
# *The Art & Science of Software Process*

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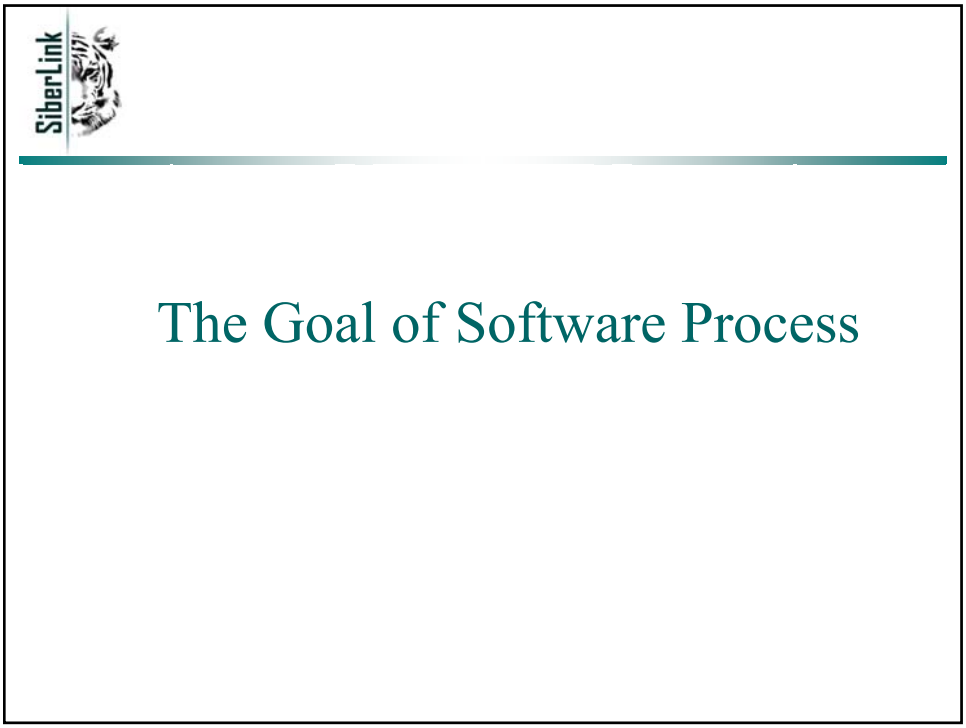
Chairman, IEEE Computer Society, Austin Chapter


## Why *Art & Science*?

When asked why he gave the title, *The Art of Computer Programming,* to his famous series of books, Donald Knuth said:

*"Science is what we understand well enough to explain to a computer and art is everything else."*

Knuth, Donald. *Computer Programming is an Art.* Communications of the ACM. December 1974.


SiberLink
The Goal of Software Process


SiberLink
The Goal of Software Process
✓ Make commitments that you can keep.
✓ Produce quality software on-time and on-budget.
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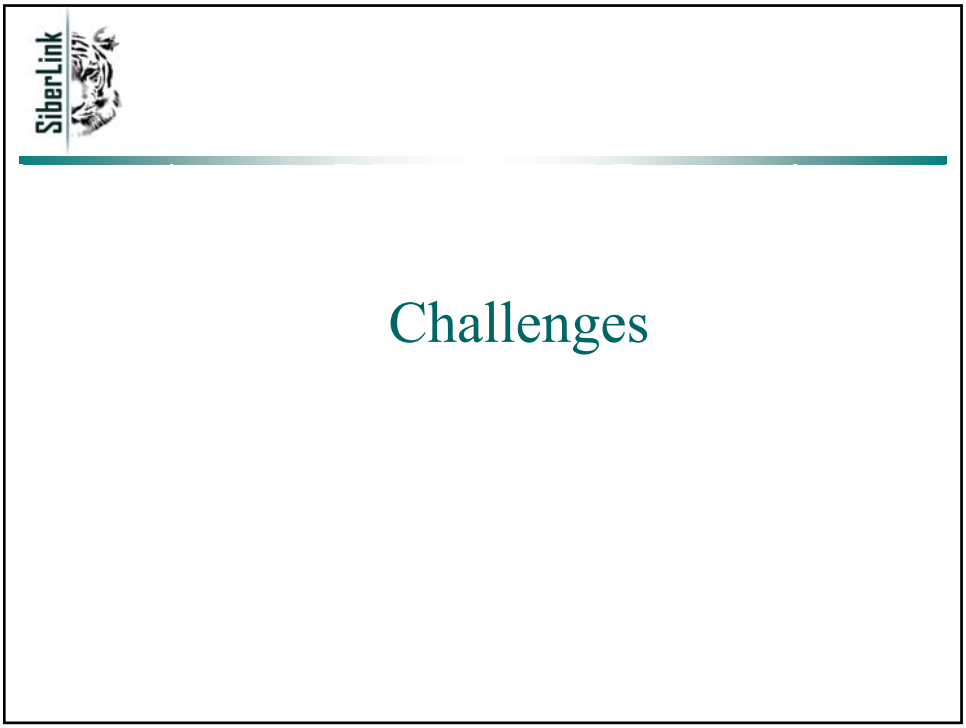
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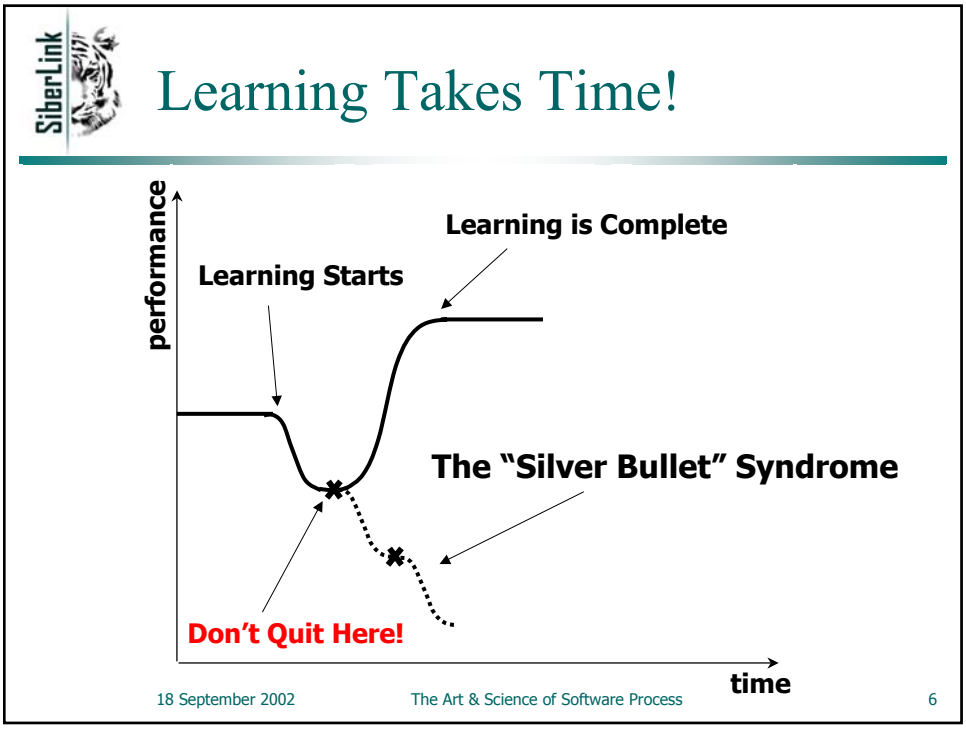
Challenges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Learning Takes Time!
performance
Learning is Complete
Learning Starts
The "Silver Bullet" Syndrome
Don't Quit Here!
time
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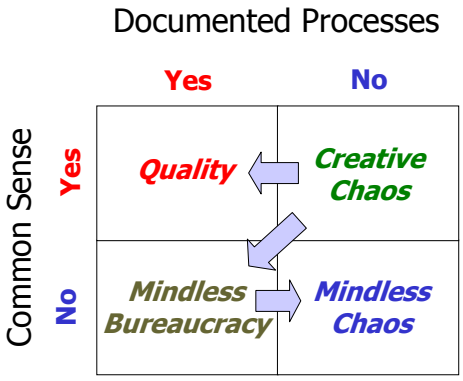
# You'll Need Common Sense!




From Mark Paulk, with thanks to Sanjiv Ahuja, President and COO of Bellcore.



# Everything Seems Crazy at First!

"We should do something when people say it is crazy. If people say something is 'good,' it means someone else is already doing it."

» Hajime Mitarai, president, Canon

Peters, Thomas J. *The Circle of Innovation, You Can't Shrink Your Way To Greatness*. Vintage Books. New York, NY, 1997.


# Organizational Expectations: What Changed In 140+ Years?

"Wanted: Young, skinny, wiry fellows not over 18. Must be expert riders willing to risk death daily. Orphans preferred. Wages $25 per week."

- Pony Express advertisement, 1860.

"We realize the skills, intellect and personality we seek are rare, and our compensation plan reflects that. In return we expect TOTAL AND ABSOLUTE COMMITMENT to project success—overcoming all obstacles to create applications on time and within budget."

- Software Developer Advertisement, Seattle Times, 1995.

McConnell, Steve. *After the Gold Rush*. Microsoft Press. 1999.




# We Must Cope With Ignorance

- ✓ 0th Order of Ignorance: Lack of Ignorance. You know.
- ✓ 1st Order of Ignorance: Lack of knowledge. You know the question.
- ✓ 2nd Order of Ignorance: Lack of awareness. This is a real problem: not only you don't know the answer, you don't even know what the question is.
- ✓ 3rd Order of Ignorance: Lack of process. You don't have a process to find out what it is that you don't know.
- ✓ 4th Order of Ignorance: Meta Ignorance. You don't know about the orders of ignorance. You are past this. ☺

Armour, Phillip G. *The Five Orders of Ignorance.* Comm. of the ACM. Vol.43. No.10. Oct. 2000.

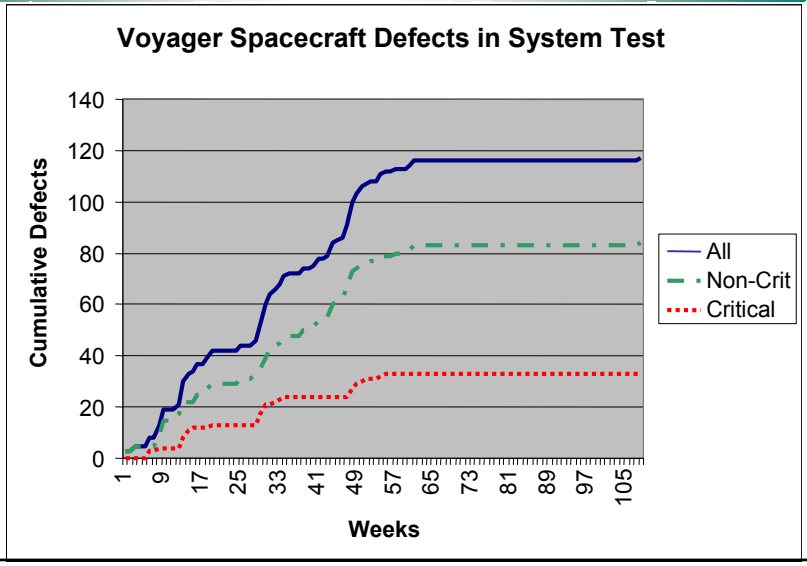
# Good is the Enemy of Great!

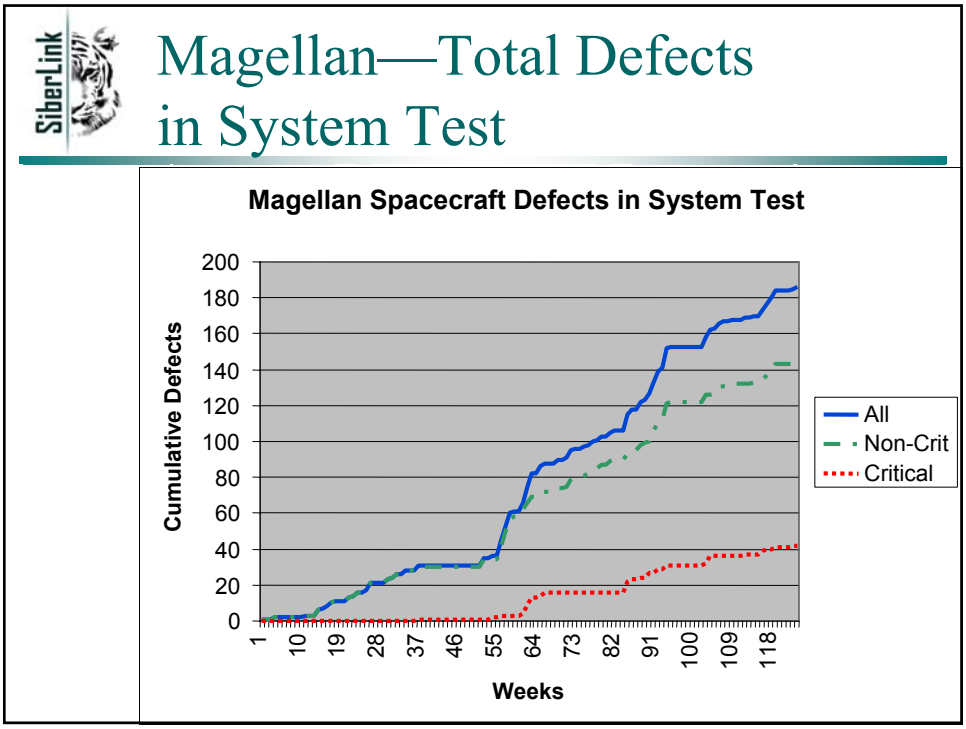
*"And that is one of the key reasons why we have so little that becomes great."*

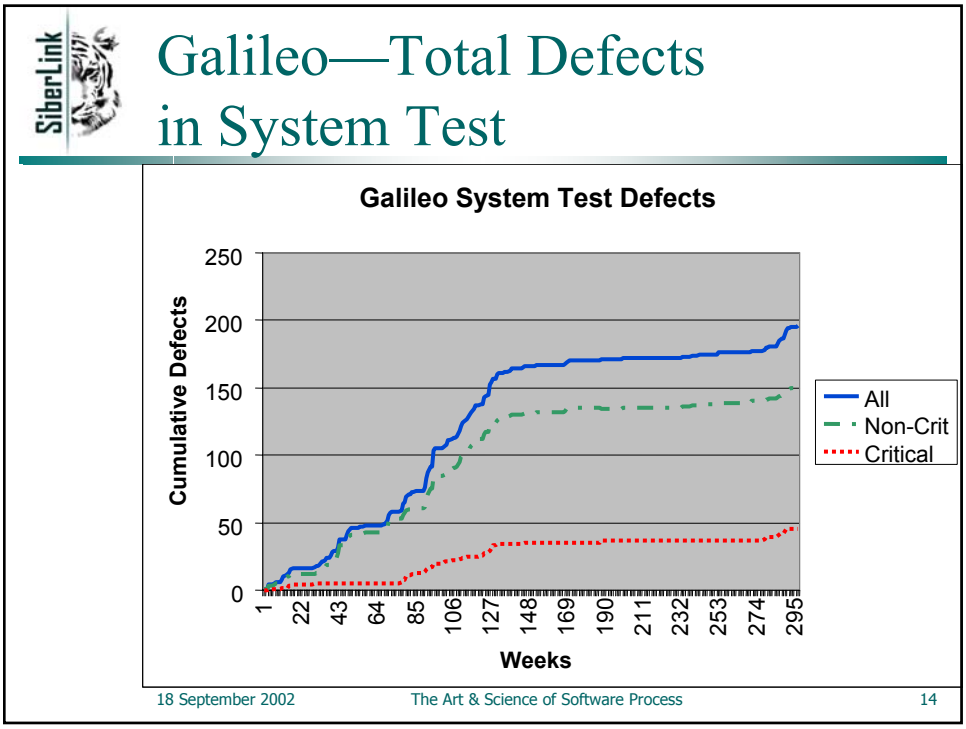
Collins, James C. *Good to Great.* Harper Business. New York, NY. 2001.



# Voyager—Total Defects in System Test




SiberLink
Magellan—Total Defects in System Test
Magellan Spacecraft Defects in System Test
Cumulative Defects
200
180
160
140
120
100
80
60
40
20
0
1
10
19
28
37
46
55
64
73
82
91
100
109
118
Weeks
All
Non-Crit
Critical


SiberLink
Galileo—Total Defects in System Test
Galileo System Test Defects
Cumulative Defects
250
200
150
100
50
0
1
22
43
64
85
106
127
148
169
190
211
232
253
274
295
Weeks
All
Non-Crit
Critical
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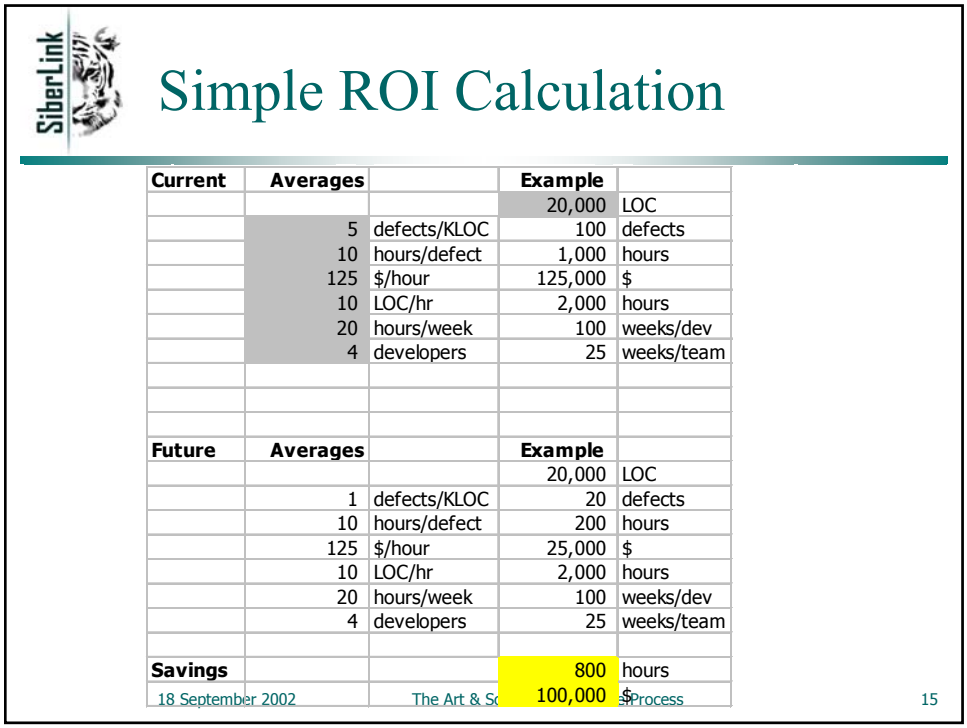



| Current | Averages | | Example | |
|---|---|---|---|---|
| | | | 20,000 | LOC |
| | 5 | defects/KLOC | 100 | defects |
| | 10 | hours/defect | 1,000 | hours |
| | 125 | $/hour | 125,000 | $ |
| | 10 | LOC/hr | 2,000 | hours |
| | 20 | hours/week | 100 | weeks/dev |
| | 4 | developers | 25 | weeks/team |
| | | | | |
| | | | | |
| | | | | |
| **Future** | **Averages** | | **Example** | |
| | | | 20,000 | LOC |
| | 1 | defects/KLOC | 20 | defects |
| | 10 | hours/defect | 200 | hours |
| | 125 | $/hour | 25,000 | $ |
| | 10 | LOC/hr | 2,000 | hours |
| | 20 | hours/week | 100 | weeks/dev |
| | 4 | developers | 25 | weeks/team |
| | | | | |
| **Savings** | | | 800 | hours |
| | | | 100,000 | $ |


# Software Engineering Institute

Q: Who is the largest software consumer in the world?

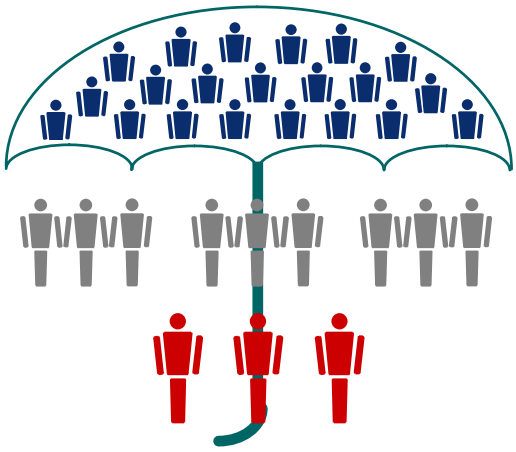
A: The US Department of Defense.

**Milestones**

- Mid ’80s: Capability Maturity Model (CMM) developed.
- Early ’90s: Personal Software Process (PSP) is developed; class taught at Carnegie Mellon University.
- Today: over 4,000 people trained in PSP Worldwide
- Team Software Process: How can an organization create high performance software development teams.




# A Comprehensive Approach to Process Improvement Focus



**Capability Maturity Model (CMM):** Focuses on the organization’s capability; management actions.

**Team Software Process (TSP):** Focuses on team performance; product development.

**Personal Software Process (PSP):** Focuses on individual skills and discipline; entirely personal.

# The CMM & The PSP

| | Level | Focus | Key Process Areas (KPA) |
|---|---|---|---|
| 5 | **Optimizing** | **Continuous Process Improvement** | **√Defect prevention**<br>**√Technology change management**<br>**√Process change management** |
| 4 | **Managed** | **Product and Process Quality** | **√Quantitative process management**<br>**√Software quality management** |
| 3 | **Defined** | **Engineering Process** | **√Organization process focus**<br>**√Organization process definition**<br>Training program<br>**√Integrated software management**<br>**√Software product engineering**<br>Intergroup coordination<br>**√Peer reviews** |
| 2 | **Repeatable** | **Project Management** | Requirements management<br>**√Software project planning**<br>**√Software project tracking**<br>Software quality assurance<br>Software configuration management<br>Software subcontract management |

√ Indicates the CMM Key Process Areas that are fully or partially addressed at the personal level in the PSP

# Rational / Unified Process

- ✓ Architecture-driven development process.
- ✓ An incremental and iterative approach to software development.
- ✓ Rich in artifacts and roles.
- ✓ A collection of best practices that can be applied on many projects (mostly *Far Transfer*, some *Expert Transfer**).

* Dixon, Nancy. *Common Knowledge: How Companies Thrive By Sharing What They Know*. HBS Press, 2000.

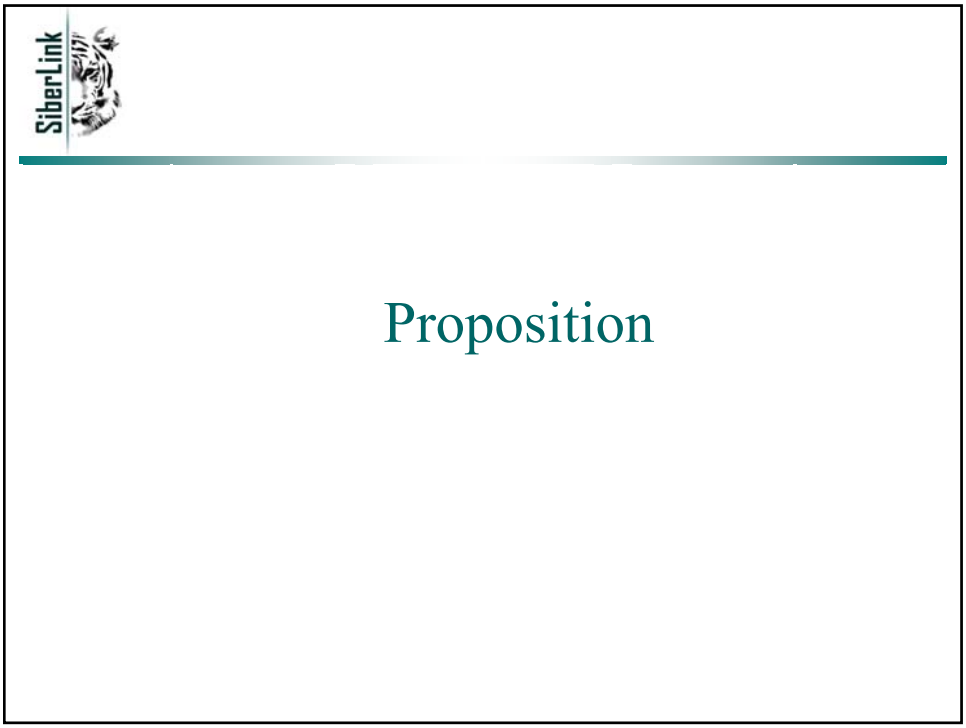

# Extreme Programming

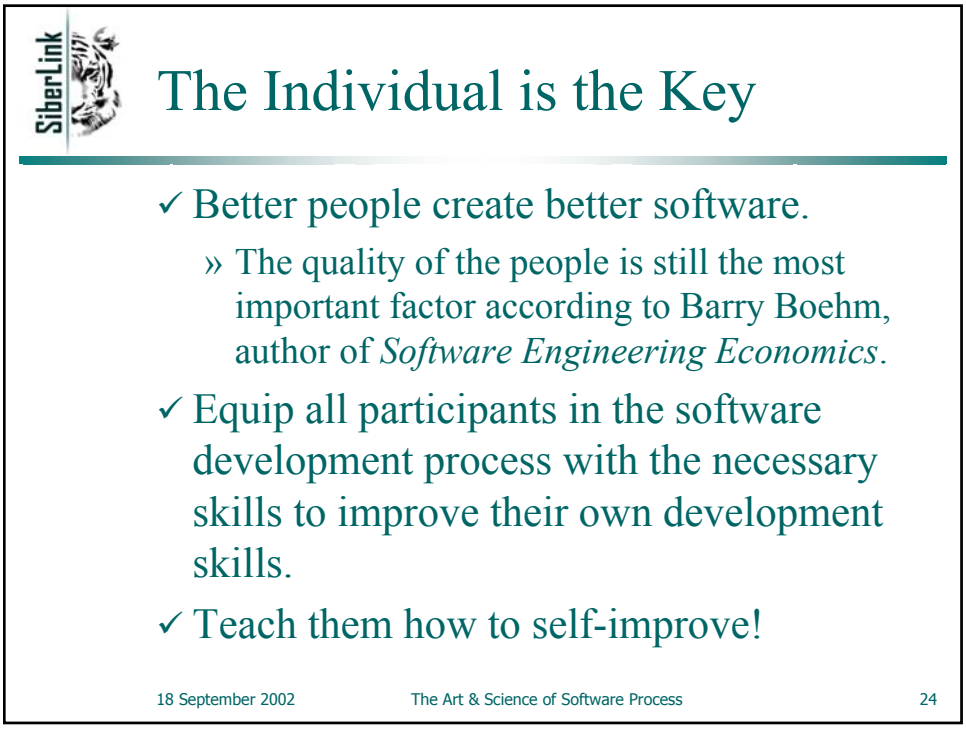
- ✓ Core practices:
  - » Whole Team
  - » Planning Game
  - » Small Releases
  - » Customer Tests
  - » Simple Design
  - » **Pair Programming**
  - » **Test-First Development**
  - » Design Improvement
  - » Continuous Integration
  - » Collective Code Ownership
  - » Coding Standard
  - » Metaphor
  - » Sustainable Pace
- ✓ *"Ruthlessly refactor."*




# Other Approaches

- ✓ ISO 9001/9000-3
- ✓ SCRUM www.controlchaos.com
- ✓ FDD (Feature Driven Development)
- ✓ Agile Methodologies
- ✓ OPEN (Object-oriented Process, Environment, and Notation) www.open.org.au
- ✓ Code 'n Fix ☺


SiberLink
Proposition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The Individual is the Key
✓ Better people create better software.
» The quality of the people is still the most important factor according to Barry Boehm, author of *Software Engineering Economics*.
✓ Equip all participants in the software development process with the necessary skills to improve their own development skills.
✓ Teach them how to self-improve!
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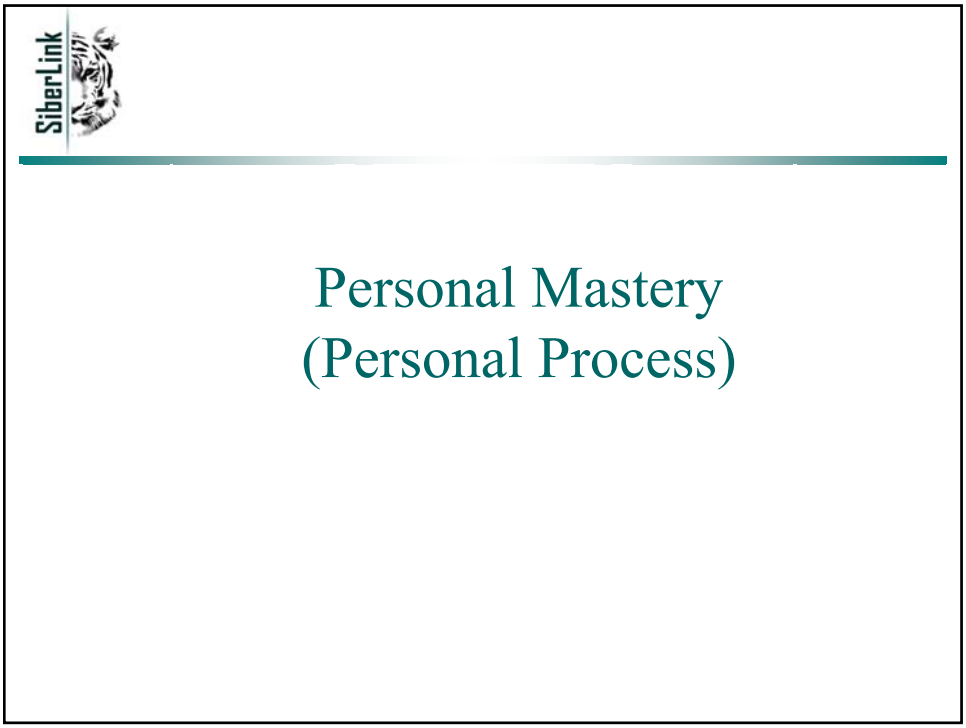
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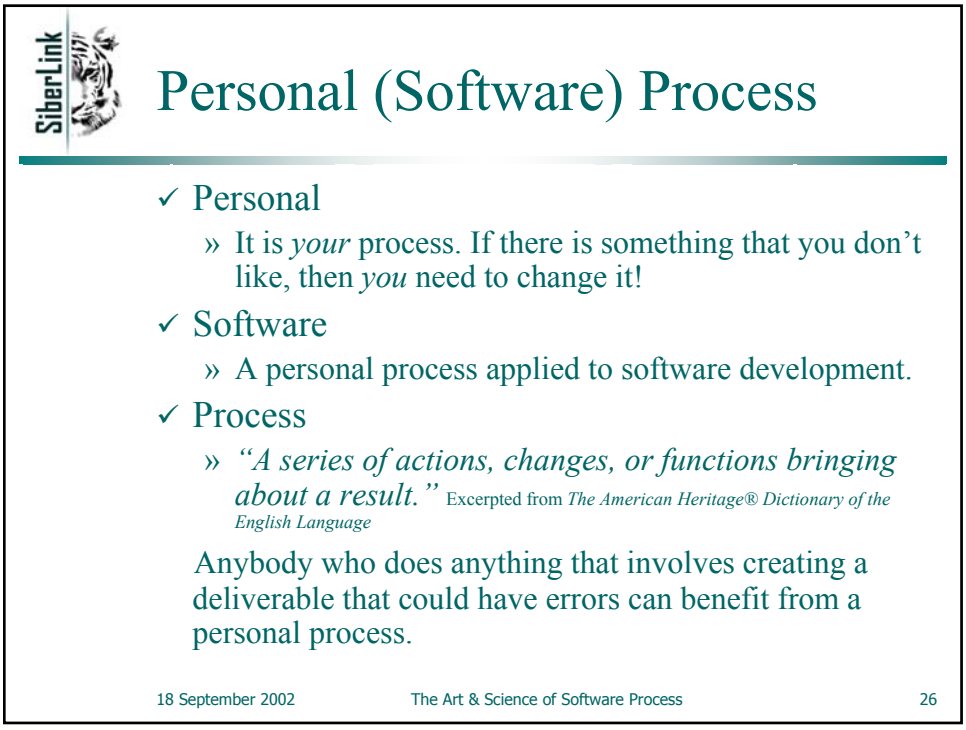
Personal Mastery
(Personal Process)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Personal (Software) Process
✓ Personal
» It is *your* process. If there is something that you don't like, then *you* need to change it!
✓ Software
» A personal process applied to software development.
✓ Process
» *"A series of actions, changes, or functions bringing about a result."* Excerpted from *The American Heritage® Dictionary of the English Language*
Anybody who does anything that involves creating a deliverable that could have errors can benefit from a personal process.
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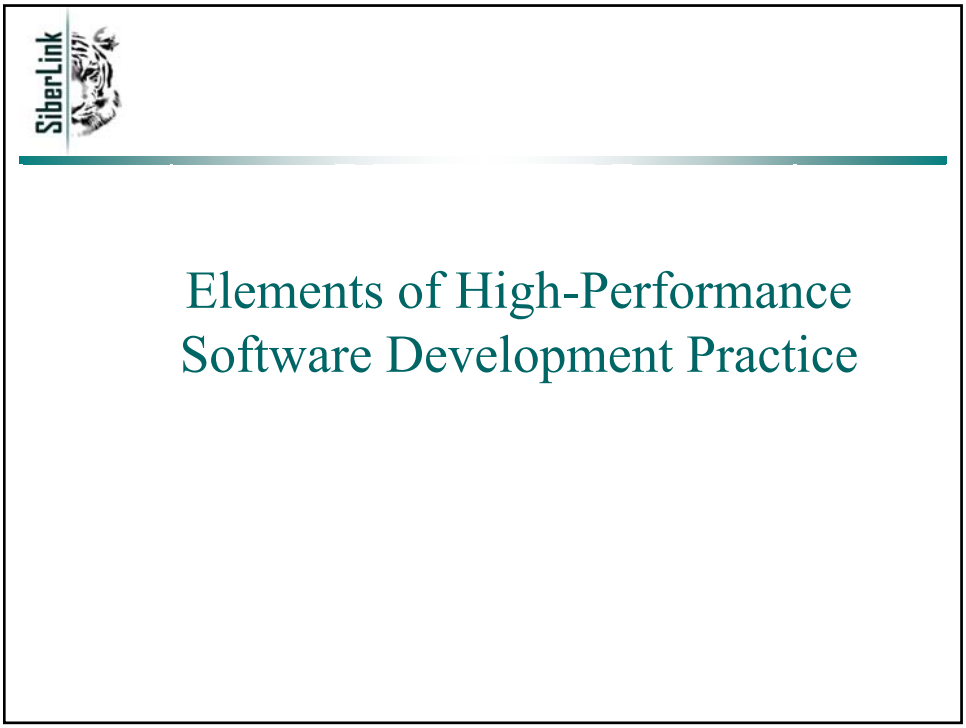
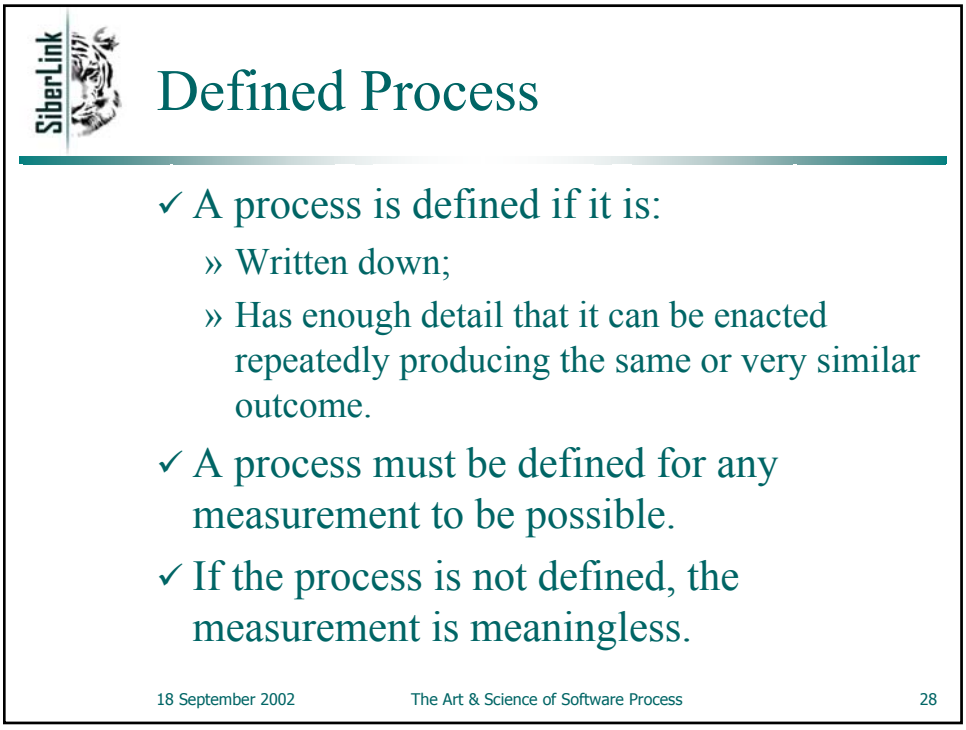

Elements of High-Performance
Software Development Practice


Defined Process
✓ A process is defined if it is:
» Written down;
» Has enough detail that it can be enacted repeatedly producing the same or very similar outcome.
✓ A process must be defined for any measurement to be possible.
✓ If the process is not defined, the measurement is meaningless.
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# Planning

- ✓ Why? Because the plan is the basis of commitments. To be successful you must be able to make commitment that you can meet—at a profit.
- ✓ What is a plan? The plan represents the amount of work that needs to be done to achieve the desired outcome.
- ✓ How? Plan in detail; task length about 45 to 90 minutes.
- ✓ Other benefits:
  - » Identifies risks.
  - » Guides your work, enables you to be more efficient.
  - » Helps you track the status of the work.




# Effective On-Task Time (EOT)

- ✓ The amount of time effectively spent on the project.
- ✓ Doesn't include:
  - » Reading email (usually even if it is project related)
  - » Attending meetings (except well defined project related meetings)
  - » Lunch time, breaks, phone conversations, etc.
- ✓ Measure how many hours per week do you spend on doing project work, that's your EOT per week.
  - » Best organizations in the world get about 20+ hrs/week.
  - » Don't be shocked if you only get about 3-5 hrs/week the first time you measure it. You should get about 15 in a couple of weeks once you start monitoring it.


# Research vs. Development

- ✓ Research:
  - » You have to invent something new, that has never existed.
  - » It can only be time limited. When the time is up, evaluate the situation and make a decision: decide whether to continue, or to seek an alternative solution.
- ✓ Development:
  - » You have to use existing technology, or implement a new invention.
  - » Can be planned & scheduled since it has been done before.
- ✓ If you are doing *"library research"* then say it so. This can be scheduled.




# Context

- ✓ What is Context?
  - » Everything that is said, done, drawn, or written during the software development process.
- ✓ How much Context do you need?
  - » Just enough to always know where you are with the development and what to do next.

# Component-Based Development

- ✓ Decompose the problem into a set of cooperating components.
- ✓ Assemble your software from high-quality components.
- ✓ If you can write high-quality components, then you have a chance of creating high-quality large programs.



# Estimation

- ✓ Size (e.g. KLOC for code)
  - » Estimate size only.
  - » Calculate time, schedule, & defects based on size.
- ✓ Time (project hours)
  - » Calculate time based on historical productivity data. If productivity data is not available then estimate it.
  - » Work in 1-2 week iterations. At the end of each iteration you have current productivity data. Adjust the plan accordingly.
- ✓ Schedule (map project hours to calendar days)
  - » Schedule is the number of hours available for project work.
- ✓ Defects (e.g. Defects / KLOC)
  - » Estimate defects based on the size using historical defect data.

# Quality Planning

- ✓ As long as you don't change your process your results will be the same and the new product will contain about the same amount of defects that the old one had.
- ✓ If you know that you will put the defects in, might as well plan on trying to remove them.
- ✓ If you know your historical injection rate per phase, then you can figure out how many defects you will have to remove and plan removal activities.
- ✓ Some removal activities are more efficient then others, you got to get the data to figure out where do you get the most bang for the buck.

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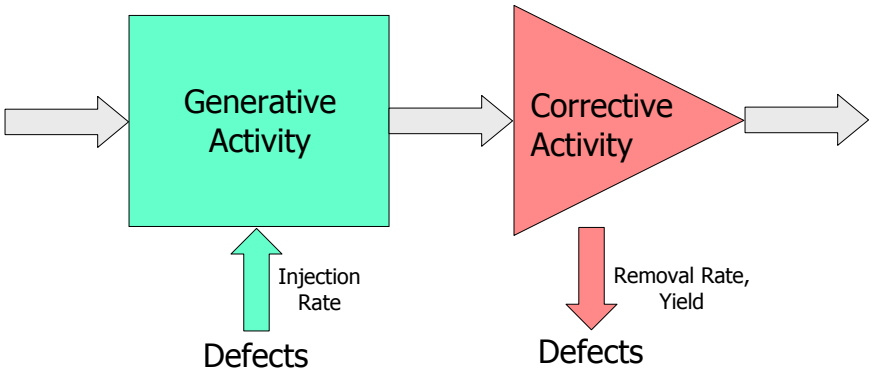
# Process Building Block

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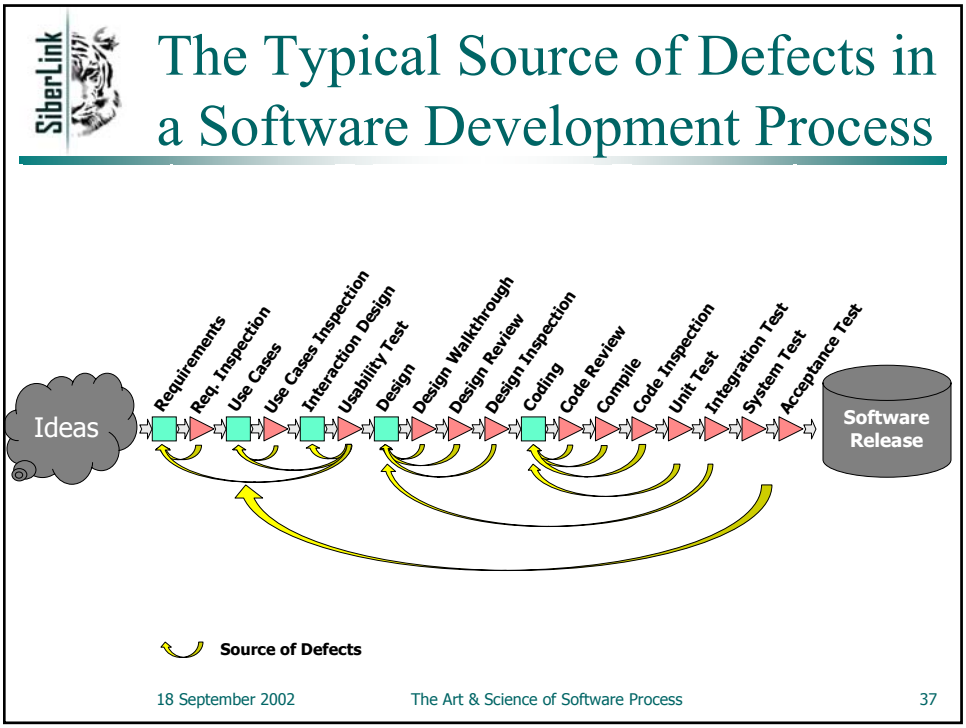
The Typical Source of Defects in a Software Development Process
Ideas
Requirements
Req. Inspection
Use Cases
Use Cases Inspection
Interaction Design
Usability Test
Design
Design Walkthrough
Design Review
Design Inspection
Coding
Code Review
Compile
Code Inspection
Unit Test
Integration Test
System Test
Acceptance Test
Software Release
Source of Defects
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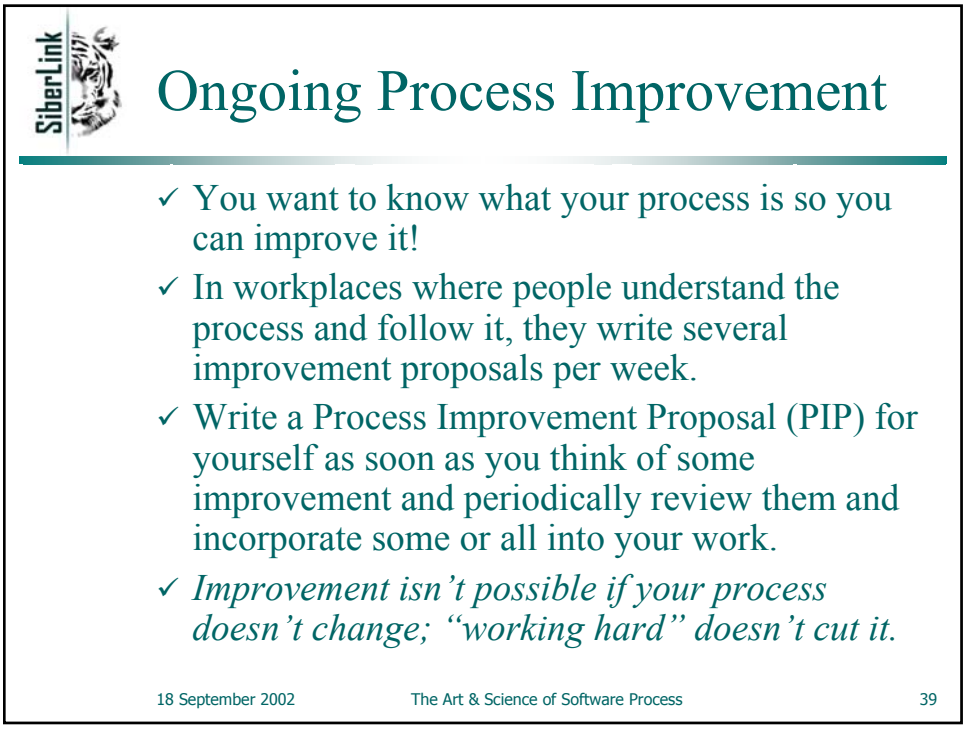
Ongoing Process Improvement
✓ You want to know what your process is so you can improve it!
✓ In workplaces where people understand the process and follow it, they write several improvement proposals per week.
✓ Write a Process Improvement Proposal (PIP) for yourself as soon as you think of some improvement and periodically review them and incorporate some or all into your work.
✓ Improvement isn't possible if your process doesn't change; "working hard" doesn't cut it.
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# Data Analysis

- ✓ Collect data for a reason! If you never look at the data you collected, then don't collect it!
- ✓ Data can tell you:
  - » Where your time goes? What did you really work on?
  - » What was forgotten from the plan? What was extra?
  - » Where can you improve? … and many more things!
- ✓ Watch out! It can be a mirror that might not be pleasant to look at, but don't be discouraged, everybody has areas for improvement.
- ✓ **The data belongs to you!** You decide who you show it to. You collect data for your own benefit.

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# This Works!

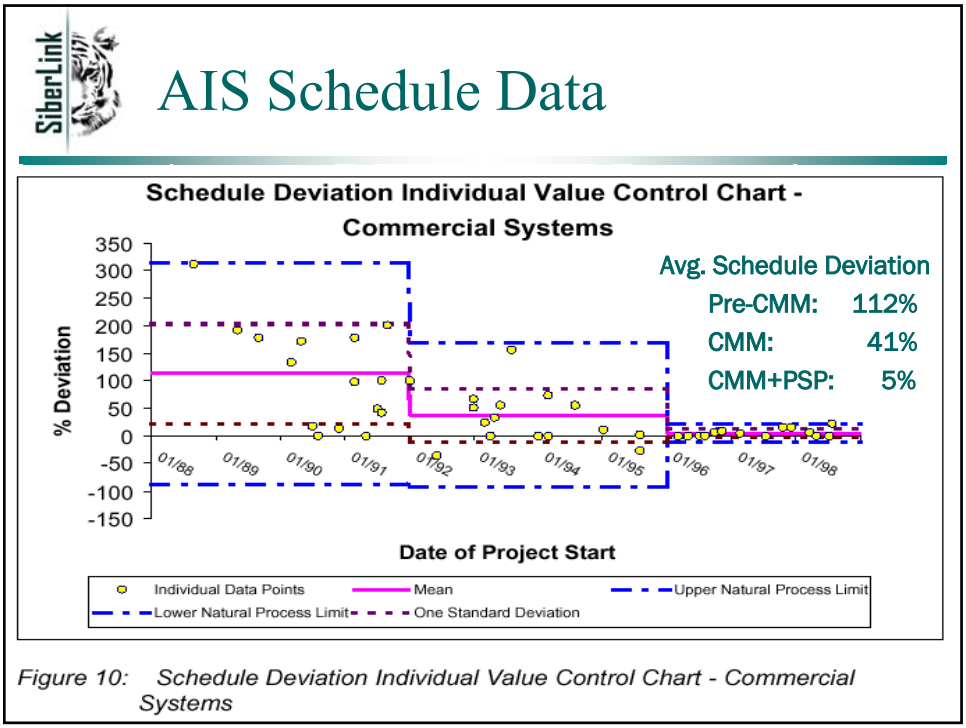



*Figure 10: Schedule Deviation Individual Value Control Chart - Commercial Systems*

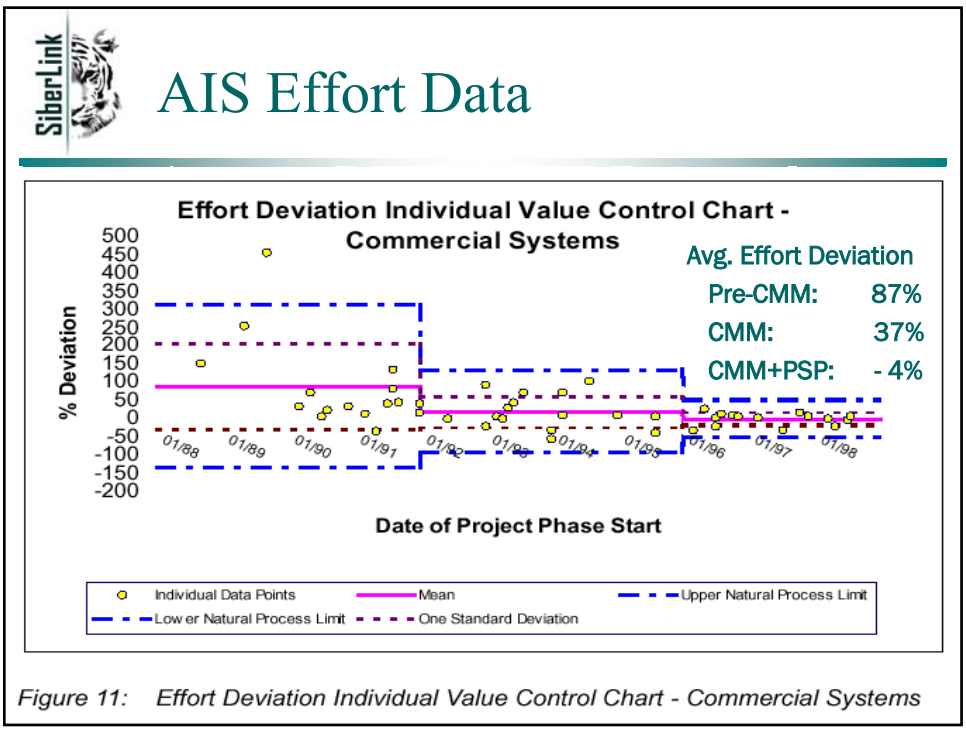
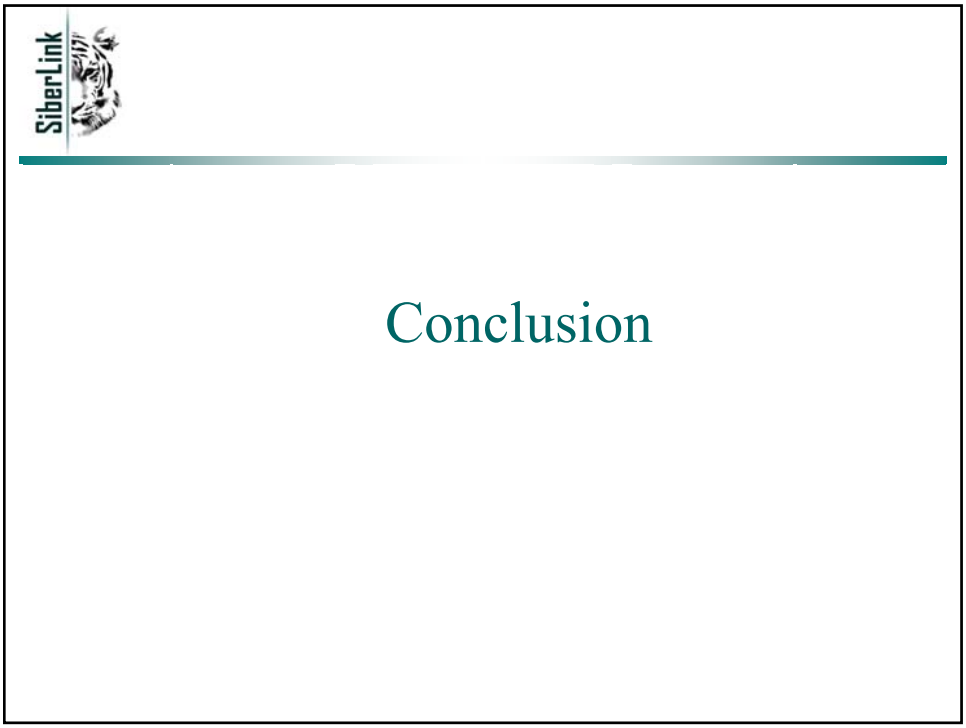



*Figure 11: Effort Deviation Individual Value Control Chart - Commercial Systems*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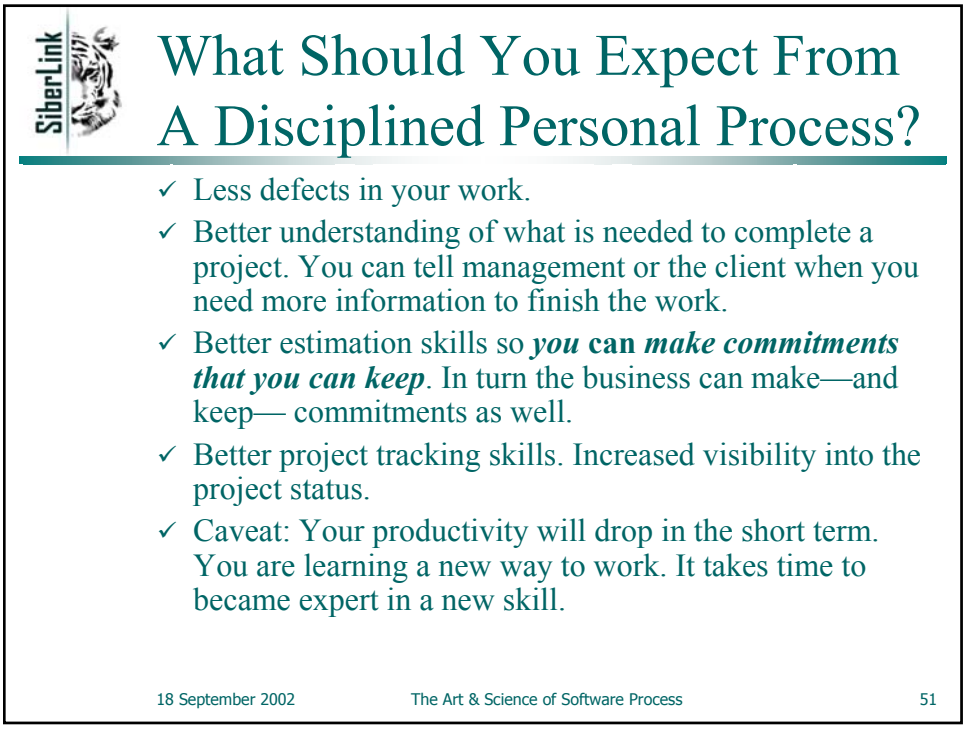
Conclusion


SiberLink
What Should You Expect From A Disciplined Personal Process?
✓ Less defects in your work.
✓ Better understanding of what is needed to complete a project. You can tell management or the client when you need more information to finish the work.
✓ Better estimation skills so ***you*** **can** ***make commitments that you can keep***. In turn the business can make—and keep— commitments as well.
✓ Better project tracking skills. Increased visibility into the project status.
✓ Caveat: Your productivity will drop in the short term. You are learning a new way to work. It takes time to became expert in a new skill.
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# Summary

*The way you work depends on **your thinking**!*

- ✓ You live with your own personal software process (psp).
- ✓ Getting a different psp then the one you have, means you have to change the way you think and work.
- ✓ It is up to you to work in the most productive way for you!
- ✓ For your own sake you should know your performance!
- ✓ It is possible to write defect free code.



# Summary (continued)

- ✓ A defined process will enable you to understand, monitor, and improve your performance.
- ✓ As you work, record accurate and complete data on your process.
- ✓ Use the collected data to improve what you do!


## Closing Quote

*"If things seem under control,*
*you are just not going fast enough."*

—Mario Andretti, race-car driver




## Thank You!

✓ Contact Information

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For a comprehensive software development reading list please visit: ***http://pseng.net/***