

Model Based Design Approach for Complex System Design 27-Apr-2017

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UTC CLIMATE CONTROLS & SECURITY

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UTC Climate, Controls & Security's fire safety, security, building automation, heating, ventilation, air conditioning and refrigeration systems and services promote safer, smarter and sustainable buildings.



56,475 Employees

\$16.9B Net sales

\$3.1B* Adjusted operating profit

Key Facts

Carrier's refrigerated containers carry more than \$6 billion worth of goods every day.

Since 2002, Kidde has donated more than 1 million smoke and carbon monoxide alarms to fire departments.

*Adjusted operating profit is a non-GAAP financial measure. For additional information regarding the use of this measure, the corresponding amount prepared in accordance with generally accepted accounting principles (GAAP) and a reconciliation of the differences between the non-GAAP and GAAP measure, please refer to page 71 in the UTC 2016 Annual Report.



UTC OTIS







Otis elevators, escalators and moving walkways keep people moving. As the world's leading installer and maintainer, we are committed to safety, performance and service.

Key Facts

67,396 Employees

\$11.9B Net sales

\$2.2B* Adjusted operating profit We introduced the world's first safety elevator to the market in 1853.

Our companies maintain 1.9 million elevators, escalators and moving walkways worldwide.

Otis is providing 670 elevators and escalators to the Hyderabad Metro in India, the largest elevator contract in the country's history.

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Reference - http://www.utc.com/Who-We-Are/Pages/At-A-Glance.aspx#otis



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HYDERABAD RESEARCH & DESIGN CENTER

United Technologies Announces Opening of New Hyderabad Research & Design Center >





















COMPLEX SYSTEM

Sample System Diagram for a Building Automation System



Reference – Automated Logic Corporation Website http://www.automatedlogic.com/pages/products.aspx



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Web Browser

WEBCTRL®



COMPLEX SYSTEM DESIGN

Main Challenges

- Complex interfaces **
- Prolonged Development time **
- Late Identification of Quality issues
- **Dynamic Behavior Simulation** •
- Lower Reliability **



The architecture of a complex system is a function of its components as well as the hierarchic relationships among these components.

Reference - http://www.webreference.com/programming/java/complexity/3.html

- Convoluted Impact of changes during iterations **
- Increased data matrices for development, testing **
- Changes in regulations, legal restrictions •••

COMPLEX SYSTEM DESIGN Main Challenges

Designs are becoming more complex 51% Early identification of system level 42% Lack of cross functional knowledge / overcoming silos of knowledge of 37% 32% 26% 0% 20% 40% 60% Percentage of Respondents, n = 146

Comparison of Best in Class and Others in using Simulation throughout the Design Phase

Multiple design criteria are analyzed simultaneously

"Real-life" design performance is analyzed during development with virtual prototypes

Existing analytical models used for simulating systems behavior

Simulation used to verify interactions between subsystems before building physical prototype

Best-in-Class All Other



Difficulty predicting system behavior until physical prototypes exist Constantly changing customer requirements

problems

expertise

All Respondents

MODEL BASED DESIGN

Benefits

- ✓ Use a common design environment
- \checkmark Link designs directly to requirements
- \checkmark Integrate testing with design
- Refine algorithms through multi-domain simulation
- Automatically generate embedded software code and documentation
- ✓ Develop and reuse test suites
- ✓ Accelerate time to market



MODEL BASED DESIGN Benefits

Entire Refrigeration Cycle can be simulated using tools and dynamic behavior can be virtualized to enhance product development



Changing customer expectations,

faster time to market and

increased regulations

Model Based Design is the way forward!







Hyderabad Research & Design Center

Thank you!