The *Transformative Fusion* of Sensing, Computing, Communication & Control
Three Key Points

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

2. This is happening now, in your work. If you understand and leverage this, you can surpass your goals.

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

Amazon's Drone Delivery Dreams Just Took a Step Closer to Reality

Alex Fitzpatrick @alexjamesfitz 4:43 PM ET

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
How India Achieved the Cheapest-Ever Interplanetary Mission to Mars

BY PAULA MEJIA 9/25/14 AT 2:10 PM

SpaceX launch illustrates NASA’s growing use of private companies

Cubesats explained and why you should build one

newsweek.com 26 September 2014

Cost Per Space Launch

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpaceX “Falcon 9”</td>
<td>$166 million</td>
</tr>
<tr>
<td>Orbital Sciences “Antares”</td>
<td>$274 million</td>
</tr>
<tr>
<td>NASA Space Shuttle</td>
<td>$1.5 billion (up to)</td>
</tr>
</tbody>
</table>

Sources: NASA; Nature

Pew Research Center 14 April 2014
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

*The Guardian* 13 February 2015

*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.

SpaceX launch illustrates NASA’s use of private companies

Cubesats explained and why you should build one

Tesla Motor Over-the-Air Reverse the Wayward

AMAZON UN MUNROIST PLAN: DELIVERY BY DRONE

Elon Musk @elonmusk
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
3,060 RETWEETS 3,411 FAVORITES
Powerful, low-cost sensors and cameras

Smartphones have **15** or more sensors!
Unlimited computing power
Range of computing choices

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

3G – 2002
- Data
- Positioning

4G – today
- Video Conferencing
- 3D Graphics

5G – 2020
- Automation Control
- Things 2.0

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

Technologies for Developing Smart Systems
- Designing MIMO-OFDM Wireless Communication Systems
  Dr. Amod Anandkumar, MathWorks

- Hybrid Concatenated Convolutional Code for Deep-Space Missions
  Dr. Deepak Mishra, Space Applications Centre, ISRO
“We navigated from launch to landing using GPS and inertial sensors, all on auto-generated code.”

Mark Jackson, Orion project engineer, Draper Labs

Model-Based Design
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
“Model-Based Design reduced development time by about two engineer-years compared with hand-coding.”

– Reutech

Model-Based Design approaches:
separate models in Simulink
HDL Coder for FPGA implementation
Fixed-Point Designer to convert floating-point design

Multi-purpose radar built with an FPGA

The RSR 210N multipurpose 2D radar system.

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

from “Advanced Driver Assistance Systems Market”
Continental AG, KSAE 2011
Cooperating assistance systems - AHS

Dynamic platooning algorithm for intelligent cars

École Polytechnique Fédérale de Lausanne
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.
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

The AirSonea device connects to an asthma patient’s smartphone and communicates with wheeze analysis algorithms on iSonea’s server.
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

Matthew Lynn
Mega mergers have been consigned to history – as they should be

Roger Bootle
Three big challenges could uproot economic success

Jeremy Warner
Austria is fast becoming Europe's latest debt nightmare

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?
A Technology Platform with a MATLAB® Backbone:
A Financial Engineering True Story

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
Machine Learning to Reduce Customer Churn

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

“MATLAB is one of the differentiators for us on client engagements. 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
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
- Asset Data Analytics
- Healthcare Predictive Analytics

- Control
- Communication
- Computing
- Sensing
Smart Emergency Response System
How will we design these multi-domain systems?
Human Machine Interface (HMI) Is Transformed

Primary Flight Display

Instrument Cluster

Heads-up Display

Center Stack
Model-Based Design for HMI Development

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

**NEW in R2015a**
- Antenna Toolbox
- Zynq - Software-Defined Radio support

**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
appearing across industries

IEC 62304
GM USA
Hybrid Powertrain

ISO 26262

IEC 61508
Weinmann Medical DE
Transport ventilator

IEC 60880

EN-50128
Alstom France
Propulsion Control Systems

Alstom Grid UK
HDVC Power Systems

MTU Germany
Nuclear Emergency Generators
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

NEW in R2015a
Robotic System Toolbox
Student projects of sensing, computing, communication, and control - in action
Student projects of sensing, computing, communication, and control - in action
Demand for the T-shaped engineer...

Broad knowledge

Deep knowledge

...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 General Electric, Local Motors, and an army of DIY inventors are rebuilding American manufacturing

Popular Science, 15 January 2015
Three Key Points

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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!