Pragmatic Strategies for Adopting Model-Based Design for Embedded Applications

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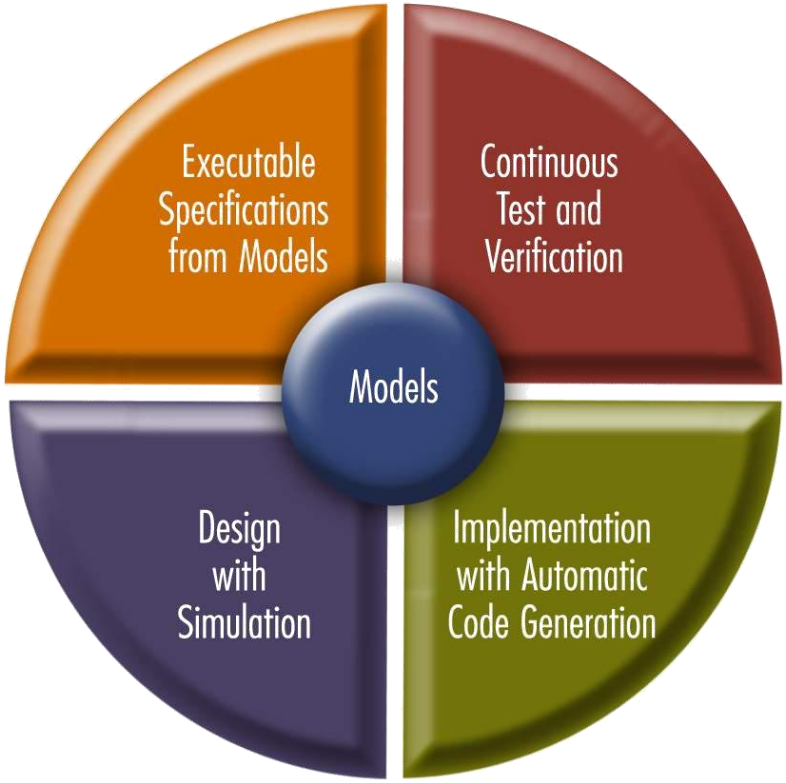
MathWorks Symposium

Adopting Model-Based Design within Aerospace and Defense

Model-Based Design (MBD)

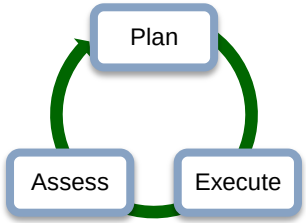
- What's MBD?
- Why do it?
  - Eliminate HW prototypes?
    - Minimize HW prototypes!
  - Build it right the first time?
    - Build it wrong a thousand times!
  - Benefits:
    - Innovate
    - Reduce time to market
    - Reduce cost
    - Improve quality
- How do you start?

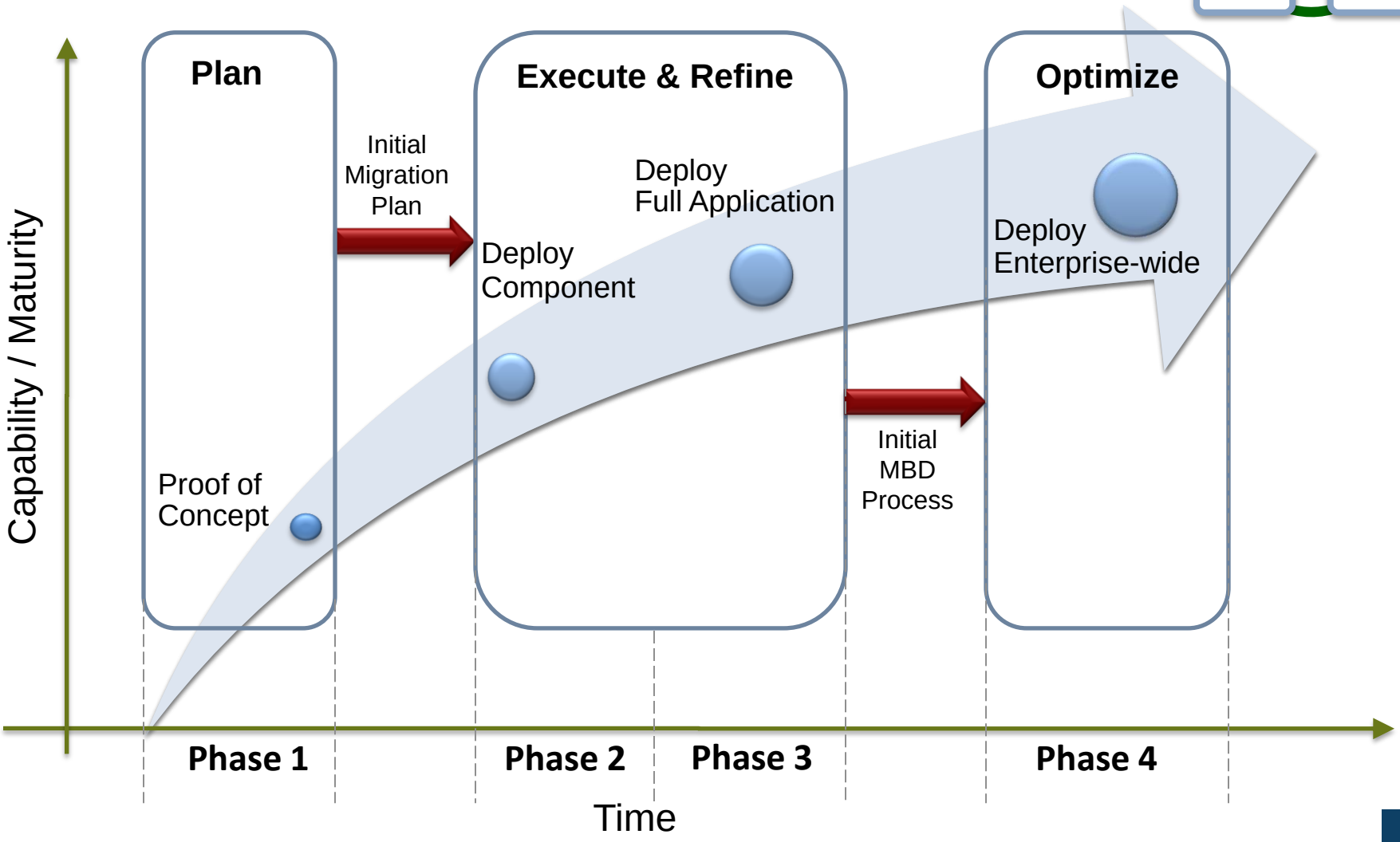


Best Practices for Establishing a Model-Based Design Culture (SAE Paper 2007-01-0777, Smith, Prabhu, Friedman)

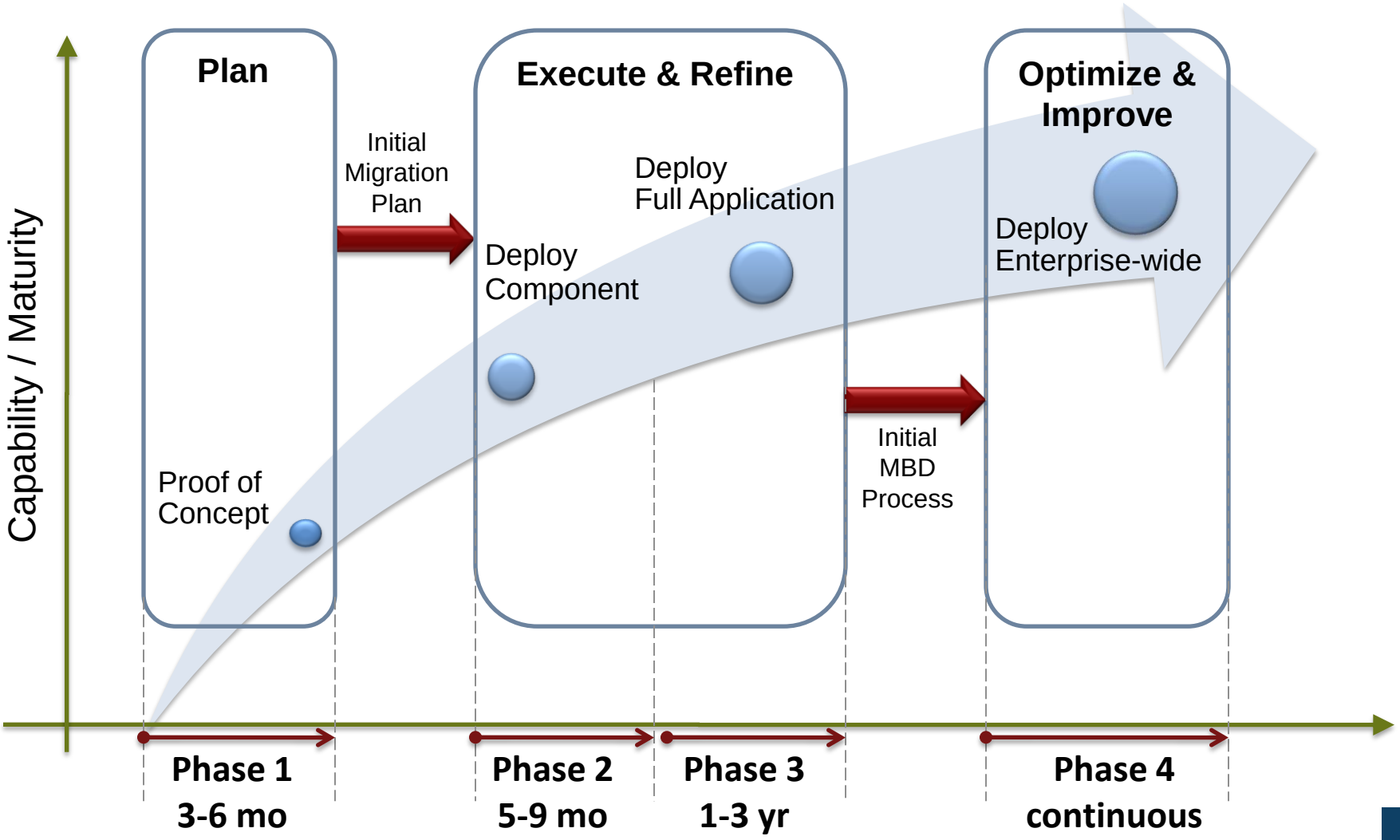
1. Identify the problem you are trying to solve
2. Use models for at least two things – “Rule of Two”
3. Use models for production code generation
4. Treat models as the sole source of truth
5. Use migration as a learning opportunity
6. Focus on design, not on coding
7. Integrate the development process
8. Designate champions with influence, expertise, and budgetary control
9. Have a long-term vision
10. Partner with your tool suppliers

The Phased Approach to Adoption



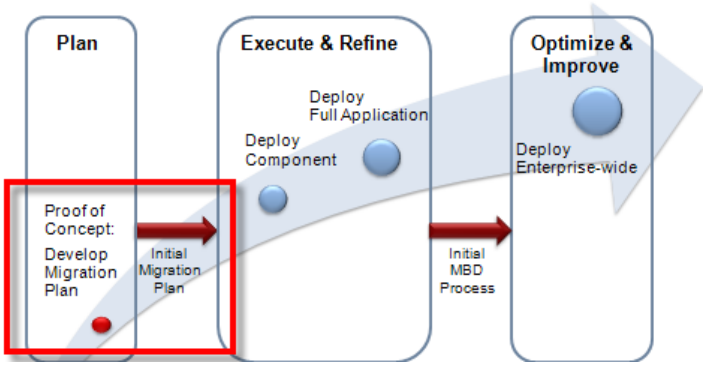


Timing the Phased Approach



Phase 1: Proof of Concept

Theme: ***Discovery***



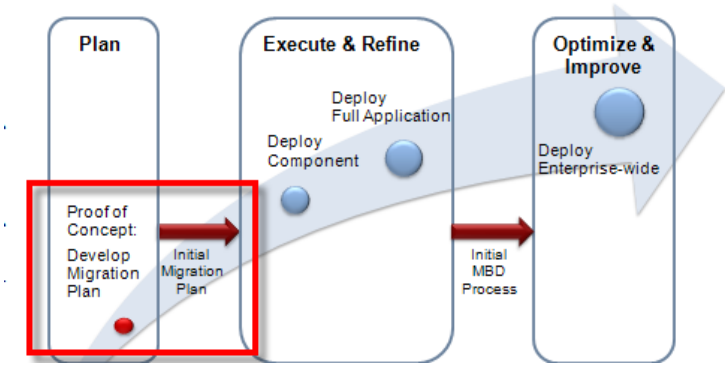
Activities:

- Identify Objectives
- Form a dedicated team and provide training
- Select an algorithm
- Build models and execute on target

What does success look like:

- Focus on technology – prove the tools can do the job
- Learn and build support for future changes
- KEY OUTPUT: Initial Migration Plan

Phase 1: Proof of Concept



Success Factors:

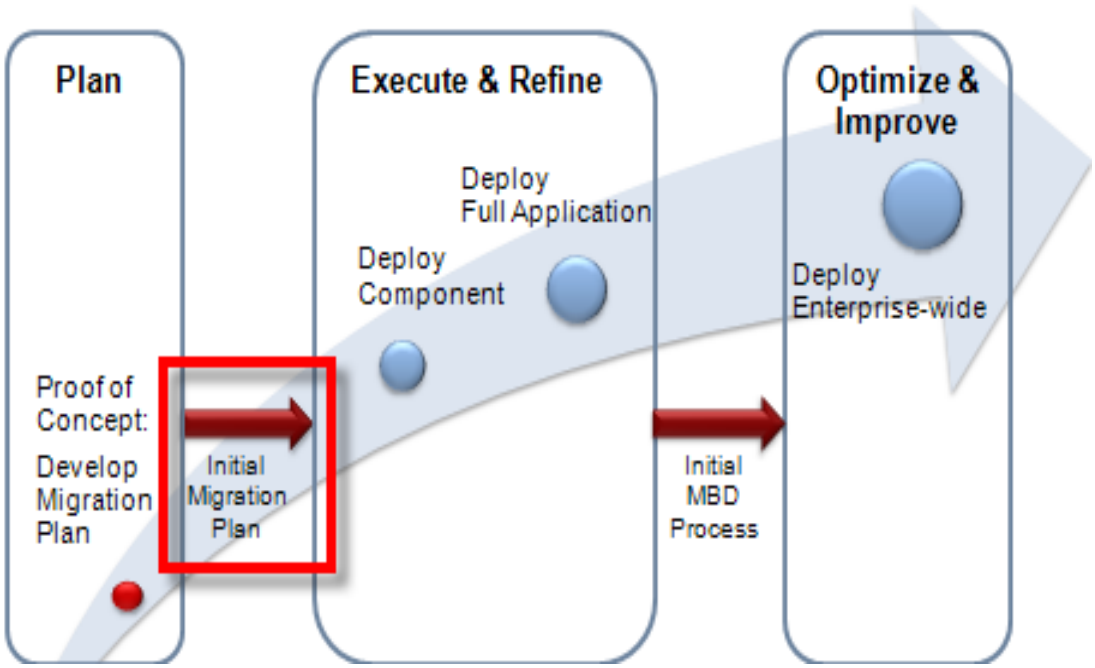
- Keep it simple
- Firm deadline
- Dedicated cross-functional team

Common Pitfalls:

- Deliverable on the production path
- Expecting ROI
- Aggressive timing without help

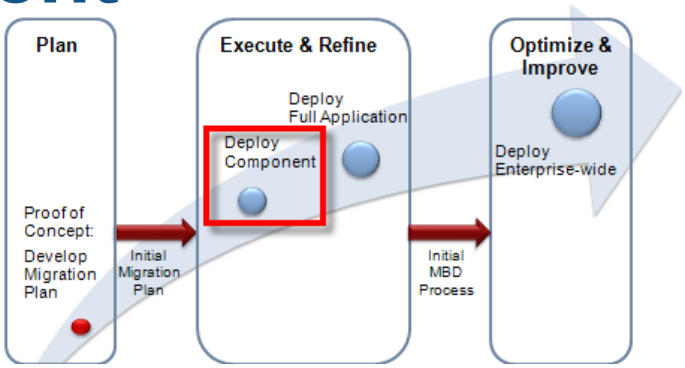
The Migration Plan

- Objectives
- Metrics
- Organization
- Training
- Process Changes
- Constraints
- Standards
- Automation



This plan will change – it is not static!

Phase 2: Deploy a Component



Theme: ***Execute & Refine***

New Activities:

- Selection of component to deploy
- Introduce Model-Based V&V: Simulation-Based Testing
- Integration with production build, configuration management

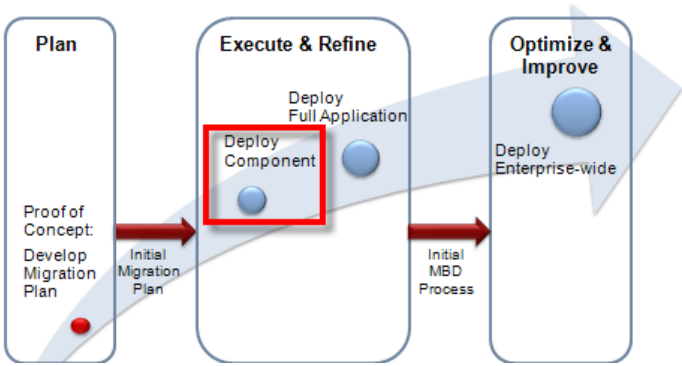
What does success look like:

- Larger number of people engaged in Model-Based Design
- Bigger model representing more functionality; ROI is emerging
- Some automation, metrics and process definition

KEY OUTPUTS:

- Production “component” delivered
- V1.0 Model-Based Process Definition

Phase 2: Deploy a Component



Success Factors:

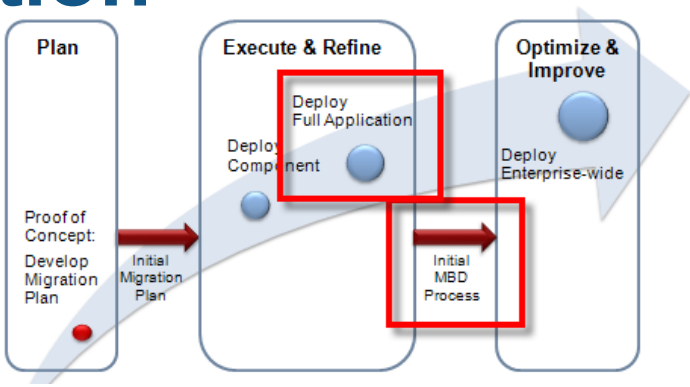
- Focus on the initial architecture
- Adopting Modeling Standards
- Common working environment

Common Pitfalls:

- Complexity, Size, and Representation (common patterns)
- Outsourcing migration
- Graphical coding

Phase 3: Deploy an Application

Theme: ***Scale Up***



New Activities:

- Requirements linking
- Full Model-Based V&V - Coverage, SIL, PIL, etc
- Automation - Standards checking, testing

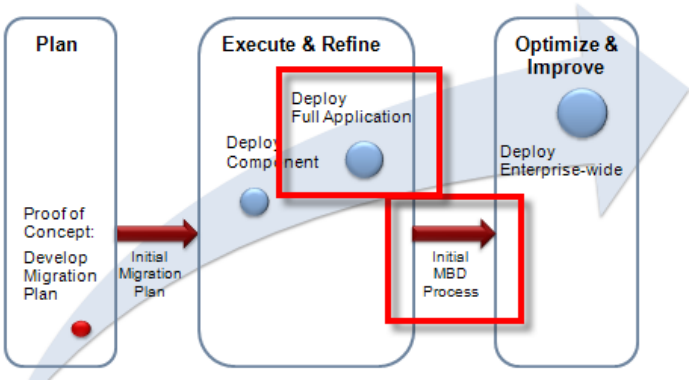
What does success look like:

- Production application delivered
- Significant return on investment
- V2.0 MBD process: Base set of capabilities

Phase 3: Deploy an Application

Success Factors:

- Multiple organizations involved
- Standardized MBD environment



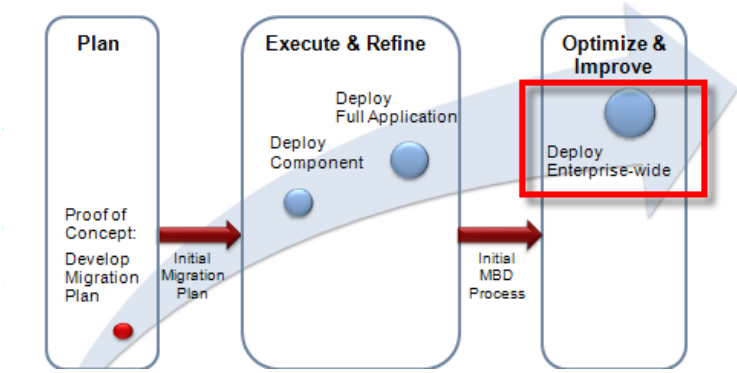
Common Pitfalls:

- Architecture scalability
- Touching the code
- Lack of modeling standards

Phase 4: Optimize & Improve

Theme: *Continuous Improvement*

- Adapt and deploy
- Fully leverage success: Optimization



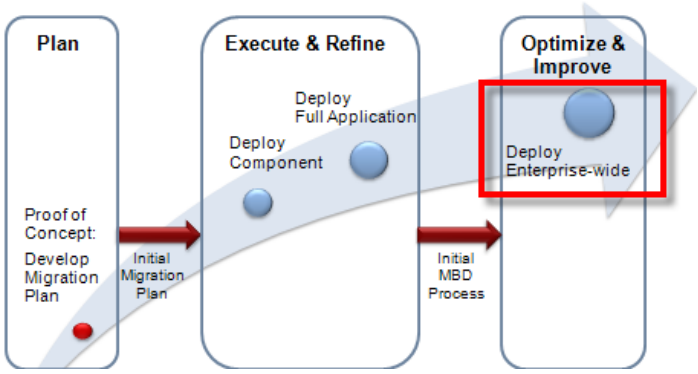
New Activities:

- Assess other site requirements
- Refine objectives & capabilities

What does success look like:

- Replicated success at multiple sites
- Dramatic productivity improvement
- Increased capacity for complexity

Phase 4: Optimize & Improve



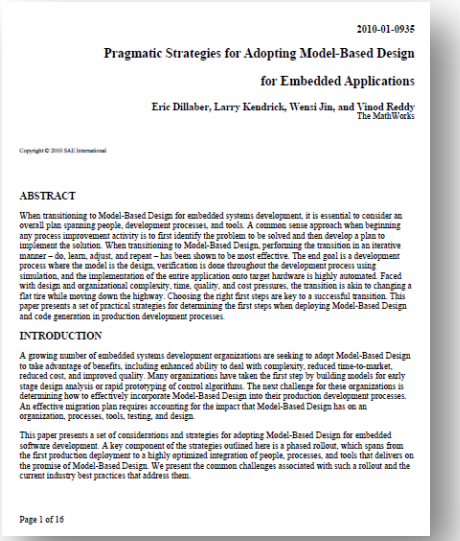
Success Factors:

- Continuous Improvement:
  - Tools & products are constantly evolving

Common Pitfalls:

- No dedicated central tool group
- Rollout without adequate representation

Pragmatic Strategies for Adopting Model-Based Design (SAE Paper 2010-01-0935, Dillaber, Kendrick, Jin, Reddy)



2010-01-0935

Pragmatic Strategies for Adopting Model-Based Design for Embedded Applications

Eric Dillaber, Larry Kendrick, Wenti Jin, and Vinod Reddy
The MathWorks

ABSTRACT

When transitioning to Model-Based Design for embedded systems development, it is essential to consider an overall plan spanning people, development processes, and tools. A common sense approach when beginning any process improvement activity is to first identify the problem to be solved and then develop a plan to implement the solution. When transitioning to Model-Based Design, performing the transition in an iterative manner – do, learn, adjust, and repeat – has been shown to be most effective. The end goal is a development process where the model is the design, verification is done throughout the development process using simulation, and the implementation of the entire application onto target hardware is highly automated. Faced with design and organizational complexity, time, quality, and cost pressures, the transition is akin to changing a flat tire while moving down the highway. Choosing the right first steps are key to a successful transition. This paper presents a set of practical strategies for determining the first steps when deploying Model-Based Design and code generation in production development processes.

INTRODUCTION

A growing number of embedded systems development organizations are seeking to adopt Model-Based Design to take advantage of benefits, including enhanced ability to deal with complexity, reduced time-to-market, reduced cost, and improved quality. Many organizations have taken the first step by building models for early stage design analysis or rapid prototyping of control algorithms. The next challenge for these organizations is determining how to effectively incorporate Model-Based Design into their production development processes. An effective migration plan requires accounting for the impact that Model-Based Design has on an organization, processes, tools, testing, and design.

This paper presents a set of considerations and strategies for adopting Model-Based Design for embedded software development. A key component of the strategies outlined here is a phased rollout, which spans from the first production deployment to a highly optimized integration of people, processes, and tools that delivers on the promise of Model-Based Design. We present the common challenges associated with such a rollout and the current industry best practices that address them.

Strategies to consider in planning your phased approach:

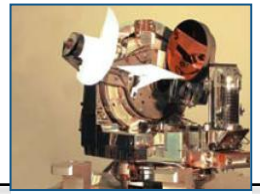
- Assess organizational challenges and impact
- Plan for change
  1. Identify the problem you are trying to solve
  2. Choose a project with proper complexity and technology
  3. Mitigate risk with a phased approach
  4. Choose the appropriate legacy components for migration

Strategies to help you choose what areas and capabilities to target first

(Selected key items)

1. Use executable spec development as an opportunity to solidify requirements
2. Make the model a source for documentation
3. Choose architecture and component technology early
4. Establish and enforce design standards
5. Develop a plant model with “trend-correct” behavior
6. Verify what you need, not what you want
7. Migrate key supporting processes such as CM

User Stories

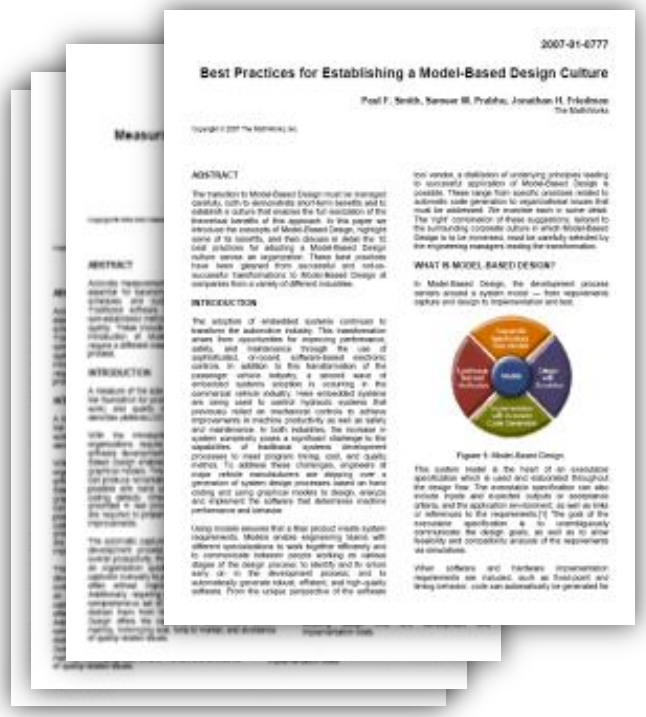
Company	Application	Strategy	Result
Astrium EADS astrium	 First of its Kind Laser Link	• Modeling, Early Verification, Code Generation, HIL/RPC	• **Design iterations reduced from days to hours** • **Overall development time reduced by six months**
BAE Systems BAE SYSTEMS	 SDR	• Modeling, Early Verification, VHDL • Traditional Effort Comparison	• **Project development time reduced by 80%:** • **SDR SP Devel 10:1** • **Overall time 4:1**
Honeywell Honeywell	 Flight Control System	• Modeling, Early verification, code generation • Legacy Reuse	• **5:1 improvement in productivity** • **Highly accurate, reusable code** • **A superior product**
Lockheed Martin LOCKHEED MARTIN	 JSF - Flight Control System	• Modeling Early verification, code generation • Large-Scale & Collaborative Devel	• **Reduced Software Defects** • **Overall Reduction in Manhours/SLOC of ~40%**

Next Steps

- Read the paper:
  Pragmatic Strategies for Adopting Model-Based Design for Embedded Applications
  http://www.mathworks.com/automotive/technicalliterature.html

- Review the MBD literature

- Connect with others who have gone through the process before



Thank You!