Best Practices for Establishing a Culture of Model-Based Design

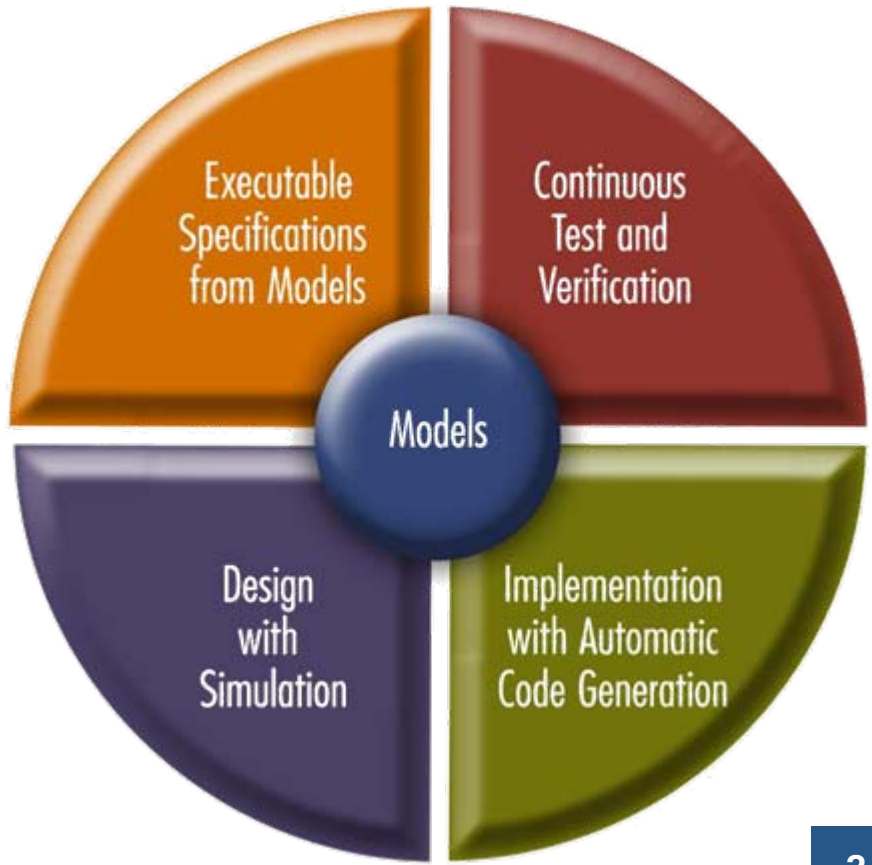
Paul Smith,

Director – North American Consulting Services

The MathWorks

Review: Benefits of Model-Based Design

- Simulation enables validation and documentation of requirements
- Requirements models are reused to generate code and documentation
- Test cases are reused to verify deployed application
- Results:
  - *Improved quality*
  - *Reduced time to market*
  - *Capability to develop more complex systems*



Adoption of Model-Based Design

What happens in the “real world”? Why do organizations adopt Model-Based Design?

- Corporate mandate
- 6 Sigma / quality initiatives
- Young engineers used it in college
- It’s more fun than writing C

Transformational Levels for the Adoption of Model-Based Design

From Phil Martens, Ford Motor Co., 2003 DARATECH Conference

Best Practice # 1:
Identify the problem you are trying to solve

- Have metrics that identify the weak points in your current process
- Attack your greatest weaknesses first
- Monitor your Return on Investment (ROI)

Example 1: Can't hit release dates

Example 2: Excessive software defects

Example 3: Availability of prototype hardware

Best Practice # 2:
Use models for at least two things – "Rule of Two"

- Overcome startup costs and resistance to change
- ROI increases with multi-use models

Example 1: Validate requirements through simulation and add new functionality through rapid prototyping

Example 2: System specification and automatic code generation

Best Practice # 3:
Use models for production code generation

- To ensure success you must connect models to real system
- Enable a culture of modeling by removing temptation and option to write code
- Executable code is what makes machines move and generates profits

Best Practice # 4:
Treat models as the sole source of truth

- Remove the temptation to hack code by hand late in a program when under time pressure
- Prevent divergence of code and model

Best Practice # 5:
Use migration as a learning opportunity

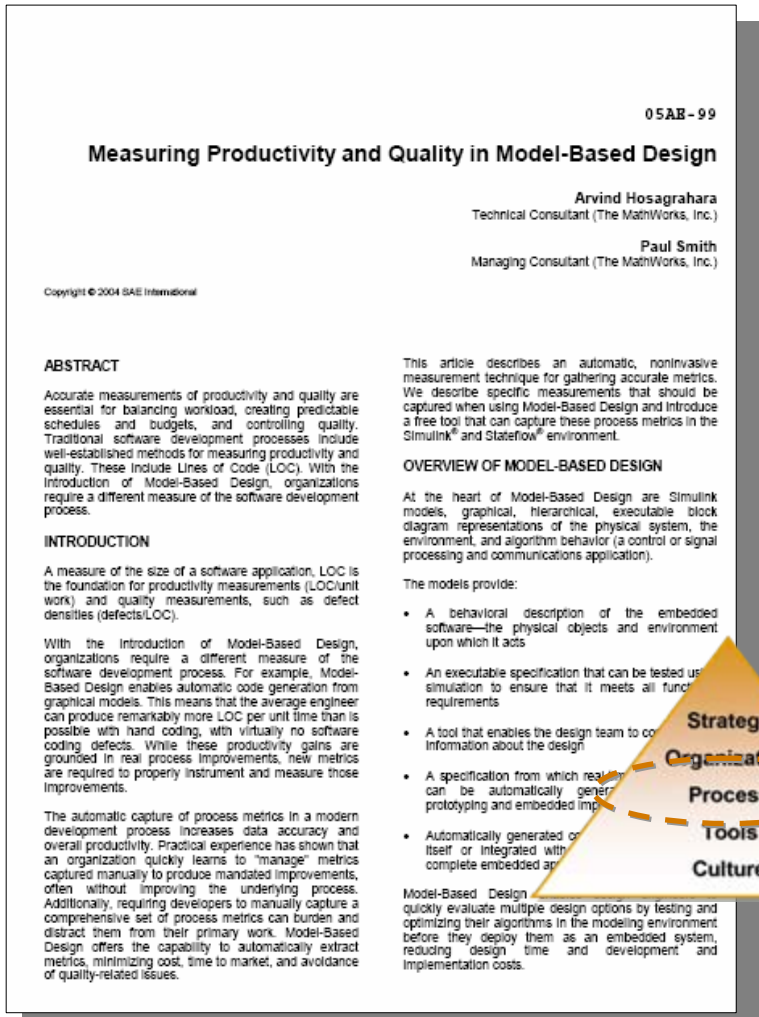
- Learn what really happens in the current system
- Solicit help on process and tools, not on translation
- Focus on value-added features first
- Conversion is a tremendous learning and quality improvement opportunity
  - True even in small code footprints and efficient organizations

Best Practice # 6:
Focus on design, not on coding

- Software design is still taking place
- Software engineers establish and manage the code generation infrastructure
- Model refinement continues after the controls engineers finish their work and before model is ready to generate code, especially in a fixed-point implementation
- Legacy code must be integrated and maintained

Best Practice # 7:
Integrate the development process

- Develop a comprehensive plan:
  - Training
  - Modeling Style
  - Enforcement.
  - Supporting Tools
  - Configuration Management
  - Requirements Management
  - Process
- Develop new metrics



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Measuring Productivity and Quality in Model-Based Design

Arvind Hosagrahara
Technical Consultant (The MathWorks, Inc.)

Paul Smith
Managing Consultant (The MathWorks, Inc.)

ABSTRACT

Accurate measurements of productivity and quality are essential for balancing workload, creating predictable schedules and budgets, and controlling quality. Traditional software development processes include well-established methods for measuring productivity and quality. These include Lines of Code (LOC). With the introduction of Model-Based Design, organizations require a different measure of the software development process.

INTRODUCTION

A measure of the size of a software application, LOC is the foundation for productivity measurements (LOC/unit work) and quality measurements, such as defect densities (defects/LOC).

With the introduction of Model-Based Design, organizations require a different measure of the software development process. For example, Model-Based Design enables automatic code generation from graphical models. This means that the average engineer can produce remarkably more LOC per unit time than is possible with hand coding, with virtually no software coding defects. While these productivity gains are grounded in real process improvements, new metrics are required to properly instrument and measure those improvements.

The automatic capture of process metrics in a modern development process increases data accuracy and overall productivity. Practical experience has shown that an organization quickly learns to "manage" metrics captured manually to produce mandated improvements, often without improving the underlying process. Additionally, requiring developers to manually capture a comprehensive set of process metrics can burden and distract them from their primary work. Model-Based Design offers the capability to automatically extract metrics, minimizing cost, time to market, and avoidance of quality-related issues.

This article describes an automatic, noninvasive measurement technique for gathering accurate metrics. We describe specific measurements that should be captured when using Model-Based Design and introduce a free tool that can capture these process metrics in the Simulink® and Stateflow® environment.

OVERVIEW OF MODEL-BASED DESIGN

At the heart of Model-Based Design are Simulink models, graphical, hierarchical, executable block diagram representations of the physical system, the environment, and algorithm behavior (a control or signal processing and communications application).

The models provide:

- A behavioral description of the embedded software—the physical objects and environment upon which it acts
- An executable specification that can be tested u… simulation to ensure that it meets all funct… requirements
- A tool that enables the design team to co… information about the design
- A specification from which rea… can be automatically gener… prototyping and embedded imp…
- Automatically generated c… itself or integrated with… complete embedded ap…

Model-Based Design … quickly evaluate multiple design options by testing and optimizing their algorithms in the modeling environment before they deploy them as an embedded system, reducing design time and development and implementation costs.

Best Practice # 8:

Designate champions with influence, expertise, and budgetary control

Business champion:

- Assigns overall priorities
- Assigns people
- Acquires tools, equipment, and services
- Sometimes act as a consensus builder
- Sometimes act as a benevolent dictator
- Handles issue escalation

Technical champion:

- Assigns technical priorities
- Is point of contact for Model-Based Design issues
- Attends MathWorks Advisory Boards
- May also be business champion in some organizations

Best Practice # 9:
Have a long-term vision

- Good things come to those who have a vision and work hard to achieve it
- The full transition from hand-coded, textual languages takes 2-3 years to fully implement in a production organization
- Research organizations often have fewer constraints and less legacy code, and can move faster
- Be flexible
  - Don't get bogged down with needs derived from traditional approaches (*paving the cow paths*)
  - Be receptive to workarounds
  - Plan for migration

Best Practice # 10:
Partner with your tool suppliers

Suppliers bring the experience of working with entire industries and can help you avoid common pitfalls, accelerate your ROI breakeven point, and quickly achieve productivity and quality goals