The *Transformative Fusion* of Sensing, Computing, Communication & Control

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Three Key Points

1. Technologies are fusing together to transform industries, companies, employment, and education.

2. This is happening now, in your work. Many industries, many applications, many markets.

3. MATLAB & Simulink form a technical foundation for this fusion and transformation.
Software update magically makes the Tesla Model S P85D even faster
Over-the-air update will knock 0.1 second off 0-60 time, says Musk
Road & Track 29 January 2015

Tesla Motors’ Over-the-Air Repairs Are the Way Forward
Tesla and GM have both issued fire-related recalls, but Tesla’s fix doesn’t require owners to bring their cars in.
MIT Technology Review 14 January 2014

Tesla Says It Will Now Be “Impossible To Run Out Of Range Unintentionally” In A Model S
techcrunch.com 19 March 2015
Google's solar-drone Internet tests about to go airborne
Project Titan gets FCC permission to begin testing

*Computerworld* 13 March 2015

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FACEBOOK LAYS OUT ITS ROADMAP FOR CREATING INTERNET-CONNECTED DRONES

*Wired* 23 September 2014
Amazon’s Drone Delivery Dreams Just Took a Step Closer to Reality

But don’t expect a drone on your doorstep anytime soon

Amazon’s hopes of delivering shipments to customers via drones got a little more real Thursday as federal regulators granted the company approval to test its unmanned aircraft.

The Federal Aviation Administration gave Amazon’s drones what’s called

time.com 19 March 2015

SpaceX launch illustrates NASA’s growing use of private companies

Cubesats explained and why you should build one

Cost Per Space Launch

SpaceX “Falcon 9” $1.66 million
Orbital Sciences “Antares” $274 million
NASA Space Shuttle $1.5 billion (up to)

Sources: NASA; Nature

Pew Research Center 14 April 2014

DIY Space Exploration website
Multiple Scientific Instruments for the Analysis of the Lower Thermosphere

- **INMS** (Ion/Neutral Mass Spectrometer)
- **FIPEX** (Flux Probe EXperiment)
- **mNLp** (multi Needle Langmuir Probe)

7th EUROPEAN CUBESAT SYMPOSIUM
Liège, Belgium
9 - 11 September 2015
www.cubesatsymposium.eu

9th QB50 WORKSHOP
Liège, Belgium
8 September 2015
(by invitation only)
An Apple car? Computer firm hires automotive engineers
Reports suggest Apple employees are designing and building a car

Ford Opens New Silicon Valley Research Center Led By Former Apple Engineer

Forbes 22 January 2015
Google testing drones that could provide Internet access to remote lands
Google plans tests in New Mexico using solar-powered unmanned aircraft.

Cubesats explained and why you should own one

SpaceX launch illustrates NASA’s growing use of private companies

Tesla press conf at 9am on Thurs. About to end range anxiety ... via OTA software update. Affects entire Model S fleet.

9:35 AM - 15 Mar 2015

Elon Musk
@elonmusk

Amazon unveils logistic plan: delivery by drone

Facebook lays out its roadmap for creating Internet-connected drones
Smartphones have 15 or more sensors!

Powerful, low-cost sensors and cameras
Unlimited computing power
Range of computing choices

- Custom ASIC
- Microcontroller
- FPGA
- Programmable SOC
- Microprocessor
4G and beyond

Evolution from 2G to 5G, Source: TU Dresden 2013a

- **2G – 1992**
  - Voice
  - Messages

- **3G – 2002**
  - Data
  - Positioning

- **4G – today**
  - Video Conferencing
  - 3D Graphics

- **5G – 2020**
  - Automation Control
  - Things 2.0
“We work with models from concept to implementation, and we have the automatically generated code flying in space.”

Ron Noteborn, OHB
Transformation happens when these combine
Transformation happens when these combine

“This is the highest award in the agricultural industry. Receiving it creates a positive perception of New Holland in the market.”

-- Karel Viaene, CNH System Engineer
Cars processing *video* in real time
“Traffic sign recognition in driver assistance systems- MATLAB at Continental”
Dr Alexander Behrens, Continental, MATLAB Expo, July 2014, Munich, Germany.

“MATLAB is used in daily work for development and evaluation of driver assistance functions”
“Engineers having good MATLAB programming skills are in high demand”

Machine Learning **done with**
Image Processing Toolbox
Signal Processing Toolbox
Statistics and Machine Learning Toolbox
Cars controlled with **video** and **radar**

**Coder Code Performance**

**Conclusions:**

- Reliable. Coder code has been used in production code for half a year and no bug is found;
- Efficient. This improved alignment algorithm with coder code can run as fast as previous old algorithm with hand code.
- Easy to integrate.
Advanced Driver Assistance Systems (ADAS)

from “Advanced Driver Assistance Systems Market” Continental AG, KSAE 2011
Automated Highway Systems

Dynamic platooning algorithm for intelligent cars
Transformation happens when these combine
Transformation happens when these combine
Wearables that detect cardiac arrhythmias

“The fixed-point test platform we built with MATLAB enabled us to conduct rigorous tests at every stage and automatically identify discrepancies in the results.”

-VivaQuant

The arrhythmia service uses an FDA 510k cleared Holter recorder to non-invasively record a 24-hour or longer three-lead ECG.
The AirSonea device connects to an asthma patient’s smartphone and communicates with wheeze analysis algorithms on iSonea’s server.

Mobile healthcare app with cloud-based analytics

“MATLAB enables us to rapidly develop, debug, and test sound-processing algorithms, and MATLAB Coder simplifies the process of implementing those algorithms in C.

There’s no other environment or programming language that we could use to produce similar results in the same amount of time.”

- iSonea
Thought-controlled prosthetics
Transformation happens when these combine
How Algorithms Have Changed the Face of Wall Street

JEFF DESJARDINS on June 19, 2014 at 5:42 pm

Inside Wall Street

Math nerds are taking over Wall Street

The Telegraph

Quants: the maths geniuses running Wall Street

Forget Gordon Gekko. Old-style City traders are being replaced by maths geniuses who use super-computers to beat the markets. But are ‘quants’ a force for good or evil?
Quite possibly the largest production integration of Matlab ever

- ~2400 Matlab events per day
- ~3000 CPU minutes of Matlab execution per day
- Excess of 1.5 GB of data captured or created per day
Data-Intensive Analytics

Machine Learning to detect customer churn

“No matter what industry our client is in, and no matter what data they ask us to analyze—text, audio, images, or video—MATLAB enables us to provide clear results faster.”

— Cognizant

Geographical modeling to predict losses

“MATLAB handles huge amounts of data, features highly sophisticated graphics, and ... interfaces for importing and exporting data into other applications, such as GIS, Excel, or text documents.”

— SwissRE

“MATLAB made it easy to clean, visualize, and analyze more than 500 gigabytes of data with no additional software or add-ons.”

— Cognizant
Rapid and reliable transmission of satellite data

“We built a communications system capable of 1200 Mbps.

“With Simulink, for the first time I can see past the noise effect and understand how distortion is affecting the link.

“Without those simulations it would be impossible for me to show management that the system is going to work.”

– Digital Globe
Big Data from the Internet of Things

- Fleet Analytics
- Sensor Analytics
- Vehicle Health Monitoring
- Financial Trading
- Asset Data Analytics
- Healthcare Predictive Analytics
Smart Emergency Response System
How Drones Are Helping Nepal Recover From The Earthquake

Situational awareness
Survivor location
Structural analysis
Supply delivery
Fire extinguishment

Drones for Disaster Response and Relief Operations
APRIL 2015
How will we design these multi-domain systems?
Human Machine Interface (HMI) Is Transformed

Primary Flight Display

Instrument Cluster

Heads-up Display

Center Stack

Images provided by DiSTI Corp. Reused with permission.
Images provided by Presagis Corp. Reused with permission.
Model-Based Design for HMI Development

Complete design modeled and tested with MATLAB, Simulink, and Stateflow
Design tools for wireless communications

NEW in R2015a
Antenna Toolbox

NEW releases in R2015a
Communications System Toolbox
LTE System Toolbox
Phased Array System Toolbox
How will we test and verify them?
Certification standards for safety & reliability . . .

DO-178

System design in Simulink

Simulink Verification and Validation to check compliance

Embedded Coder for C code for software verification

Eurocopter France Air Conditioning
Verify, Validate, and Document – Design Automation Track

ISO 26262

GM USA
Hybrid Powertrain

IEC 62304

Alstom France
Propulsion Control Systems

IEC 61508

Weinmann Medical DE
Transport ventilator

Alstom Grid UK
HDVC Power Systems

IEC-60880

MTU Germany
Nuclear Emergency Generators

... appearing across industries
Weichai Power: Fully-tested production ECU in 36 months

“Model-Based Design enabled us to reduce labor costs by 30%, cut testing costs by 20%, and increase productivity by more than 30%.”

- Weichai Power

Checked compliance with modeling standards

Linked textual requirements to the model to ensure traceability

Verified control design through closed-loop simulation

Generated test vectors to achieve complete model coverage

More than 340,000 effective lines of code for the production ECU
How will students prepare for transformative fusion?
By spending less time on HW/SW configuration ...
And more time on systems using Project-Based Learning...
Student projects of sensing, computing, communication, and control - in action
Student projects of sensing, computing, communication, and control - in action
Student projects of sensing, computing, communication, and control - in action

From Academia to Industry – Afternoon Plenary Talk

#1 (tied) Drone Formation Flying – University of Sydney
Demand for the T-shaped engineer...

...met with Project-Based Learning.
... in a world of distributed innovation.

“We’re moving to distributed innovation processes. The innovation going on in the rest of the world can probably overwhelm what companies can do internally.”

James Cash, Harvard Business School

WELCOME TO THE MAKER-INDUSTRIAL REVOLUTION

How GE, Local Motors, and an army of DIY inventors are rebuilding American manufacturing

*Popular Science, 15 January 2015*
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Next Steps

• Attend the talks and exhibits

• Talk to your colleagues – from MathWorks and other companies and academies

• Learn from each other, share best practices across industries and applications

• Use these tools and methods to transform your application and industry!