

High Maturity Practices

The Way Forward

Solving Software Engineering's Persistent Problems

TSP Symposium
September 18, 2012

A group of people are riding a red and yellow tandem bicycle on a paved path in a park. The bicycle has a blue canopy and the number '10' is visible on its frame. The background is filled with tall trees and other people walking, creating a lively park atmosphere.

Agility With Discipline

“Self-managed individuals jointly working for themselves in democratic teams towards a common goal”

The Genius of Watts Humphrey



Watts on Agility with Discipline

Agility

Quality is more important than schedule

“In today’s software marketplace, the principal focus is on cost, schedule, and function; quality is lost in the noise. This is unfortunate since poor quality performance is the root cause of most software cost and schedule problems.”

Professional Discipline

Not authoritarian, parental; more like athletes, concert artists, surgeons

Includes effective defect management, comprehensive planning, and precise project tracking and reporting

“If our methods do not serve the individual professionals, they will not endure”

Software Engineering Persistent Problems

Cost of finding/fixing defects

Cybersecurity vulnerabilities

Arbitrary and unrealistic schedule commitments

Individual productivity variation

Scale

Measuring, managing and rewarding knowledge
work

Work place democracy

The Top 15 U.S. Software Cost Drivers in Rank Order Circa 2009

1. **The cost of finding and fixing bugs**
2. The cost of cancelled projects
3. The cost of producing paper documents and English words
4. The cost of recovery from security flaws and attacks
5. The cost of requirements changes during development
6. The cost of programming or coding
7. The cost of customer support
8. The cost of meetings and communication
9. The cost of project management
10. The cost of application renovation
11. **The cost of innovation and new kinds of features**
12. The cost of litigation for cancelled projects
13. The cost of training and learning software applications
14. The cost of avoiding security flaws
15. **The cost of acquiring reusable components**

Capers Jones, STN 13-1 April 2010: Software Quality, Reliability, and Error Prediction

Cybersecurity Vulnerabilities

Cumulative Count of Web Application Vulnerability Disclosures
1998-2010 H1



Classes of Problems

Wicked Problems

- Messy
- Ill-defined
- Open to multiple interpretations

Examples

- Poverty
- Obesity

Tame Problems

- Completely understood
- Crisply defined
- Fixed through complex technical solutions

Examples

- Putting a man on the moon
- Devising a cure for diabetes

Solutions

Tame problems are solvable

Solutions to tame problems either work or they don't

Solutions to wicked problems, by contrast, are only better or worse

Trade-offs are unavoidable

Unanticipated complications and benefits are both common

Difficult or impossible to learn by trial and error

No solution to a wicked problem is ever permanent or wholly satisfying, which leaves every solution open to easy polemical attack

CMMI, A Procedural Process - 1

CMMI defines characteristics of an effective process

Sets organizational standards and baseline procedures for use by all projects in an organizational unit

Organizations use CMMI to enforce repeatable processes and work in a predictable way

CMMI, A Procedural Process - 2

CMMI is extremely helpful in stabilizing an organization and getting a level of statistical control

CMMI levels build the foundation needed for real improvement

CMMI level 5 is the beginning and not the end

CMMI Improves Quality

For Projects of 5000 Function Points in Size			
CMM Level	Defect Potential per Function Point	Defect Removal Efficiency	Delivered Defects per Function Point
SEI CMM 1	5.50	73.00%	1.49
SEI CMM 2	4.00	90.00%	0.40
SEI CMM 3	3.00	95.00%	0.15
SEI CMM 4	2.50	97.00%	0.08
SEI CMM 5	2.25	98.00%	0.05

Capers Jones, STN 13-1 April 2010: Software Quality, Reliability, and Error Prediction

Issues with Procedural Processes

Procedural processes rely on artifacts to make sure process is being followed

Artifacts are produced by organizational bureaucracy and not the developers

Artifacts may have no relationship to the actual work being done

Easier to pass appraisals than to change engineering behavior

The Real Question

Whose Process Is It?

“If our methods do not serve the individual professionals, they will not endure”

Agile Manifesto

Individuals and interactions over processes and tools

Working software over comprehensive documentation

Customer collaboration over contract negotiation

Responding to change over following a plan

Agile Manifesto

Assumptions - 1

Requirements are not knowable in advance

Less than 30% of a customer's initial requirements can be captured in the form of written documentation.

Requirements change throughout the project

Planning and tracking project progress is non-value adding

More than 65% of requirements are never used at all

<http://davidfrico.com/rico-apm-evolution.pdf>

Agile Manifesto

Assumptions - 2

Big up-front design causes more problems than it solves

Creates larger attack surfaces vulnerable to security incidents

Large projects are unsuccessful or canceled

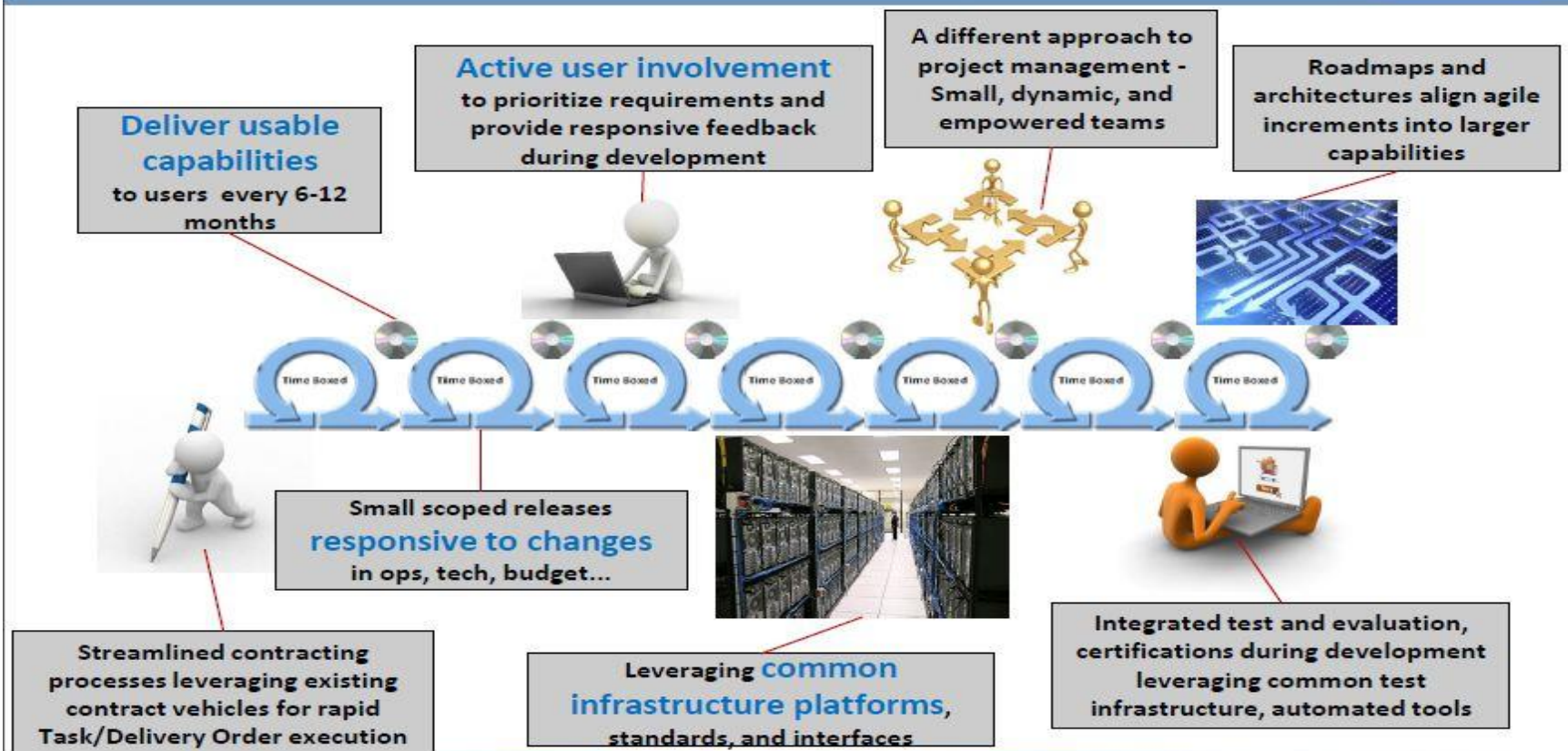
Requirements defects are #1 reason projects fail

<http://davidfrico.com/rico-apm-evolution.pdf>

DoD and Agile



4. Enable Agile IT



DoD CIO's 10-Point Plan for IT Modernization, Ms. Teri Takai, DoD CIO

Agile Sprints

Example

Two year modernization project to deliver 600,000 lines of code

Two week sprints

Working software 12,000 LOC every two weeks

Issues

Management overhead

Customer acceptance testing time

Defect density in delivered product

“Deliver now, Fix later”?

Software Engineering

Persistent Problems

Cost of finding/fixing defects

Cybersecurity vulnerabilities

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Individual productivity variation

Scale

Measuring, managing and rewarding knowledge work

Work place democracy

The Way Forward -1

CONNECT THE DOTS

AGILITY, QUALITY, INNOVATION,

AND

JOY IN WORK

The Way Forward -2

Unhappy people rarely do quality work

Without quality, agility is in name only

Culture of innovation is possible only in
environments where people are respected,
self-aware and practice agility with discipline

We can get there by applying the principles of
Deming, Drucker, and Humphrey to software
technical work

Dr. Deming

Constancy of purpose brings innovation

Various components should work together for optimization of profit and joy in work

Rewards motivate people to work for the rewards

Extrinsic motivation leads to the destruction of the individual

Remove barriers that rob people of pride of workmanship

Numerical goals set for other people, without a road map to reach the goal, have effects opposite to the effects sought

Dr. Drucker

That one can truly manage other people is by no means adequately proven

Three-step process – recording time, managing time, consolidating time – is the foundation for effectiveness

What motivates technical professionals is what motivates volunteers, who have to get more satisfaction from their work than paid employees, precisely because they do not get a paycheck

Dr. Humphrey

Jelled teams are the most powerful tool ever devised for doing challenging work

The best engineers and scientists don't work for a company, a university, or a laboratory; they really work for themselves

If we are to call ourselves engineers, we must learn to produce quality products on predictable schedules

The PSP is not a magical answer to all of your software engineering problems, but it can help you identify where and how you can improve. However, you must make the improvement yourself

Koestenbaum

Don't think of business as a life without greatness

Unless the distant goals of meaning, greatness, and destiny are addressed, we can't make an intelligent decision about what to do tomorrow morning – much less set the long-term strategy of the company

First decision must be to commit to an ethical world, a civilized existence, a moral order

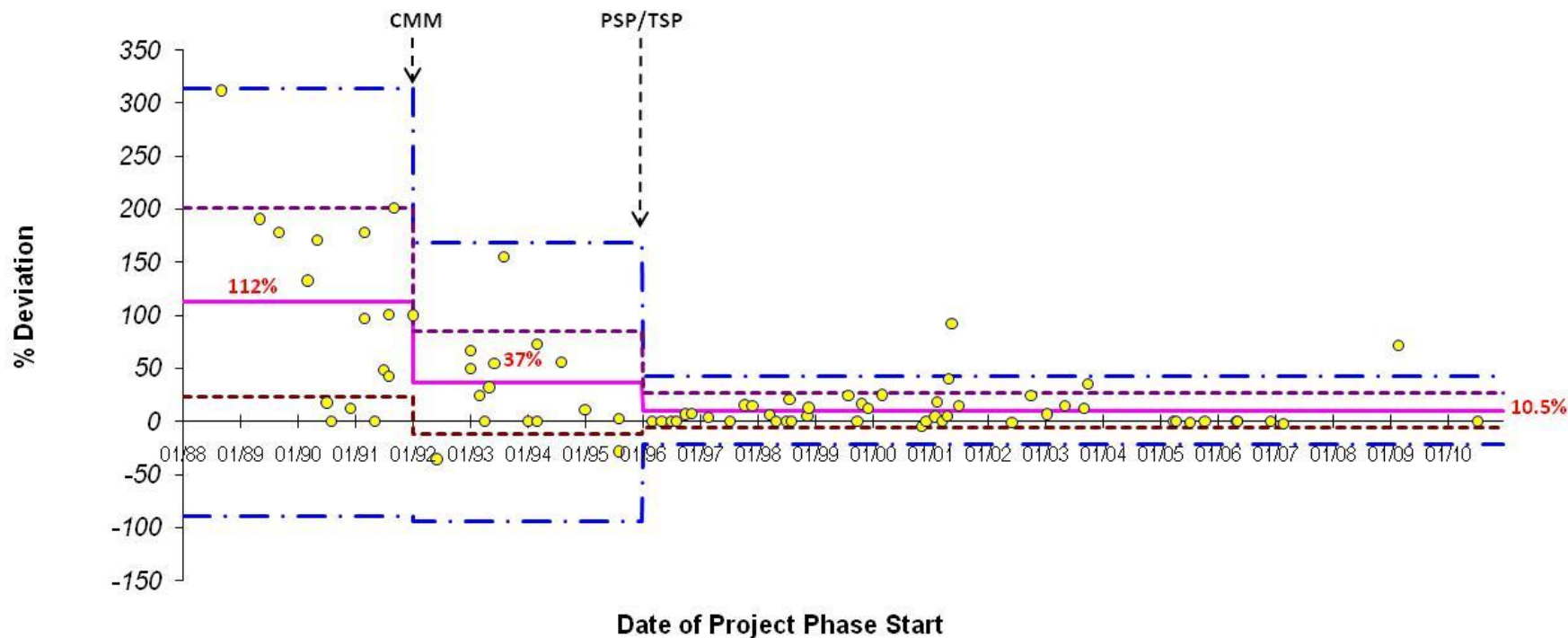
Nothing is more practical than for people to deepen themselves

www.pib.net

Constancy of Purpose

AIS Schedule Performance

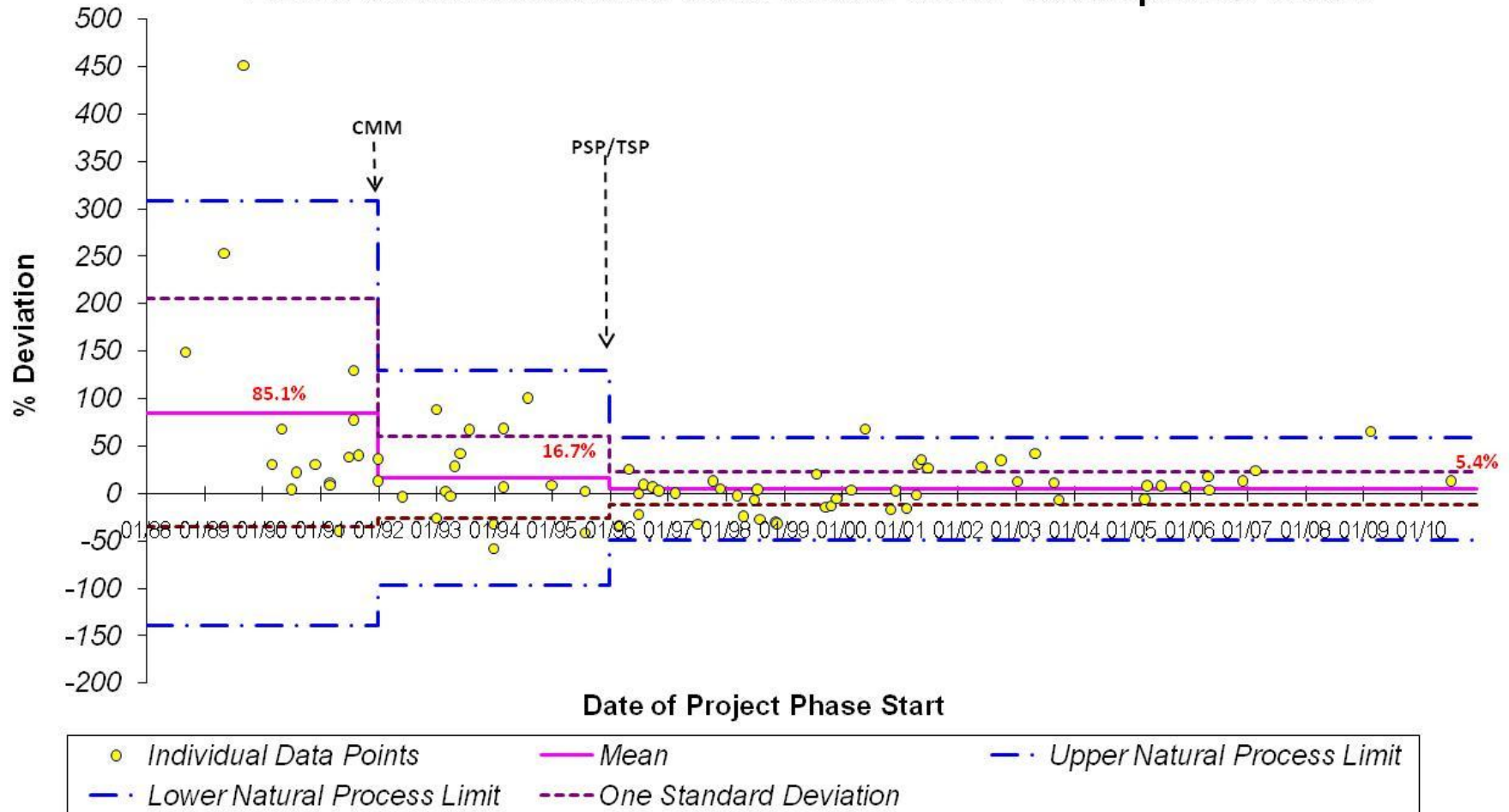
Schedule Deviation Individual Value Control Chart - Development Phases



● Individual Data Points — Mean — Upper Natural Process Limit
 — Lower Natural Process Limit - - - One Standard Deviation

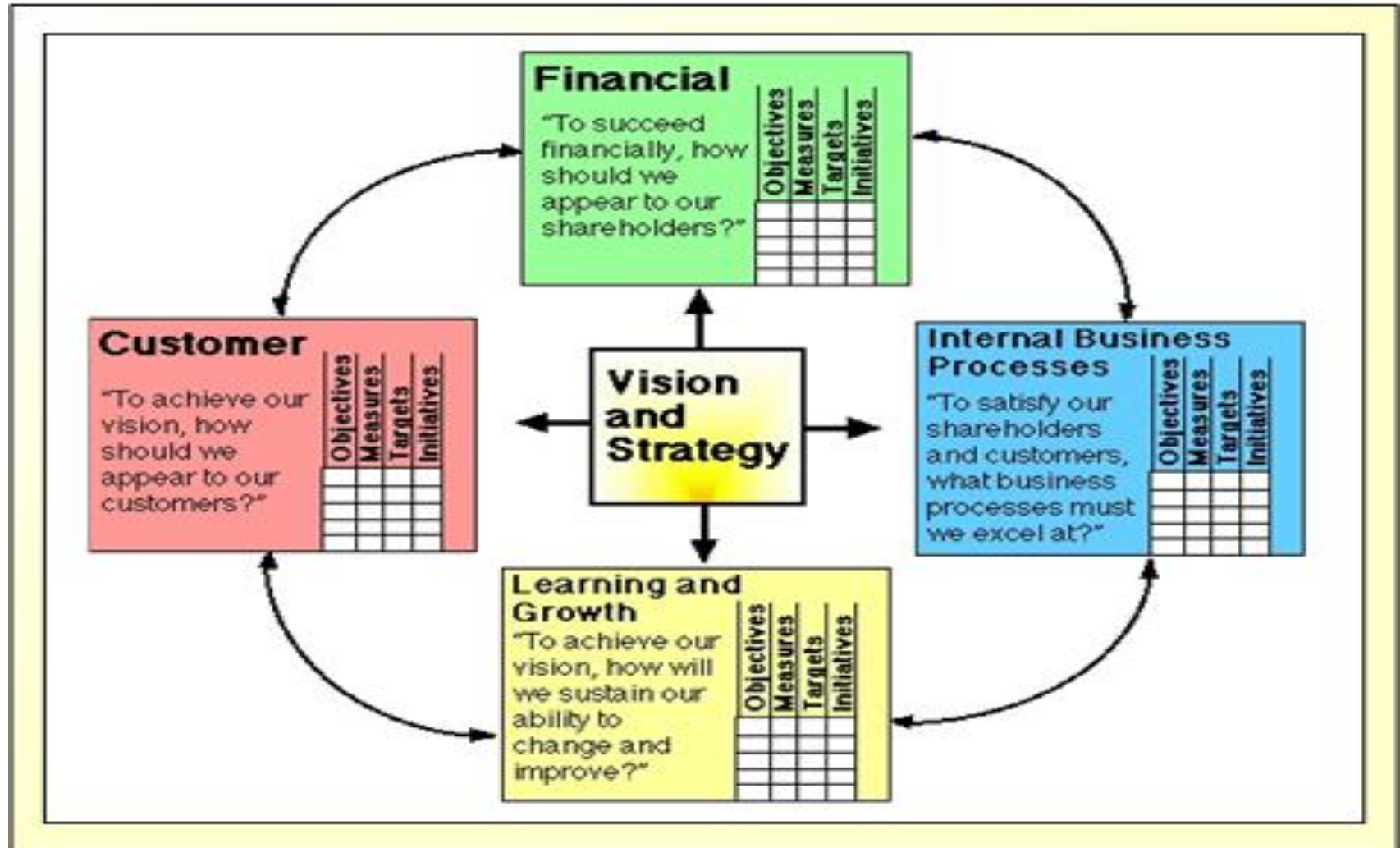
Constancy of Purpose AIS Cost Performance

Effort Deviation Individual Value Control Chart - Development Phases



Performance Metrics That Matter

The Balanced Scorecard



Performance Metrics That Matter

Leading, Lagging Indicators - 1

FINANCIAL	CUSTOMER	EMPLOYEE	INTERNAL BUSINESS PROCESS	LEARNING & GROWTH
CORE OUTCOMES – LAGGING INDICATORS				
<ul style="list-style-type: none"> •Quarterly revenue increase •Annual valuation increase 	<ul style="list-style-type: none"> •Customer feedback indicating met or exceeded customer expectations for: <ul style="list-style-type: none"> - Quality - Timeliness - Value for Products & Services 	<ul style="list-style-type: none"> •Targeted employee turnover rate 	<ul style="list-style-type: none"> •Work products with less than or equal to targeted rework effort •Work products with zero post development defects •Commitments with actual effort equal to or less than committed effort •Commitments with actual schedule equal to or less than committed schedule 	<ul style="list-style-type: none"> •Teams achieving quantitative goals •Employees advancing to the next level in the career path •New products developed and released •New services offered
PERFORMANCE DRIVERS – LEADING INDICATORS				
<ul style="list-style-type: none"> •Monthly percent of revenue from targeted customers •Monthly percent of revenue from targeted services •Monthly percent of employees meeting or exceeding their budgeted revenue target 	<ul style="list-style-type: none"> •Defect free delivery •On-time delivery 	<ul style="list-style-type: none"> •Assessment indicating targeted P-CMM Key Process Areas fully satisfied 	<ul style="list-style-type: none"> •Individuals following the PSP •Work products with targeted percent of defects removed before peer review 	<ul style="list-style-type: none"> •Teams using the TSP •Employees achieving training goals •Internal products being developed •Identified market needs

Performance Metrics That Matter

Leading, Lagging Indicators - 2

FINANCIAL	CUSTOMER	EMPLOYEE	INTERNAL BUSINESS PROCESS	LEARNING & GROWTH
CORE OUTCOMES – LAGGING INDICATORS				
<ul style="list-style-type: none"> • Quarterly revenue increase • Annual valuation increase 	<ul style="list-style-type: none"> • Customer feedback indicating met or exceeded customer expectations for: <ul style="list-style-type: none"> - Quality - Timeliness - Value for Products & Services 	<ul style="list-style-type: none"> • Targeted employee turnover rate 	<ul style="list-style-type: none"> • Work products with less than or equal to targeted rework effort • Work products with zero post development defects • Commitments with actual effort equal to or less than committed effort • Commitments with actual schedule equal to or less than committed schedule 	<ul style="list-style-type: none"> • Teams achieving quantitative goals • Employees advancing to the next level in the career path • New products developed and released • New services offered
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Performance Metrics That Matter

Weekly Status – Team

Estimate At Completion

Task Status Summary									
Status Summary	Plan	Actual	Pln/Act	Act/Pln	Current Week		7 of 29		
Project Hours	450.3	468.3	0.96	1.04			Week(s)		
Project Hours To-date	3173.0	3255.3	0.97	1.03	Current Status Based On EV		0.4	Behind	
Earned Value	4.3	1.7	2.51	0.40	Projected Completion Based On				
EV To-date	28.5	26.9	1.06	0.94	Earned Value Earn Rate		3.0	Ahead	
To-date Hours for EV Tasks Closed	2482.0	1977.1	1.26	0.80	Remaining Plan Hours and EV				
To-date Hours for Non-EV Tasks		429.6			Project Hours and Estimate Accuracy		4.9	Ahead	
							Blocked EV Effort	848.6	
							Avg EV Hours Per Week	465.0	
							Avg EV Per Week	3.8	
							EVHours reqd for 100% EV	5219.9	
							For ontime completion	Per Week	
							Required EV	3.3	
							Required EV Hours	237.3	

Performance Metrics That Matter

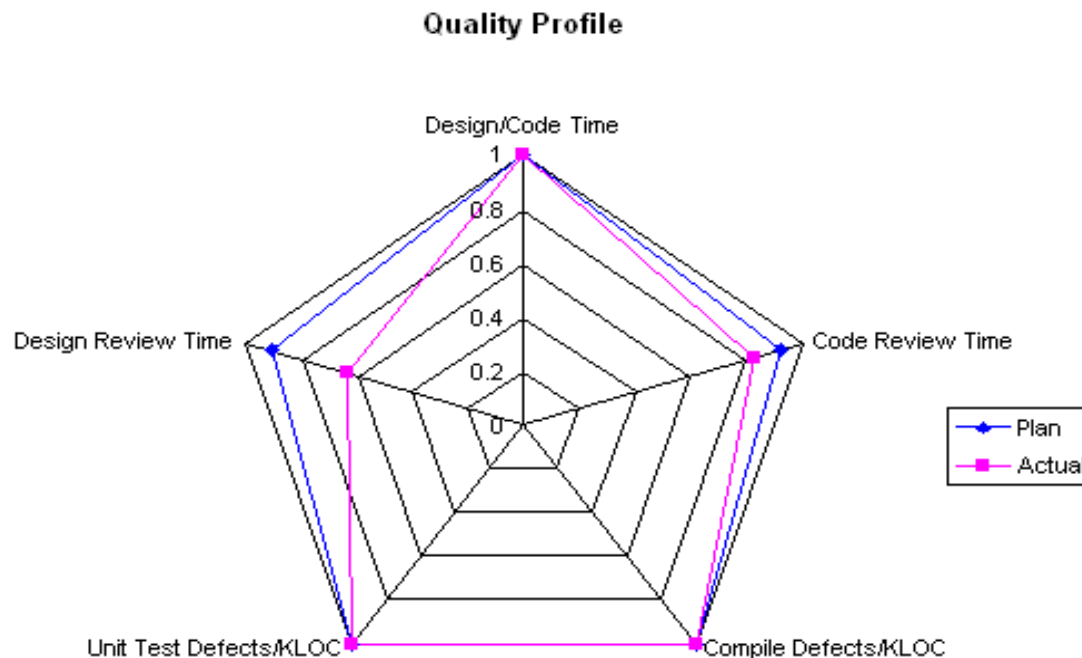
Weekly Status – Individual A

Estimate At Completion

Task Status Summary									
Status Summary	Plan	Actual	Pln/Act	Act/Pln	Current Week		7 of 29		
Project Hours	38.0	41.1	0.92	1.08			Week(s)		
Project Hours To-date	269.7	298.8	0.90	1.11	Current Status Based On EV		4.9	Behind	
Earned Value	8.1	6.7	1.22	0.82	Projected Completion Based On				
EV To-date	62.6	36.9	1.70	0.59	Earned Value Earn Rate		10.0	Ahead	
To-date Hours for EV Tasks Closed	141.9	269.4	0.53	1.90	Remaining Plan Hours and EV				
To-date Hours for Non-EV Tasks		20.7			Project Hours and Estimate Accuracy		15.7	Behind	
							Blocked EV Effort	8.7	
							Avg EV Hours Per Week	42.7	
							Avg EV Per Week	5.3	
							EVHours reqd for 100% EV	460.4	
							For ontime completion	Per Week	
							Required EV	2.9	
							Required EV Hours	20.9	

Performance Metrics That Matter

Quality Profile

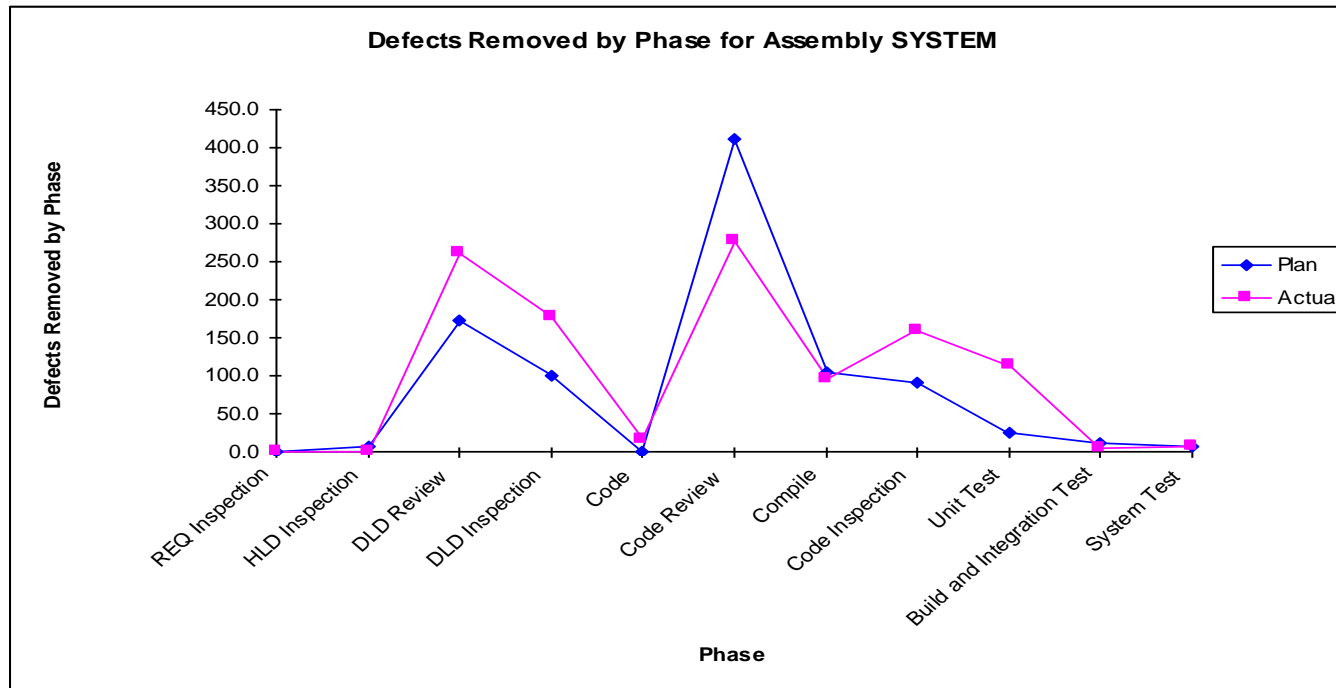


The above chart shows our 5 measures to achieve our quality goals:

- 1) Design time to Code time comparison
- 2) Design Review Time as a % of design time (should be 50% or greater)
- 3) Code Review Time as a % of code time (should be 50% or greater)
- 4) Compile Defects per KLOC (Compile should find less than 10 defects per KLOC)
- 5) Unit Test Defects per KLOC (UT should find less than 5 defects per KLOC)

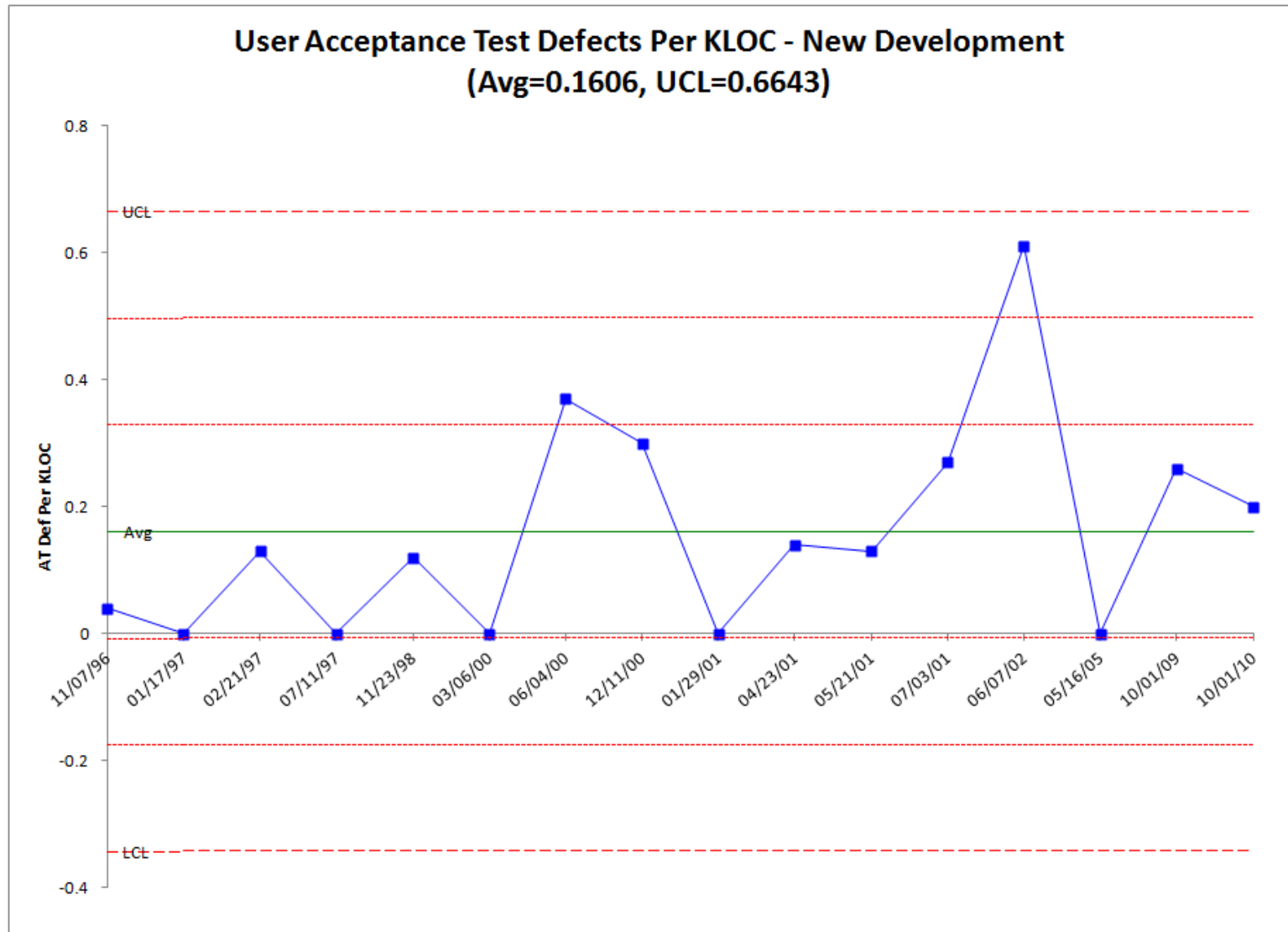
Performance Metrics That Matter

Defects Removed by Phase



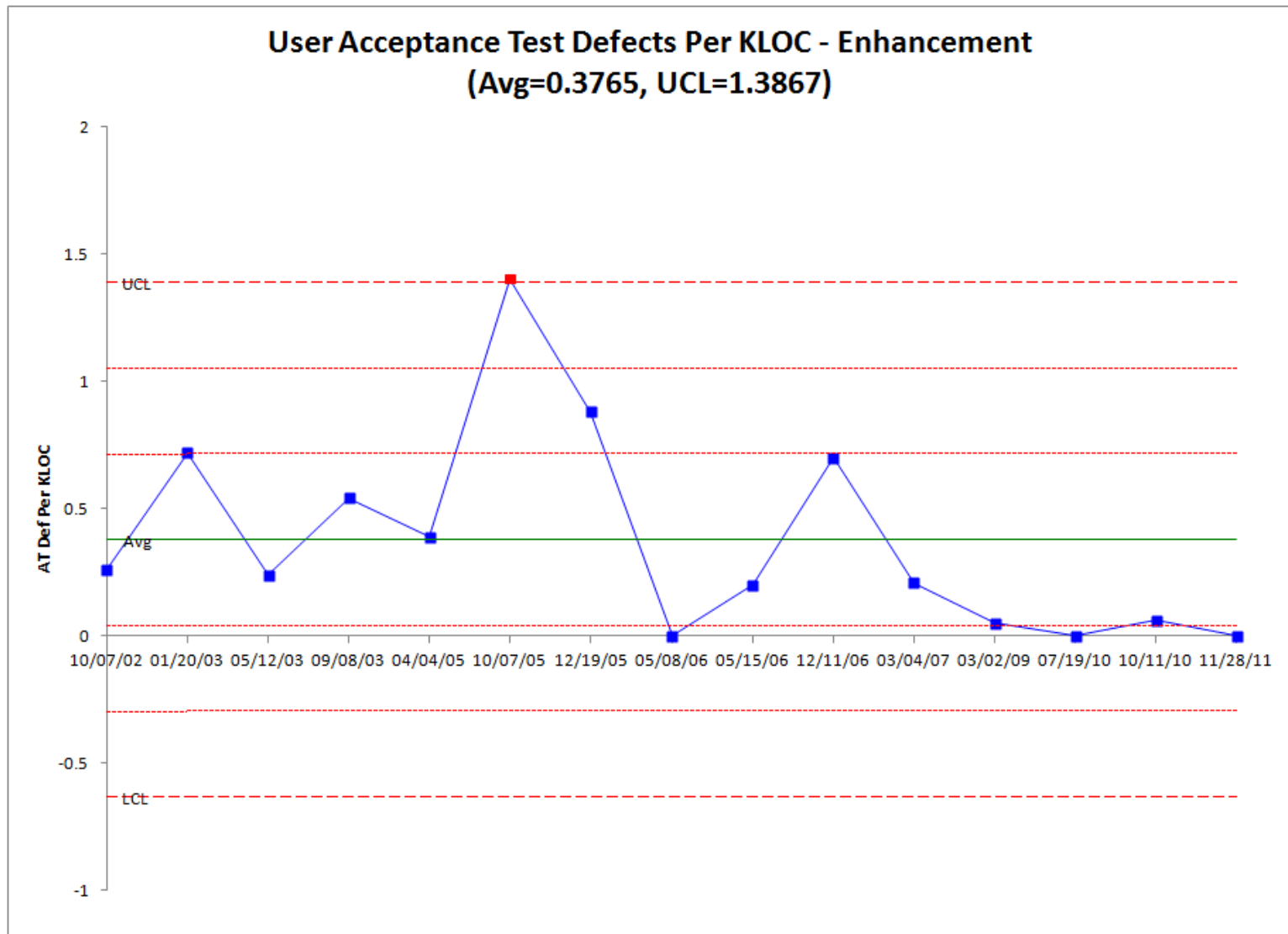
Performance Metrics That Matter

Post-delivery Defects - 1



Performance Metrics That Matter

Post-delivery Defects - 2



Performance Metrics That Matter

Process Improvement Proposal Activity

From October 1992 to August 2012

1741 PIPs have been submitted

Approximately 1255 PIPs have been
implemented

Continuous Improvement

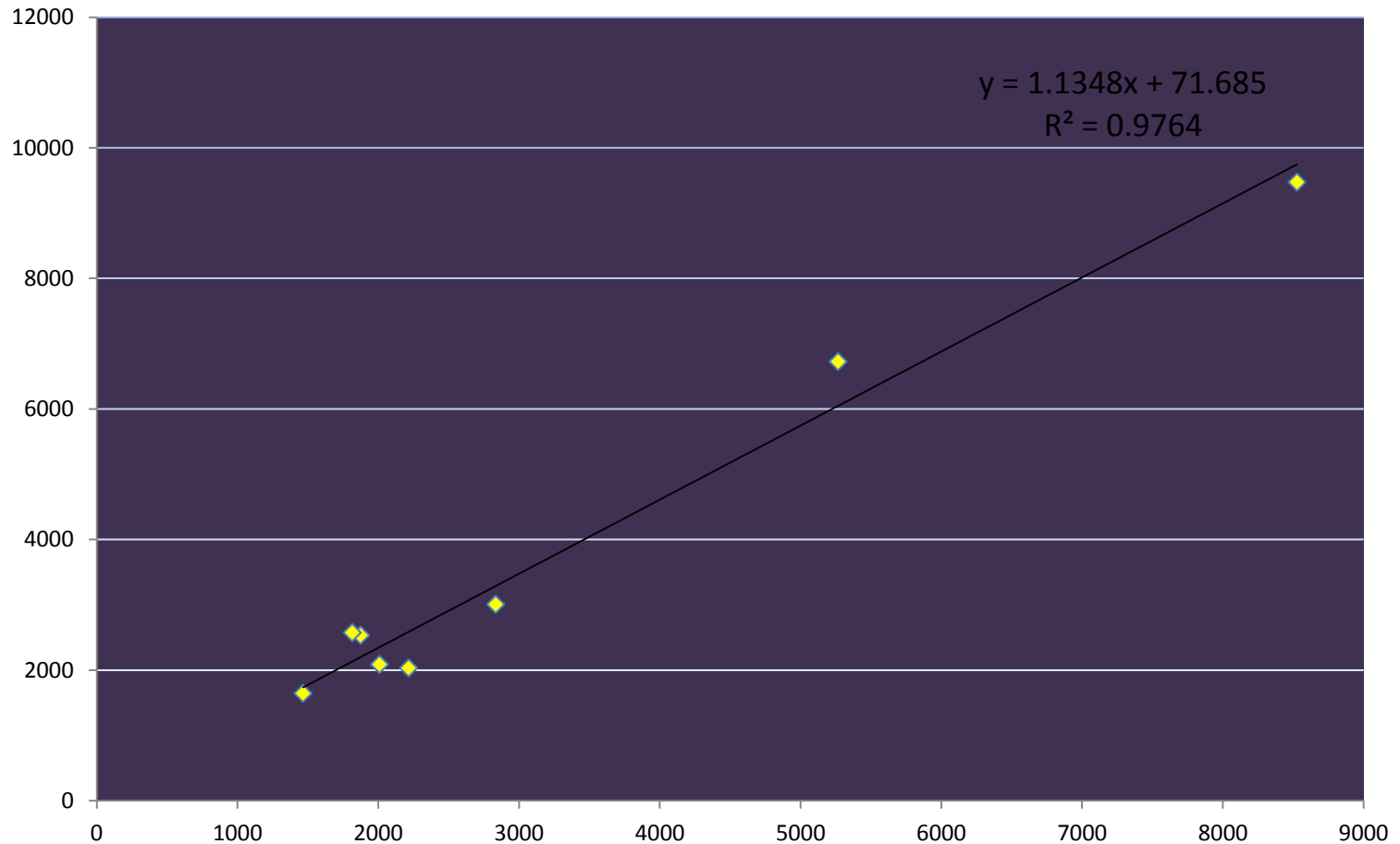
Data is captured and analyzed after each development cycle

Estimated and actual size, effort and defects builds personal history

Regression continuously improves estimation

Analysis of defects results in actions to prevent similar defects in the future

Using Organization Data for Project Planning - Regression



Performance Metrics That Matter

Benchmarking

	Industry Average	AIS Average
Schedule deviation	>50%	<10%
No. of defects in delivered product 100,000 LOC	>100	<15
% of design and code inspected	<100	100
Time to accept 100,000 LOC product	10 Months	5 Weeks
% of defects removed prior to system test	<60%	>85%
% of development time fixing system test defects	>33%	<10%
Cost of quality	>50%	<35%
Warranty on products	?	Lifetime

High Velocity DevelopmentSM

Competitive Game Changers

Proven track record – 15 years

Lifetime warranty against software defects

Firm Fixed Price with performance guarantees

Precise and accurate tracking with ability to detect one-day slip in schedule

Level 5 behavior - Organization, Team, Individual

High Velocity DevelopmentSM

Customer Value Proposition

Dramatically reduces and practically eliminates cyber security incidents attributable to poor quality software code

Reduces software operations & maintenance (O&M) costs by more than half

Fewer bugs to fix in production software making available a larger percentage of O & M spend for new features and enhancements

The Way Forward

Seven

**“Outrageous
Commitments”**

1. Create constancy of purpose and dedication to address the persistent wicked problems

Way Forward

“Outrageous Commitment” No. 1

Create constancy of purpose and dedication to address the persistent wicked problems

Establish five-year “to be” state and describe methods to achieve goals by connecting the dots : agility, quality, innovation and joy in work

Eliminate sub-optimal “deliver now, fix later” solutions

2. Restore the individual

Way Forward

“Outrageous Commitment” No. 2

Restore the individual

Establish minimum competency in planning and tracking the work and managing and measuring software quality

Abolish performance review and substitute with self evaluation and feedback with coaching support

Provide line of sight and explicit cause and effect linking individual performance to organization's aim and team goals

3. End the practice of imposing arbitrary and unrealistic schedules

Way Forward

“Outrageous Commitment” No. 3

End the practice of imposing arbitrary and unrealistic schedules

Abolish arbitrary no. of sprints and time-bound releases

Ensure engineers have the skill to make a plan and the conviction to defend it

When pressed for early deliveries, the responsible team members say “I understand your requirements, I will do my utmost to meet it, but until I make a plan, I can not responsibly commit to a date”

Trust and support the teams

When pressed for early deliveries, the responsible managers say “I trust you to create an aggressive and realistic plan, I will review the plan, but I will not commit you to a date that you can not meet”

4. Improve continuously and forever the performance metrics that matter

Way Forward

“Outrageous Commitment” No. 4

Improve continuously and forever the performance metrics that matter

Cost and schedule performance, defect density in delivered software, **percent of software reuse**, phase yields, cost of quality, and process improvement proposals

5. Cease dependence on test and rework cycle for defect removal

Way Forward

“Outrageous Commitment” No. 5

Cease dependence on test and rework cycle for defect removal

Promote the practice of putting highest quality product into test

Strive for 100 percent defect free components in integration, system and acceptance testing

Improve capability to predict quality early in the software development lifecycle

6. Transform acquisition practices with less emphasis on oversight and create a culture of continuous improvement based on facts

Way Forward

“Outrageous Commitment” No. 6

6. Transform acquisition practices with less emphasis on oversight and create a culture of continuous improvement based on facts

Eliminate the practice of using maturity levels as pass/fail criteria

Substitute appraisals and certifications with measuring organizational competency in performance metrics that matter

Substitute bureaucratic status reporting with precise and accurate reporting of performance metrics that matter

7. Take action to fulfill the outrageous commitments

Way Forward

“Outrageous Commitment” No. 7

Take action to fulfill the outrageous commitments

Sponsor national dialogue on persistent wicked software engineering problems

Elaborate and refine the seven outrageous commitments

Leverage the purchasing power of the stakeholders to change acquisition as well as industry/supplier practices

Reactionary Arguments Against Solutions To Wicked Problems

Three basic forms: perversity, futility, and jeopardy

Perversity thesis: change will not just fail but make the problem worse

Futility thesis: change can't make a meaningful difference, and therefore won't be worth the effort

Jeopardy thesis: change will impose unacceptable costs upon society

Redundancy thesis: we are already doing it

Joy in Work

“There is a square; there is an oblong. The players take the square and place it upon the oblong. They place it very accurately; they make a perfect dwelling place. Very little is left outside. The structure is now visible; what was inchoate is here stated; we are not so various or so mean; we have made oblongs and stood them upon squares. This is our triumph; this is our consolation.”

The players in Virginia Woolf's *The Waves*

What does
“FUN ON THE JOB”
Mean to you?