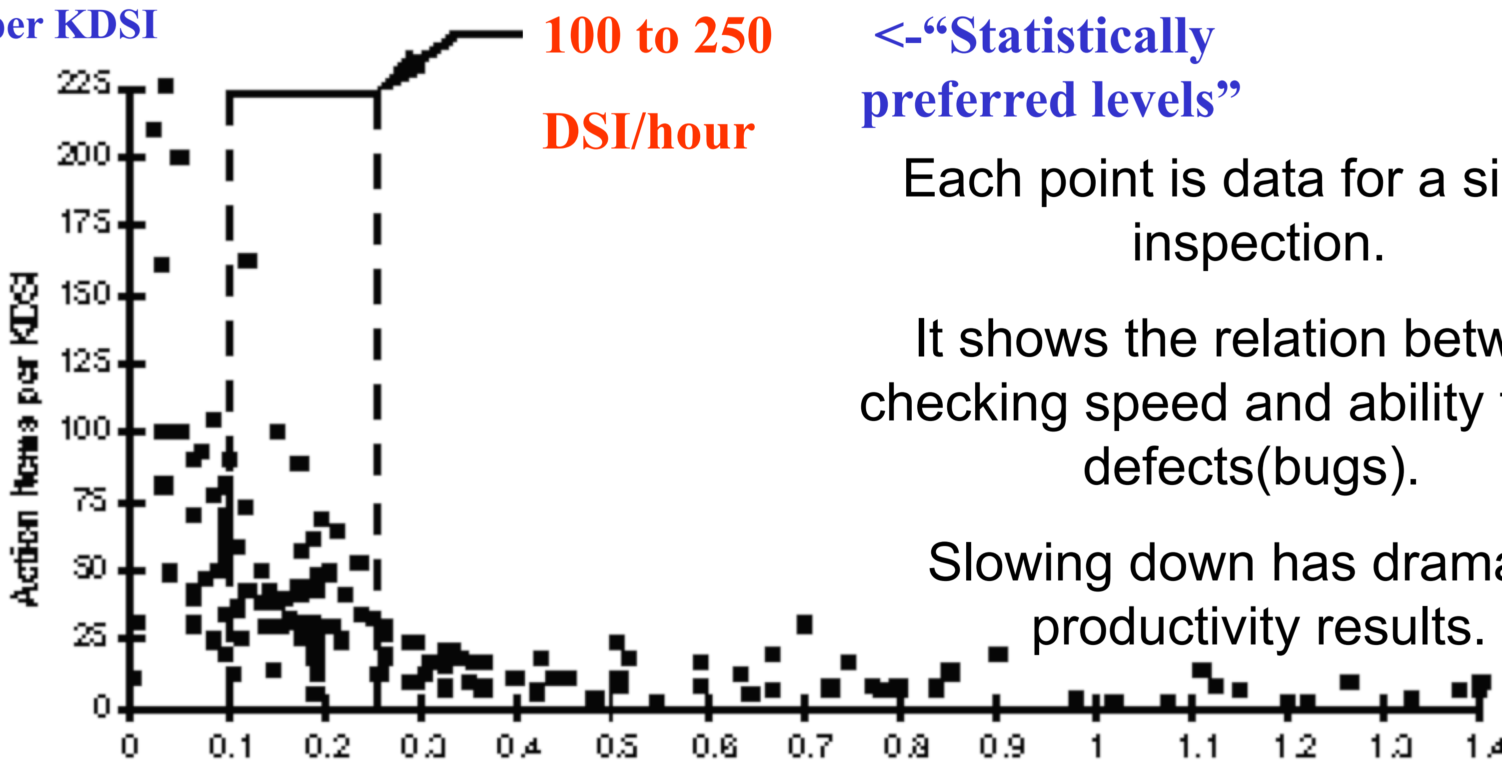
- **2162 DPP Actions implemented (~2,000 Software Engineers)**
  - **between Dec. 91 and May 1993 (30 months)   <-Steve Kan**
- **RTP about 182 per year for 200 people.   <-Robert Mays 1995**
  - **1822 suggested ten years (85-94)**
  - **175 test related**
- **Research Triangle Park (NC, USA) 227 person org   <- Mays slides**
  - **130 actions (@ 0.5 work years**
  - **34 causal analysis meetings @ 0.2 work years**
  - **19 action team meetings @ 0.1work years**
  - **Kickoff meeting @ 0.1 work years**
  - **TOTAL costs 1% of org. resources**
- **total ROI (Return On Investment) DPP 10:1 to 13:1,**
- **internal ROI 2:1 to 3:1**
- **Defect Rates at all stages 50% lower with DPP**

Fault Density versus Checking Rate: Raytheon 95

Feedback on optimum rates leads to orders of magnitude better performance

Action items

per KDSI



Each point is data for a single inspection.

It shows the relation between checking speed and ability to find defects(bugs).

Slowing down has dramatic productivity results.

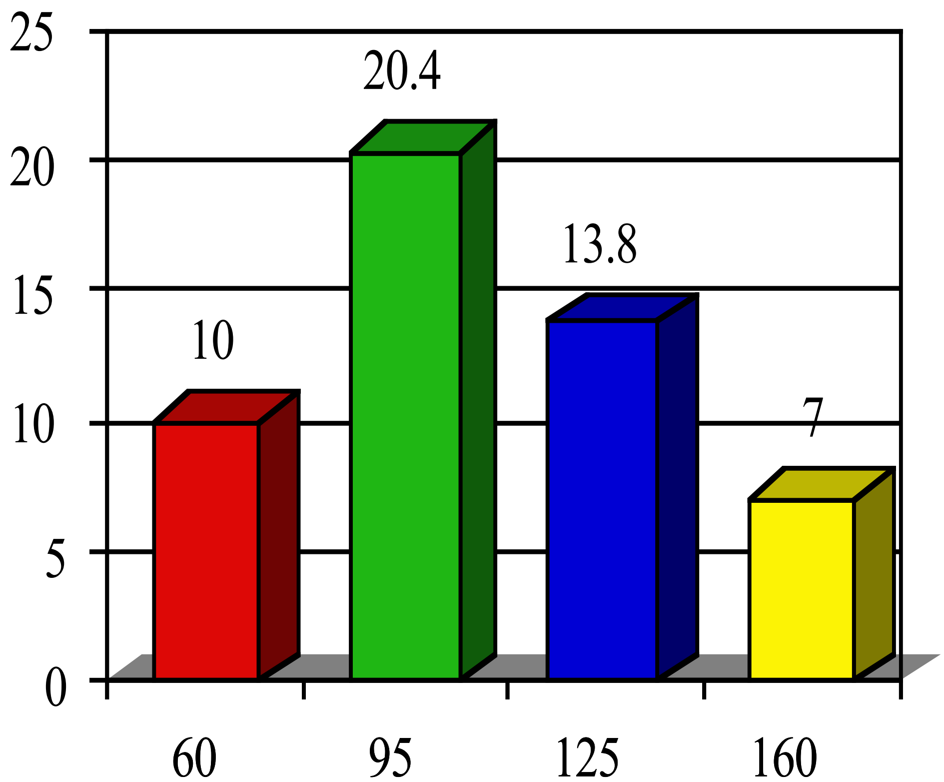
KDSI/Hour

Why do you think they avoid using the optimum rate?

Hint: "Our process mandates 100% inspection coverage"

Effectiveness a function of checking rate (Buck)
Feedback on optimum rates enables bug finding effectiveness

Bugs found of 21 maximum known

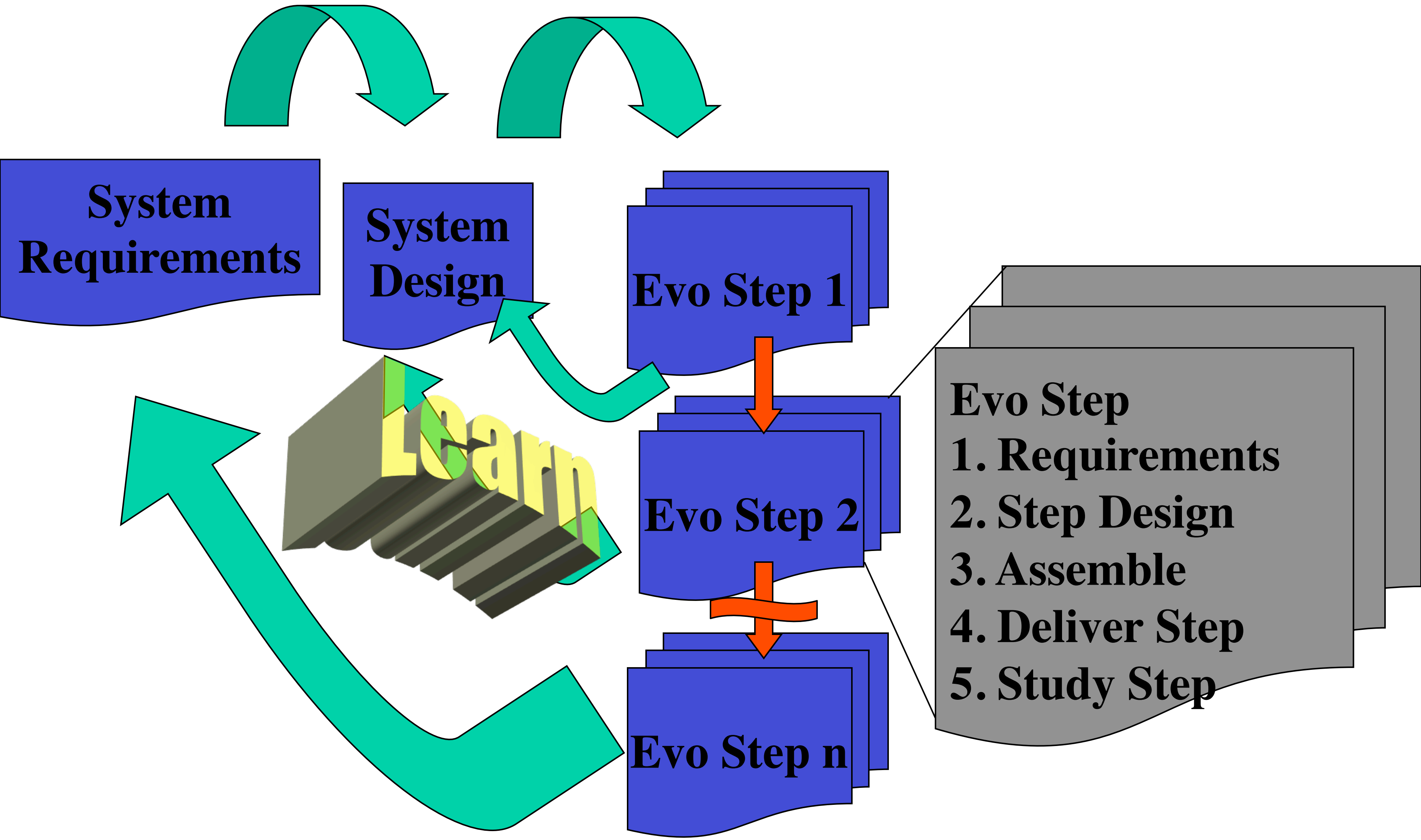


Checking Rate in Lines per hour

From Frank Buck IBM 1980

Evo 'Learning' model

Project feedback improves requirements and design and process!



Evo shortens project by feedback at Microsoft

- "It *appears* that this incremental approach takes longer,
- but it *almost never does*, because it keeps you in close touch with where things really are"
- *Brad Silverberg, Senior VP for Personal Systems Microsoft in CUSUMANO95 ('Microsoft Secrets'), page 202*

Customer **feedback weekly!**

An example of a typical one-week Evo cycle at the HP Manufacturing Test Division during a project. [MAY96, HP* Journal Aug 96]

* one of my direct customers, TG

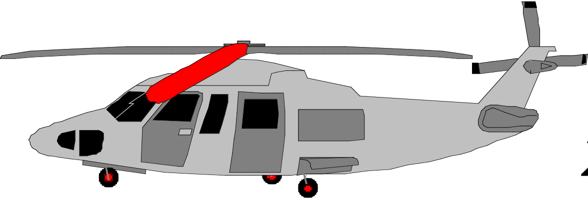
	Development Team	Users
Monday	✓ System Test and Release Version N ✓ Decide What to Do for Version N+1 ✓ Design Version N+1	
Tuesday	✓ Develop Code	✓ Use Version N and Give Feedback
Wednesday	✓ Develop Code ✓ Meet with users to Discuss Action Taken Regarding Feedback From Version N-1	✓ Meet with developers to Discuss Action Taken Regarding Feedback From Version N–1
Thursday	✓ Complete Code	
Friday	✓ Test and Build Version N+1 ✓ Analyze Feedback From Version N and Decide What to Do Next	

See also: MIT Sloan Management Review, Winter 2001, Alan MacCormack, (HBS Professor) **“Product Development Practices That Work: How Internet Companies Build Software”**, Pages 75-84, Reprint 4226

Direct Customer Input (MS)

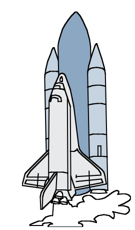
- "Microsoft's general philosophy has been to ….. focus on evolving features and whole products incrementally, with *direct input from customers during* the development process."

CUSUMANO95 , 13, Microsoft Secrets



Harlan Mills on Project Control:
2% deliveries feedback gives full project control!

- **"Software Engineering began to emerge in FSD" (IBM Federal Systems Division, from 1996 a part of Lockheed Martin Marietta) "some ten years ago [about 1970] in a continuing evolution that is still underway.**
  - **Ten years ago general management expected the worst from software projects – cost overruns, late deliveries, unreliable and incomplete software.**
  - **Today [1980] , management has learned to expect on-time, within budget, deliveries of high-quality software.**
- **A Navy helicopter ship system, called LAMPS, provides a recent example.**
  - **LAMPS software was a four-year project of over 200 person-years of effort,**
  - **developing over three million, and integrating over seven million words of program and data for eight different processors distributed between a helicopter and a ship,**
  - **in 45 incremental deliveries.**
  - **Every one of those deliveries was on time and under budget.**



- **A more extended example can be found in the NASA space program,**
  - **where in the past ten years, FSD has managed some 7,000 person-years of software development, developing and integrating over a hundred million bytes of program and data for ground and space processors in over a dozen projects.**
  - **"There were few late or overrun deliveries in that decade, and none at all in the past four years." Harlan Mills [IBM Systems Journal No. 4, 1980, p. 415], Reprinted IBM SJ Vol. 38 1999, 289-295**

User Feedback (JPL)

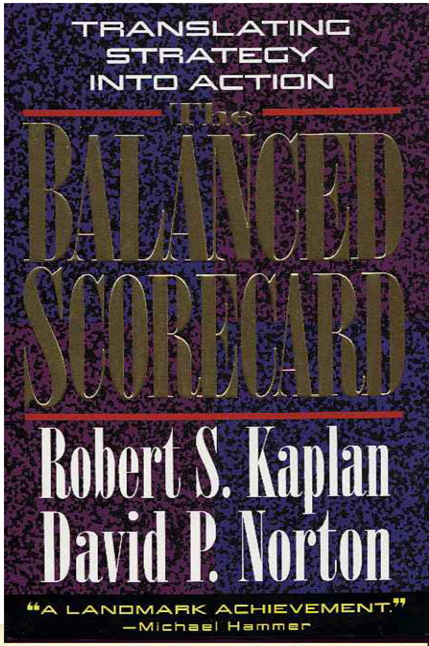
- Evo "expects active feedback from the experience gained from one incremental delivery to the requirements from the next.
- As Evo periodically delivers to the users an increment of capability, the users are able to provide understanding of how effectively that delivery is meeting their needs.
- As the users assess the impact of a delivery on their operations, the system developer is able to work with them to adjust the system requirements to better satisfy their operational needs.
- Evo lets that adjusted set of requirements be the basis for all subsequent incremental deliveries.
- This feedback process is formal and proactive. It is a key element in making Evo effective from a user's perspective."
- [SPUCK93] Jet Propulsion Labs

2. Critical Measurement

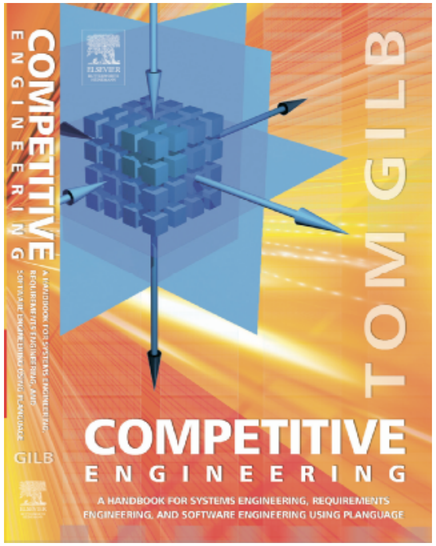
- If you do not focus on the few measures critical to your system, then it will fail.

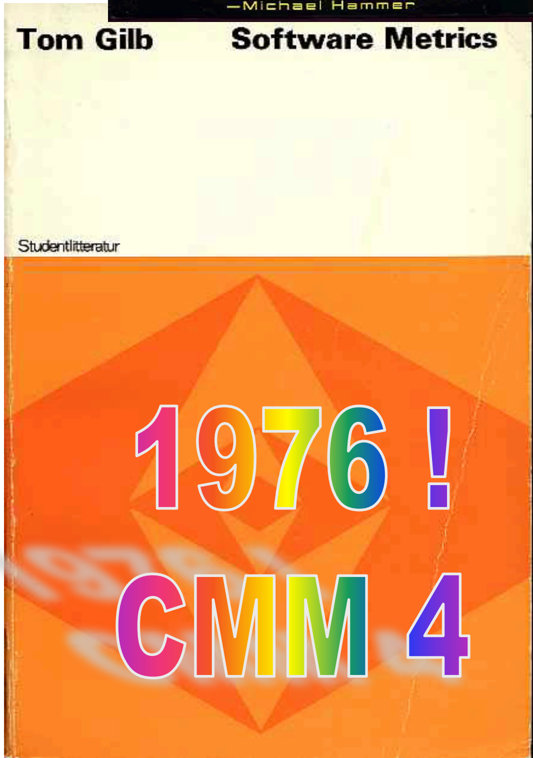
- *This principle is supported by the slide detail for several other principles here, so I will not comment in more detail just here. TG*

3. Multiple Objectives



- If you cannot control multiple measures of quality and cost simultaneously, then your system will fail due to the ones you did not control.



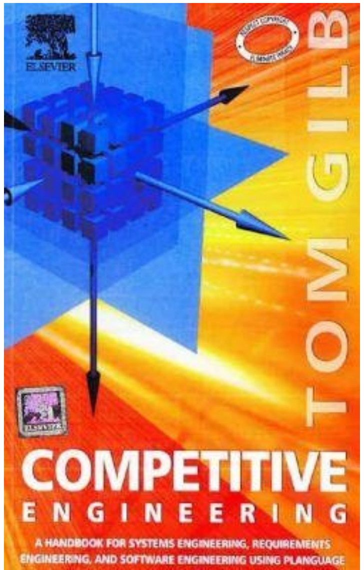


Impact Table for Step Management: how to directly control many cost and quality objectives in small evolutionary project steps simultaneously

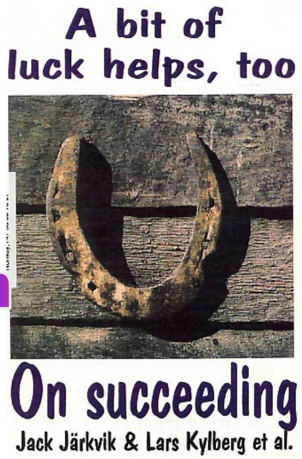
	Step #1 Plan A: {Design-X, Function -Y}	Step #1 Actual	Differe-nce. - is bad + is good	Total Step 1	Step #2 Plan B: {Design Z, Design F}	Step #2 Actual	Step #2 Differe-nce	Total Step 1+2	Step #3 Next step plan
Reliabil-ity 99%-99.9%	50% ±50%	40%	-10%	40%	30% ±20%	20%	-10%	60%	0%
Perform-ance 11sec.-1 sec.	80% ±40%	40%	-40	40	30% ±50%	30%	0	70%	30%
Usability 30 min. -30 sec.	10% ±20%	12%	+2%	12%	20% ±15%	5%	-15%	17%	83%
Capital Cost 1 mill.	20% ±1%	10%	+10%	10%	5% ±2%	10%	-5%	20%	5%
Enginee-ring Hours 10,000	2% ±1%	4%	-2%	4%	10% ±2.5%	3%	+7%	7%	5%
Calend-ar Time	1 week	2 weeks	-1week	2 weeks	1 week	0.5 weeks	+0.5 wk	2.5 weeks	1 week

4. Evolution

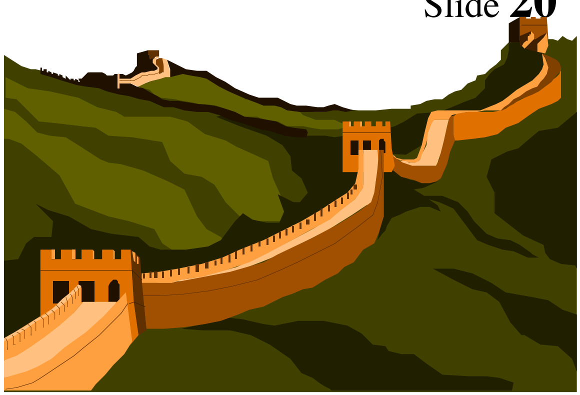
- You must evolve in small steps towards your goals; large step failure kills the entire effort.
  - And early frequent result delivery is politically and economically wise.
  - 2% of total is a small step, you can afford to fail on



Ericsson case in Japan



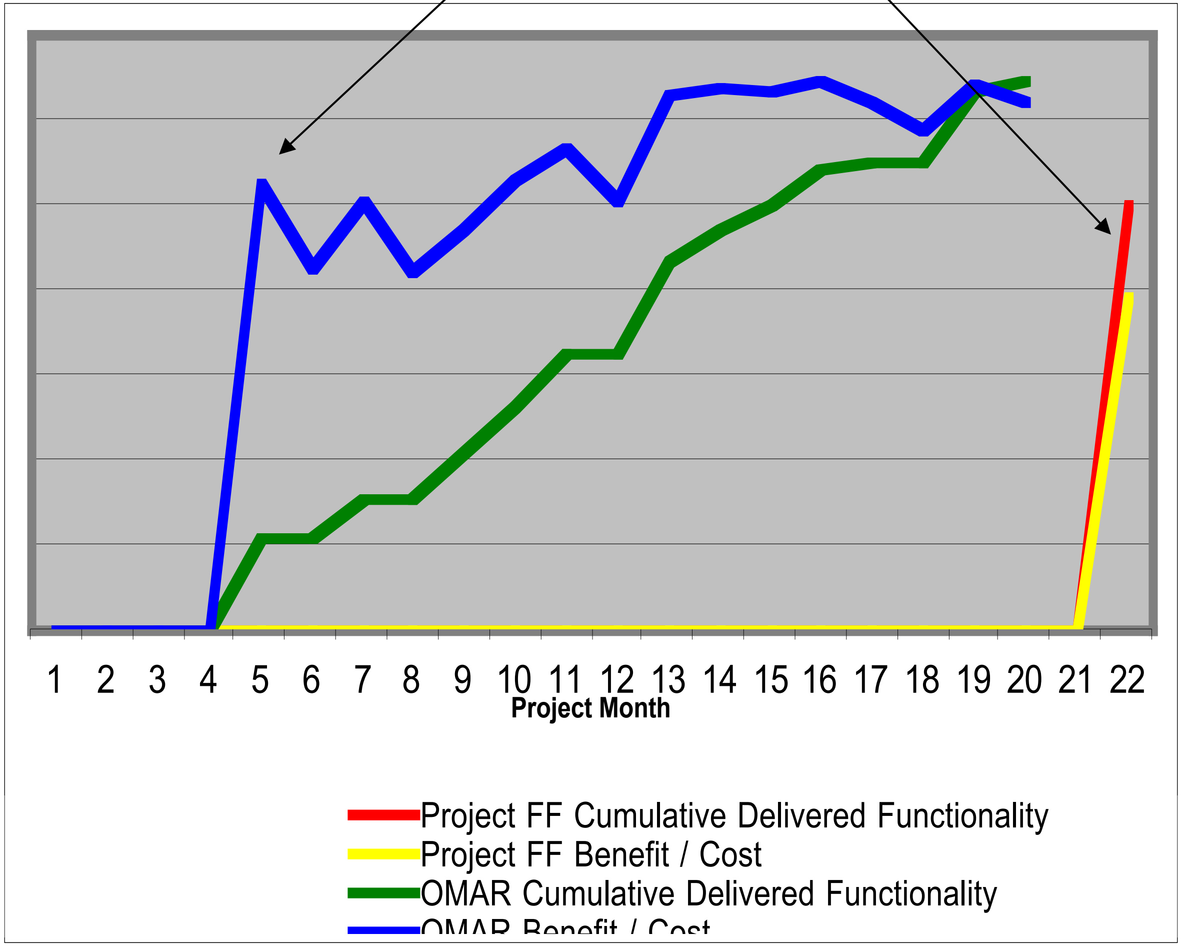
Tao Te Ching (500BC)



- That which remains quiet, is easy to handle.
- That which is not yet developed is easy to manage.
- That which is weak is easy to control.
- That which is still small is easy to direct.
- Deal with little troubles before they become big.
- Attend to little problems before they get out of hand.
- For the largest tree was once a sprout,
- the tallest tower started with the first brick,
- and the longest journey started with the first step.
  - From Lao Tzu in Bahn, 1980 Penguin book

Value delivery early

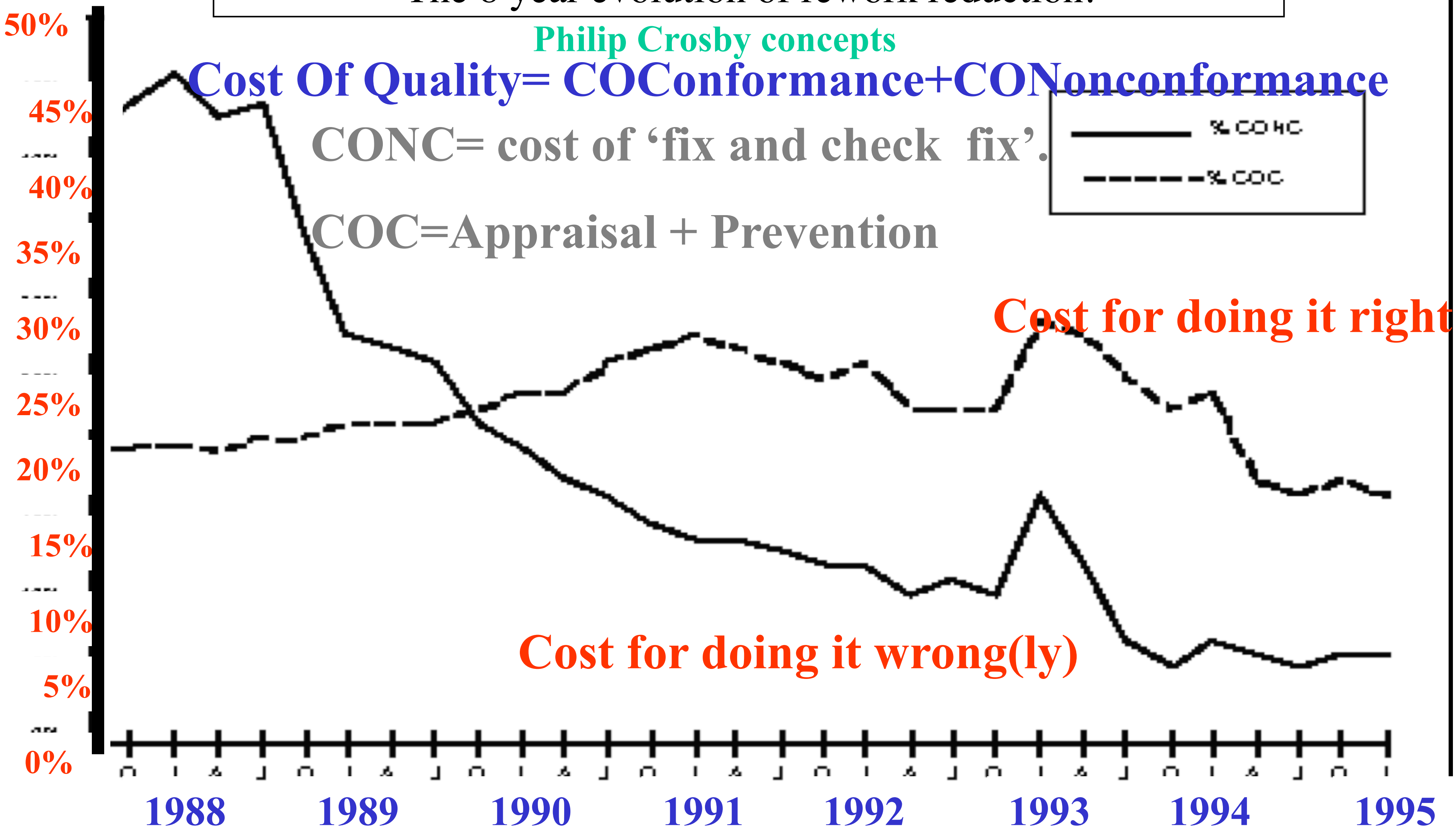
OMAR Case delivery value vs Waterfall (1998)



Stuart Woodward: Evolutionary project Management

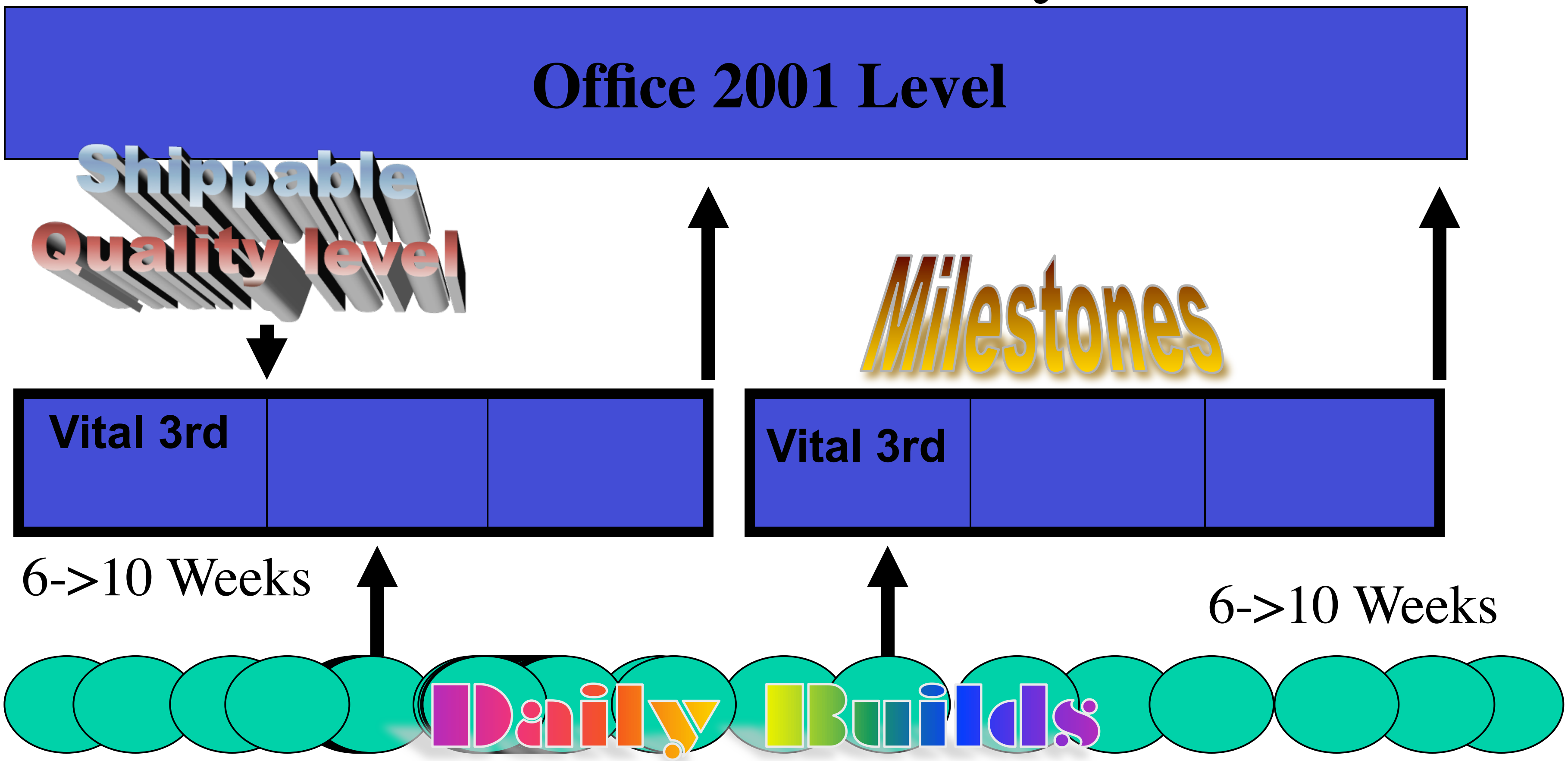
IEEE Computer Oct 1999, page 49-57
s.woodward@computer.org

Cost of Quality versus Time: Raytheon 95
The 8 year evolution of rework reduction.



Project Cost = {Cost of Quality + Cost of Performance}.
Cost of Performance={Planning, Documentation, Specification}.

Multiple Levels of Microsoft Evo: Ms does Evo daily!

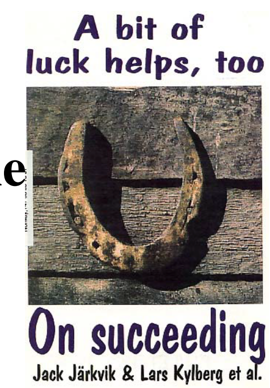


Go to next Graphic

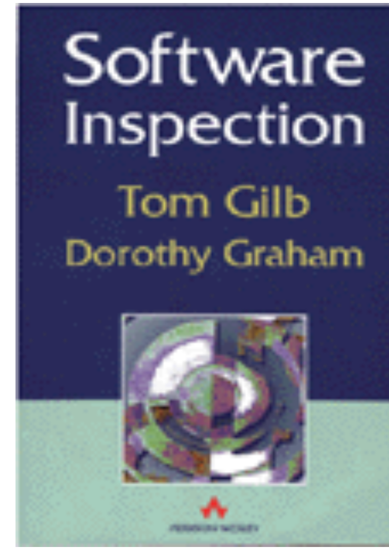
Early simple proof of concept (Ericsson): Ericsson used Evo to deliver a 15 month project in 9 months to Japan

- **"Organic integration [Evo] is a way of getting rid of the myth [that problems don't exist] very early on.**
- **You could say that organic integration demands of an organization that it do the specifications, the system, the design and the verification for *one first very small task* very quickly.**
- **It also demands of the organization that it *do this right* in terms of delivering products correctly.**
- **If the organization cannot even manage its first simple task in the time agreed, it certainly should *question the ability* to manage more difficult tasks.**
- **This *process of questioning* is very healthy. It may for example prevent the *delusions of grandeur* so common in nearly all organizations".**
- **[Ericsson94], page 26, Jack Järkvik, in the context of building mobile telephone base stations**

Ericsson case in Japan



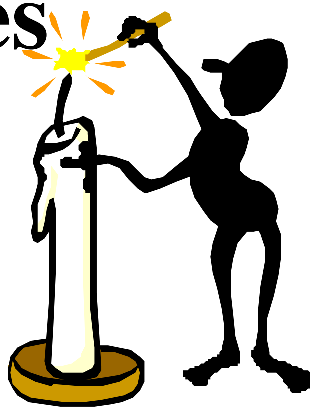
5. Quality Control



- Quality Control must be done as early as possible, in planning, to reduce the delays from late defect finding.
  - Use numeric Exit from development process
    - Like "Maximum 0.2 Majors/Page"
  - Use Inspection sampling to keep costs down, and to permit early, before completion, action and learning.

August 1999

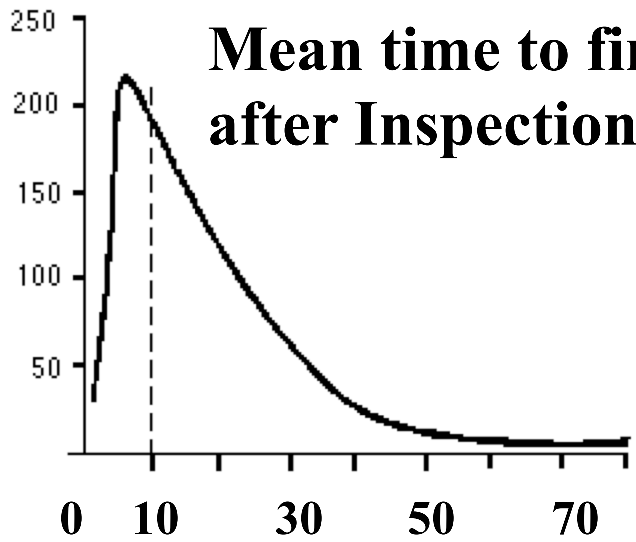
10 Top Advanced Inspection Principles



- Pr1. *Prevention* is more effective than Cure
- Pr2. *Avoidance* is more efficient than removal
- Pr3. *Feedback* teaches effectively
- Pr4. *Measurement* gives facts to control the process
- Pr5. Priority to the *Profitable*
- Pr6. *Forget perfection*, you can't afford it!
- Pr7. Teach *fishing*, rather than 'give fish'
- Pr8. *Framework for Freedom* beats bureaucracy
- Pr9. *Reality* rules
- Pr10. *Facts* beat intuition

The downstream alternative cost of quality at a Defence Electronics Factory (all types of documents).

Number of defects of the 1,000 sampled Majors



Mean time to find and correct a Major after Inspection was 9.3 Hours.

It cost about 1 hour to find and fix a Major using Inspection

Estimated hours to find and correct in test or in field.

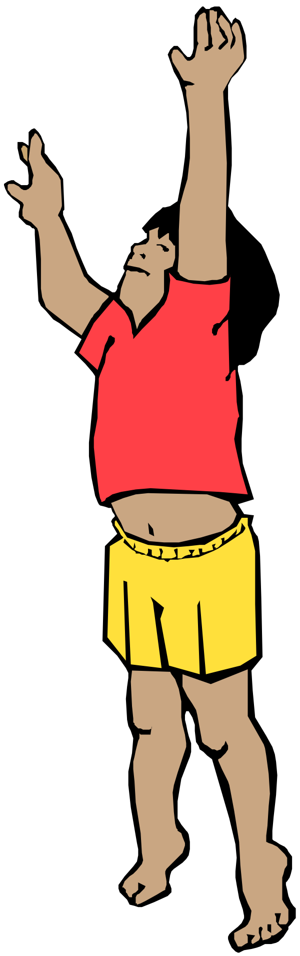
Range 1 to 80 hours

Source: Trevor Reeve, Case Study Chapter in "Software Inspection"

Philips MEL became "Thorn EMI", then Racal, now Raytheon. Crawley UK.

Advanced Inspection Objectives

- Central Objectives
  - 1. Engineering Process Control
  - 2. *Measuring* Document Quality
  - 3. Reduce Project Time & Cost
- Secondary Objectives
  - 4. Identify and Remove Major Defects
  - 5. Reduce Service/Maintenance Costs
- *NOT* Objectives
  - Approve document '*content*'
  - Remove *minor* defects
  - '*Improve*' Quality



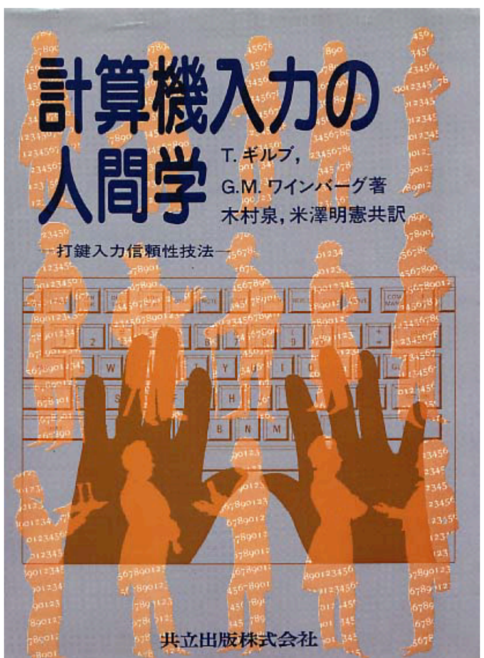
Larger set of Inspection Objectives

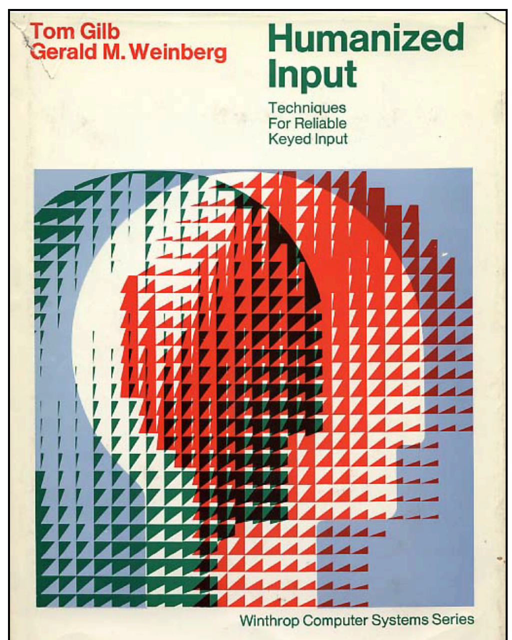
1. Time-to-Delivery
2. Measurement
   - document quality
   - doc. process quality
   - inspection value/cost
3. Release “downstream”
4. Identify defects
5. Fix defects
   avoid new defect injection
6. Improve process
   product producers
   inspection itself
7. On-the-job training

8. Motivation
9. Help Author
10. Effectiveness (Quality)
11. Efficiency (Productivity)
12. Train Inspection team leader
13. Certify the leader
14. Motivate Managers
15. Reduce Maintenance Costs
16. Relieve Project Leader.
17.<u>many others</u>

6. Motivation

- The ‘best methods’ work only when people are motivated
  - ‘Drive out fear’ (Deming)





Motivation 'is Everything!'

- **People are 'sensitive'**
- **Avoid all 'threats'**
- **Give 'positive' motivators**
- **Very many 'details' support this attitude**
- **You will respect this, or fail!**
- **Do unto others, as you would have them do with *your* work!**

Positive Motivators in our Inspection version

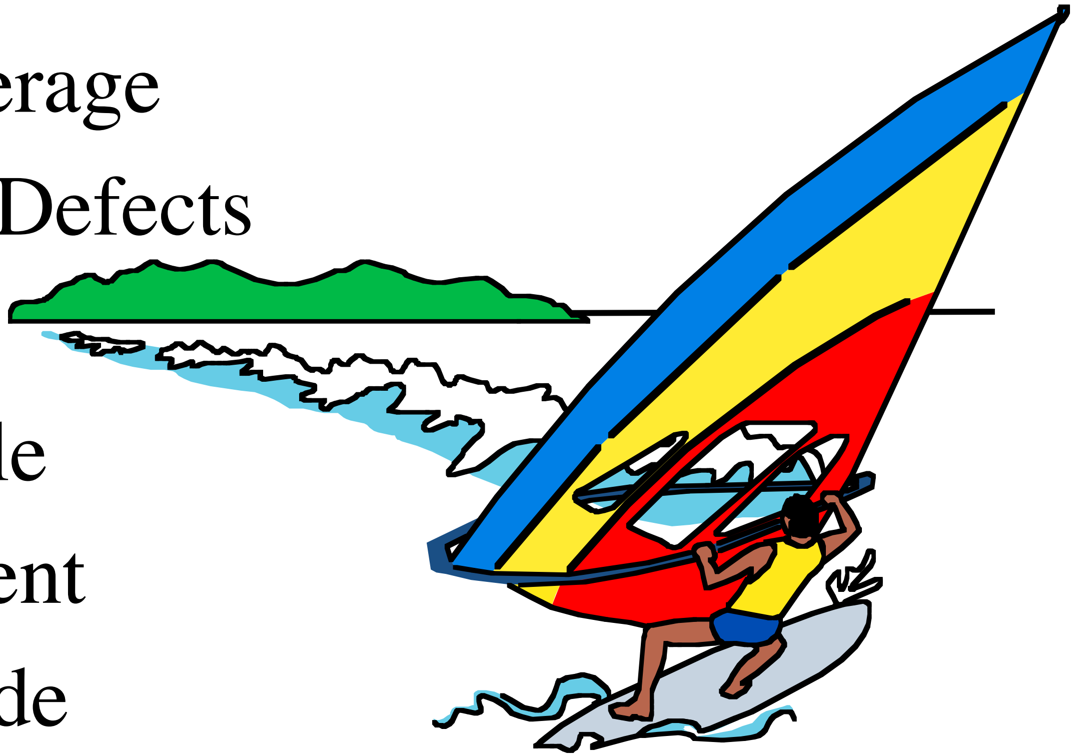
- Group-work
- Team
- Freedom
- Learning
- Game
- Experiments
- Challenge
- Numeric Feedback
- Process Improvement
- Positive Leadership
- Sampling

Potentially Negative Motivators in bad Inspection practice

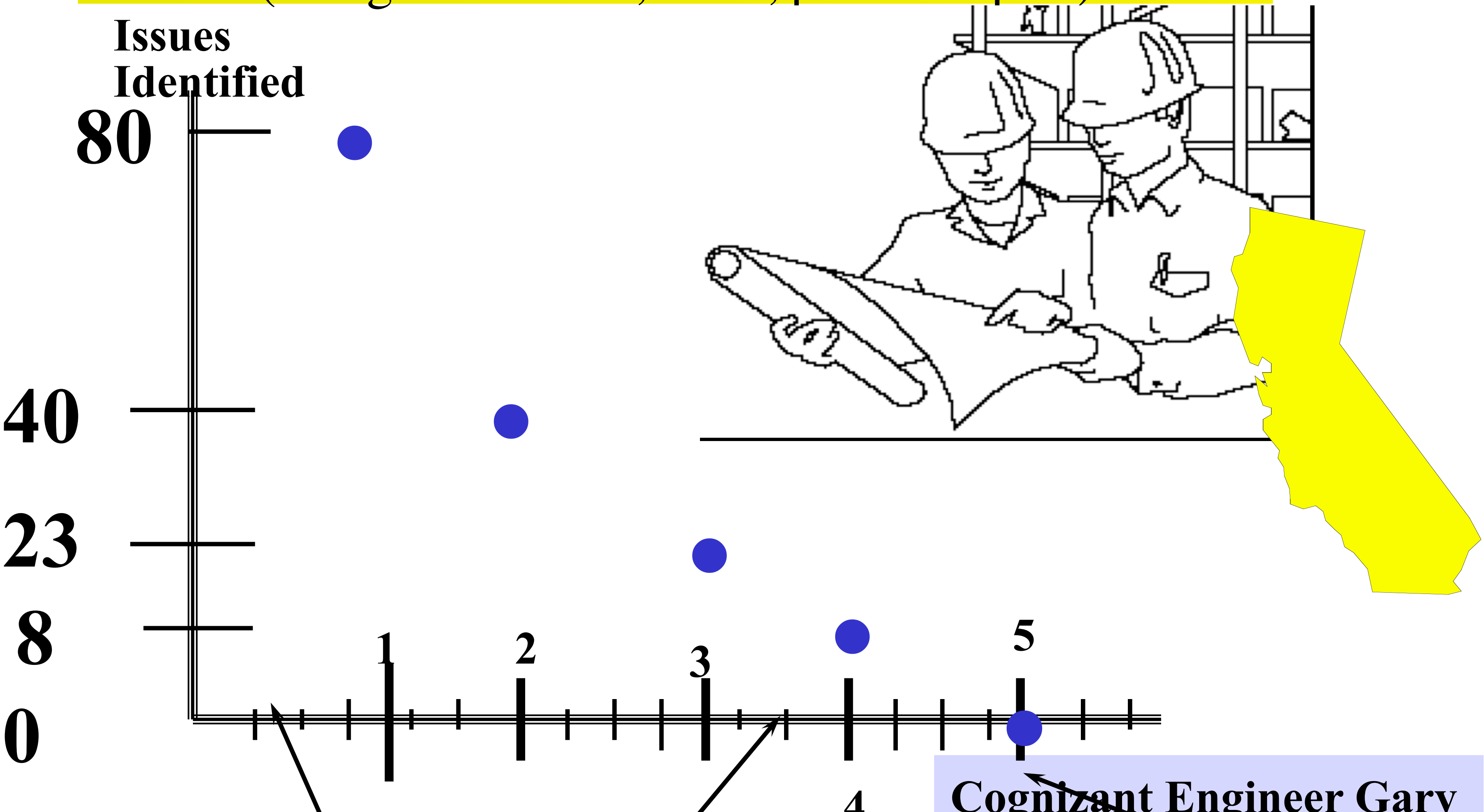
- Time Pressure
- Result Pressure
- Personal Attacks
- Bureaucracy
- Small-minded Leader
- Personal-fault blaming
- Process corruption
- High volume/cleanup

Motivational Philosophy

- Intelligent Inspection
- Maximum Leverage
- Process causes Defects
- Trust people
- Empower people
- Allow experiment
- Let results decide
- Continuously improve



Gary's Personal Learning (to follow process) Curve (Douglas Aircraft, 1988, private report)



Experience as Checker

Cognizant Engineer Gary was" document author" at points 1 to 5

THE BUSINESS IMPACT OF REACHING CMU/SEI LEVEL 5

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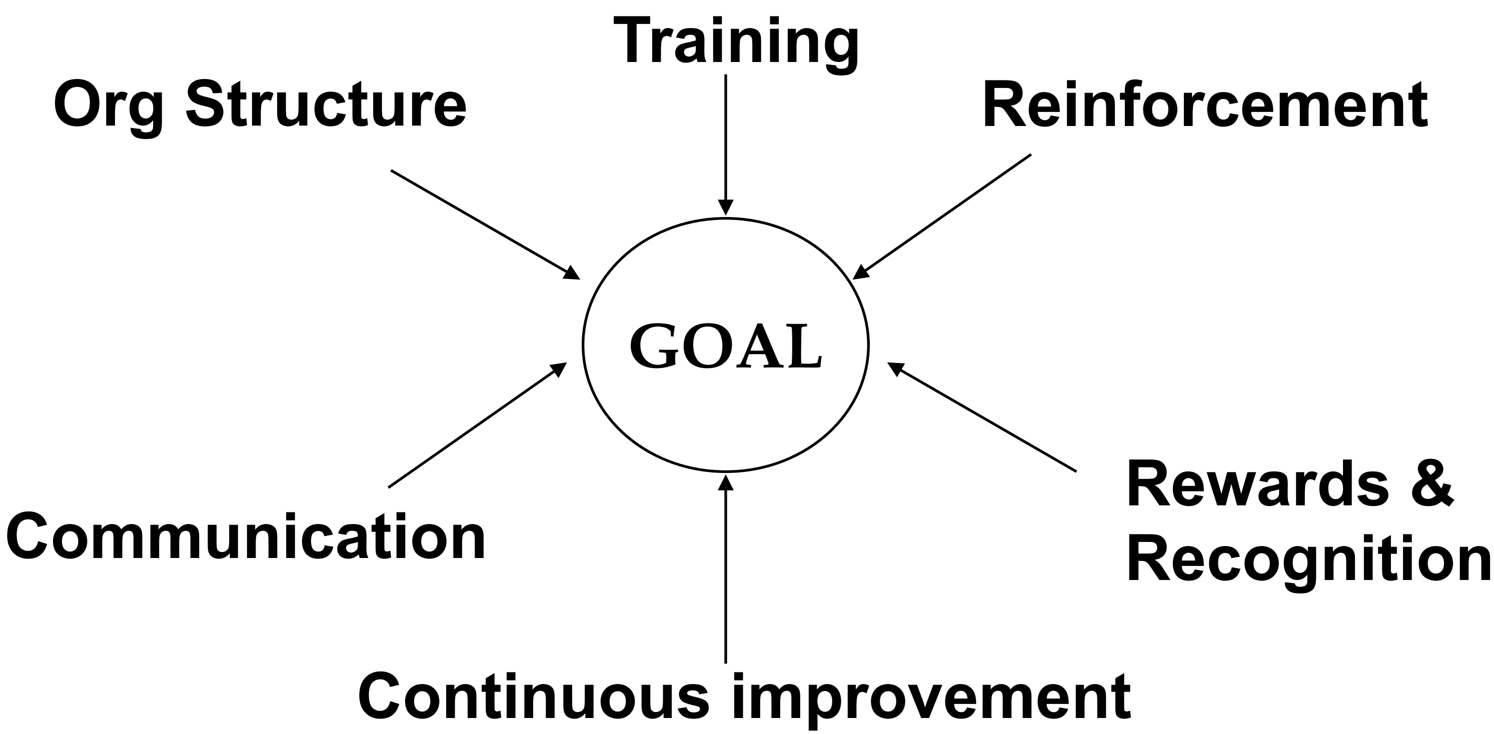
Visited by Gilb March 2000

Slides July 1996 Given Gilb by Fordham 1999

MIEL ~ THE EXPERIMENT



ORGANIZATIONAL VALUE SYSTEM & MANAGEMENT COMMITMENT

CONCLUSION

- ***Benefits of a well-controlled process in terms of quality, productivity and cycle time are very apparent.***
- ***Developing software across an ocean can be done in no other better way.***
- ***Process maturity provides a sense of self-esteem for individuals.***
- ***Process ownership has to lie with the decision makers.***
- ***Complete commitment, cooperation & participation from all levels of management required.***

CONCLUSION(2)

- ***Process maturity requires an open & mature culture.***
- ***Fear of making / admitting failures should not exist, however all failures should provide lessons learnt & same mistakes should not be repeated.***
- ***Involvement wears out resistance.***
- ***Empowerment is key to process maturity. It must be tempered with explicit bounds on what employees can & cannot address.***
- ***Long term cost benefit orientation will help in directing organizational change.***

RESULTS (1 of 2)

- LINES OF CODE RELEASED IN 1995
  - OVER 3 MILLION
- PRODUCTIVITY
  - 2 TIMES THE INDUSTRY AVERAGE
- POST-RELEASE QUALITY
  - **190 TIMES** INDUSTRY AVERAGE*
    - (they had 2 bugs in 800,000 LOC!, TG)
- 85% OF PROJECTS ARE DELIVERED ON SCHEDULE
- CUSTOMER SATISFACTION HAS BEEN CONSISTENTLY BETWEEN GOOD & EXCELLENT.

* US AVERAGE POST RELEASE DEFECTS OF 0.75 DEFECTS/FUNCTION POINT
(6 DEFECTS/1024LOC) *Industry average*
SOURCE: CAPERS JONES

RESULTS (2)

- BUILT BASELINES OF PRODUCTIVITY & DEFECT DENSITY FOR ELEVEN CATEGORIES OF PROJECTS.
- HAVE ACHIEVED BETTER THAN 20% ACCURACY FOR DEFECT PROJECTIONS 50% OF THE TIME
- BUILT SUFFICIENT HISTORICAL DATA FOR A BETTER REFINEMENT OF THE REGRESSION MODEL.
- BUSINESS HAS GROWN 300% IN THE LAST 5 YEARS.

7. Process Improvement

- Eternal Process improvement is necessary as long as you are in competition
  - Paraphrasing Deming about PDSA cycle end.

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FAX (202) 363.3501

18 May 1991

Dear Tom,

It is the PDSA cycle, not PDCA. Check means to hold back. I hope that you will correct your book. I remain with best greetings

Sincerely yours,

W. Edwards Deming

To Dr. Tom Gilb
Iver Holters vei 2
N-1410 KOLBOTN
Norway

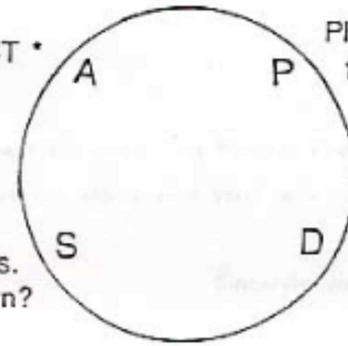
THE SHEWHART CYCLE

FOR LEARNING AND IMPROVEMENT

THE P D S A CYCLE

ACT *

Plan a change or a test, aimed at improvement.



Study the results. What did we learn? What went wrong?

Carry out the change or the test (preferably on a small scale)

* ACT. Adopt the change.

or Abandon it.

or Run through the cycle again, possibly under different environmental conditions.

From a letter to Tom Gilb 18 May 1991

The Road To Wisdom : Piet Hein

"The road to wisdom

is plain and simple to express,

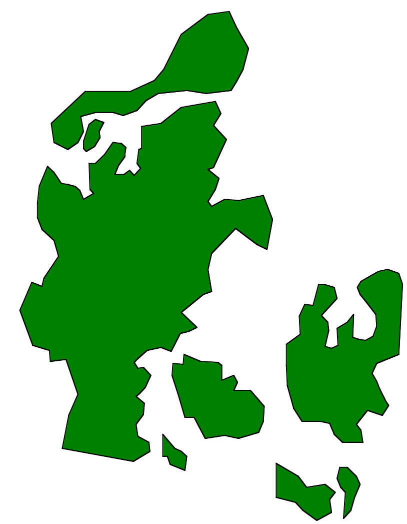
to err, and err, and err again,

but,

less, and less, and less."

Piet Hein,

(Danish Philosopher



The PB Process

- **Team Stays together after 'Logging'**
  - **Same room**
  - **Same people**
  - **Maybe a break first**
  - **Same documents**
  - **Up to half an hour**
- **Shift mentality!**
  - **Not the project**
  - **The process, our organization**
  - **How we feel it can be improved for us**
  - **So we are not 'forced' to make mistakes**

Quick Break from Logging

↓

Leader Picks a real Sample Major Issue from Log, tells Team (1 min)

↓

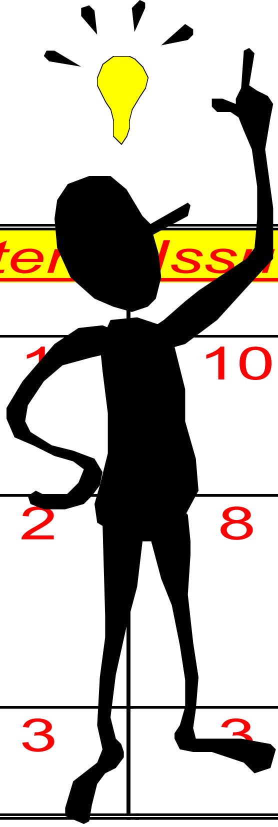
Team Brainstorms 'Root Cause' (1 min)

↓

Team Brainstorms 'Cause Cure' (1 min)

10x max.

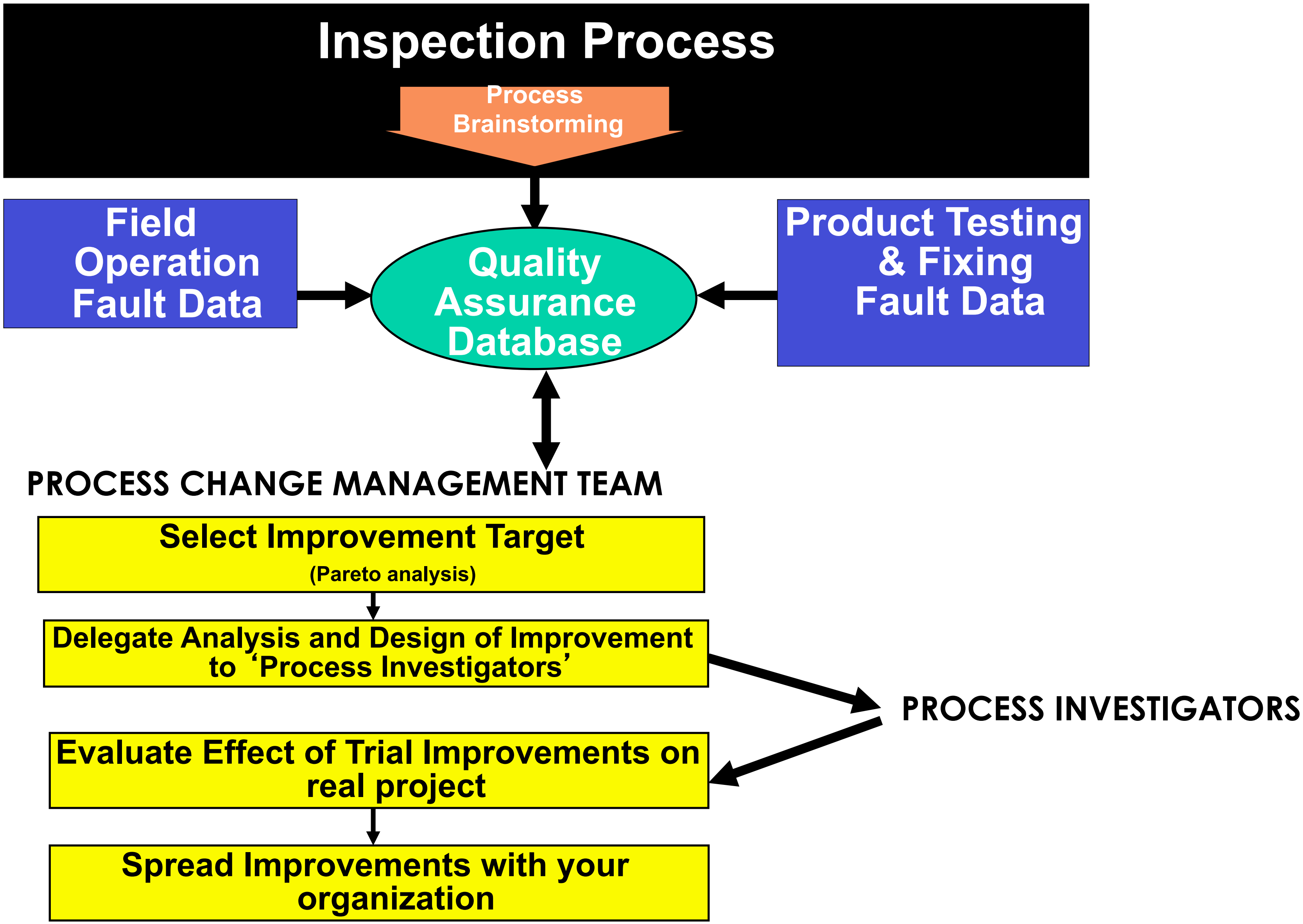
The P.B. Log



Item	Issue	Classify	Root Causes	Improvement Suggestions
1	10	Oversight	• Time pressure • no tools • no info	• optimum time • build tool • give info on PC
2	8	Education	• trainees don't know • manual not updated	• special meeting for trainees • manual on Web
3	3	Commun-ication	• authors are unknown	• publish their email on doc. head

- Brainstorming Rules: no criticism, flow ideas in
- Getting 'Grass Roots' opinions, investigation later

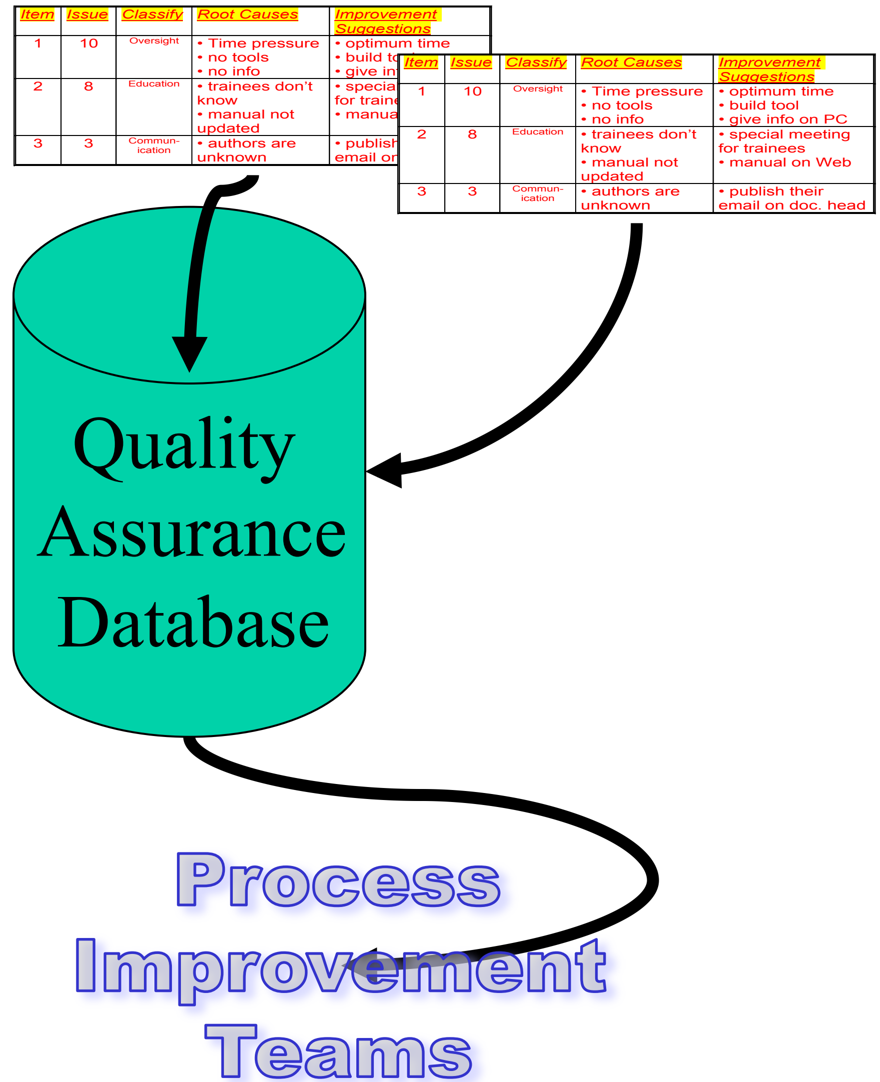
Defect Prevention Process within 'Inspection'



See 'Software Inspection' Chapters 7 and 17 for detail.

The Process Brainstorming Aftermath

- **Brainstormed suggestions**
  - **Are input to Process Improvement Teams.**
  - **Are part of the inputs**
    - **& cost of defect data**
    - **& frequency of defect.**
  - **PB Insights are**
    - **Accurate**
    - **Decentralized**
    - **Real time**
    - **Socially acceptable**
    - **Proven (Mays) to work better than centralized efforts (Fagan's Method 1973)**



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3	3	Commun-ication	• authors are unknown	• publish their email on doc. head

8. Persistence

- Years of persistence are necessary to change a culture.
- W. Edwards Deming
  – It takes 2-3 years to change a project, and a generation to change a culture
- Piet Hein (Denmark)
  – Things Take Time (TTT)

1

$ $ $

Secrets of Software Quality

Software Quality Week

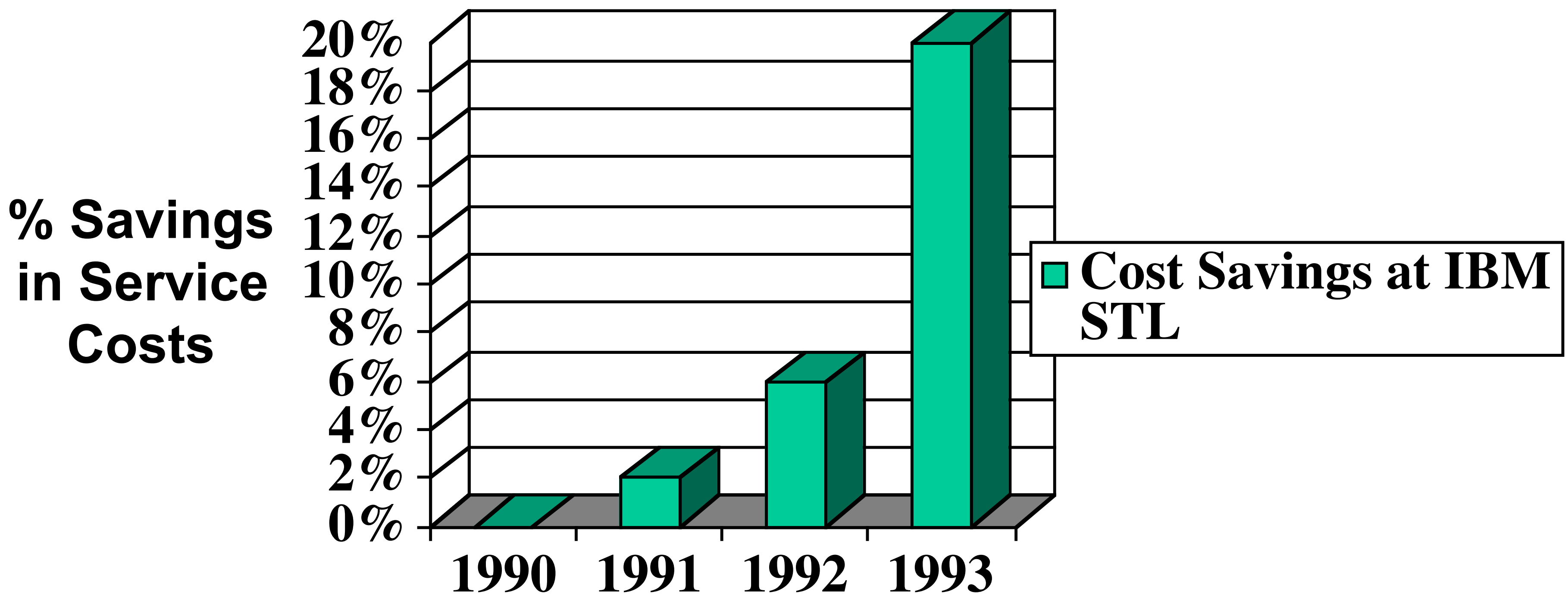
Craig Kaplan, Ph.D.

ckaplan@iqco.com

I.Q. Company

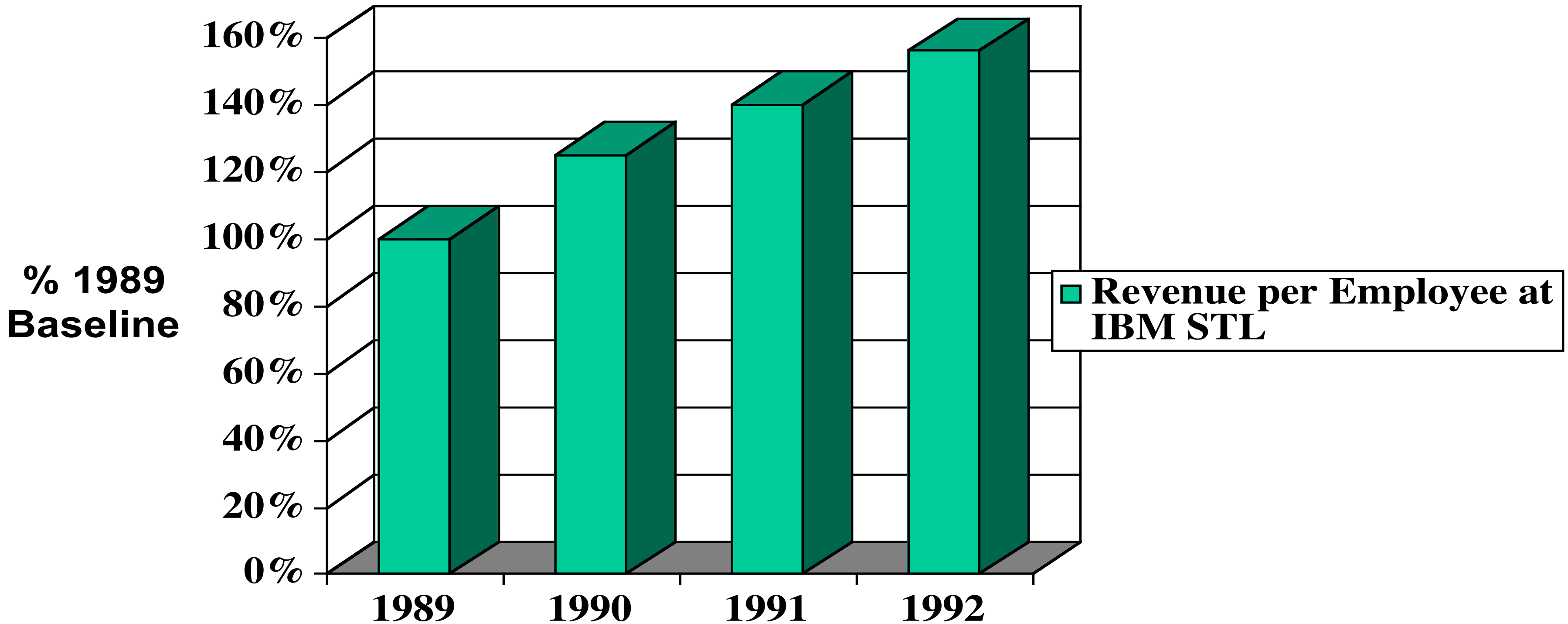
http:\\www.iqco.com

20% Savings on Service Costs Note the 4 year time perspective.



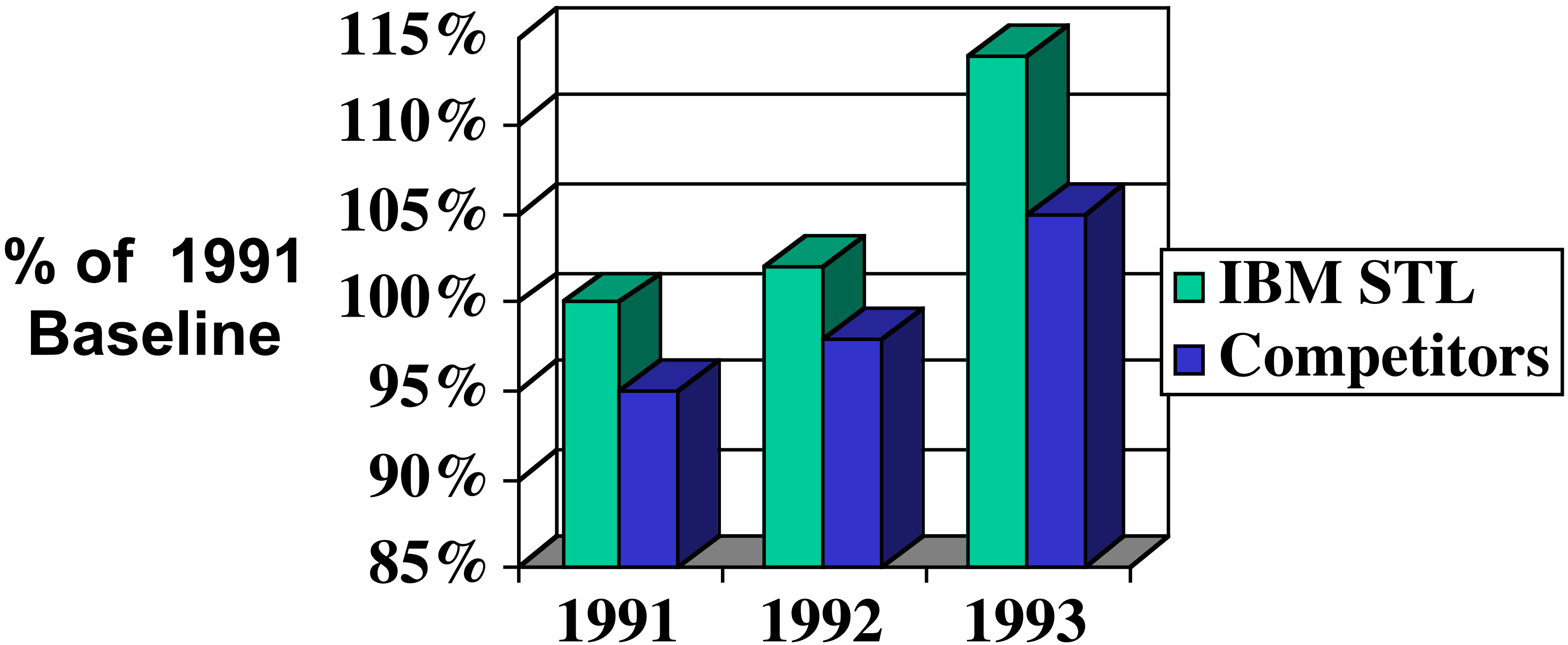
Source: <u>Secrets of Software Quality</u> by Kaplan, Clark, & Tang (McGraw-Hill 1995)

56% Increase in Revenue per Employee



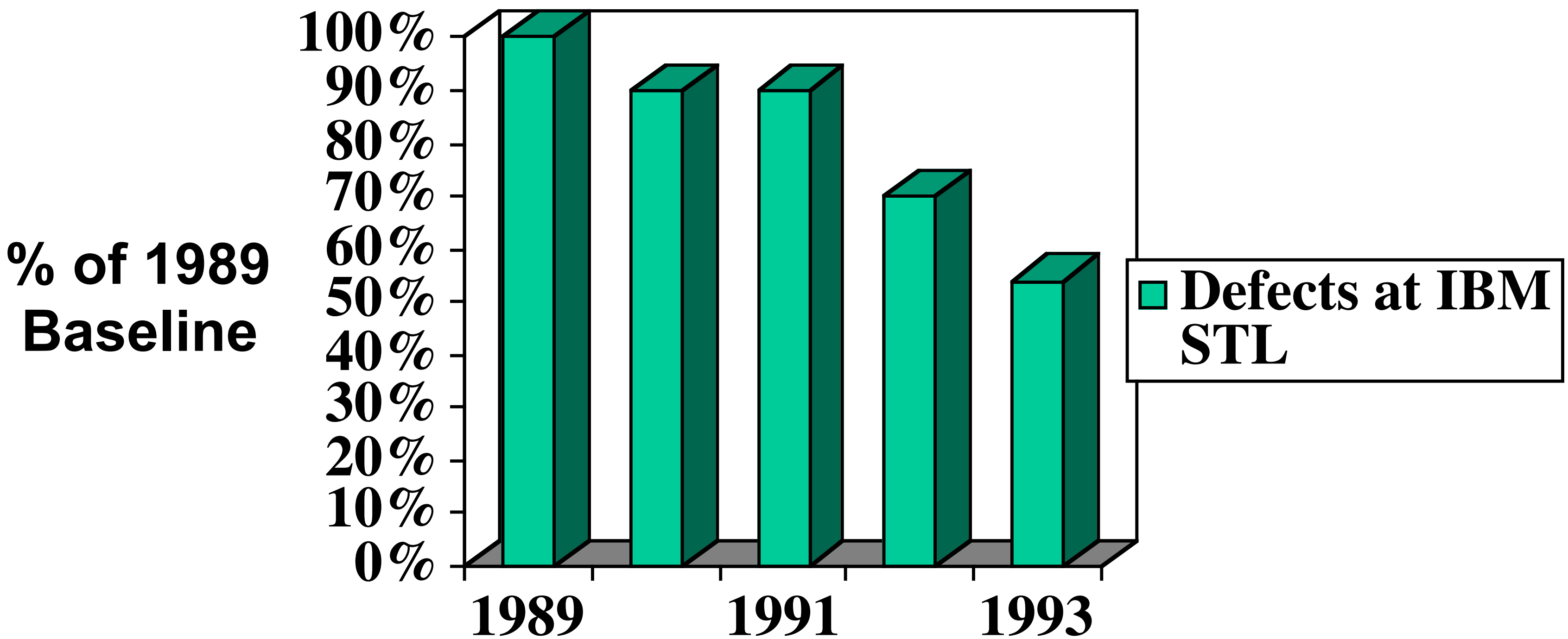
Source: Secrets of Software Quality by Kaplan, Clark, & Tang (McGraw-Hill 1995)

14% Improvement in Customer Satisfaction



Source: Secrets of Software Quality by Kaplan, Clark, & Tang (McGraw-Hill 1995)

46% Reduction in Field Defects

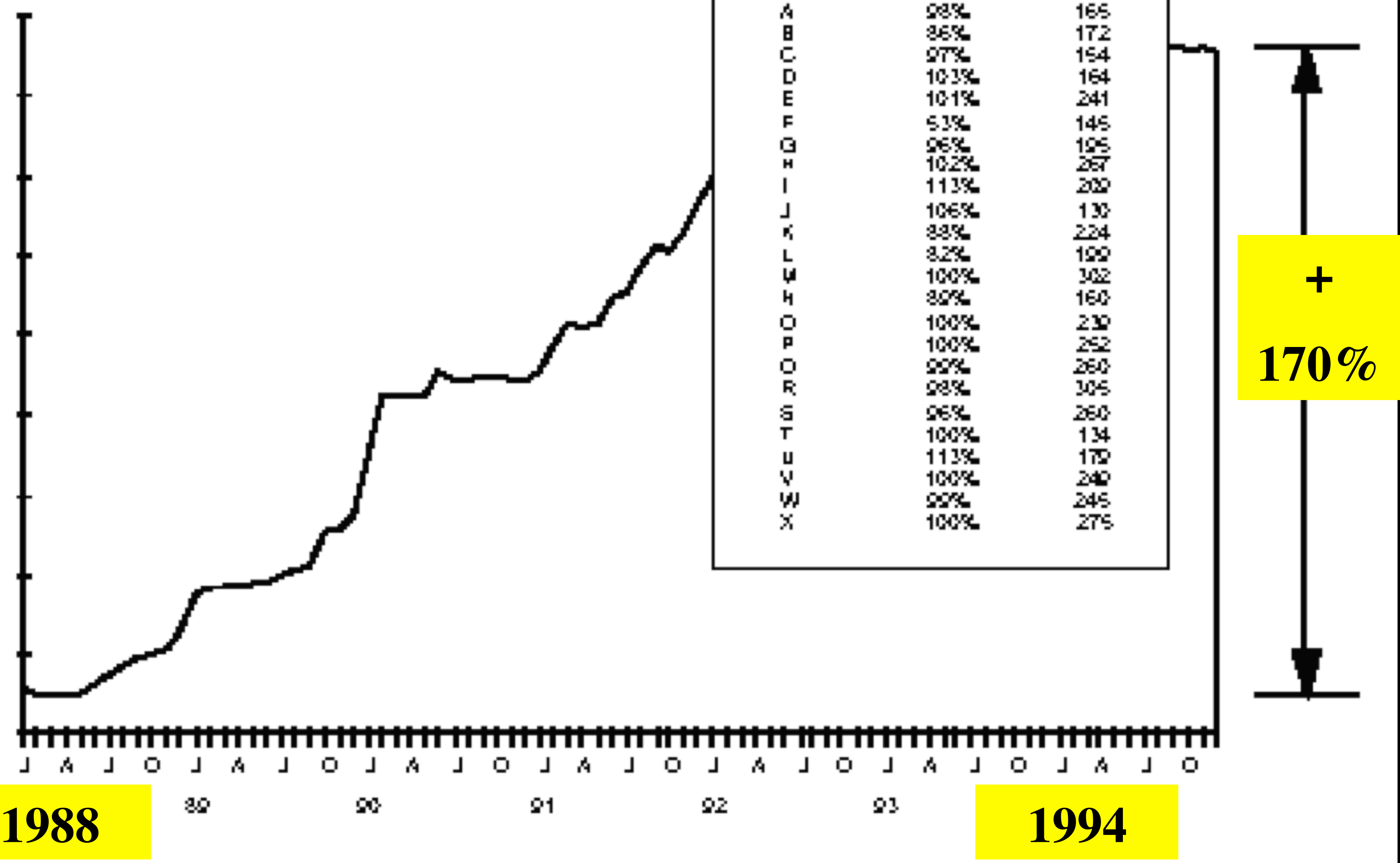


Source: Secrets of Software Quality by Kaplan, Clark, & Tang (McGraw-Hill 1995)

Raytheon 95 Software Productivity 2.7X better.

Note the 5 years to peak time perspective.

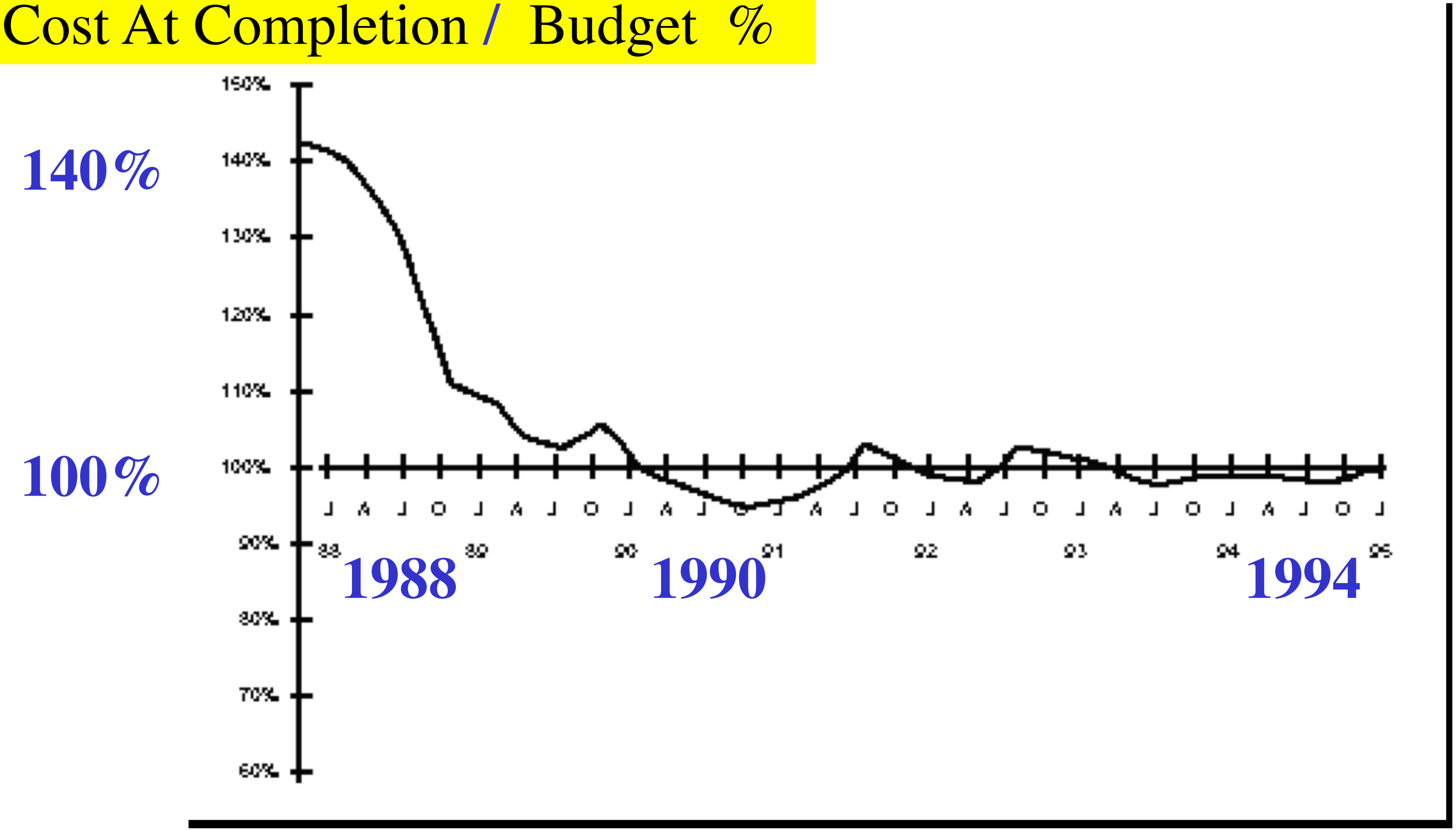
Productivity



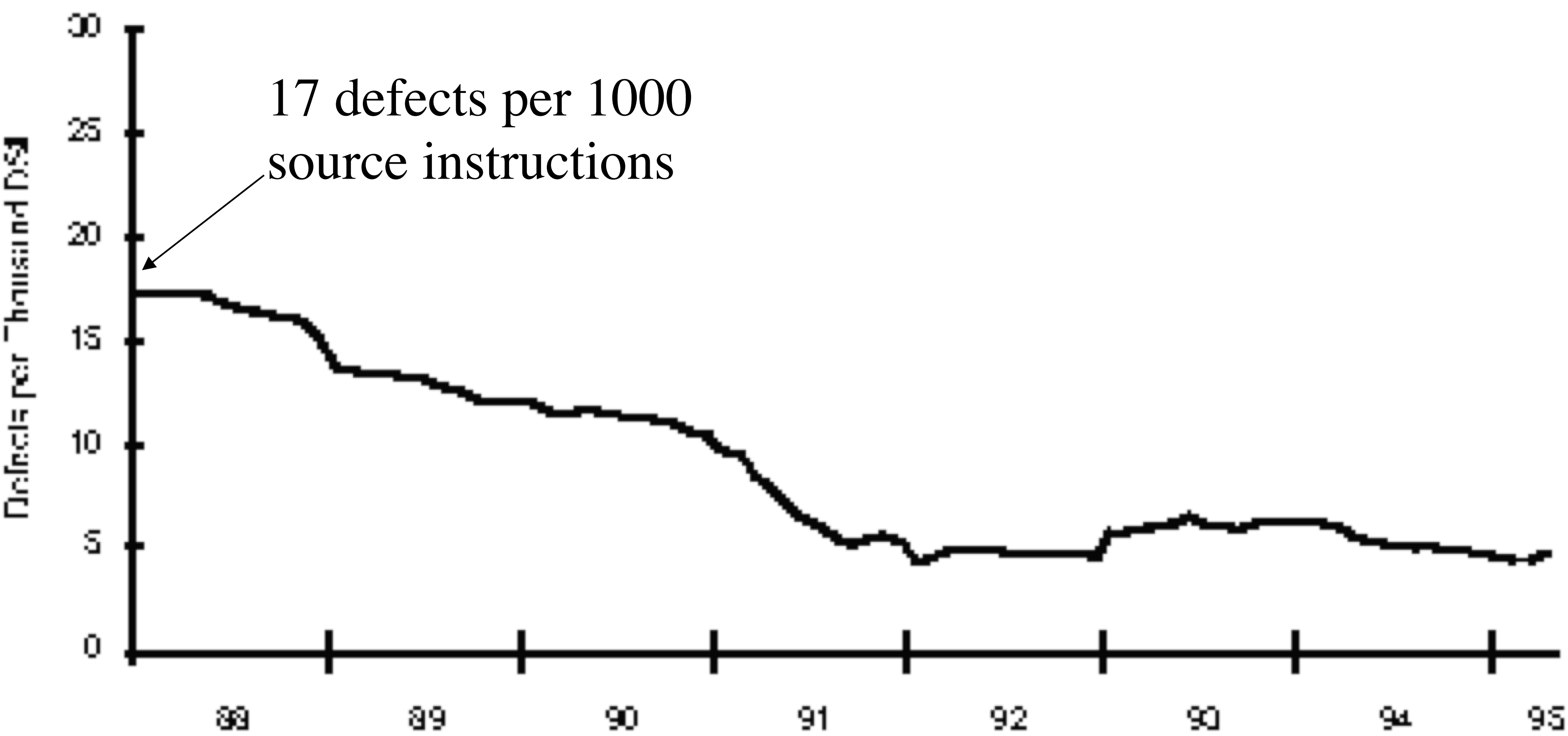
Project	CAC/Bu D	Productivity
A	98%	165
B	86%	172
C	97%	154
D	103%	164
E	101%	241
F	53%	145
G	96%	195
H	102%	267
I	113%	209
J	106%	130
K	88%	224
L	82%	199
M	100%	302
N	89%	160
O	100%	230
P	100%	252
O	99%	260
R	98%	305
S	96%	260
T	100%	134
U	113%	179
V	100%	240
W	99%	245
X	100%	275

Achieving Project Predictability: Raytheon 95: This miracle took almost 2 years

Cost At Completion / Budget %



Overall Product Quality: Raytheon 95 Defect Density Versus Time: 3 times better. This took about 4 years.



Source:http://www.sei.cmu.edu/products/publications/95.reports/95.tr.017.html

9. Multiple Impacts

- Any method you choose will have multiple quality and cost impacts, whether you like them or not!
  - We need to estimate all impacts on our objectives
  - We need to reduce or accept negative impacts
  - We must avoid simplistic one-dimensional arguments

Single next Step Comparison Table
Evaluating multiple impact to decide which step to deliver first.

	Next-Step Candidate **A**: {Design-X, Function-Y}	Next-Step Candidate **B:** {Design Z, Design F}
Reliability 99%-99.9%	**50%**	100%
Performance 11sec.-1 sec.	**80%**	30%
Usability 30 min.-30 sec.	**-10%**	20%
Capital Cost 1 mill.	**20%**	5%
Engineering Hours 10,000	**2%**	10%
Performance/Capital Cost Ratio	80/20= *4.0*	30/5= *6.0*
Quality/Cost Ratio	120/22=**5.46**	150/15=**10.00**

For written details of Impact Estimation method: see Competitive Engineering, free at www.result-planning.org and available from Addison Wesley

Risk Analysis for each Step
Which is 'best' when risk is considered, on multiple qualities and costs?

	Step Candidate A: {Design-X, Function-Y}	Step Candidate B: {Design Z, Design F}
Reliability 99%-99.9%	**50% ±50%**	**100% ±20%**
Performance 11sec.-1 sec.	**80% ±40%**	**30% ±50%**
Usability 30 min.-30 sec.	**-10% ±20%**	**20% ±15%**
Capital Cost 1 mill.	**20% ±1%**	**5% ±2%**
Engineering Hours 10,000	**2% ±1%**	**10% ±2.5%**
Worst Case B/C ratio (1 to 3)	**(0+40-30)/(21+3) =*0.42***	**(80-20+5)/(7+12.5) =*3.33***
Best Case B/C ratio	**(100+120+10)/(19+1) = 11.5**	**(120+80+35)/(3+7.5)= 22.38**

Step Choice with 'Credibility'

Evaluating multiple impacts with respect to experience spread and evidence credibility.

	Step Candidate **A**: {Design-X, Function-Y}	Step Candidate **B:** {Design Z, Design F}
Reliability 99%-99.9%	50% ±50%	100% ±20%
Performance 11sec.-1 sec.	80% ±40%	30% ±50%
Usability 30 min.-30 sec.	-10% ±20%	20% ±15%
Capital Cost 1 mill.	20% ±1%	5% ±2%
Engineering Hours 10,000	2% ±1%	10% ±2.5%
Worst Case B/C ratio	(0+40-30)/(21+3) =**0.42**	(80-20+5)/(7+12.5) = **3.33**
"Worst Worst" case considering estimate credibility factor	0.8 x 0.42= **0.33**	0.2 x 3.33= **0.67**

A's Credibility=0.8 (High)

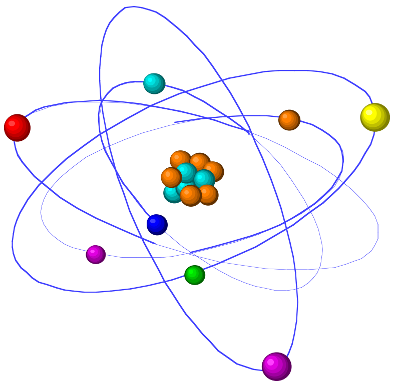
B's Credibility=0.2 (Low)

10. Results Orientation

- You must keep your focus on the essential results, and never fall victim to the means.

- *"Perfection of means and confusion of ends seem to characterize our age"*

  – *Albert Einstein*.



Software Engineering Productivity Study

- An example of setting objectives for process improvement
- For 1997 Multinational Electronics Company with 70% software labor development content in products
    -

Levels of objectives.

- **1. Fundamental Objectives (above us)**
- **2. Generic Constraints (our given framework)**
  - Political Practical
  - Design Strategy Formulation Constraints
  - Quality of Organization Constraints
  - Cost/Time/Resource Constraints
- **3. Strategic Objectives (objectives at our level)**
- **4. Means Objectives:** (*supporting* our objectives)

Strategic Objectives

- Support the Fundamental Objectives (Profit, survival)
  - Software Productivity: Lines of Code Generation Ability
  - Lead-Time:
  - Predictability.
  - TTMP: Predictability of Time To Market:
  - Product Attributes:
  - Customer Satisfaction:
  - Profitability:

Predictability of Time To Market: A sample strategic objective

- **TTMP: Predictability of Time To Market:**
  - » *Gist: From Ideas created to customers can use it. Our ability to meet agreed specified customer and self-determined targets.*

- **Scale: % overrun of actual Project Time compared to planned Project Time**
  - **Project Time: Defined:** time from the date of Toll-Gate 0 passed, or other Defined Start Event, to, the Planned- or Actually- delivered Date of All [Specified Requirements], and any set of agreed requirements.
  - **Specified Requirements: Defined:** written approved Quality requirements for products with respect to Planned levels and qualifiers [when, where, conditions].
    And, other requirements such as function, constraints and costs.
- **Meter: Productivity Project or Process Owner will collect data from all projects, or make estimates and put them in the Productivity Database for reporting this number.**
- **Past [1994, A-package] < 50% to 100%> <- Palli K. guess.**
  [1994, B-package] 80% ?? <- Urban Fagerstedt and Palli K. guess
- **Record [IBM Federal Systems Division, 1976-80] 0%**
  <- RDM 9.0 quoting Harlan Mills in IBM SJ 4-80
- ***"all projects on time and under budget"***
- **[Raytheon Defense Electronics, 1992-5] 0% <- RDE SEI Report 1995 Predictability.**
- **Must [All future projects, from 1999] 5% or less <- discussion level TG**
- **Plan [All future projects, from 1999] 0% or less <- discussion level TG**

Means Objectives:

- Support the Strategic Objectives
  - **Complaints:**
  - **Feature Production:**
  - **Rework Costs:**
  - **Installation Ability:**
  - **Service Costs:**
  - **Training Costs:**
  - **Specification Defectiveness:**
  - **Specification Quality:**
  - **Improvement ROI:**

Complaints: a sample 'means' objective

- **Complaints:**
  - *"Customer complaint rate to us"*
- *Gist:*
  - Means Goal: for Customer Satisfaction (Strategic).
- Scale: number of complaints per customer in [defined time into <operation>]
- Past [Syracuse Project , 1997] ?? <bad> <- ML
- Plan [Long term, software component, in first 6 months in Operation] zero complaints <- R PROJECT 96 1.1 b
- "zero complaints on software features"

Strategies
Intended to impact strategic objectives

- (means to achieve objectives)
- Evo [Product development]:(serious)
- DPP [Product Development Process]: Defect Prevention Process.
- Inspection?
- Motivation.Stress-Management-AOL
- Motivation.Carrot
- DBS
- Automated Code Generation
- Requirement -Tracability
- Competence Management
- Delete-Unnecessary -Documents
- Manager Reward:?
- Team Ownership:?
- Manager Ownership:?

- Training:?
- Clear Common Objectives:
- Application Engineering area:
- Brainstormed List (not evaluated or prioritized yet)?
- Requirements Engineering:
- Brainstormed Suggestions?
- Engineering Planning:
- Process Best Practices: (silly)
- Brainstormed Suggestions?
- Push Button Deployment:
- Architecture Best Practices:
- Stabilization:
- World-wide Co-operation?

A mixture of silly and serious strategies! 2 examples given.

US Army Example: PERSINSCOM

STRATEGIES ➔ OBJECTIVES	Technology Investment	Business Practices	People	Empow-erment	Principles of IMA Management	Business Process Re-engineering	SUM
Customer Service ?➔0 Violation of agreement	50%	10%	5%	5%	5%	60%	185%
Availability 90% ➔ 99.5% Up time	50%	5%	5-10%	0	0	200%	265%
Usability 200 ➔ 60 Requests by Users	50%	5-10%	5-10%	50%	0	10%	130%
Responsiveness 70% ➔ ECP's on time	50%	10%	90%	25%	5%	50%	180%
Productivity 3:1 Return on Investment	45%	60%	10%	35%	100%	53%	303%
Morale 72 ➔ 60 per mo. Sick Leave	50%	5%	75%	45%	15%	61%	251%
Data Integrity 88% ➔ 97% Data Error %	42%	10%	25%	5%	70%	25%	177%
Technology Adaptability 75% Adapt Technology	5%	30%	5%	60%	0	60%	160%
Requirement Adaptability ? ➔ 2.6% Adapt to Change	80%	20%	60%	75%	20%	5%	260%
Resource Adaptability 2.1M ➔ ? Resource Change	10%	80%	5%	50%	50%	75%	270%
Cost Reduction FADS ➔ 30% Total Funding	50%	40%	10%	40%	50%	50%	240%
SUM IMPACT FOR EACH SOLUTION	***482%***	***280%***	***305%***	***390%***	***315%***	***649%***	
Money % of total budget	15%	4%	3%	4%	6%	4%	
Time % total work months/year	15%	15%	20%	10%	20%	18%	
SUM RESOURCES	***30***	***19***	***23***	***14***	***26***	***22***	
BENEFIT/RESOURCES RATIO	**16:1**	**14:7**	**13:3**	**27:9**	**12:1**	**29:5**	

Sample of Objectives/Strategy definitions

- *Example of one of the Objectives:*

Customer Service:

Gist: Improve customer perception of quality of service provided.

Scale: Violations of Customer Agreement per Month.

Meter: Log of Violations.

Past [1991] Unknown Number ←State of PERSCOM Management Review

Record [NARDAC] 0 ? ← NARDAC Reports 1991

Must : <better than Past, Unknown number> ←CG

Plan [1991, PERSINCOM] 0 "Go for the Record" ← Group SWAG

Technology Investment:

Exploit investment in high return technology.

Impacts: productivity, customer service and conserves resources.

- *An example of one of the strategies defined.*

The summary principle

Motivate people

towards real results

by giving them numeric feedback frequently

and the ability to change anything for success.

SOFTWARE POLICY

- (suggestion, draft)
- Version
- OWNER:
- Editor: Tom@Gilb.com. Detailed practical technical background for this draft see www.Gilb.com and especially ‘Priority Management’ (116 pages manuscript).

Purpose:

- to define a powerful framework
  - for improving your organization's ability
  - to improve their software organization's capability,
  - as defined in their quantified objectives.

- *Constraint:*
  - *this policy should never exceed one physical page, to keep it focussed.*

.STAKEHOLDER VALUE:

- For all software and systems engineering projects
  - we will formally identify all critical stakeholders, internal and external.
  - We will identify their critical and profitably-served requirements.
  - The requirements will be testable and, if variable,
    - **they will be quantified.**
  - Delivering this defined value to these stakeholders
    - will be the *primary focus and measure*
    - of all product development process activity.

- *Rationale: to focus our efforts on critical needs, listen to 'voice of stakeholders'.*

.ENDS/MEANS CLARITY:

- project requirements will focus on the *real 'stakeholder-perceived value'* as the 'requirements'.
  - They will NOT allow design or strategy to replace the real stakeholder needs.
  - Requirements and design to meet those requirements will be *rigorously separated*
    - in terms of project specification and work processes.

- *Rationale:*
  - *extreme clarity of real needs,*
  - *never confusing this with technology with good intent.*
  - *Help engineers to focus efforts on serving and competing on the market.*

.NUMERIC CLARITY:

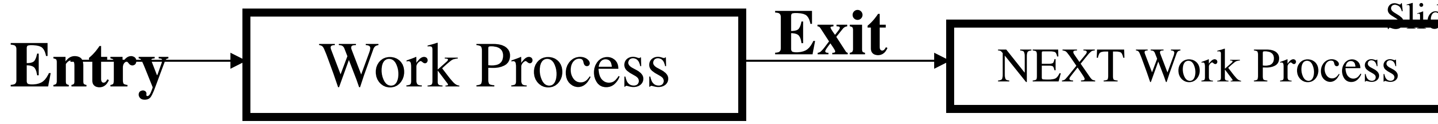
- all notions of qualities (stakeholder values) and costs will
  - in all contexts (requirements, design impacts, project progress, contracts with customers and suppliers)
  - be expressed in terms of **numeric levels on defined scales of measure,**
  - and measured in practice with defined 'Meters'.
  - If it varies, if you can say 'improved',
    - then you must convert these ideas into numbers
    - on defined scales of measure,
    - which become the language of the project.

- *Rationale:*
  - *we must have perfect clarity of the stakeholder-critical values,*
  - *and numeric definition is the ONLY acceptable way to do that.*
  - *This is necessary for multinational communication.*
  - *This saves time to market, human resource and will more effectively target our stakeholder values.*
  - *It allows feedback and correction processes to operate.*

.NUMERIC DEVELOPMENT PROGRESS:

- the primary instrument for ***tracking development progress*** will be
  - the numeric progress for defined stakeholder values (product and service qualities)
    - towards defined and agreed targets,
    - with respect to time.
  - A secondary set of measures will be with respect to the costs or resources planned.

- *Rationale:*
  - *this management tracking concept is intended to allow projects to monitor their own progress realistically,*
  - *using the same measures which any other level of managers would use to judge them.*
  - *It is intended to be the main component for discussion and evaluation for any meeting, review, milestone or judgement.*
  - *It should replace conventional milestone progress reporting.*



.WORK PROCESS ENTRY/ EXIT CONTROL:

- All software engineering specifications (from contract to code)
  - will be subject to formal entry and exit control.
  - This is primarily numeric and based on 'Major defects remaining' levels,
    - i.e. economic suitability for downstream work processes.
    - Default level maximum 1 major defect remaining per page.

- *Rationale:*
  - *to make sure that poor specification practices do not*
    - *pollute downstream activity,*
    - *and threaten time to market, human resources or product quality.*

Thank you for inviting me here. Happy to discuss with you the rest of the conference and by email

- By Tom Gilb, Result Planning Limited
  - TOM@GILB.com, www.**Gilb**.com