

MATLAB EXPO

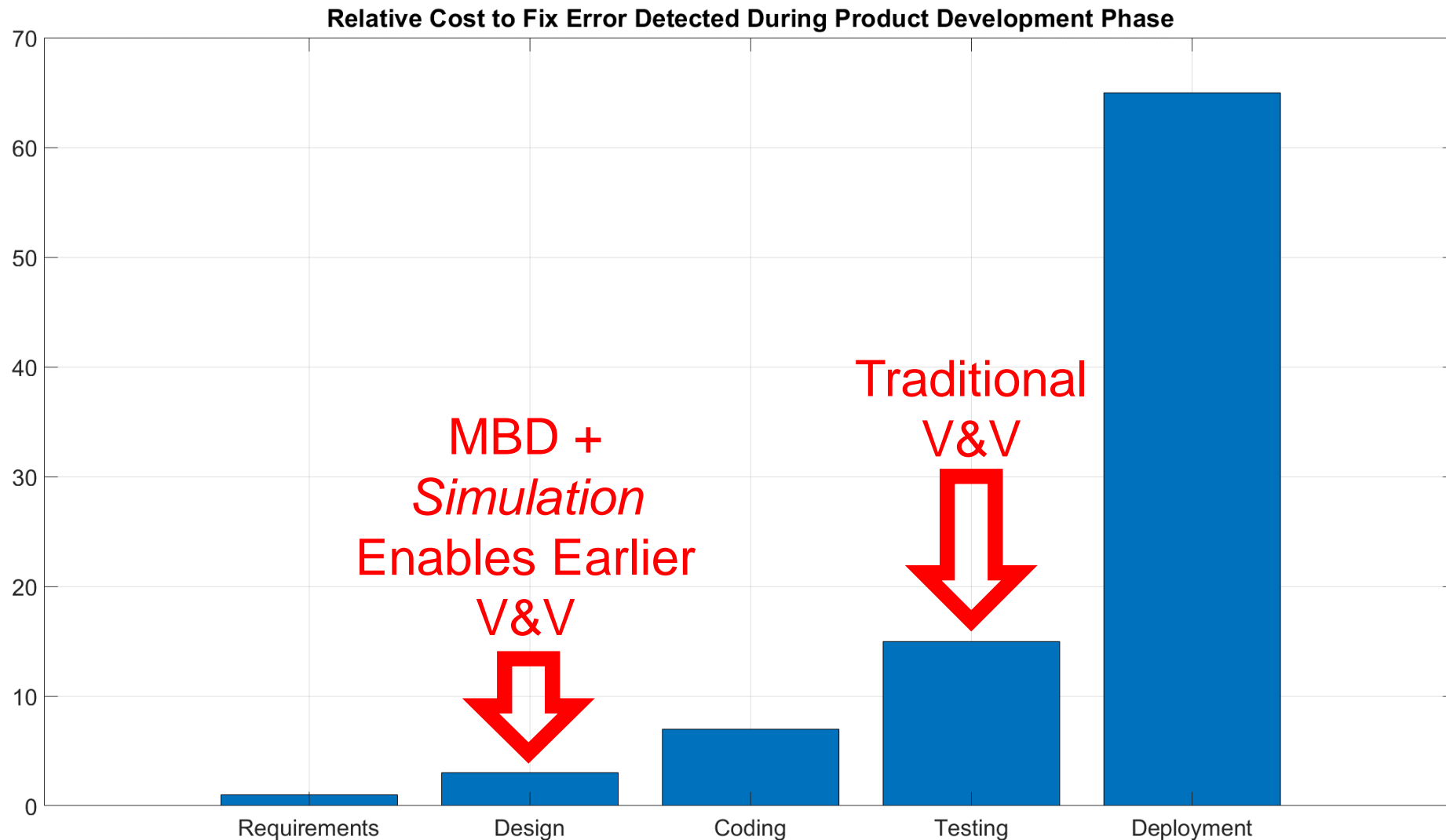
Formalizing Requirements and Generating Requirements-Based Test Cases

Dalton L'Heureux, MathWorks

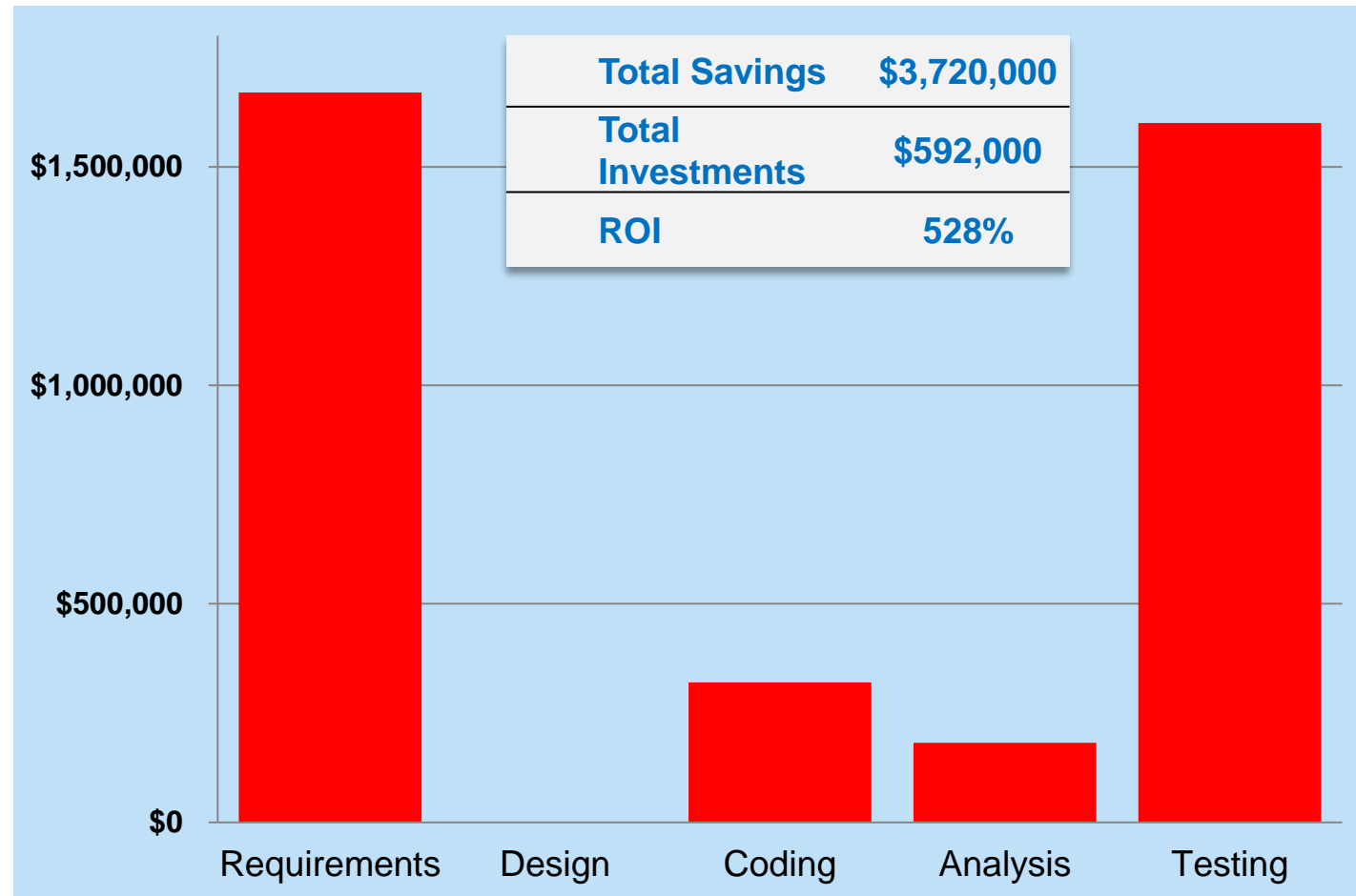


Why Model-Based ~~Design~~ Anything?

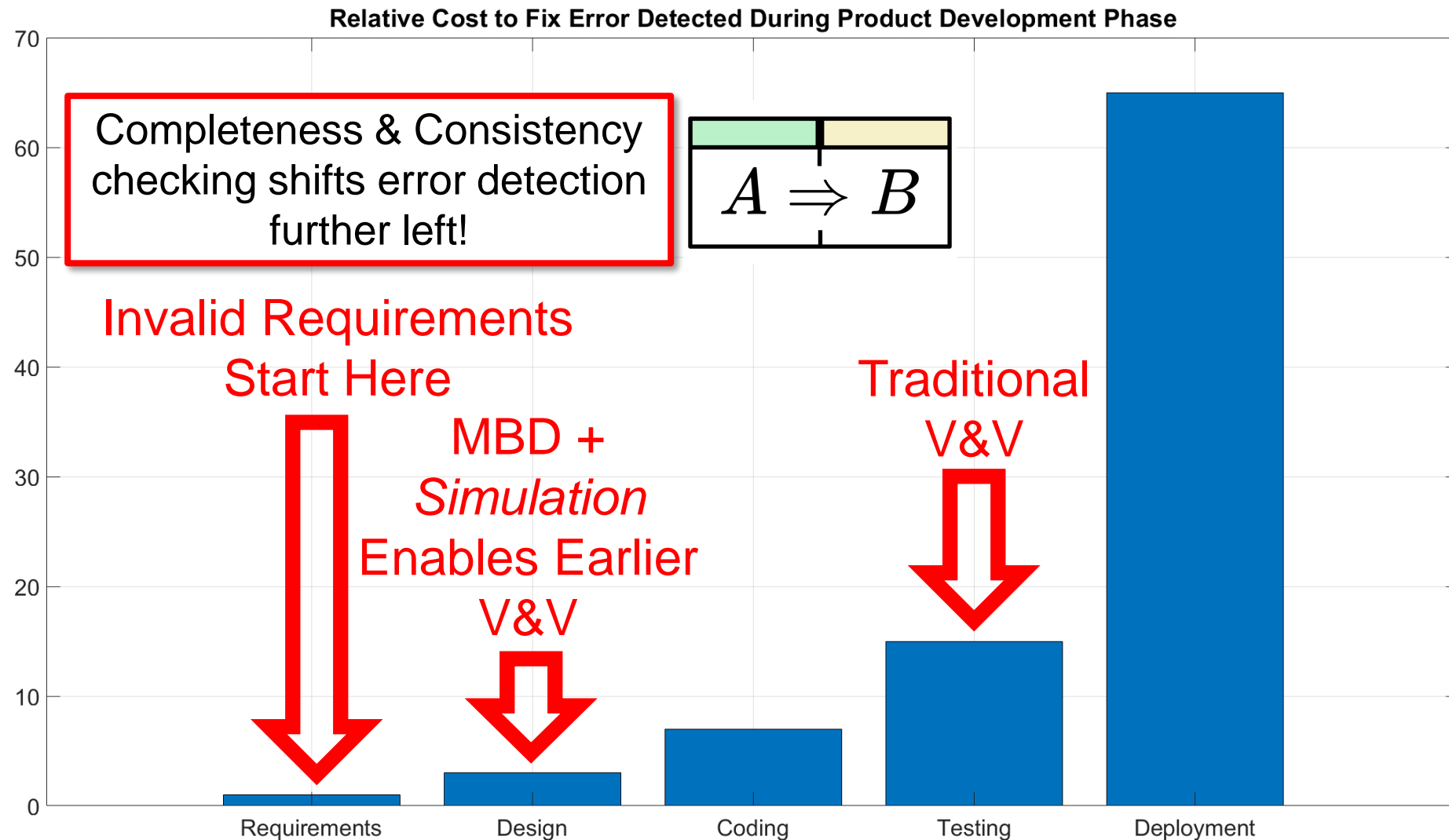
Model-Based Design: Detect Error Earlier to Minimize Costs



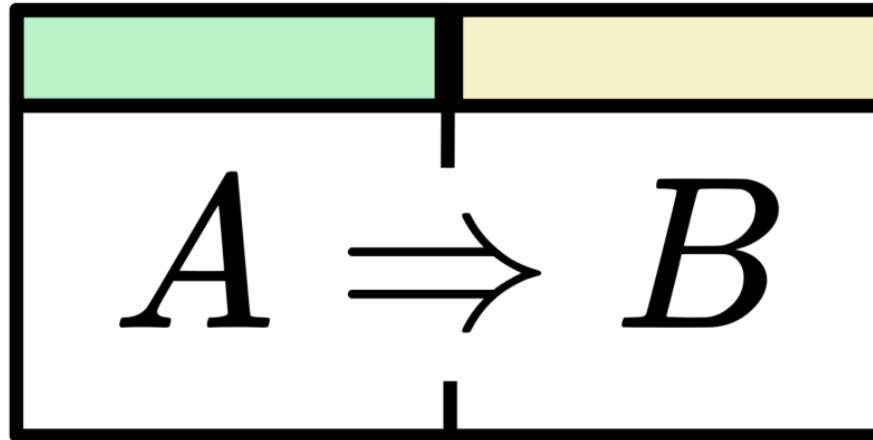
Model-Based Design ROI Calculation for Aerospace Applications



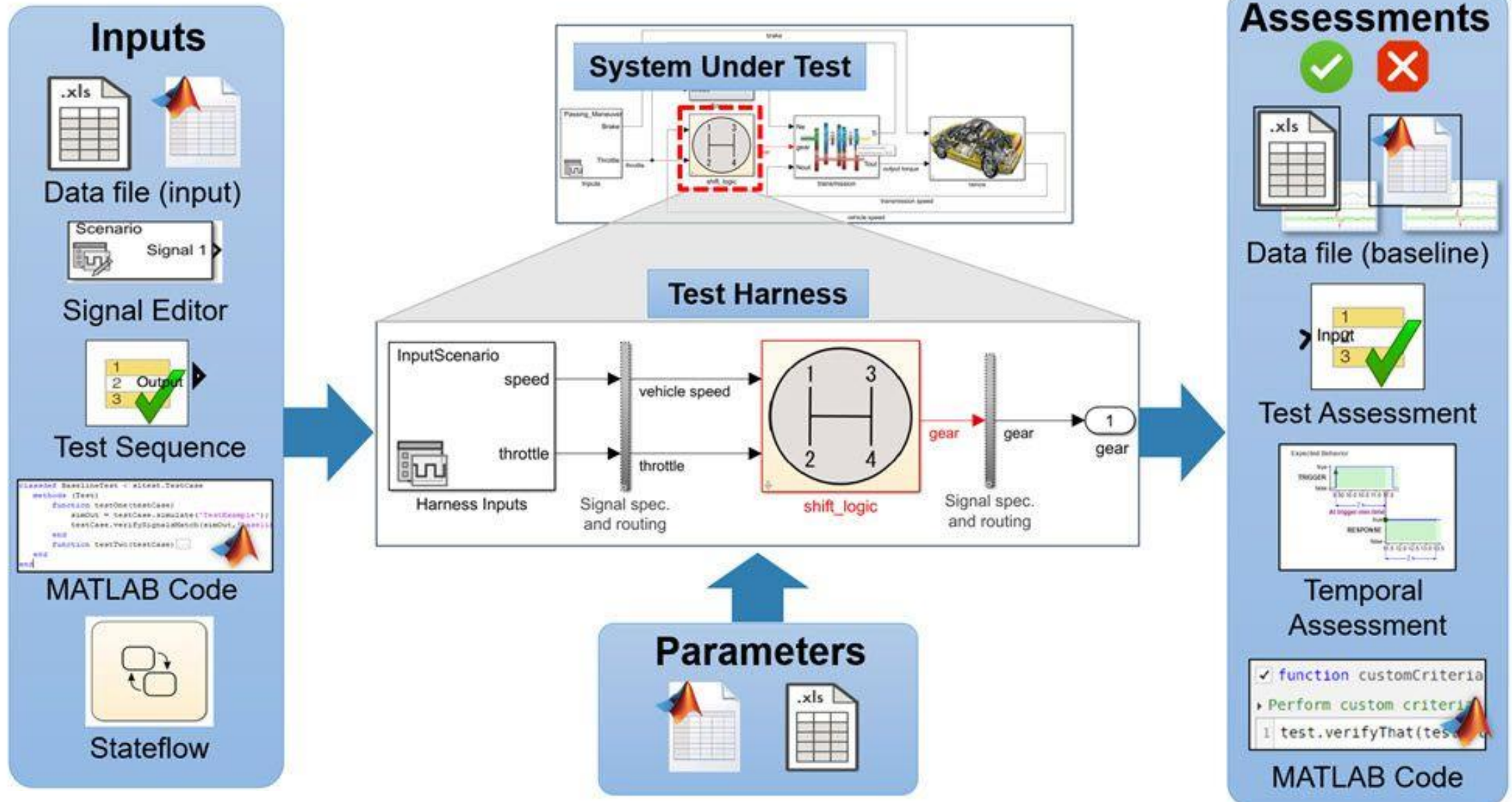
Can we Detect Errors Even Earlier?



Let's Look at an Example!



#1: Manually Author Tests with Simulink Test



#2: Generate Tests off Requirement Models Using Simulink Design Verifier Verifier Blocks

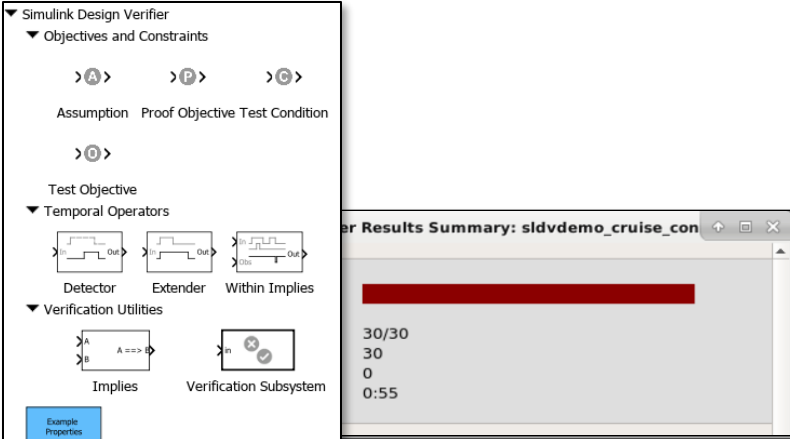
- Simulink Design Verifier can generate test cases that satisfy coverage objectives for your model, including Decision, Condition, MCDC, Relational Boundary, and Custom Objectives.

- Custom Objectives are modeled using the following constructs:

- [Test Objective](#) - Define values of a signal a test case must satisfy
- [Test Condition](#) - Constrain values of a signal
- [Verification Subsystem](#) - Conceals logic/objectives from analysis

- What do your test cases *ACTUALLY* mean?

- Structural Coverage Based Tests?
- Low-Level Requirements Based Tests used to test generated code?
- Requirements Based Tests generated from an *Independently* developed requirement model?
- Requirements Based Tests generated from a Design Model? What about with *Independently* defined expected outputs?



The screenshot shows the Simulink Design Verifier interface. On the left, a tree view lists 'Objectives and Constraints' with sub-items: Assumption, Proof Objective, Test Condition, Test Objective, Temporal Operators (Detector, Extender, Within Implies), and Verification Utilities (Implies, Verification Subsystem). Below this is an 'Example Properties' button. On the right, a 'Results Summary' window for 'slvdemo_cruise_con' displays a red progress bar and the following statistics:

30/30
30
0
0:55

Below the results summary is a table showing coverage percentages for various test types:

Decision		Condition		Test 1 MCDC		Statement		Function	
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
--	--	--	--	--	--	100%	100%	100%	100%
--	--	--	--	--	--	100%	100%	100%	100%

#3: Generate Tests off Requirement Models Using the Requirements Table Block

ModelLogicSpec ▶ Requirements Table

Requirements Assumptions

Index	Summary	Precondition			Duration	Postcondition
		getSimulationTime() == 0	getPrevious(Mode)			Mode
1		true				WaitForComms
2		false				
2.1			WaitForComms	GCSCmds.WIFconnected && ... GCSCmds.BTconnected		Init
2.2			Init	GCSCmds.CalibrateCmd		Calibration
2.3			Calibration	GCSCmds.GCS_MissionMode == uint8(1) && ... State.CalibrationDone		ReadyForTO
2.4						Calibration
2.5						TrackAlt
2.6						Track3D
2.7						LostBall
2.8						Land
2.9						LostBall

Inconsistent with requirement 2.7 for inputs:

Time	0-0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Step	1-3	4	5	6	7	8	9	10
GCSCmds.EMERGENCY_OFF	0	0	0	1	0	0	0	0
GCSCmds.WIFconnected	1	0	0	0	0	0	0	0
GCSCmds.BTconnected	1	0	0	0	0	0	0	0
GCSCmds.CalibrateCmd	0	0	0	0	1	0	0	0
GCSCmds.GCS_MissionMode	79	0	0	0	0	1	0	0
IsBall	0	0	0	0	0	0	1	0
State.CalibrationDone	1	0	0	0	0	1	0	0
State.V_BODY	[-0.00363 7.1509 0.54371]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]
State.Angles	[2.9851 -1.3752 -0.86424]	[-1 0 0]	[-1.3963 2.3963 0]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]	[0 0 0]
State.Altitude	-1.3077	0	0	0	0	0	0	0
State.BatteryVolts	2.5219	0	0	0	0	0	0	0

Additional Resources

Product Page:

- [Requirements Toolbox - MATLAB & Simulink \(mathworks.com\)](https://www.mathworks.com/products/requirements-toolbox.html)

Documentation:

- [Requirements Toolbox Documentation \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/)
- [Requirements Definition \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/requirements-definition.html)
- [Requirements Table Block \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/requirements-table-block.html)
 - [Use a Requirements Table Block to Create Formal Requirements \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/requirements-table-block-to-create-formal-requirements.html)

Examples:

- [Requirements Toolbox — Examples \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/requirements-toolbox-examples.html)
- [Formalize Requirements in Simulink Models — Examples \(mathworks.com\)](https://www.mathworks.com/help/requirements-toolbox/formalize-requirements-in-simulink-models-examples.html)

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Thank you



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