Engineering the “Internet of Things” Using Simulation

Dr. Larry Williams
Director of Product Management
The Internet Of Things Is Here!

Image Source: Outpost Orlando
IoT Is A Logical Evolution Of Product Design

IoT = SMART & CONNECTED PRODUCT

PHYSICAL PRODUCT

SMART PRODUCT
Imagine if you could experience a newly designed product before building it.
A Multi-physics Approach
How We Simulate
Computational Fluid Dynamics
Millions of Elemental Volumes
Simulation-Driven Product Development
HPC and Hardware

• High Performance Computing (HPC)
  • Increased productivity by leveraging modern compute technologies

Bigger
Faster
Higher Fidelity
ANSYS Enterprise Cloud
A Single-Tenant Simulation Platform on the Public Cloud

Company-Specific Isolated Cloud Resources (Virtual Private Cloud)

Anytime, Anywhere Web-Based Access
Grundfos Pumps – Industrial IoT

Automated design loop enables engineers to investigate hundreds of designs without manual intervention.

“The multiple physics simulation process reduced overall design time for the new pump design by 30 percent and saved approximately $400,000 in physical prototyping.”

Jacob Vernersen
Head of Mechanical Technology &
Nicholas Engen Pedersen
Chief Hydraulic Design Engineer
Grundfos

Pumps Account for 10% of World Electricity Consumption*

*Grundfos calculated estimate
Electric Motor Acoustic Noise Modeling

Predict and reduce electromagnetic induced vibration and noise from electric motor
Grundfos Industrial IoT Solutions

- Data security with solution hosted at Grundfos
- Monitoring of pump and system performance
- SMS text alarm messages
- Reduced onsite inspection
- Energy consumption monitoring
Smart Home
Smart Home Simulation

House CAD Model provided courtesy of Juliano Mologni, ESSS
Team Orange - UC Irvine “Casa del Sol” Solar Decathlon

Orange County Great Park
October 8-18
3D Mechanical CAD Drawing of Home
Main Control Unit (Hub) and Controlled Systems
Camera, Ceiling Lighting, HVAC Unit and Dampers
Human Model & Smart Watch ...
Device-Level Power Efficiency & Reliability

- **Power Efficiency**
  - Longer battery lifetime with RTL power reduction, tracking

- **Power Delivery**
  - Low-Power design enablement
  - Power delivery verification
  - ESD Protection validation

- **Power Reliability**

- **Thermal Management**
  - Cooling solution verification
  - Power/Thermal convergence
  - Thermal/Mechanical integrity

- **Structural Integrity**

- **Antennas and MEMS**
  - Gyroscope and accelerometer analysis
  - Stress, Resonance analysis

- **Thermal Management**
Smart Motion Detection & Surveillance Camera
Energy Control Unit

Triple Band Antenna

@ 900 MHz

@ 2.45 GHz

@ 5.8 GHz
Energy Control Unit + Light Bulb
Thermal Analysis of LED Light Bulb

- Temperature contour of the LED light bulb (external parts)
- Temperature contour of the LED heatsink and LED sources
- Orthotropic thermal conductivity map ($K_z$) of the PCB
  - left: top layer
  - right: bottom layer
Smart Home HVAC System with Sensing Actuator
ANSYS CFD Simulations Enable Virtual Energy Efficient Homes

Time = 0 sec
Occupant enters

Time = 0 sec
Actuator opens the duct damper

Time = 0.5 sec
Damper fully open, maximum flow of cold air

Iso-surfaces of Temperature at 55 F
Full Virtual Model of Zonal Cooling Controlled by IoT Devices
Smart Meter Reliable Antenna Performance

• Need to understand the interaction of dual-band antenna (2.4 GHz and 900 MHz) in smart meter
• Need to study the effects of PCB and RF shielding
HFSS Simulation

- PCB > effect of Simulating Power and ground plane true geometries

Current distribution for WLAN Antenna
Reliable Antenna Performance

• Proliferation of antennas in complex industrial environment create reliability issues.
• Shooting and Bouncing Ray simulation techniques can identify and help prevent these antenna ‘co-site’ issues.

Model and simulation results provided courtesy of Juliano Mologni, ESSS
Rays w/ 2 Reflection
Rays w/ 3 Reflection
Rays w/ 4 Reflection
Automotive
Autonomous Driving: Making radars and communications reliable
Smart Vehicles: Innovating electronics with simulation

Solving tough EMI problems upfront in the design cycle

Making touch screens robust and easier to operate
Connectivity While in Motion
RFID Example: Scattering near Toll Plaza
Astigmatism: Linked to Cornea Shape

The laser surgery « Arcuate keratotomy » consists of making small incisions in the cornea so that the cornea shape under eye pressure is the best possible (near-spherical cap)
Patient-Specific Planning With Finite Element Simulations
Optimeyes Software App

Harald Studer, Team Leader, Integrated Scientific Services AG, Biel, Switzerland
Process

1. Measure patient cornea geometry
2. Surgeon applies proposed cuts in OptimEyes
3. Launch simulation
4. Analyze predicted surgical outcome
GE Predix and Digital Twin
Transformational Journey to Digital Twin

As Is

Design Twin

Test Twin

Operating Twin

To Be

Design

Test

Operate

SIMULATION
IN THE CLOUD
High Speed Networking Equipment
Application of Simulation for High Speed Electronics

Signal Integrity
Power Integrity
EMI/EMC
Thermal
Vibration
Mechanical Stress
Extend Performance of DIMM Connector by Layout Modifications

- In successive generations, used same connector for 3Gbs single ended, 6.4Gbs, 9.6Gbs differential.

- Can same connector be used for 16Gbs differential?

DIMM Connector
Closing Comments

• Great products are designed using advanced engineering simulation

• IoT deployment benefits from new simulation opportunities

• It is possible to go beyond the traditional and try new ideas without ever building prototypes
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- **10,000+** Professors use ANSYS for research globally

**&**

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- **86,000+** Students are taught simulation using ANSYS products
UCI HyperXite Team Finished 5th in the second round of the SpaceX Hyperloop Pod Competition
Thank You