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Metrics, Software Engineering, Small Systems – the Future of Systems Development

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Metrics, Software Engineering, Small Systems - the Future of Systems Development

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Metrics, Software Engineering, Small Systems – the Future of Systems Development

Outline

1. Where I Started = Early Metrics
2. Metrics Today
3. What are "Embedded Systems" – Where / What Today
4. Growing Importance of Small Systems (and their networks)
5. Why Good Software Engineering is Essential
6. Summary Thoughts

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What I Hope You Will Remember:

1. Trend to smaller and smaller computing devices will continue
2. Quality, Reliability, Trustworthiness of computer systems will increase in importance
3. Metrics, and good software engineering are key to it all

What I want YOU to do!

1. Questions are GOOD!
2. You can ask anytime.
3. It is not BAD to ask questions or make comments
   - It does not mean "I don't understand"
   - It does not mean "I am stupid"
4. It is GOOD to ask questions
   - Shows you are awake
   - Shows you are interested
   - Help others understand too!

I am expecting you to ask questions ANY TIME!!
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My First Computer

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– Instruction Speed: 1 instruction every 2 msec.
– QUIZ: What speed processor would this be in today's terms (Ghertz)?

Quiz 1

IBM 7094
1 instruction every .002 seconds
1/.002 = 500 instructions a second
(assume 1 clock cycle for instruction)
Today Mcycles or Gcycles per second
500/10**6

Speed→
.0005 Mhz processor
(and I had the whole computer to myself for a few seconds)

Programming Tools

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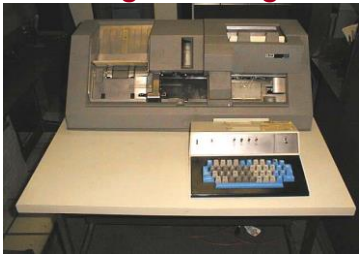

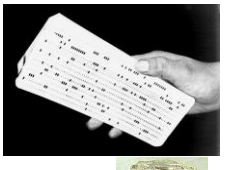

– One punched card per line of program (72 characters)

My First Job – Bell Labs

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Metrics:
1. Seconds to complete a call
2. Number of customers an hour
3. Customers who call back quickly
4. …

- Computer controlled telephone switching
- Reliability and performance
- EVERYTHING is measured = METRICS
- Metrics can be used for GOOD and BAD

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I did not know at this point how important it would be!

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What are Metrics?

Measures, Quantitative Values, Numbers

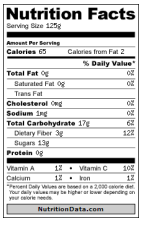
Things you need or want to measure

IEEE Standard Glossary of Software Engineering Terminology
Std 610.12 -1990:

Metric. A quantitative measure of the degree to which a system, component, or process possesses a given attribute.

Food Metrics

Things you may want to know before buying a food item



Example Metrics:
1. Protein per servings
2. Salt (NaCl per serving

What are some typical software development metrics?

SLOC, KSLOC - Source Lines of Code (may distinguish new, reused, changed, …)

Still the best measure of size / how big something is

Person Hours - Actual Time Worked (e.g. on coding, or on whole development project)

Why many developers have to record time worked.
My first job: time card

Defects - Count of Bugs or Problems Found (tracking where defects are found and where they were caused is key to process improvement)

DEFECT = fancy word for bug

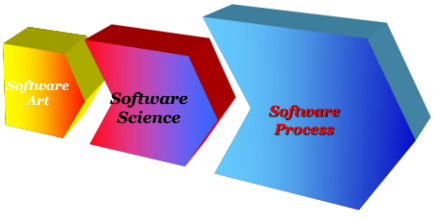
Earned Value - A Measure of Performance to Schedule

More complex development metrics

AFR - Appraisal to Failure Ratio (comparing time spent preventing bugs to time spent fixing them)

History of System Development

1960 → 1990



Why bother?

If you don't know where you're going, any road will do!

Keio University
1858
CALAMVS GLADIO FORTIOR

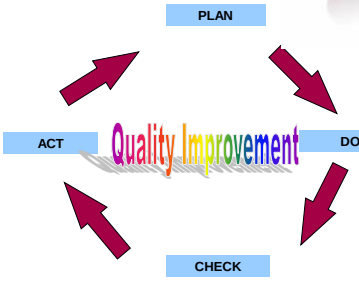
Questions:

- How good is my system (right now)?
- How good is my software process (right now)?
- What must I do to improve it?
- Where do I start?
- What am I doing well (and not so well)?
- Am I on schedule?
- Is the system high quality
- Will it be high quality when finished?

The general quality process:

Measure (something(s))
Set Targets, Goals
Try to Improve to Meet Goals
Do it again (and again…)

The quality improvement process PDCA



In the USA:
Much work on product quality is motivated by the Japanese success in high technology manufacturing.

1. Automobiles
2. Cameras
3. …

Kaizen 改善

The Quality Process and Metrics
(two parts of a whole)

Defined Process; Repeatable Process; Quality Process

- Known steps, known inputs and outputs, entry and exit criteria
- Cost to remove defects or correct mistakes doubles each step further into the development
- Feedback: defect reporting, cause analysis, corrective action plan

Measurement and Metrics

- Data gathering for understanding, evaluation, control, prediction. (Data gathering can be expensive)
- Metrics can be objective or subjective

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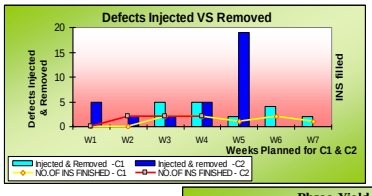
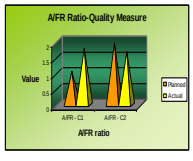
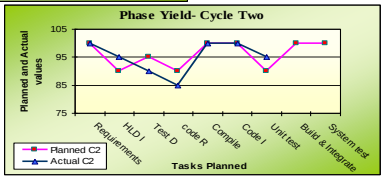
EMPHASIS ON
QUALITY METRICS AND PROCESS METRICS







Chicago Loyola University
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SSTSPi ProductSummary
Team (KingMe), Cycle (3), 4/13/2015

	Units	Plan	Actual	% Actual of Plan	Notes
A1: Product Size - Documents (Count New and Changed)					
Team Goals	pages	1	2	200%	Number of Goals: 7
SRS	pages	7	3	43%	Number of Use Cases: 2
STP	pages	4	11	275%	Number of Test Cases: 43
SDS	pages	1	1	100%	Class Diagram
Inspection form	pages	16	14	88%	
Personal review	pages	16	14	88%	
Other (specify)	pages				
Total	pages	45	45	100%	
A2: Product Size - Software (Count New and Changed)					
CheckersGame	LOC	507	940	185%	many reusable methods
CheckersSystem	LOC	229	261	114%	Comments on limits, design issues, etc
Color	LOC	4	4	100%	
CurrentBoard	LOC	54	59	109%	
Piece	LOC	29	47	162%	
LocalMultiPlayerActivity	LOC	82	80	98%	
Rank	LOC	4	4	100%	
RemoteMultiPlayerActivity	LOC	306	257	84%	
Square.java	LOC	159	256	161%	
SquareView	LOC	84	159	189%	
GameListener	LOC	17	17	100%	
GameState	LOC	6	6	100%	
ViewUpdateListener	LOC	21	21	100%	
BaseKMPPacket	LOC	75	75	100%	
KMPAcknowledgement	LOC	45	46	102%	
KMPChallenge	LOC	100	69	69%	
KMPMove	LOC	100	85	85%	
KMPResponse	LOC	100	94	94%	

W. Edwards Deming

Software Engineering Institute

Software Engineering Institute (SEI) - the world's premier metrics and process organization

Watts Humphrey

Want to know more?
As a real world software engineer, you should…

✓ See more on SEI
http://www.sei.cmu.edu/about/index.cfm

✓ Learn more on quality process
https://asq.org/learn-about-quality/total-quality-management/overview/deming-points.html

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I soon realized that this kind of computer work was different!

My First Programming Work (Bell Labs)

Code, ready to run

- Cross Development
  - » Develop programs on one computer, run on another
- Time Sharing
  - » many users at once
- Embedded System
  - » Computer inside to do things
- "Hands off" or "Lights out" Computing
  - » Do not expect or need human's around

My First Keyboard

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Normal output: paper tape.

Could Wire to Computer as Input/Output

IBM Time Sharing System:

1. Many people used the computer at once
2. You typed a command and get an "instant" response

Metrics == Run Time
(for reliability and quality)

- Lights out system, watches itself
  - Part of the software does the "job"
  - Other parts watch for hardware failures
  - Other parts correct software failures
  - Measure (Count and Keep) EVERYTHING
- Count, Measure, Report all Events
- Key goal RELIABILITY
  - five 9's (99.999% availability)

- Health of whole system more important than most individual tasks
  - Ignore a request for a new phone call, but keep the whole system running

Quiz: How long can a 5 9's system be down in a week (or in a year)?

Quiz 2

99.999% availability
24 * 365 days = 8760 hour in a year
.99999 * 8760 = .0876 hours per year
Or 5.26 minutes a year
Or 6 seconds a week

Availability→
This includes:
Hardware problems
System upgrades
Power Failures
Bugs

Also→
Never write code without knowing how long it might take to run

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What a wonderful world it will be….

Quiz - What Know About Small Systems and Mobility?

Who / When First Tablet Computer?

Who / When First Smart Phone?

Early Adopters / Missionaries / Pioneers….

Archos (French)

Windows 7, Touch On Screen Keyboard Stylus

2006

Palm Treo

PalmOS, Touch Graffiti and Cursive Stylus, and PHONE

2003

Small Systems - Wearables

- Personal Area Network or Wearable Area Network
- Things we keep around us and use to do what we do
- Likely to become much smaller than a phone or tablet

- Increased Importance
  - Metrics
  - Quality
  - Reliability

Power? "Hey, can you spare a charge?"

Small Systems

Shrinking Computer parts means small systems

Examples

Toaster

Home appliances

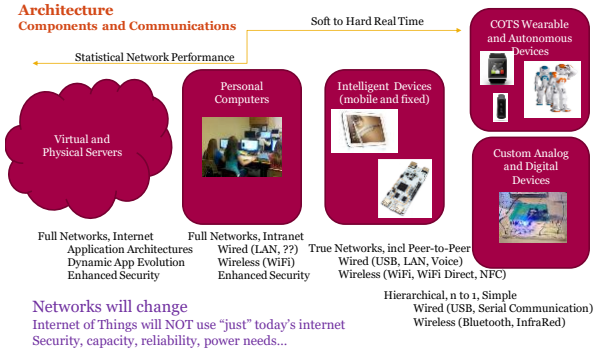
https://juneoven.com/

These systems change the kind of software developers need to know

Embedded System →

1. Programs run inside a device.
2. Computer may not be seen.
3. System is Always On
4. Expect 5 9's Reliability

Broad Framework Architecture
Components and Communications



Networks will change
Internet of Things will NOT use "just" today's internet
Security, capacity, reliability, power needs…

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What is needed to make it all work?

Early Anti-Computer Movement

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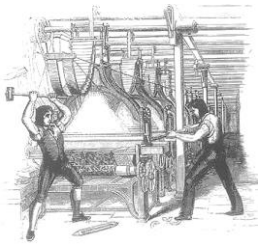
Ned Ludd, 1812



Luddites Destroying Loom

Luddites Today??

Early reaction to automated ("computer driven") manufacturing ("embedded systems")

Do Computers Help or Hurt?

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Alan Turing

Bletchley Park

Computers Today??

Code sheets were calculated by hand by women "computers"
Is it bad they lost their jobs? Replaced by machines….

Does Software Engineering Work?

Dr. William L Honig

Definition

…of Software Engineering
Dr. S. Takada (高田眞吾)
Keio University

- Many definitions exist, but the core is:

  "The study of the development (including maintenance) of software of high quality in a highly productive manner."

  「質のよいソフトウェアの効率よい開発，およびその運用・保守を扱う学問」

Software Process

- Policies, techniques, procedures, etc for developing software
  - Activities such as analysis and design
- Software is normally developed by a team.
  - Not by just one individual.
  - Need to manage the team.
    → Need to define the process.
    → Process may need to be defined per organization.

Why Software Engineering

Problems:
- Systems Late
- Incomplete
- Buggy
- No one knows when it's "done"

If you don't know where you are going, any road will get you there.
Paraphrase of exchange between whom?
Hint: Lewis Carroll

Possible Solutions:
- Requirements
- Analysis & Design
- Metrics and Measures
- Continuous Quality Improvement

The disciplined development of great computer based systems for the world!

Quiz 4

Alice and the Cheshire Cat
(of course)

Reading→
(1865..) Alice's Adventures in Wonderland; Through the Looking Glass
Math and programming fundamentals

(1995) Neal Stephenson, The Diamond Age: Or, A Young Lady's Illustrated Primer
Nano technology, virtual reality

(2009) Paolo Bacigalupi , The Windup Girl
Post oil, biotechnology

A Growing Problem

- Software that has hidden features
  - spyware
  - Unexpected functions and impacts
- Why?
  - Malicious intend (a whole other issue)
  - Poor systems thinking and analysis

Software Transparency and Purity

Transparency: All functions are disclosed to the users / owners / operators of the system

Purity: system does nothing irrelevant to its stated purpose, nothing foreign to it's advertised nature

For more details see Pascal Meunier, Software Transparency and Purity, *Communications of the ACM* (51,2) Feb 2008.

Quiz 5

A team of programmers has been working hard to finish a system. They have written 2347 lines of Java code over the last 3 months.

They have been testing for the last two weeks.

So far they have found and fixed 23 bugs

How many more bugs may be in the system?

Are they finished testing? Or should they keep working? Is the system finished and ready to release?

Management→
What if the future of the company depends on this system coming out on time and with good quality?

Quiz 5

Defects→
Another word for bugs, errors, mistakes.

Answer→
It's impossible to tell how many bugs remain

BUT!

Good software engineering + quality processes can solve it

Metrics that can give answers:
Defect Density (past and similar projects)
Defect Arrival Rate and Defect Fix Rate
Cost of Rework (Defects caused by other fixes)
Capture / Recapture Calculation (Inspections)

YOU→
Don't you want to be able to do this???

Believe Me…

Maturity to use Metrics and Software Engineering Process

- **Alternative is chaos, heroes, burnout, no predictability**

Democratic Development Teams

- **Teams can control their own destiny, schedule, results, rewards…**
- **No need to guess (schedules, results, quality)**

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My thoughts…..who knows for sure?
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What does this mean to computer science students today?

Learn the difference between Great, Good, and OK programming

- Even more important for small systems
- To me, this requires metrics, good software engineering process

Growth opportunities in

- Reliable, secure, trustworthy systems
- Small systems, their networks and security

Three waves of computing systems….

1 Big Computing
- Large dedicated mainframes (eventually mini computers)
- Large and reliable embedded systems
- Global access to applications
- Large programming organizations

2 Personal Computing
- Go to computer to do work
- Democratic applications
- Quality and Reliability Suffers; Defects Acceptable
- More, smaller, quicker programming teams

3 Pervasive Computing
- Devices with us all the time (in us?)
- Devices work "on their own", talk to each other
- Who and how will the software be made?

This is YOUR future.
Be Ready for It.

whonig@luc.edu