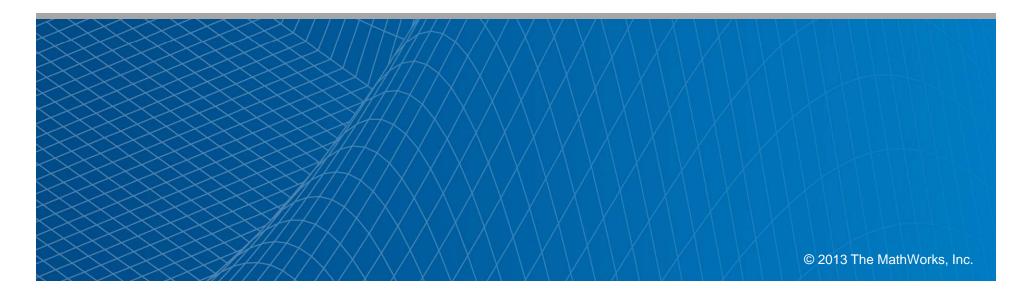
Model-Based Design for High Integrity Software Development

Mike Anthony Senior Application Engineer MathWorks Tucson, AZ USA





Model-Based Design for High Integrity Software Development Agenda

Development and V&V of the Model

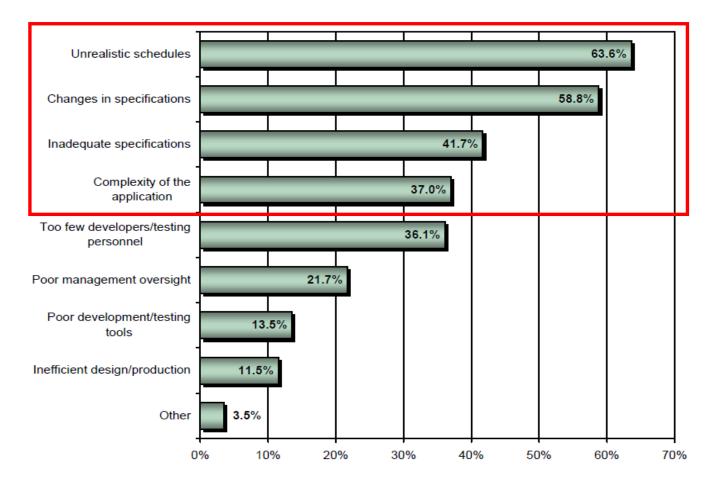
- Building a Model from Requirements
 - Introduction to Simulink
- Traceability of a Model to Requirements
 - Using the Requirements Management Interface
 - The Requirements Report
- Conformance to Modeling Standards
 - Using the Model Advisor
 - Customizing the Model Advisor
 - Model Advisor Report
- Verification of the Model against Requirements
 - Requirements-Based Testing & Report Generation
 - Formal Methods Verification

Development and V&V of the Code

- Production Code Generation
 - Creating Data Objects
 - Function Prototype Control
 - Traceability of the Generated Code to the Model
 - Code-to-Model Linking
 - Model-to-Code Linking
 - Traceability Report & Traceability Matrix
- Conformance to Coding Standards & Code Verification
 - PolySpace
 - MISRA-C Compliance
 - Proving the Absence of Runtime Errors
 - Verification of the Source Code
 - Automating Code Reviews with Simulink Code Inspector
- Verification of the Object Code
 - Test Case reuse
 - SIL/PIL Testing
 - Code Coverage



Why did we miss our deadline?

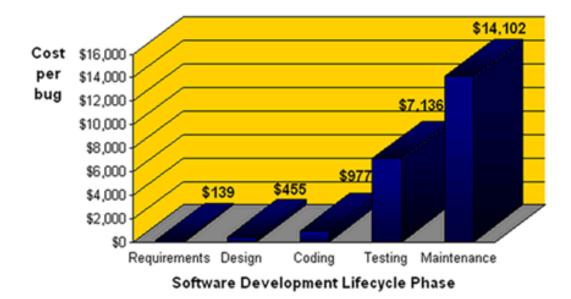


Reasons for late projects, as reported by Venture Development Corporation.

Source: Embedded Software Strategic Market Intelligence report, Volume 4, December 2007, VDC. Note: Percentages sum to over 100% due to multiple responses.



Minimize Costs by Detecting Errors Earlier



Source: B. Boehms and V. Basilli, "Software Defect Reduction Top 10 List", IEEE Computer

"...each delay in the detection and correction of a design problem makes it <u>an order of magnitude more</u> <u>expensive</u> to fix..."

Clive Maxfield and Kuhoo Goyal "EDA: Where Electronics Begins" TechBites Interactive, October 1, 2001 ISBN: 0971406308]



62% Cost Savings





Methods for Verification and Validation

Verification: Did I do the design right? Validation: Did I do the right design?

Traceability

- Requirements to model and code
- Model to code

Modeling and Coding Standards

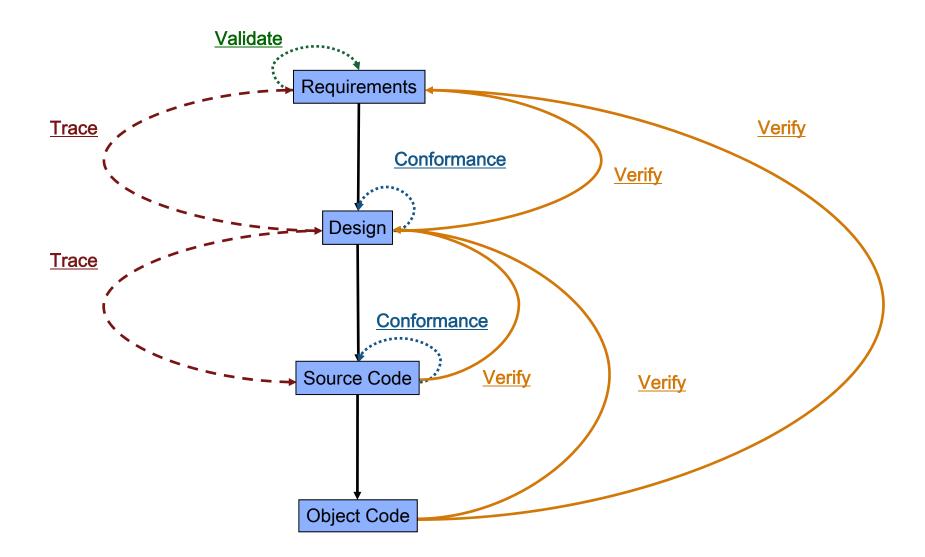
- Modeling standards checking
- Coding standards checking
- Testing
 - Model testing in simulation
 - Processor In the loop

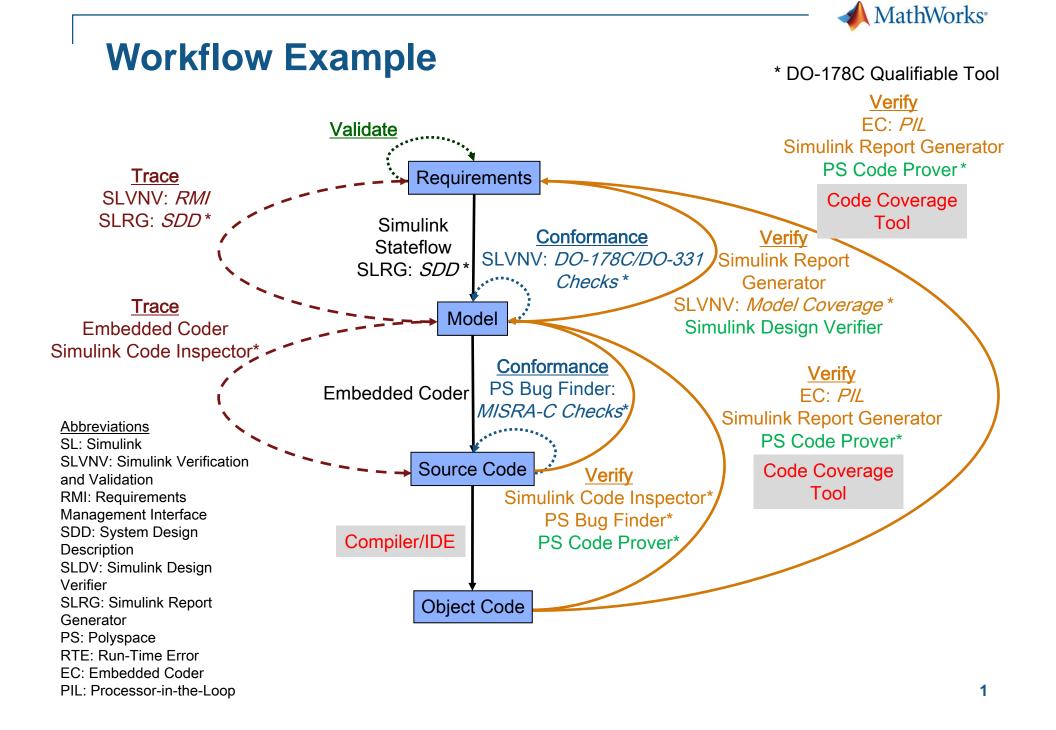
Proving

- Proving design properties
- Proving code correctness



Workflow Example







Model-Based Design Maturity

Modeling & Simulation Adoption

Requirements-Based V&V (requirements-based algorithm development and testing, requirements modeling)	Model Verification & Validation (simulation-based analysis of requirements)	System Verification & Validation (re-use of requirements-based tests and results comparisons between simulation and real time environmer	Fully-lev Model-B> (requir de ⁺ Jftware)
System Simulation (algorithm models and plant models)	System Modeling (closed-loop simulation of algorithms and plant models)	System Pr (real-tir sim	del-Based Development (real-time closed-loop system simulation with production algorithms on target hardware)
Algorithm Modeling (algorithm models, no plant models)	Design Mr (open-' of c'	sign Prototyping (real-time open-loop simulation of algorithms)	Model-Based Programming (automatic production code generation from algorithm models)
	Simulation	Real-Time Testing	Production

Code Generation Adoption



Septentrio Streamlines DO-178B Certification with MATLAB and Simulink

Challenge

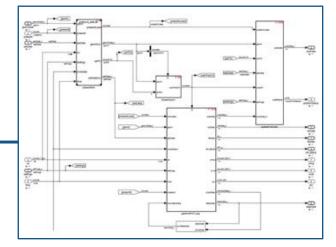
Obtain DO-178B certification for a GNSS-based landing system for precision aviation applications

Solution

Use Model-Based Design with MATLAB and Simulink to trace requirements, architect system components, simulate the design, and generate and verify source code

Results

- Design test cases reused on generated C source code
- Models verified via simulation, ensuring virtually bug-free code
- Key SOI-1 certification milestone achieved



Simulink model of part of the AiRx2 system.

"Model-Based Design enabled us to streamline the certification process by tracking requirements, verifying the design using simulation, and maintaining the system model as the single source of truth throughout development."

> Jan D'Espallier Septentrio

Link to article



Eurocopter Accelerates Development of DO-178B Certified Software with Model-Based Design

Challenge

Speed the development, validation, and verification of DO-178B certified helicopter flight software

Solution

Use Model-Based Design to model the system design and software design, and to generate flight code

Results

- Software testing time cut by two-thirds
- Requirements stabilized earlier
- Certified flight software automatically generated



The Eurocopter EC130 helicopter.

"We use our system design model in Simulink for ARP4754 to establish stable, objective requirements. We save time by using the model as the basis for our software design model for DO-178—from which we generate flight code—and reusing validation tests for software verification."

> Ronald Blanrue Eurocopter



Airbus Develops Fuel Management System for the A380 Using Model-Based Design

Challenge

Develop a controller for the Airbus A380 fuel management system

Solution

Use MATLAB, Simulink, and Stateflow for Model-Based Design to model and simulate the control logic, communicate the functional specification, and accelerate the development of simulators

Results

- Months of development time eliminated
- Models reused throughout development
- Additional complexity handled without staff increases



Airbus A380, the world's largest commercial aircraft.

"Model-Based Design gave us advanced visibility into the functional design of the system. We also completed requirements validation earlier than was previously possible and simulated multiple simultaneous component failures, so we know what will happen and have confidence that the control logic will manage it." Christopher Slack Airbus



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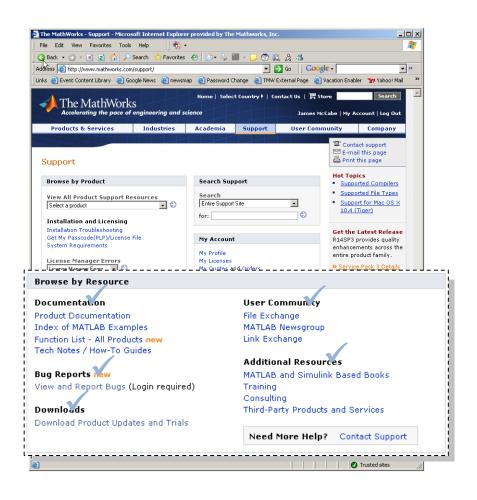
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