CSSE 490 Model-Based Software Engineering: Addressing the Software Productivity Gap

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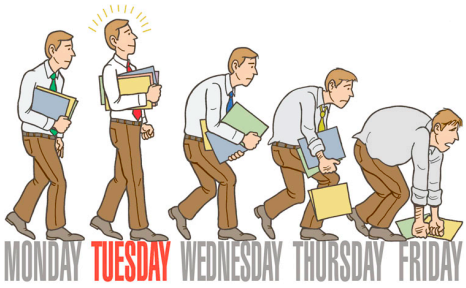
It's Tuesday… are we productive yet?



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What is Software Productivity?

- Think for 15 seconds…
- Turn to a neighbor and discuss it for a minute

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Learning Outcomes: MBE Discipline

Relate Model-Based Engineering as an engineering discipline.

- Software demand outstripping pace
- Examine how software productivity addressed
- What can MBE do for software productivity?

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Size Matters in Software

	Early	On-Time	Delayed	Canceled
1 FP	14.68%	83.16%	1.92%	0.25%
10FP	11.08%	81.25%	5.67%	2.00%
100FP	6.06%	74.77%	11.83%	7.33%
1KFP	1.24%	60.76%	17.67%	20.33%
10KFP	0.14%	28.03%	23.83%	48.00%
100KFP	0.00%	13.67%	21.33%	65.00%
Average	*5.53%*	*56.94%*	*13.71%*	*23.82%*

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From Capers Jones, *Patterns of Software Systems Failure and Success* (International Thomson Computer Press, 1996)

Q1

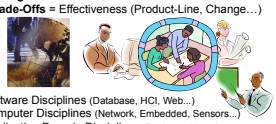
Thirty-five Years of Progress

1976 → *2011*

Structured Design (Data flow, modules, …)
Computing = Centralized
Systems = Standalone; **Large** = ~100K SLOC
Change focus = Source Code
Trade-offs = Efficiency (Memory, processing time…)

Software Programmers
(Database, Algorithm...)

Engineering Design (Inter/Multidisciplinary, Optimize…)
& Human Centered Design (Usability, Customer…)
Computing = Pervasive
Systems = Distributed; **Large** = ~10M SLOC
Change Focus = Architecture
Trade-Offs = Effectiveness (Product-Line, Change…)



Software Disciplines (Database, HCI, Web...)
Computer Disciplines (Network, Embedded, Sensors...)
Application Domain Disciplines (Business Mgt., Aerospace...)

We have better Software and Productivity… but, we are still not keeping pace with demand!

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Q2

Provocative Statements on Software Engineering

- Software Engineering's time has past.
  Tom DeMarco
- Software engineering isn't engineering.
  Peter Denning
- Many advancements now measurable - we have come a long way, but there is still much to do
  Barry Boehm
- Social problems complicate technical ones -- adoption of new tools hampered by business and management objectives
  Bob Glass

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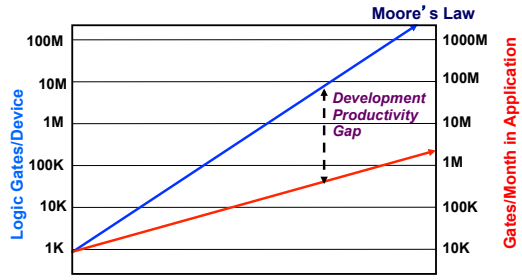
Hardware View of Productivity Gap



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Software System Landscape

- Littered with lots of new stuff
  - Self-Aware/Healing Systems, Web Apps, Service-Oriented Architectures, Ubiquitous Computing…
- It's Big and Connected
  - Lots of Components Distributed across Net
- It's Complex
  - The number and intricacy of the interactions
- Can't fit it all in the engineer's head!

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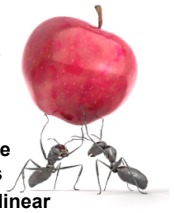
Productivity



- Typically expressed as a ratio of
  Outputs / Inputs
  - E.g., Function Points / Staff Month
  - Assumes units of output & input are known, consistent, & unambiguous
  - Assumes they are continuous and linear
- Also a function of quality
- Business productivity viewed as Utility/Cost

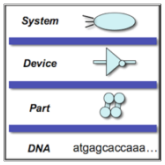
Software Productivity's Greatest Increases

1. Abstraction Higher Level Models (Languages)
2. Reuse (levels)
3. Software Process (types/maturity)
4. Automation - (cobbler's children)

Language Abstraction

General Purpose Languages

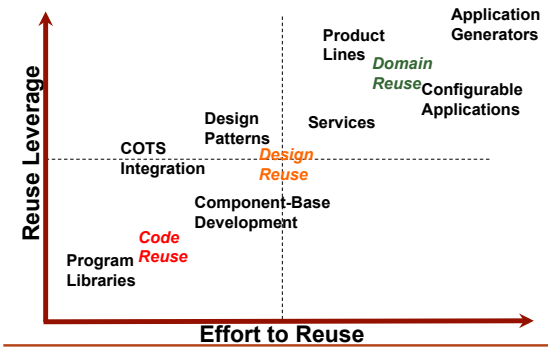
- Micro Code – bit by bit
- Assembly Code – register by register
- Early Procedural Languages (e.g., Fortran)
  - Decision by decision, Computation by computation
- Object-Oriented Languages
  - Object by object, class by class, …



Domain Specific Languages ?

Architecture Description Languages ?

Software Reuse Effectiveness



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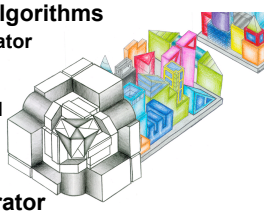
Generative Reuse

- Program generators involve the reuse of standard patterns and algorithms
  - Embedded in the generator and parameterized
  - Program then automatically generated



- Types of program generator
  - Application generators for business processing
  - Parser / lexical analyser generators for language processing
  - Code generators in CASE tools

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Product Line (Application Families)

- Software product lines are applications with generic functionality that can be adapted and configured for use in a specific context
- Product specialization: Platform, Environment, Functional, and Process
- Adaptation may involve:
  - Component and system configuration
  - Adding new components to the system
  - Selecting from a library of existing components
  - Modifying components to meet new requirements

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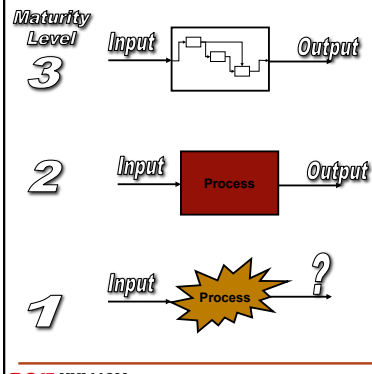
Process Maturity Levels



- ▲ Process metrics focus
- ▲ High predictability
- ▲ Process => Success
- ▲ Medium Risk

- ▲ Project metrics focus
- ▲ Low variability/Medium predictability
- ▲ PM => Success
- ▲ Medium-High Risk

- ▲ High variability/Low predictability
- ▲ Heroes => Success
- ▲ High Risk

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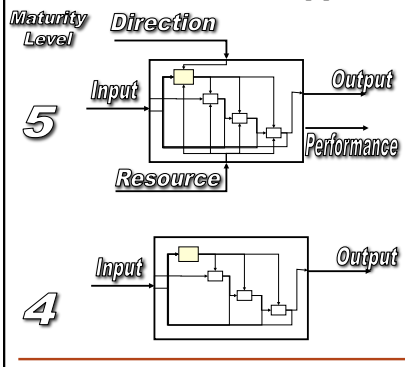
More Traction at Upper levels…



- ▲ Value metrics
- ▲ High predictability
- ▲ Agility => Success
- ▲ Low Risk

- ▲ Product and Process metrics
- ▲ High predictability
- ▲ Managed Process => Success
- ▲ Low-Medium Risk

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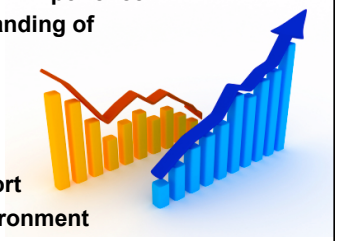
Factors Effecting Productivity

- Abstraction level of Language/Reasoning
- Application Domain Experience
- Common understanding of problem/solution
- Process
- Quality
- Project
- Technology support
- Development environment



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Productivity Enhancement

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Another way to increase productivity is to involve more people. Who could get involved if models were used for programming?

- Again, think for 15 seconds…
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Model-Based Mindset Adjustment

- Model-Based Engineering (MBE) in most engineering disciplines is used largely for understanding and verification
  - Models serve as basis for simulations
- For software, our simulations become operational!
- In software, everything is a model!
  - Assembly Language, 3rd Generation Language, …
  - Object, functional, procedural, symbolic, …
  - Finite State Machines, Petri-net, data/control flow, …

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Somewhat unproductive...

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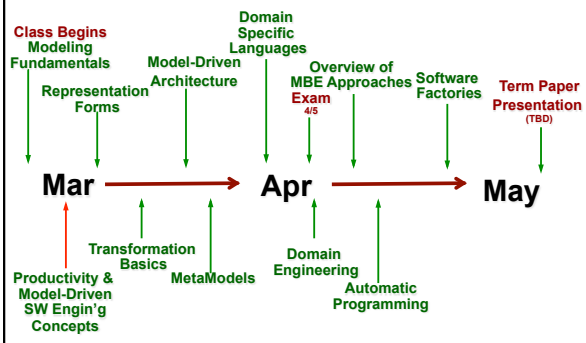
Tentative Spring Quarter Timeline



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Homework and Milestone Reminders

- Read Chapter 3 of MBSD Text
- Let's talk Thursday about elements of Model-Based Software Development

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