Pragmatic Strategies for Adopting Model-Based Design for Embedded Applications

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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

Phase 1: Proof of Concept
- Initial Migration Plan

Phase 2: Execute & Refine
- Deploy Component
- Deploy Full Application

Phase 3: Optimize
- Deploy Enterprise-wide
- Initial MBD Process

Phase 4

Capability / Maturity

Time
Timing the Phased Approach

- **Plan**
  - Proof of Concept
  - Initial Migration Plan

- **Execute & Refine**
  - Deploy Component
  - Deploy Full Application

- **Optimize & Improve**
  - Deploy Enterprise-wide
  - Initial MBD Process

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**Phase 1**: 3-6 mo
**Phase 2**: 5-9 mo
**Phase 3**: 1-3 yr
**Phase 4**: continuous
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)

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

<table>
<thead>
<tr>
<th>Company</th>
<th>Application</th>
<th>Strategy</th>
<th>Result</th>
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| Astrium          | ![Astrium Logo](image)       | • 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 Logo](image)   | • Modeling, Early Verification, VHDL  
• Traditional Effort Comparison | • Project development time reduced by 80%:  
• SDR SP Devel 10:1  
• Overall time 4:1 |
| Honeywell        | ![Honeywell Logo](image)     | • Modeling, Early verification, code generation  
• Legacy Reuse       | • 5:1 improvement in productivity  
• Highly accurate, reusable code  
• A superior product |
| Lockheed Martin  | ![Lockheed Martin Logo](image) | • 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](http://www.mathworks.com/automotive/technicalliterature.html)

- Review the MBD literature

- Connect with others who have gone through the process before
Thank You!