Using Model-Based Design to Design Real-Time Video Processing Systems

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Image Processing Applications

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The MathWorks
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MathWorks Aerospace and Defense Customers
Video and Image Processing Application Examples
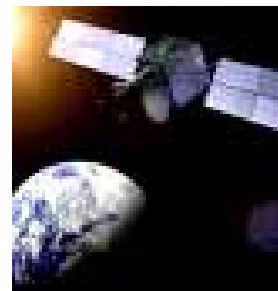
Autonomous Vehicles
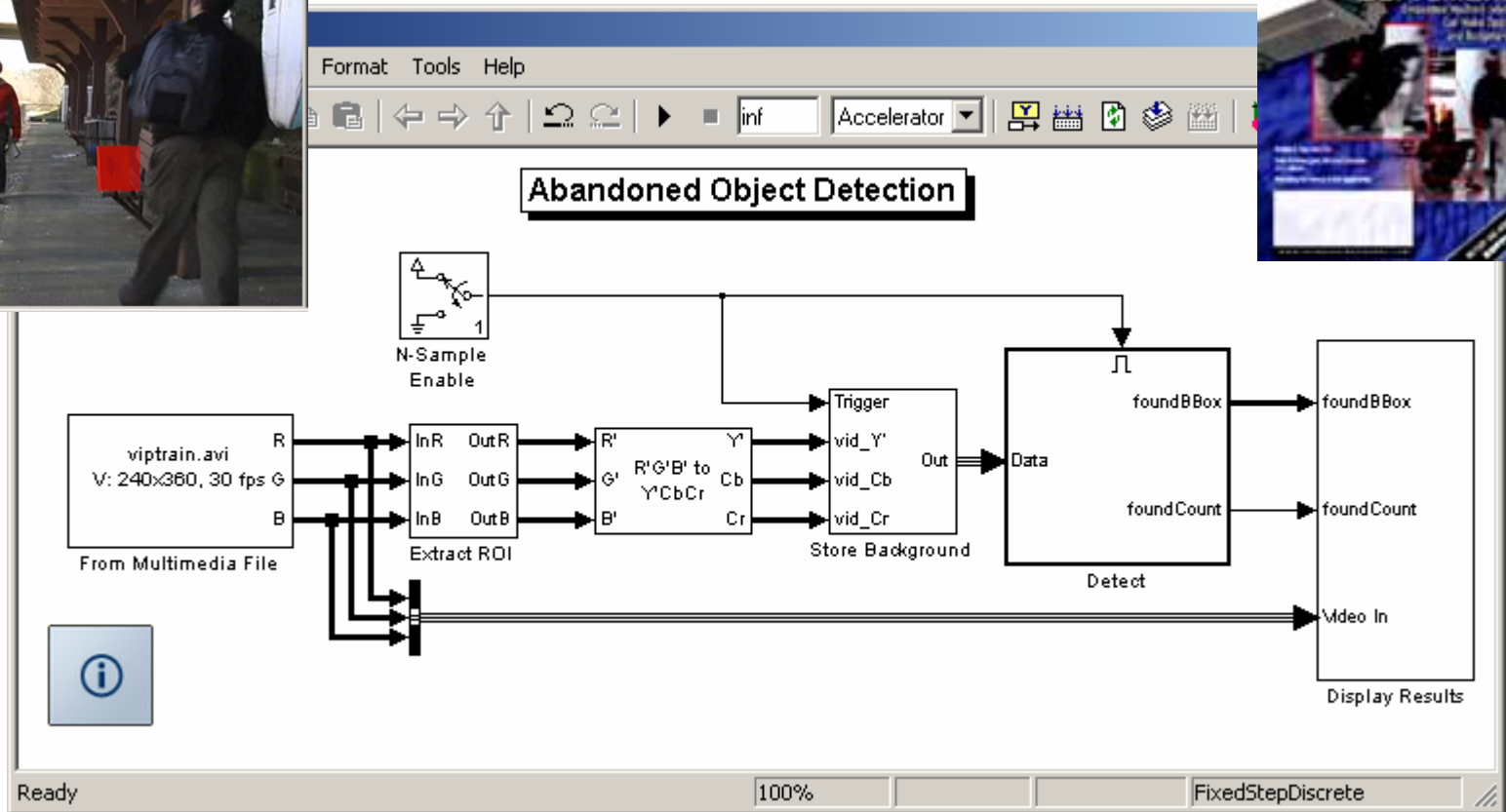
Night Vision

Targeting

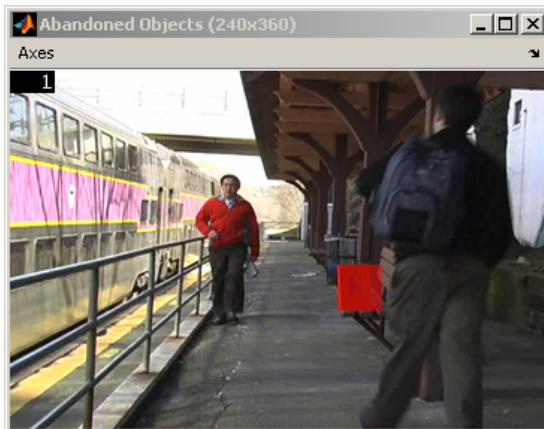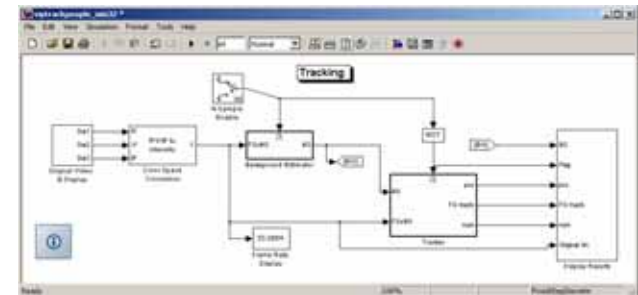Surveillance

FLIR

Heads-Up Display

Satellite

Border Security

Demo: Abandoned Object Detection

Embedded Video Design Challenges

- Extreme computation demands

- Embedded system resource constraints
    - Target hardware:
      DSP, FPGA (fixed-point)
    - Real-time requirements

- End-product focus on price,

  power, performance, and size

- Testing and validation of results

Model-Based Design with Simulink®

How is this useful for video?

- Implicit timing and concurrency
- Extensive algorithm library
- Fixed-point modeling
- C code generation
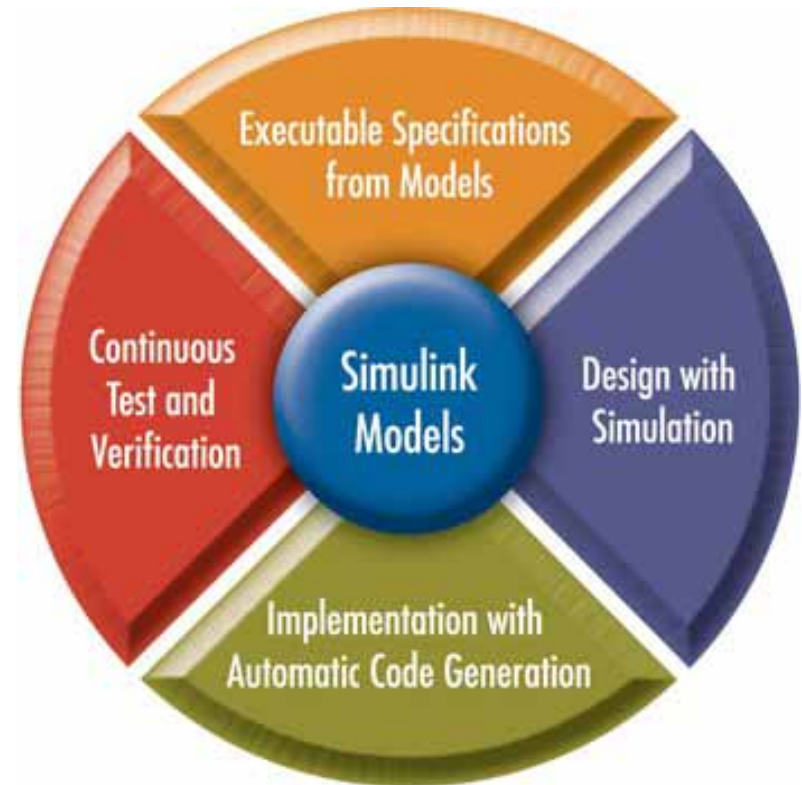
Video and Image Processing Blockset

Model, simulate, implement, and verify real-time video and imaging systems

- Includes more than 60 components and 100s of algorithms
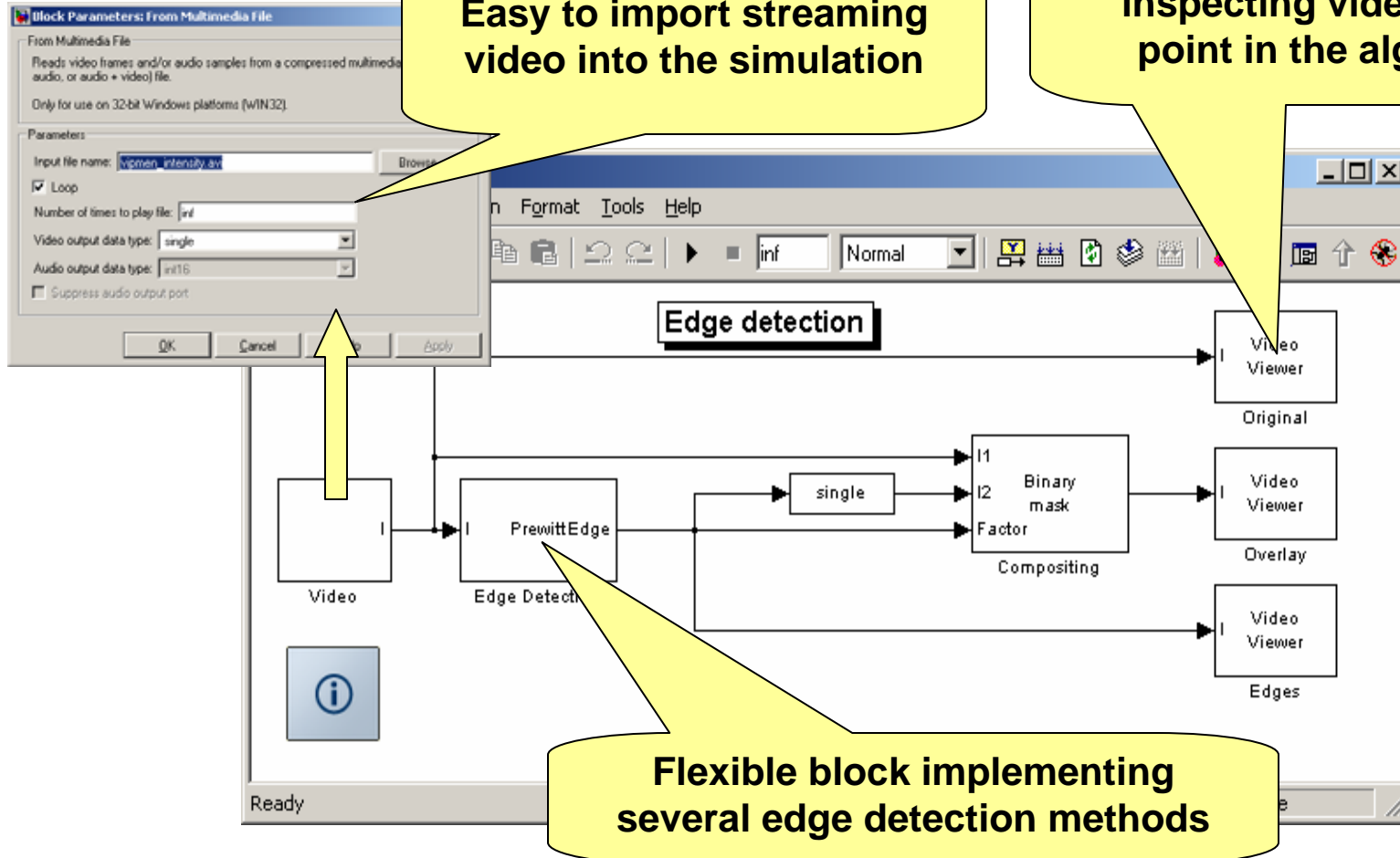
- Focused on implementation of embedded systems

Original Video   **Stabilized**

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Demo: Edge Detection

Easy to import streaming video into the simulation

Handy viewers for inspecting video at any point in the algorithm

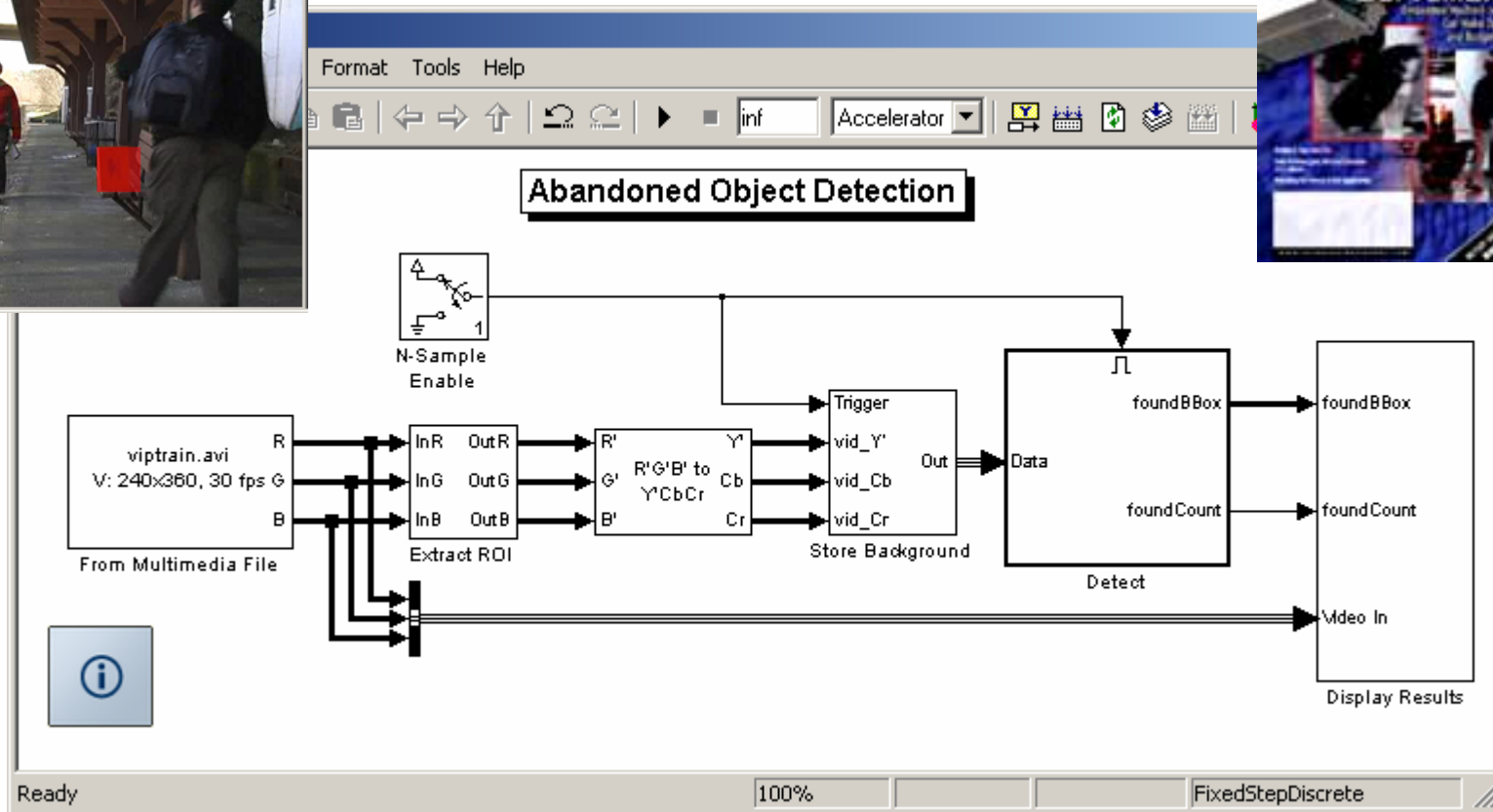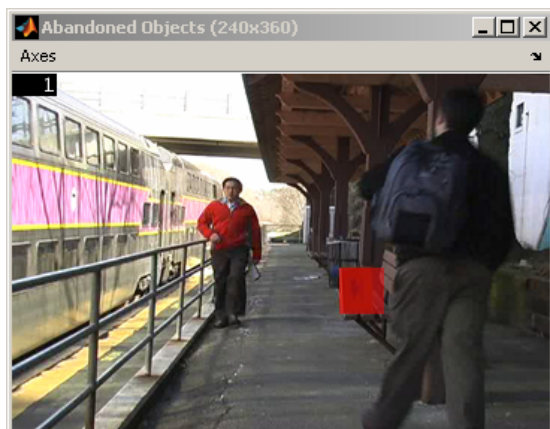**Flexible block implementing several edge detection methods**

Demo: Abandoned Object Detection

Fixed-Point Modeling*

- Avoid inaccurate results due to finite word effects

- Access tools built directly into block interfaces

- Easily change parameters to model the impact of rounding, overflow, and scaling

Requires Simulink® Fixed Point for integer and fixed-point data types
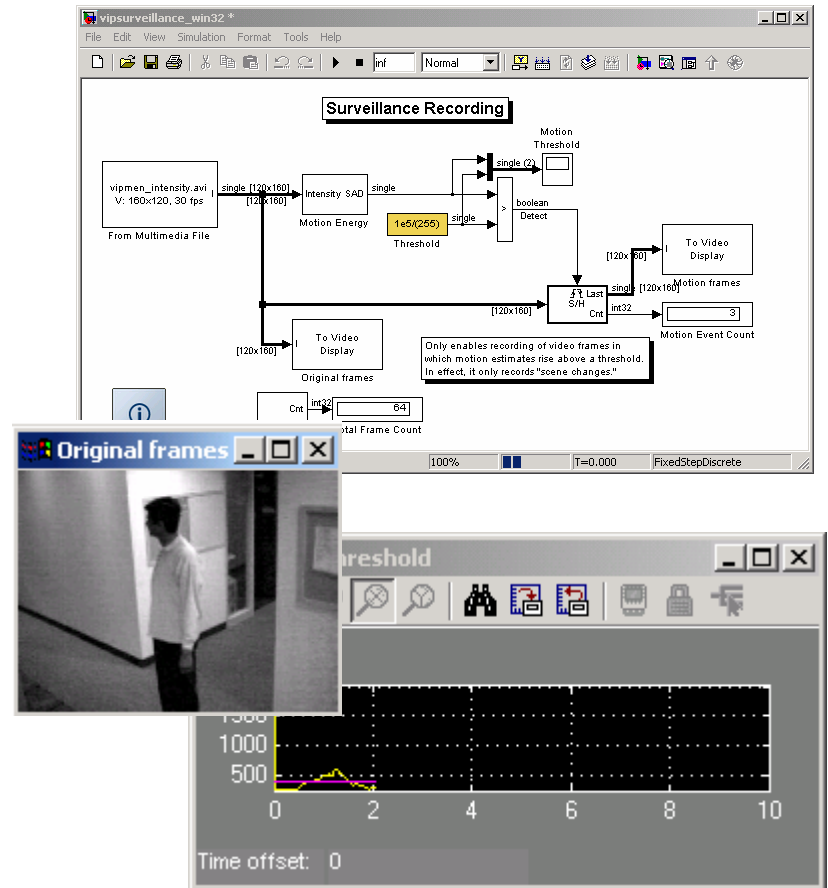
C-Code Generation

Breadth - Support for all embedded processors that support ANSI C

- Real-Time Workshop®
- Real-Time Workshop® Embedded Coder

Depth - Examples of processor specific enhancements

- Link for Code Composer Studio™
- Embedded Target for TI C6000™ DSP
- MathWorks Consulting
- Third-party products

TEXAS INSTRUMENTS

THE DSP COLLABORATIVE

ANALOG DEVICES

Link for Code Composer Studio™ and Embedded Target for TI C6000™ DSP

- Production code generation
  - Processor-specific, optimized code

- Project automation
  - Processor-specific, automatic
  - APIs for Code Composer Studio IDE, compiler, and linker

- Rapid prototyping
  - Target-specific and integrated
  - Simulink hardware blocks and device drivers (ADC, DAC, RTDX, daughter cards)

- Hardware Support
  - Development Boards: TI C6701 EVM, 6711 DSK, 6713 DSK, C6416DSK, and DM642 EVM
  - DSPs: TI DM64x, C64x, C62x, and C67x families

The Value of Model-Based Design
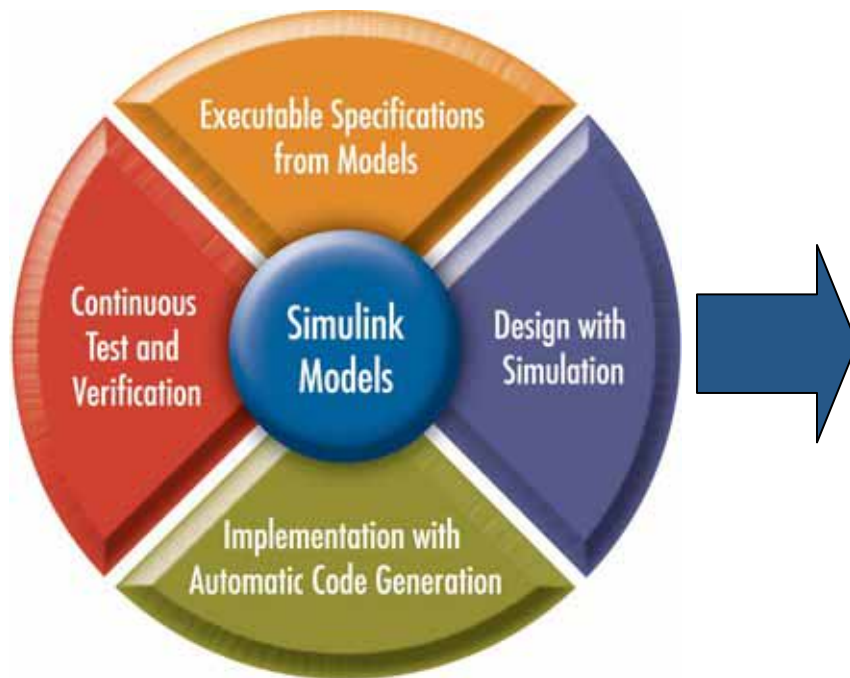
Innovation
- Rapid design iterations and "what-if" analyses

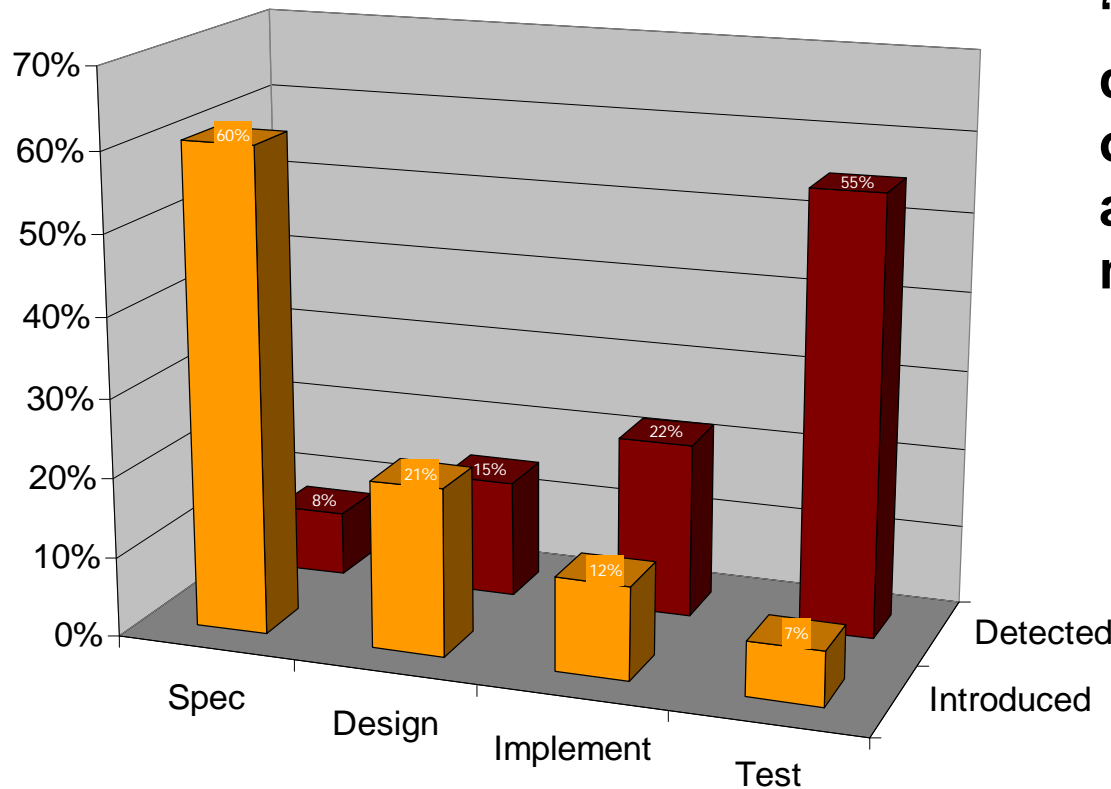**Quality**
- Reduced design errors

Cost
- Reduced expense from physical prototypes and re-work

Time-to-market
- Get the product right the first time

Where Errors Are Introduced … and Detected

"Each delay in the detection and correction of a design error makes it an order of magnitude more expensive to fix."

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

Source: "Migration from Simulation to Verification with ModelSim®" by Paul Yanik. *EDA Tech Forum*, 2004 Mar 11, Newton MA

User Story: Doheny Eye Institute Enables the Blind to See with MathWorks Products

Visor Prototype

The Challenge

To develop a retinal prosthetics proof-of-concept prototype that interfaces with a permanent micro-electronic retinal implant enabling the blind to see

The Solution

Use MathWorks products for Model-Based Design to model, simulate, and generate rapid prototype of prosthetic vision system

The Results

- Completed phase II of research project ahead of schedule
- Currently in trials with patients through Doheny Eye Institute at University of Southern California

"We are working on real-time image processing with the TI DM642 processor as the target. The Video and Image Processing Blockset makes the task of creating our design and working prototypes much simpler."

Dr. James Weiland
Director, Intraocular
Retinal Prosthesis Lab
Doheny Institute

Thank You