

# Scrum4Life: *A Tale of 2 Journeys*

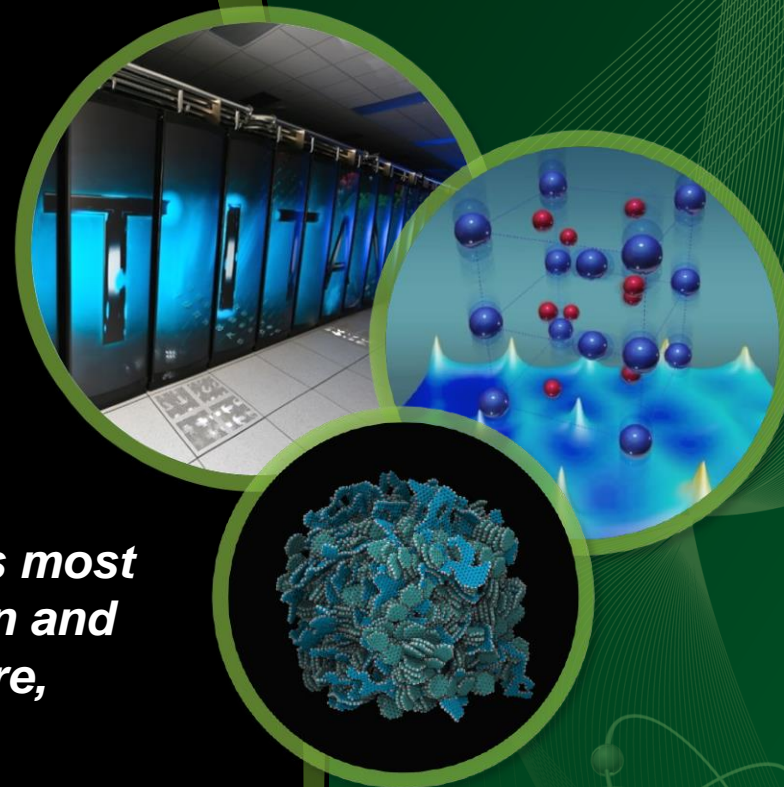
**Mark A. Buckner, PhD**  
Power & Energy Systems Group Leader  
[bucknerma@ornl.gov](mailto:bucknerma@ornl.gov)

**FIRST Robotics Mentor**  
**FRC Team 4265 Secret City Wildbots**

***P&ES Mission: Provide innovative solutions to the nation's most challenging energy problems, accelerating the investigation and transition of science into practice for a cost-effective, secure, resilient, and sustainable electric grid of the future.***


***FRC4265 Mission: To inspire the next generation of STEM leaders and innovators by building a world class FIRST Robotics program, integrating a K-12 curriculum within our community, and creating a sustainable program through partnerships in our region.***

ORNL is managed by UT-Battelle  
for the US Department of Energy



*“Passionately Pursuing  
Perfection ... Catching  
Excellence!”*



A glowing heart shape is the central focus, surrounded by intense orange and yellow flames. The background is dark with swirling, ethereal patterns in shades of blue and purple, suggesting a storm or a magical atmosphere.

*“Light yourself on  
fire with passion and  
people will come  
from miles to watch  
you burn...”*

“Creativity is thinking up new things. Innovation is doing new things.”

Theodore Levitt



# Everything is a Remix

Part 3: The Elements of Creativity  
& Innovation

TED Q:A

“

We're all copying and transforming and combining...  
you can't get something from nothing, you can't just  
summon it out of the air.



# Oak Ridge National Laboratory is uniquely positioned to deliver science and technology for energy

## Ability to leverage an extraordinary set of assets:

- Outstanding materials R&D tools
- Nation's most powerful system for open scientific computing
- The nation's broadest portfolio of energy programs
- Unique resources for nuclear technology
- Robust national security programs

## Our mission is to ....

Deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security, and in doing so create economic opportunity for the nation.



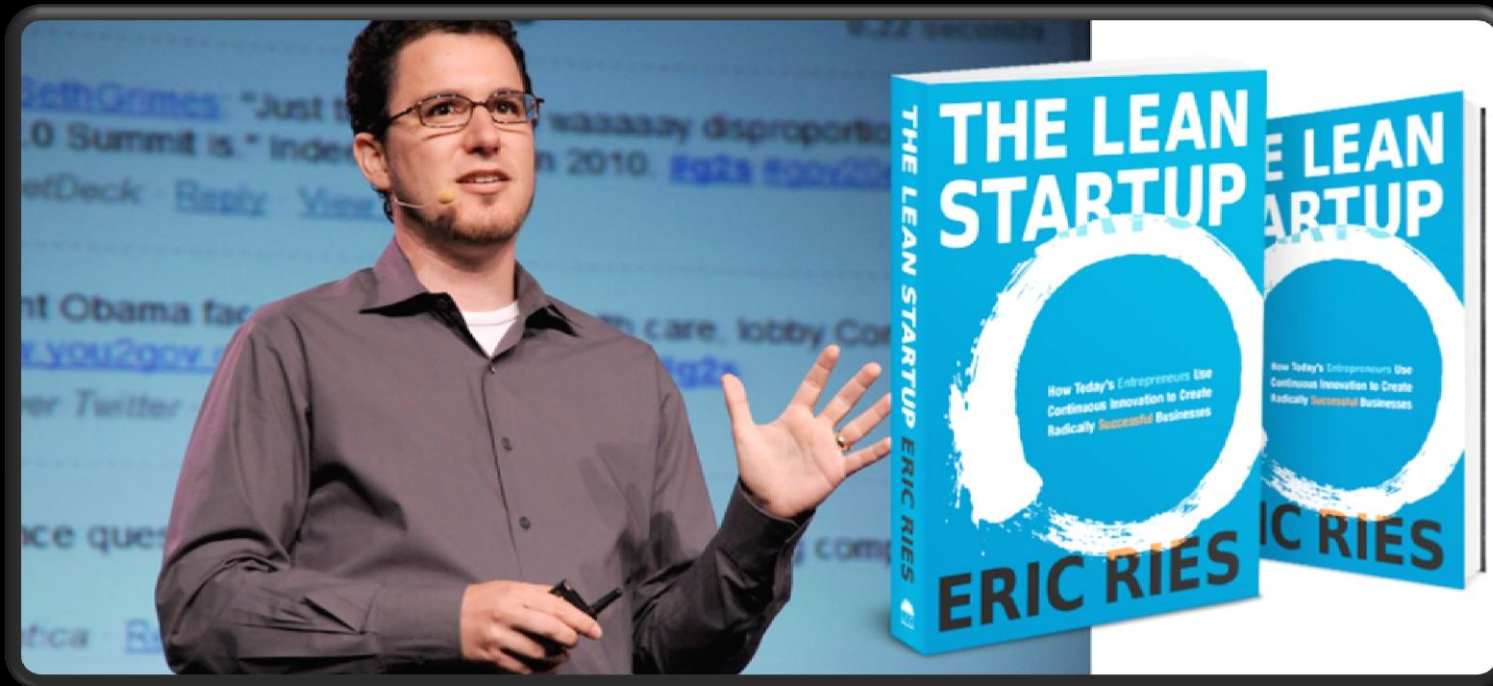
# A little about me...

- @ORNL 29 years
- Group Leader, Power and Energy Systems
- 11<sup>th</sup> career
- Certified Scrum Master
- Certified Scrum Product Owner
- Certified Scrum in Hardware Trainer
- Certified LabVIEW Associate Developer
- FIRST Mentor & Regional Woodie Flowers Recipient
- Adjunct: University of Tennessee, Roane State Community College, Oak Ridge High School



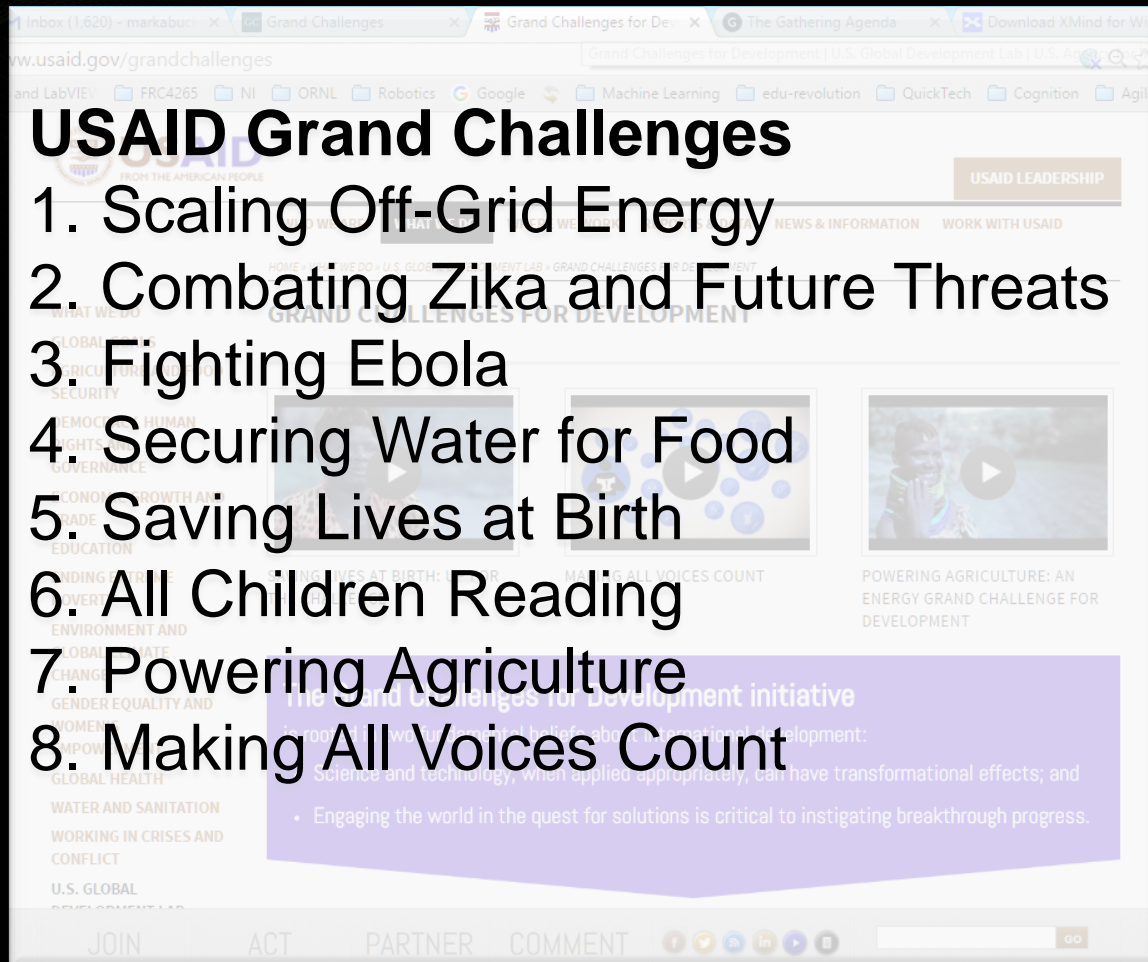


“A startup is a **human institution** designed to create **a new product or service** under conditions of **extreme uncertainty**.”



Eric Ries

# The Big Hairy Audacious Problems (BHAP) facing the world require high performing cross-functional teams...



The screenshot shows the USAID Grand Challenges website. The header includes the USAID logo and navigation links. The main content area features a list of eight grand challenges, each with a corresponding image and a brief description. The challenges are: 1. Scaling Off-Grid Energy, 2. Combating Zika and Future Threats, 3. Fighting Ebola, 4. Securing Water for Food, 5. Saving Lives at Birth, 6. All Children Reading, 7. Powering Agriculture, and 8. Making All Voices Count. The website also includes a sidebar with various topics and a footer with social media links.

**USAID Grand Challenges**

1. Scaling Off-Grid Energy
2. Combating Zika and Future Threats
3. Fighting Ebola
4. Securing Water for Food
5. Saving Lives at Birth
6. All Children Reading
7. Powering Agriculture
8. Making All Voices Count

<https://www.usaid.gov/grandchallenges>



The screenshot shows the 21st Century Grand Challenges website. The header includes the White House logo and navigation links. The main content area features a list of four grand challenges, each with a corresponding image and a brief description. The challenges are: 1. NIH, DARPA, and NSF's BRAIN Initiative, 2. DOE's EV Everywhere Grand Challenge, 3. NASA's Asteroid Grand Challenge, and 4. A fourth challenge partially visible. The website also includes a sidebar with various topics and a footer with social media links.

**21<sup>st</sup> Century Grand Challenges**

NIH, DARPA, and NSF's BRAIN Initiative

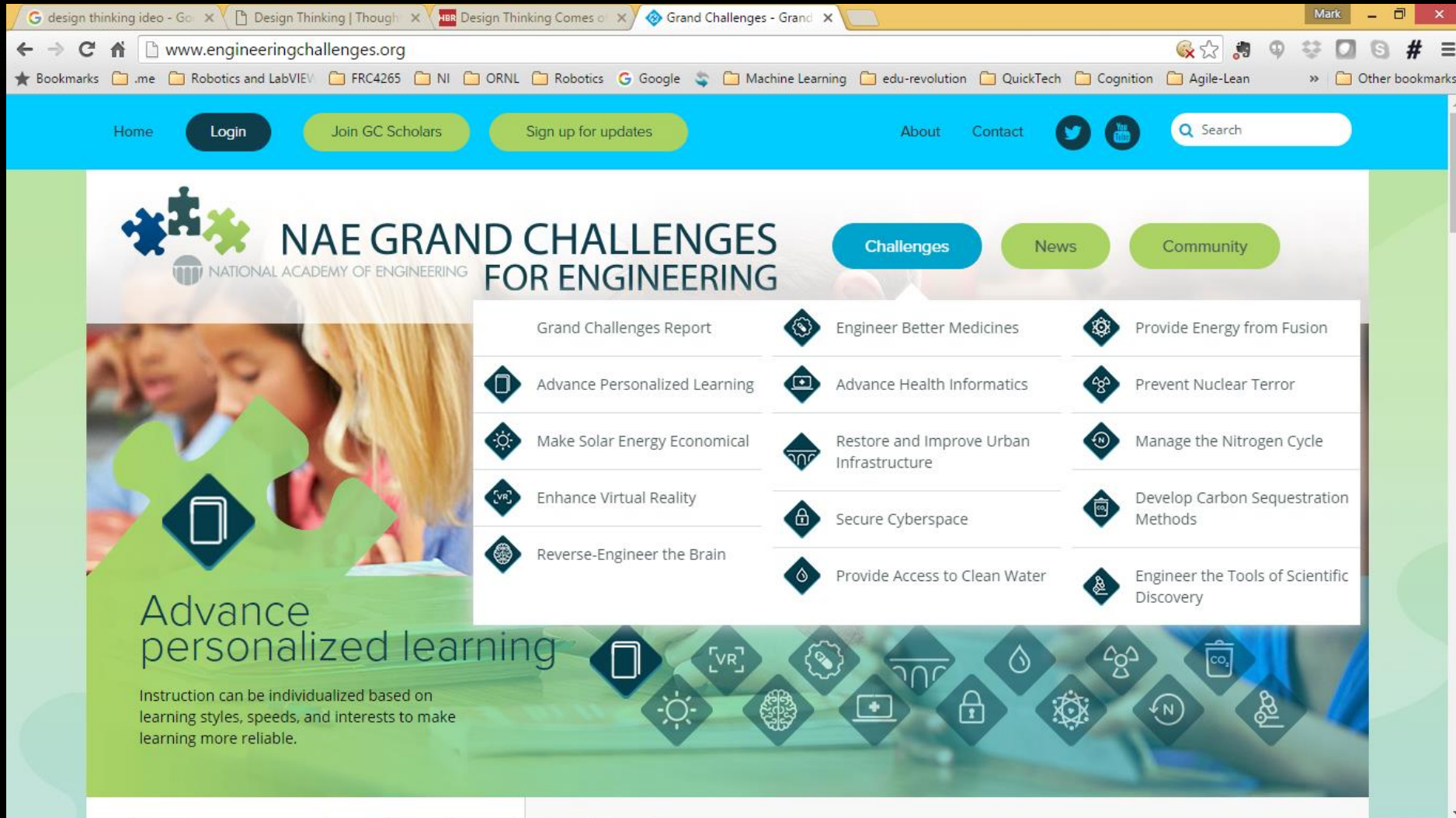
DOE's EV Everywhere Grand Challenge

NASA's Asteroid Grand Challenge

<https://www.whitehouse.gov/administration/eop/ostp/grand-challenges>



# The Big Hairy Audacious Problems (BHAP) facing the world require high performing cross-functional teams...



The screenshot shows the homepage of the NAE Grand Challenges for Engineering website. The browser's address bar displays [www.engineeringchallenges.org](http://www.engineeringchallenges.org). The website features a blue header with navigation links: Home, Login, Join GC Scholars, Sign up for updates, About, and Contact. A search bar is also present. The main content area is titled "NAE GRAND CHALLENGES FOR ENGINEERING" and includes a "Challenges" button. Below this, a grid of 15 challenges is displayed, each with a unique icon and a brief description. The challenges are: Grand Challenges Report, Engineer Better Medicines, Provide Energy from Fusion, Advance Personalized Learning, Advance Health Informatics, Prevent Nuclear Terror, Make Solar Energy Economical, Restore and Improve Urban Infrastructure, Manage the Nitrogen Cycle, Enhance Virtual Reality, Develop Carbon Sequestration Methods, Reverse-Engineer the Brain, Secure Cyberspace, Provide Access to Clean Water, and Engineer the Tools of Scientific Discovery. A large green gear icon is overlaid on the left side of the page, with the text "Advance personalized learning" and a subtext: "Instruction can be individualized based on learning styles, speeds, and interests to make learning more reliable."

Challenge	Icon
Grand Challenges Report	Report icon
Engineer Better Medicines	Medical icon
Provide Energy from Fusion	Fusion icon
Advance Personalized Learning	Learning icon
Advance Health Informatics	Health icon
Prevent Nuclear Terror	Nuclear icon
Make Solar Energy Economical	Solar icon
Restore and Improve Urban Infrastructure	Infrastructure icon
Manage the Nitrogen Cycle	Nitrogen icon
Enhance Virtual Reality	VR icon
Develop Carbon Sequestration Methods	Carbon icon
Reverse-Engineer the Brain	Brain icon
Secure Cyberspace	Cyber icon
Provide Access to Clean Water	Water icon
Engineer the Tools of Scientific Discovery	Discovery icon

<http://www.engineeringchallenges.org/>

# ORNL Power & Energy Systems Team

- Ben Dean, Bianca Hinojosa, me, Ishita Ray, Drew Herron, Dan King, Phil Irminger, Stan Hadley, Daniel Merced, Max Ferrari, Bailu Xiao, Mitch Smith, Samantha Jamerson, Raymond Borges, Nevin Sawyer, Graham Pash, Michael Starke, Ben Ollis, Travis Smith, Isabelle Snyder, Lakshmi Sundaresh





# Challenge #1 ... we live in a Stage 3 Tribal Culture

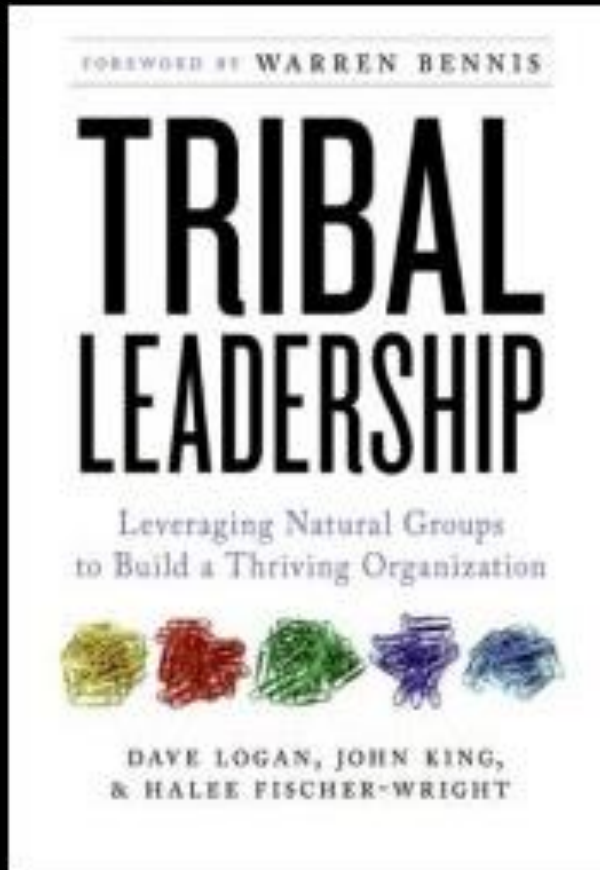
***“I’m Great”***

*(and you’re not)*

**Stage 3**

*Personal achievement dominates*

- 49% of Workplace Tribes
- “Lone warriors”
- Focus on personal achievement
- Individuals win by out working & outthinking the competition
- Hoard information as a strategy to stay on top.
- Need to be the best ... at other’s expense



## Challenge #2 ... our “customers” require/expect waterfall effort and reporting

- Expectation: a dedicated team built for each project vs bringing projects to high performing teams
  - Single PI/lead with a captive team
  - Lots of small projects
- Detailed Project Plans/WBS
- Pre-defined Milestones/Deliverables
- Steady burn-rates

*Compounded: >10  
PI's and >15  
projects*

“Demands” undue task-switching to keep all projects moving forward to have something to report each month/quarter

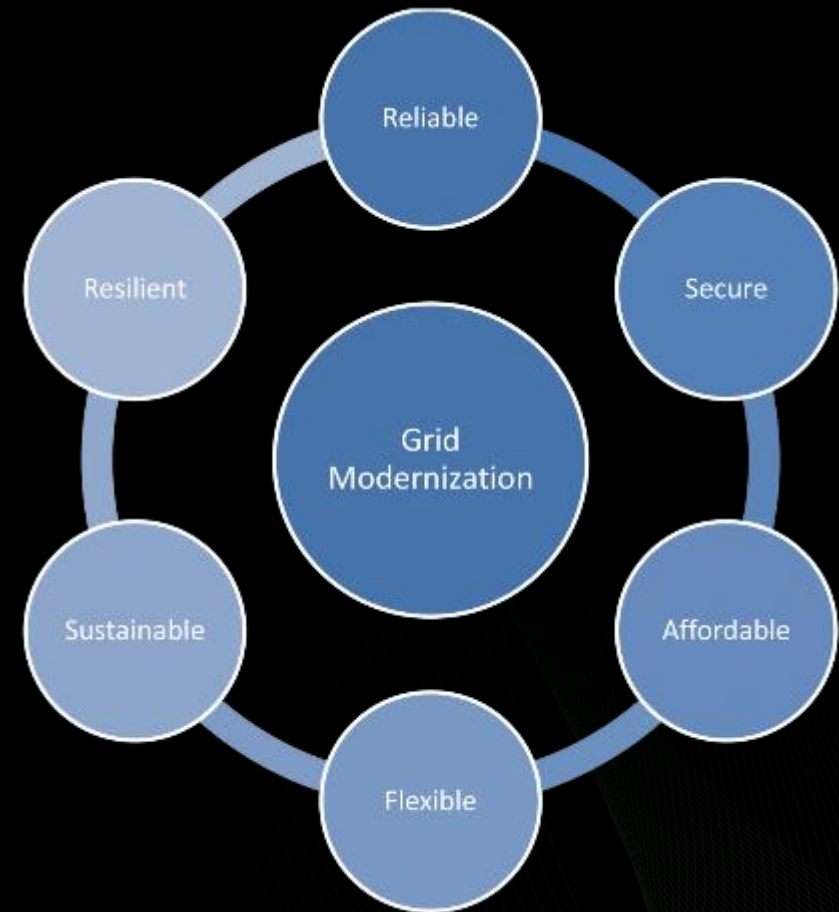


# Grid Modernization Initiative



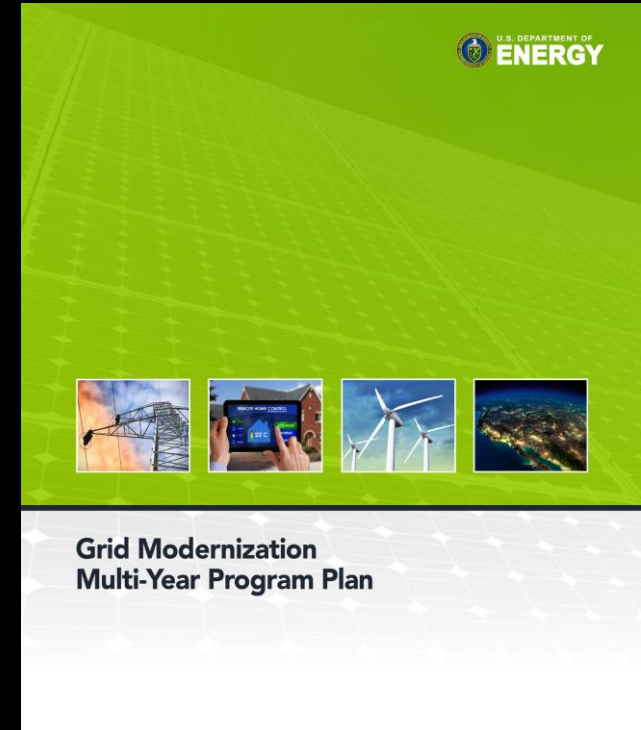
*The vision of DOE's Grid Modernization Initiative (GMI) is:*

- A future grid that will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation.
- The future grid as a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.
- A future grid that will deliver **resilient, reliable, flexible, secure, sustainable, and affordable** electricity to consumers where they want it, when they want it, how they want it.



# Why Grid Modernization?

The existing U.S. power system has served us well...  
*but our 21<sup>st</sup> Century economy needs a 21<sup>st</sup> Century grid.*



More details can be found at:  
<http://www.energy.gov/doe-grid-modernization-laboratory-consortium-gmlc-awards>



Emerging Threats



Extreme Events



Renewables



New Services



# Key Partners/Collaborators



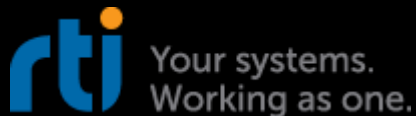
[Time Sensitive Networking \(TSN\) Testbed](#)  
[NI Lead User](#)



**HPE Moonshot** is an energy-efficient, integrated server system that gives you the right compute for your workloads.



ThingWorx is the most widely adopted IoT technology platform.



**Top 50** Internet of Things Technology Company. **Most Influential** Industrial IoT Company.

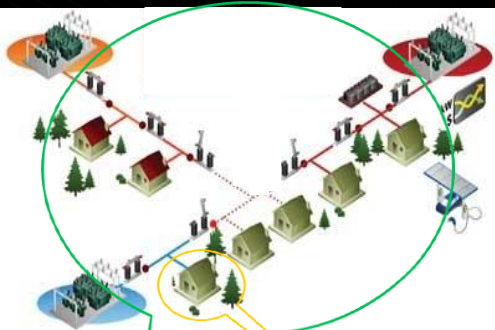


**Beyond Limits** has emerged as the universal leader in “**Applied Artificial Intelligence**” (AAI) and **Cognitive Cloud Computing** based on more than 20 years of proven success supporting NASA and the Space program.... actively designing and developing products and services for the burgeoning Internet of Things (IOT) market that we call the **Universe of Things (UOT)**.



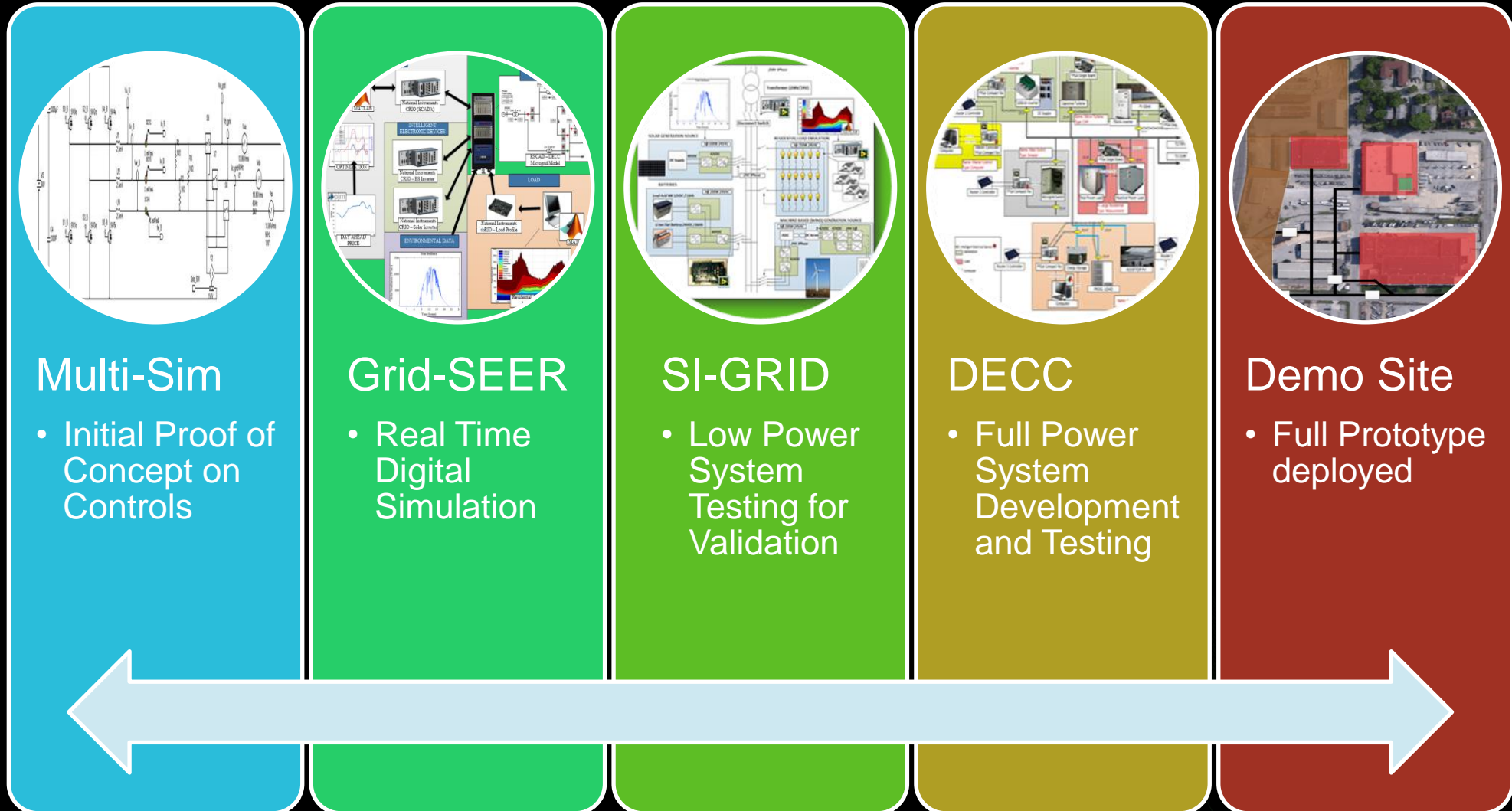
# Our Prototyping Platforms

Approach to rapidly prototype different generations of microgrid systems.



Microgrid  
(<1MW\*)

Nanogrid  
(<150kW\*)



\*definitions vary: Sercan Teleke, Nanogrids with Energy Storage for Future Electricity Grids, 2014. <http://www.ieee-pes.org/presentations/td2014/td2014p-000083.pdf>



# P&ES's Scrum Journey



2014

**Took Group Leader Position**

**Intro to Scrum and Kanban**

- Lightning Talk
- Nov'14

2015

**Scrum-but...**

- Implemented on a single project and single team tracked using Axosoft

**CSM for Hardware Jul'15**

**Declaration of Intent Sept'15**

**CSPO Training Dec'15**

**LDRD Kick-off Meeting Dec'15**

2016

**Intro to Aggressive Scrum**

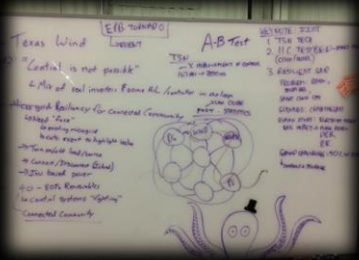
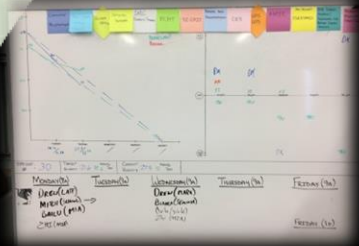
**CSM Scrum4Hardware Train the Trainer Feb'16**

**Scrum**

- Aggressive Scrum
- 2 Cross-functional teams
- SM/TM
- 15+ projects
- >10 PIs/POs
- Meta/Chief-PO
- Single Product Backlog
- Individual Sprint Backlogs
- 1 week sprints
- Daily Standup
- Sprint Reviews/Demos
- Retrospectives
- Tracked Velocity
- Tracked Happiness
- Backlog grooming
- Kaizen

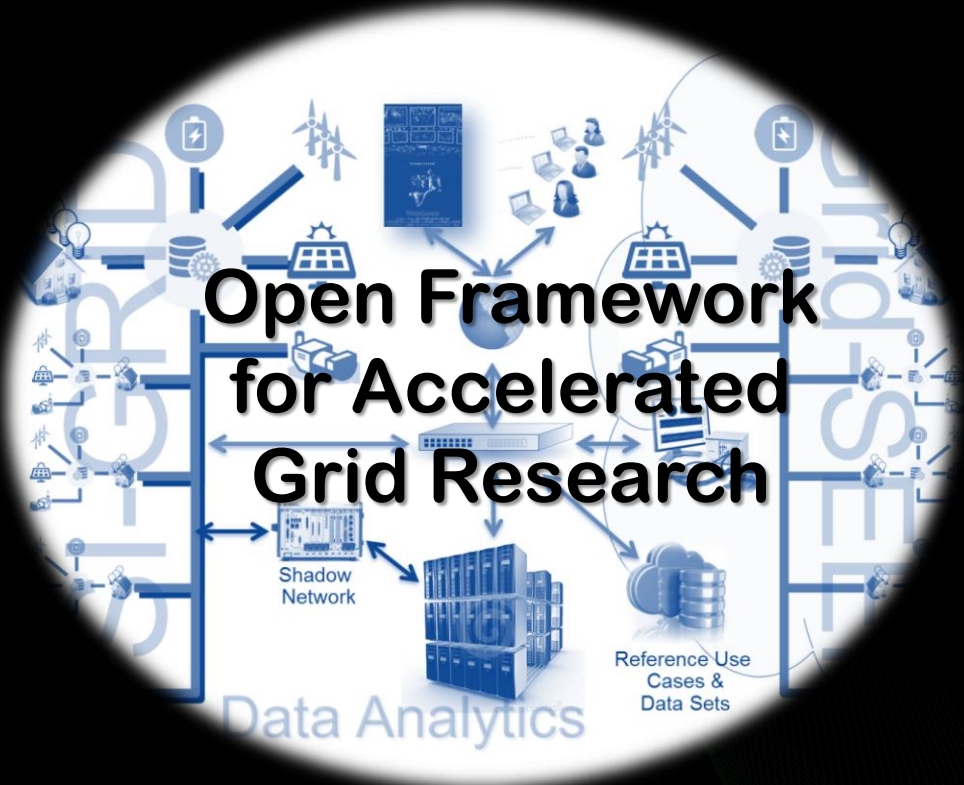


Agile Innovation Lunch-n-Learn





## Additive Manufacturing Integrated Energy



## Open Framework for Accelerated Grid Research

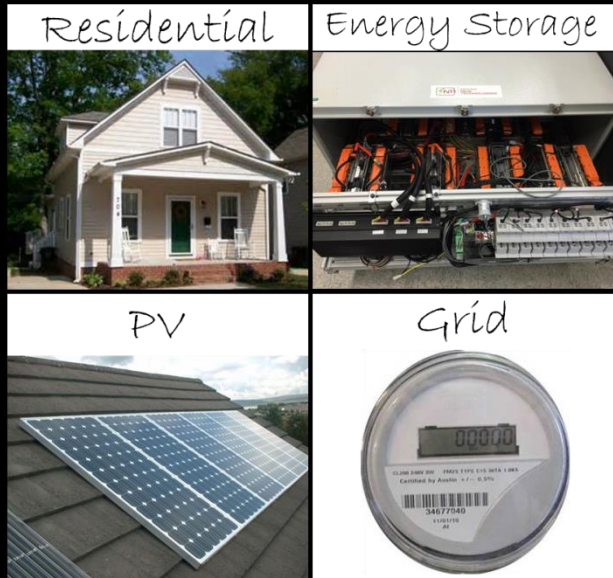
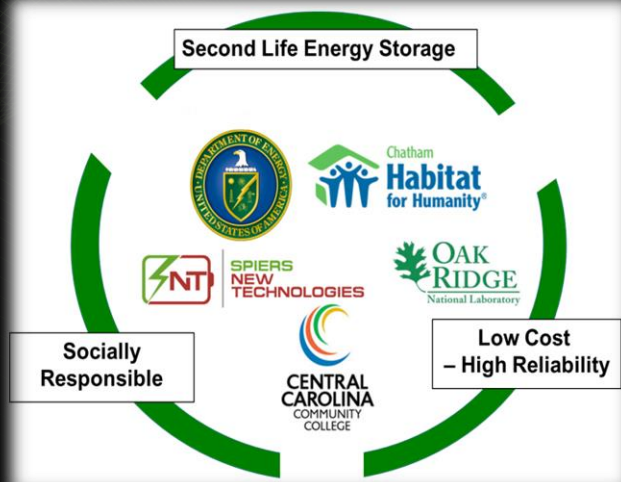
Data Analytics

Shadow  
Network

Reference Use  
Cases &  
Data Sets



# AMIE – Additive Manufacturing and Integrated Energy



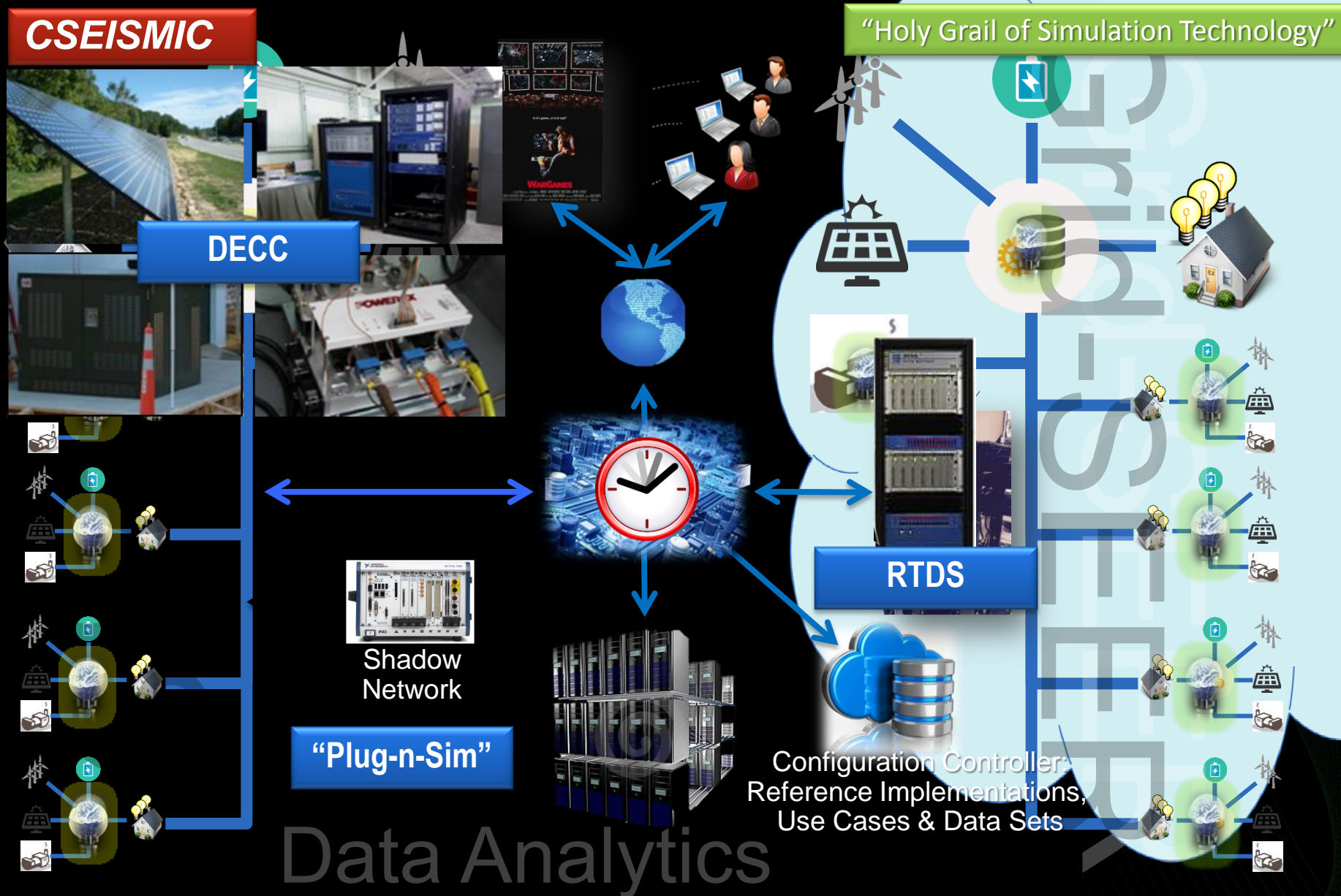
[starkemr@ornl.gov](mailto:starkemr@ornl.gov)

 OAK RIDGE  
National Laboratory





# An open framework for advanced grid research...

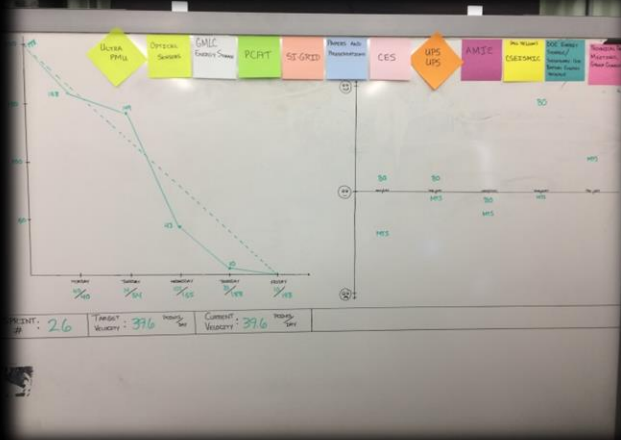
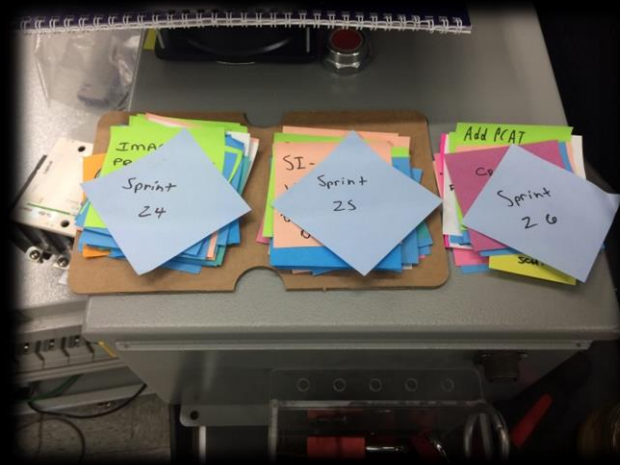
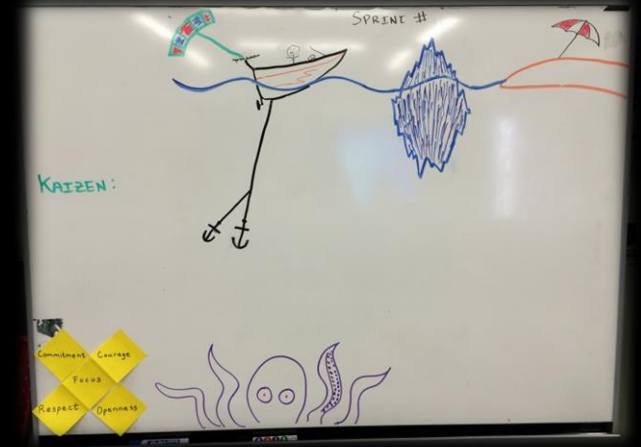
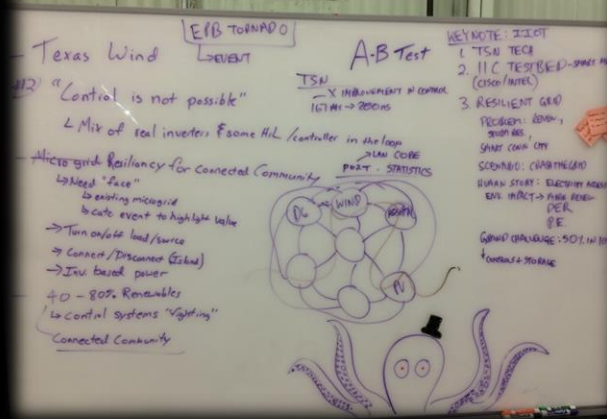
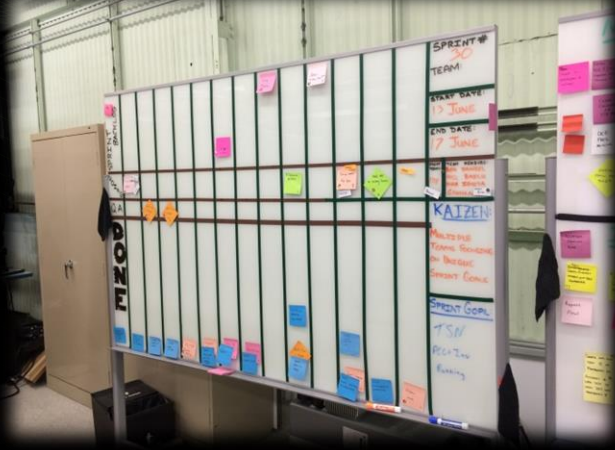


# Time Sensitive Networking Demonstration at NI Week 2016





# Some of our “Tools”





# FRC Team 4265 Secret City Wildbots



2015-2016 Season



2016 Off-Season



# What is FIRST?

*Igniting young minds.*

*Teaching life skills.*

*Nurturing passions for science and technology.*

*Practicing "Gracious Professionalism®."*



FOR INSPIRATION AND RECOGNITION OF SCIENCE AND TECHNOLOGY



*Founded in 1989 by inventor Dean Kamen*

**Devoted to helping young people discover and develop a passion for science, technology, engineering, and math (STEM).**

***FRC 2016***

***“The only high school sport where every kid can go pro”***

3,100+ teams

78,000 students (Grades 9-12)

56 Regional Events; 8 State/District Championships; 66 District Events

FIRST Robotics Competition Championship  
St. Louis, MO, April 27-30, 2016

120 lb. robot built in **6 weeks**





# FIRST Vision



*"To transform our culture by creating a world where science and technology are celebrated and where young people dream of becoming science and technology leaders."*





# FIRST Progression of Programs

## FIRST PROGRAMS

A progression of four programs for ages 6 to 18; gets young people involved early, developing skills and building confidence, keeping them engaged through high school.



### FIRST ROBOTICS COMPETITION

Grades 9-12 (ages 14 to 18)

Mentored by professional engineers, teams compete with 120-pound robots of their own design in this varsity Sport for the Mind™, combining the excitement of sport with the rigors of science and technology

- Robotics
- Learn from the pros
- Game Play
- Scholarships



### FIRST TECH CHALLENGE

Grades 7-12 (ages 12 to 18)

Students learn to think like engineers and develop an engineering notebook to document their progress. Teams develop strategies, build robots from a reusable kit of parts, and compete head to head

- Robotics
- Engineering Notebook
- Game Play
- Scholarships



### FIRST LEGO LEAGUE

Grades 4-8 (ages 9-16\*)  
\*Ages vary by country

Guided by the program's Core Values, teams build LEGO®-based autonomous robots and develop research projects based on a real-world Challenge that changes annually

- Robotics
- LEGO
- Game Play
- Research



### JUNIOR FIRST LEGO LEAGUE

Grades K-3 (ages 6 to 9)

Teams explore today's scientific challenges, then present their research using a LEGO® model with motorized parts and a Show Me poster

- LEGO
- Research



## YOUR HELP MAKES AN IMPACT!

Together, we can show students of every age that hands-on problem solving using STEM is fun and rewarding, and is a proven path to successful careers and a bright future for all.

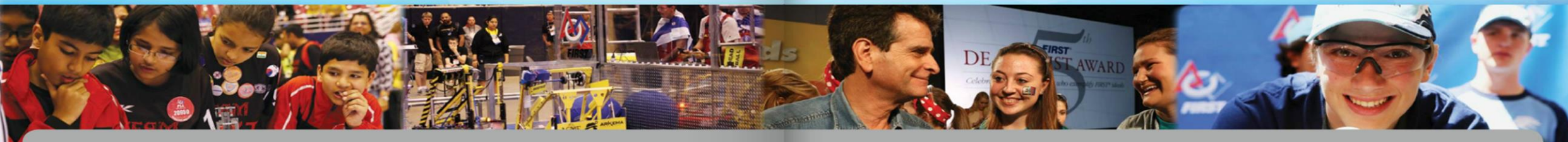
**WON'T YOU HELP TODAY?**





# 25 years EXCEEDING EXPECTATIONS & CREATING REAL IMPACT

A decade of data and research shows that exposing kids to fun, exciting FIRST programs builds 21<sup>st</sup> century work skills and greatly increases their motivation to seek education and careers in STEM fields.



## STEM EXPOSURE



## STEM INTEREST & SKILLS



## EDUCATION & STEM CAREERS



## LONG-TERM OUTCOMES

\* Unless noted, the data represented is the lowest value from the formal evaluations of the programs.

- **84%** work on the robot
- **90%** work on team strategy
- **88%** in FLL work on programming (63% in FTC; 37% in FRC)
- **84%** learn about STEM jobs
- **66%** make presentations to judges
- **97%** have FUN!



LEADS TO



- **88%** more interested in learning about science or technology
- **88%** better understand how STEM is used to solve real-world problems
- **98%** increase teamwork skills
- **93%** increase problem solving skills



LEADS TO



- **86%** more interested in doing well in school
- **84%** motivated to take challenging math or science classes (FRC, FTC)
- **94%** embraced importance of Coopertition® & Gracious Professionalism®
- **80%** more interested in jobs that use STEM



LEADS TO



- **41%** Alumni major in engineering
- **33%** female Alumni major in engineering

Sources:  
Brandeis University: Cross-Program Evaluation of FTC and FRC (2011); Evaluation of the 2012-13 FLL Program (2013); and More Than Robots: Evaluation of FRC Participant and Institutional Impacts (2005)  
FIRST, 2011 Survey of FRC and FTC Alumni

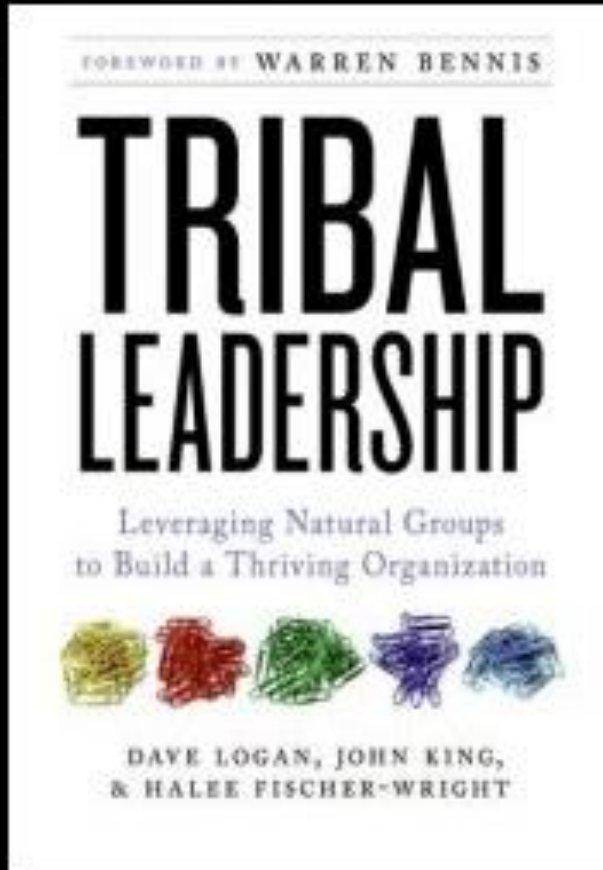
## ULTIMATE IMPACT



**89.6%** of **FIRST** Alumni are in a STEM field (student or professional)

**Inspired to learn more?**  
[www.usfirst.org/aboutus/impact](http://www.usfirst.org/aboutus/impact)

# Challenge #1 ... we live in a Stage 3 Tribal Culture



***"I'm Great"***

*(and you're not)*

*Stage 3*

- High School ... ego, top-dog, image, rules



## Challenge #2 ... “Varsity Sport of the Mind”

Vision is for kids to be “inspired”  
by professional scientists and  
engineers



*Resources and  
philosophy of the  
competition ...*

# Challenge #3 ... our resources

We went the World Championship the first 4 years of our existence...

After being part the 2<sup>nd</sup> place alliance at the 2015 World Championship we were downsized from a shop w/ 4 lathes, 3 mills and 1/2 field to a classroom ...





# 4265's Scrum Journey



2013



2012

## Lean Startup

- MVP
- BML

## eXtreme Manufacturing

- Pairing
- Swarming
- Modular Components
- Design Patterns
- Make Work Visible
- Iterative Design

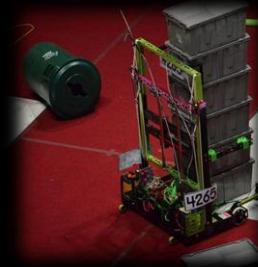
2014



## Kanban

- Flow
- Pull
- Make Work Visible

2015



## Scrum-but...



2016



## Scrum

- Aggressive Scrum
- Executive Action Team
- Cross-functional teams
- SM/PO/TM
- Single Product Backlog
- Individual Sprint Backlogs
- 1 week sprints
- Daily Standup
- Sprint Reviews/Demos
- Retrospectives
- Tracked Velocity
- Tracked Happiness
- Backlog grooming
- Kaizen



Thanks for Contacting WIKISPEED! Re: Extreme Manufacturing content/curriculum



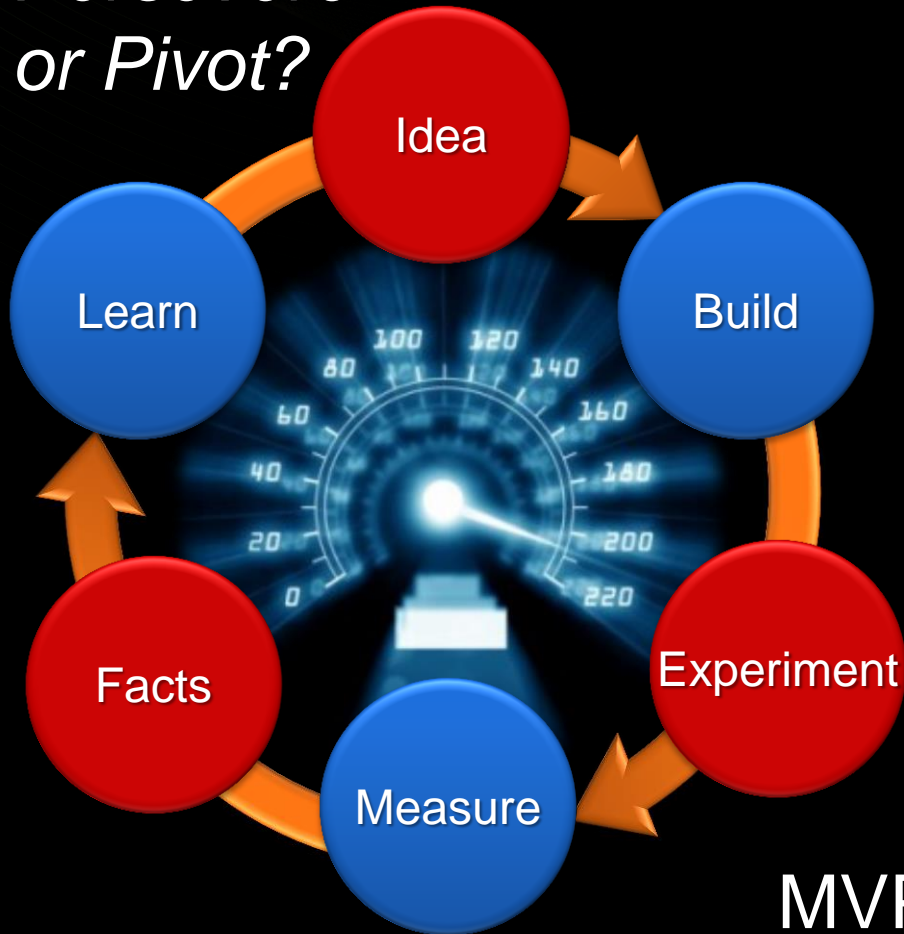
Joe Justice <info@wikispeed.com> to me

11/2/13

Thanks so much for emailing team WIKISPEED! We all spend between 2 and 8 hours a week volunteering for team WIKISPEED, and at least one of us spends 30 minutes each day replying to as many emails as we responsibly can. Please consider joining team WIKISPEED and answering 30 minutes worth of emails with us one or two days a week!

# Build-Measure-Learn Feedback Loop

*Persevere  
or Pivot?*



*Identify the riskiest/most valuable  
elements/tasks (hypothesis) ... test  
these first ... **validated-learning***

*Anything that doesn't  
move the needle is **waste***

**[PROTOTYPE]**

MVP: Minimum Viable Prototype  
MVF: Minimum Viable Feature





# Scrum4Hardware eXtreme Manufacturing

Scrum is an Agile “framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value.”

XM

## I. Scrum Organization

- Roles & Responsibilities
- Sprints/Iterative Design
- Make Work Visible
- Measure Velocity
- Continuous Improvement (Lean)

## II. XP Engineering Principles

- User Stories
- Pairing & Swarming
- Test Driven Development

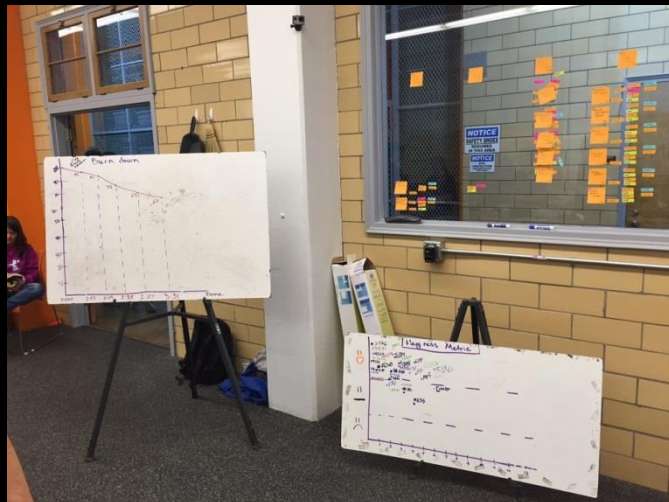
## III. Object-Oriented Architecture

- Modular Components
- Contract-First Design
- Design Patterns
- Re-use & Inheritance





# Scrum at the 2016 FRC Kick-Off Quick Build





# Executive Action Team

- Scouting Lead
- Team Director
- Electrical Lead
- Pneumatics Lead
- Safety Lead
- CAD Lead
- Financial/Business Lead
- Mechanical Lead
- Mentor
- Team Image Lead
- Engineering Director
- Programming Lead (not pictured)

*Clockwise from bottom left*





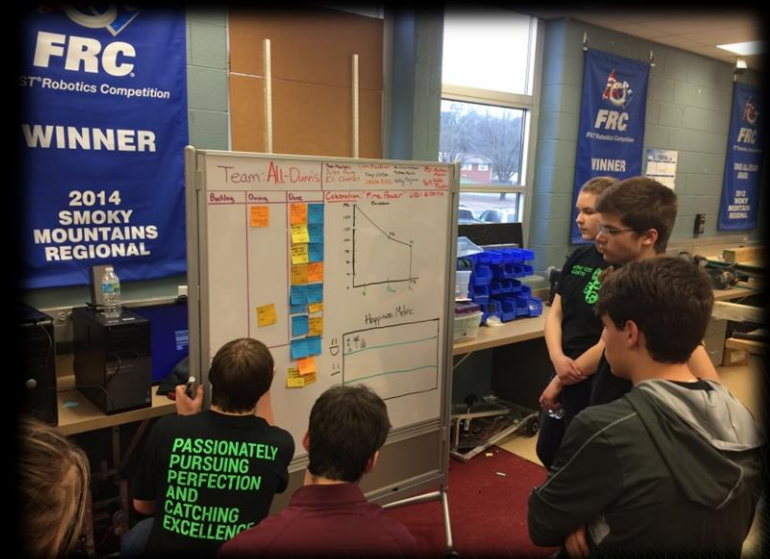
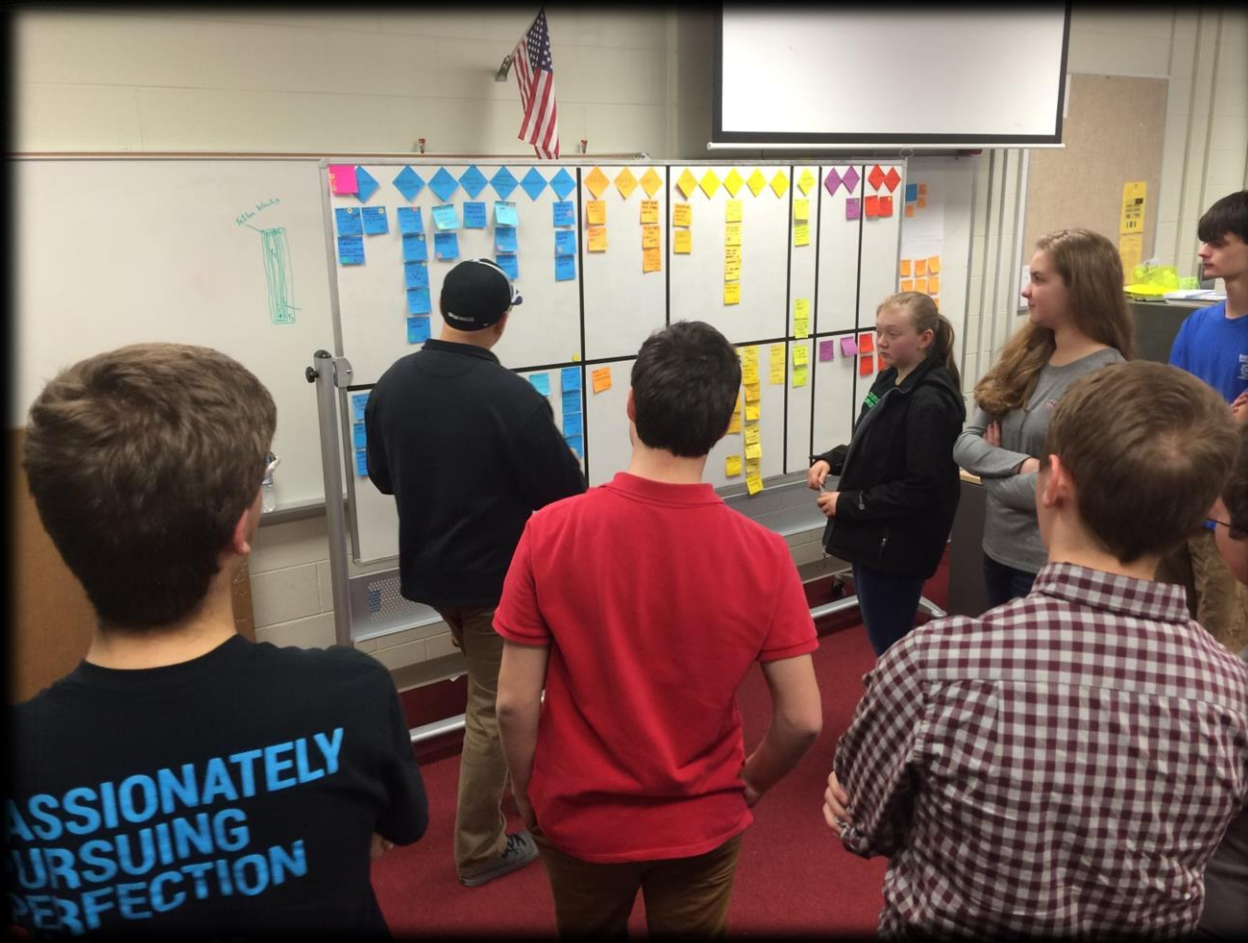
# Scrum works

F.S.M. 3/5 Compromise		All-Dunn's	
BRANDON EXTENSION IDEAS (1)	WEEK 1 112	TEAM PHOTO (2)	WEEK 1 187
SHOOTER/ OTHER (1)	Week 2 179	WHEEL/WIRE UP LAYOUT SCATERBOT ELECTRICAL TANARD	WEEK 2 141
TEST MVP Collection	Week 3 142	TO ORDER FOR WEEK PROTOTYPE OF IT	WEEK 3 268
Rivets with hex bolts on intake	WEEK 4 195	CHAIRMAN'S ESSAY [DRAFT, DEVELOP CONCEPT/STORY]	WEEK 4 311
ASSEMBLE VP FOR INTAKE (2)	Week 5 385	COAST OF ROBOT PART 1	WEEK 5 379
AND END RIVETS	WEEK 6 651	AXELS FOR SHOOTER	WEEK 6 574



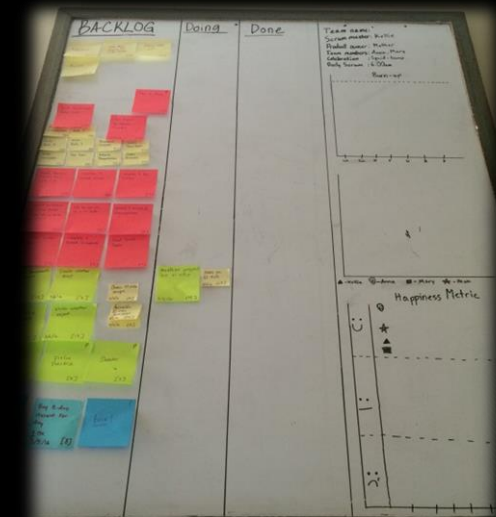
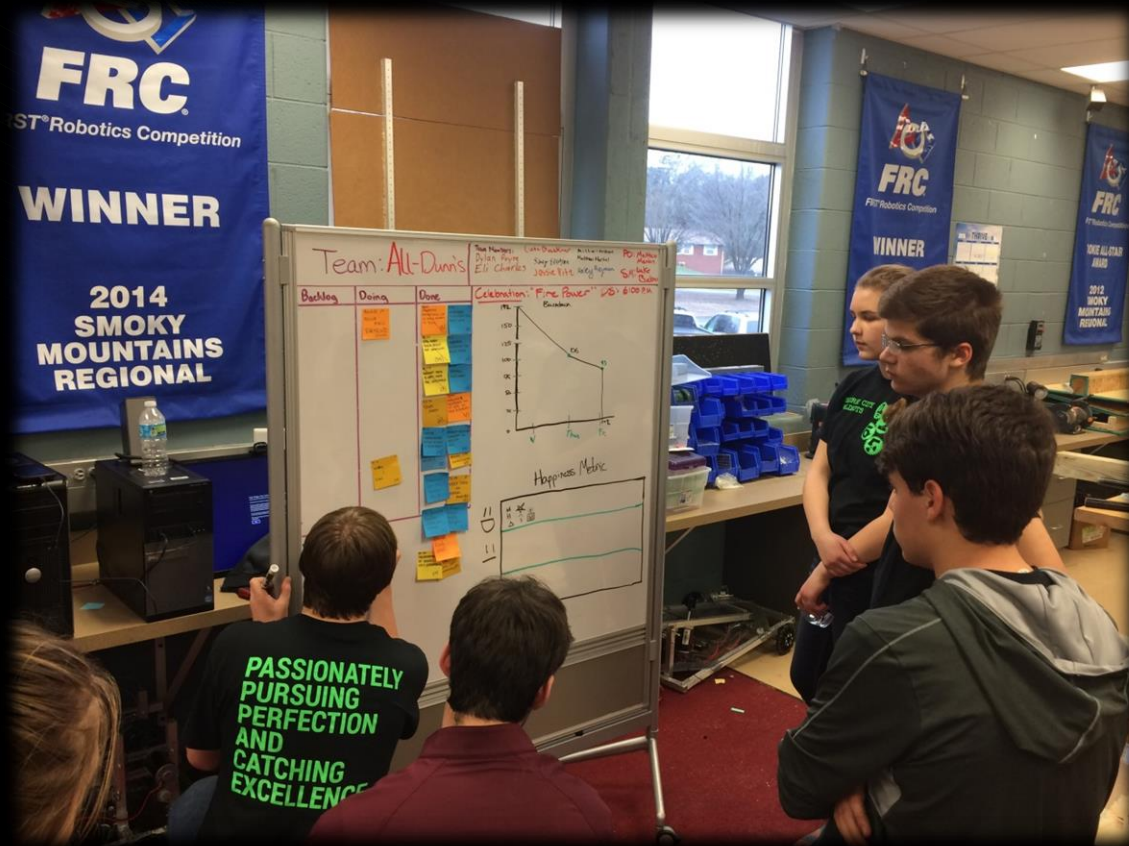


# Scrum in Action



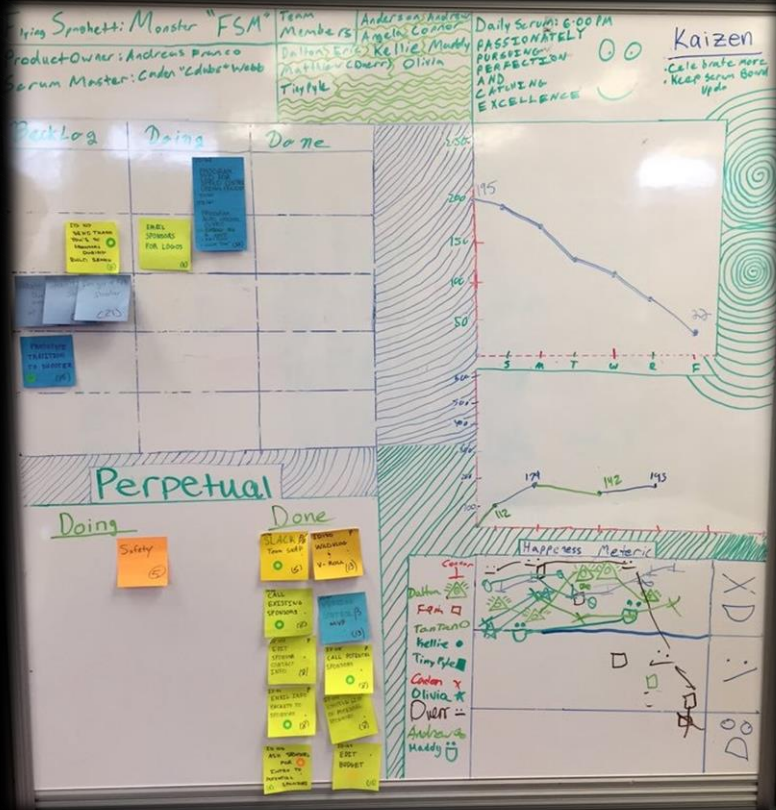


# Scrum in Action



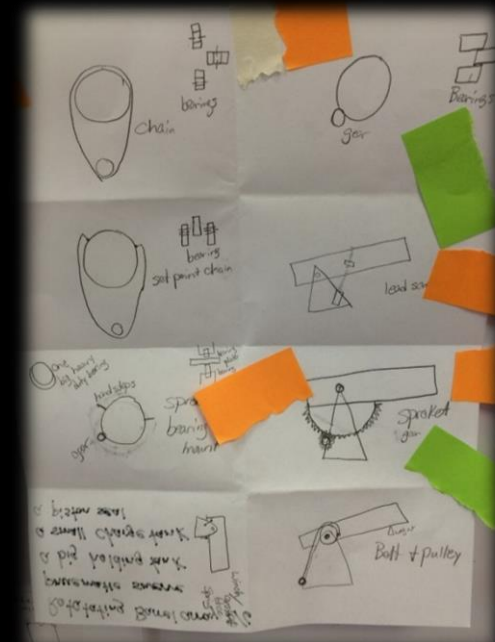
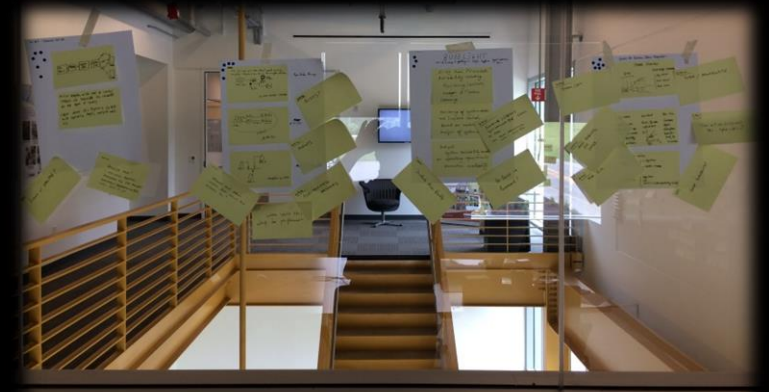
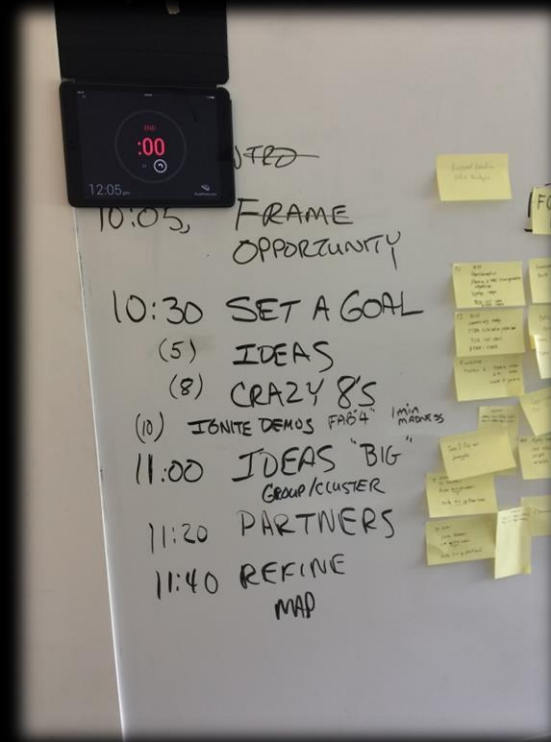


# Scrum in Action



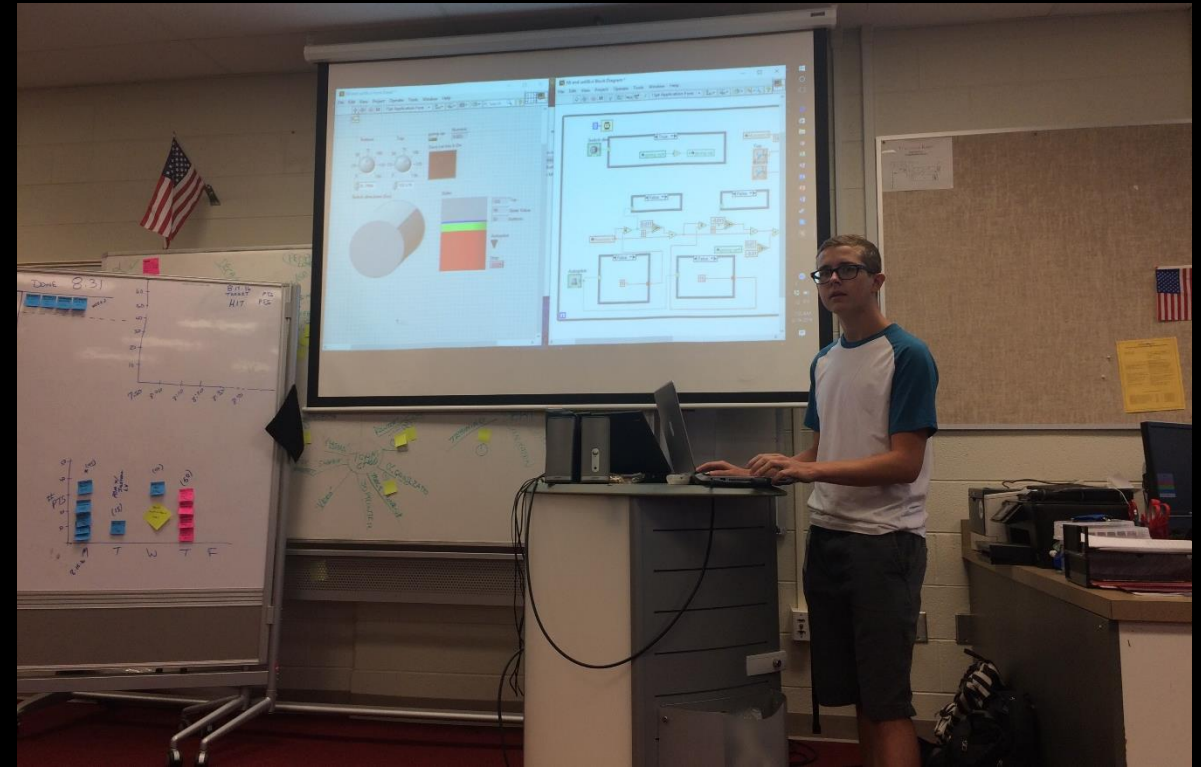


## Introduced a Modified Version of the GV's Design Sprint



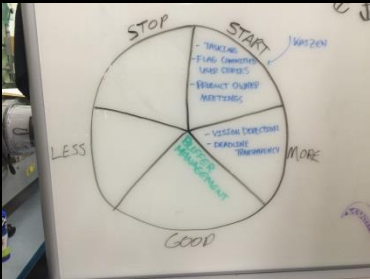
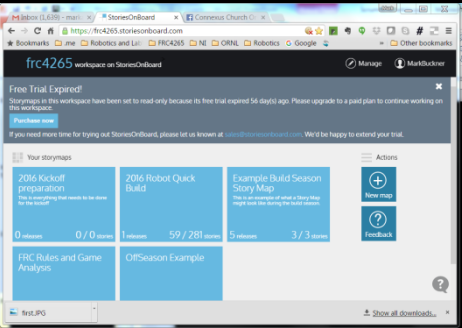
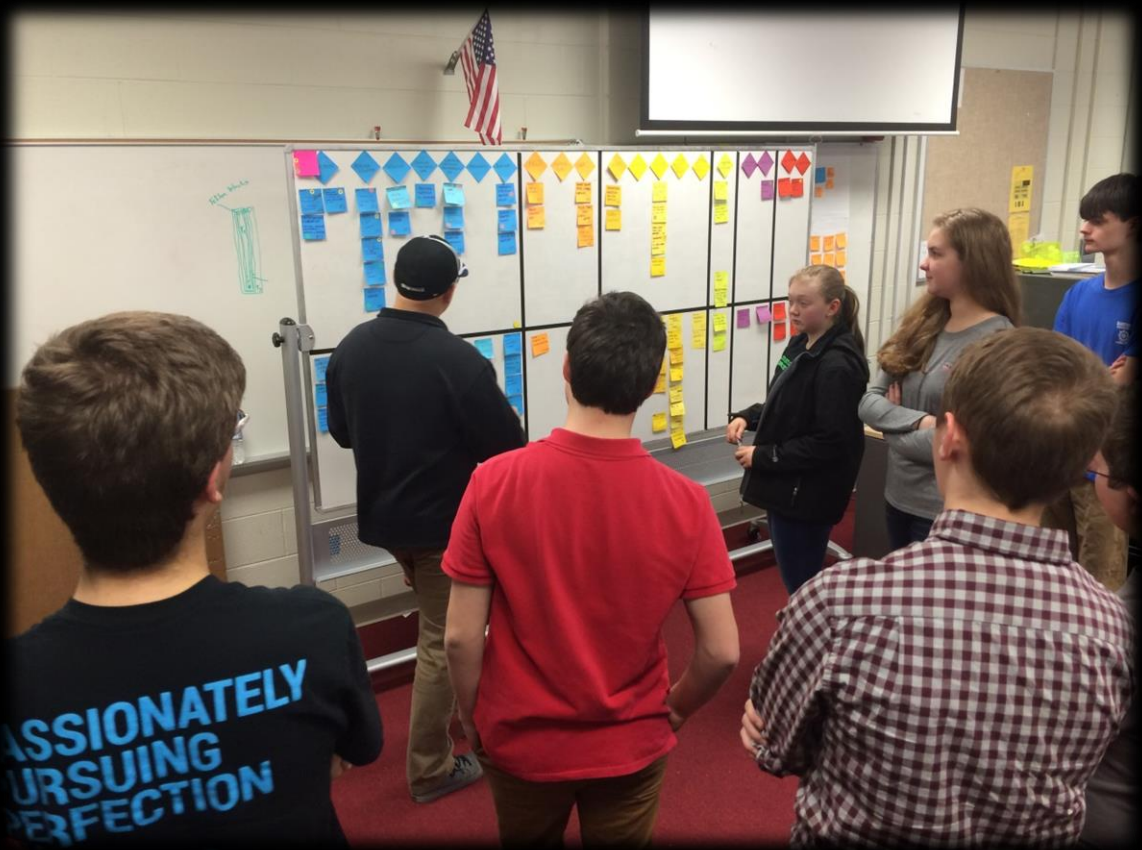
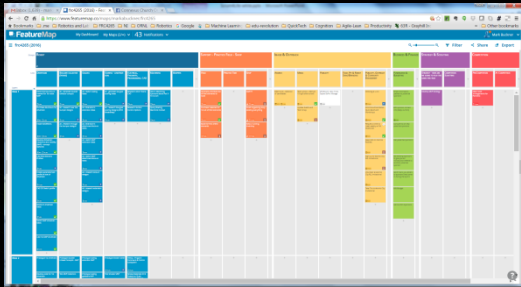


# Scrum in the Classroom





# Some of our “Tools”

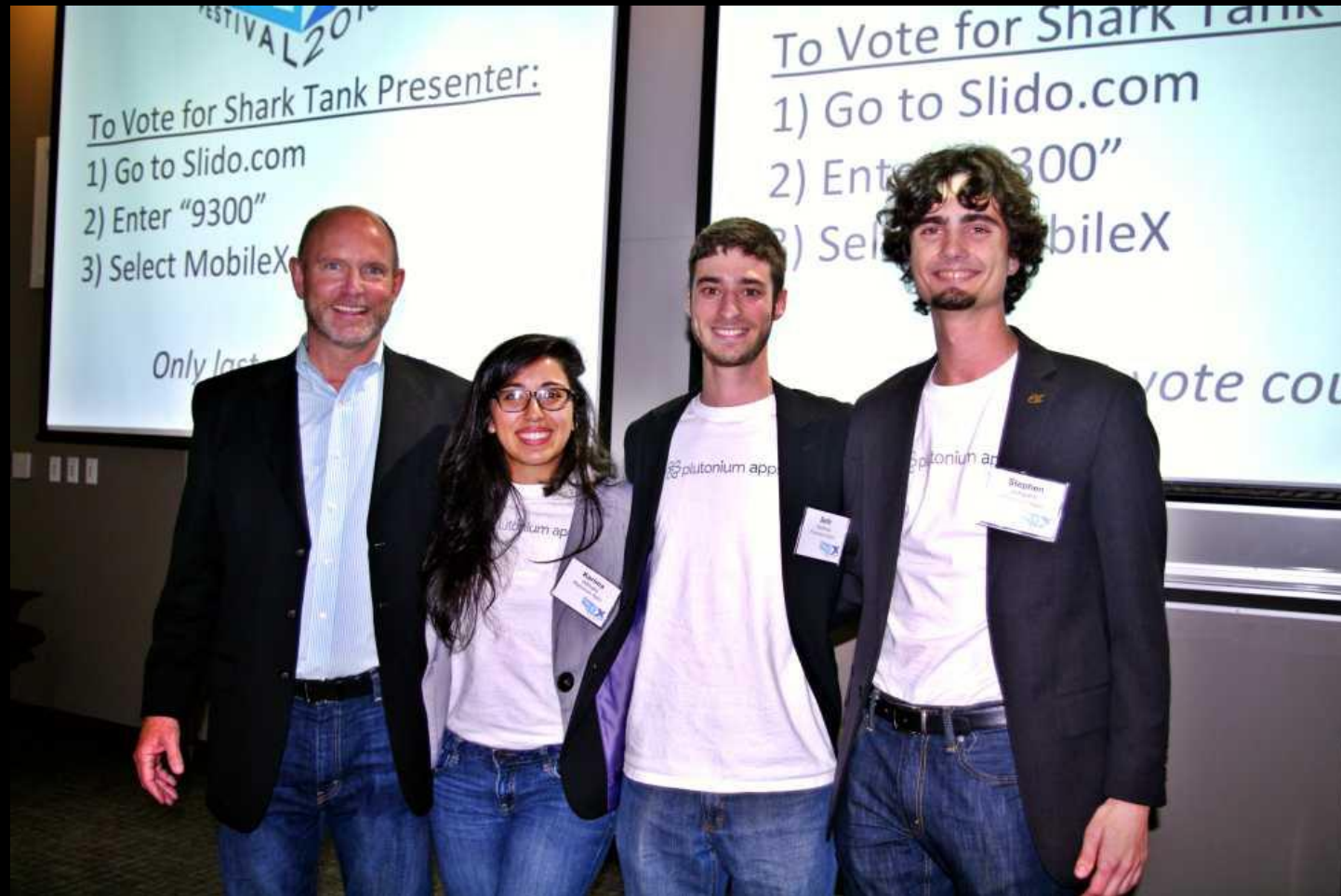




# FRC4265 has produced 3 Certified Scrum Masters



# FRC4265 Alumni using Scrum...



**“Tech-based startup Plutonium Apps, invited to audition for season eight of ABC’s hit show “Shark Tank.”**



# Joe's Advice for Secret City...



# What's Next...?

## STEM Gym Innovation Accelerator



scruminc.



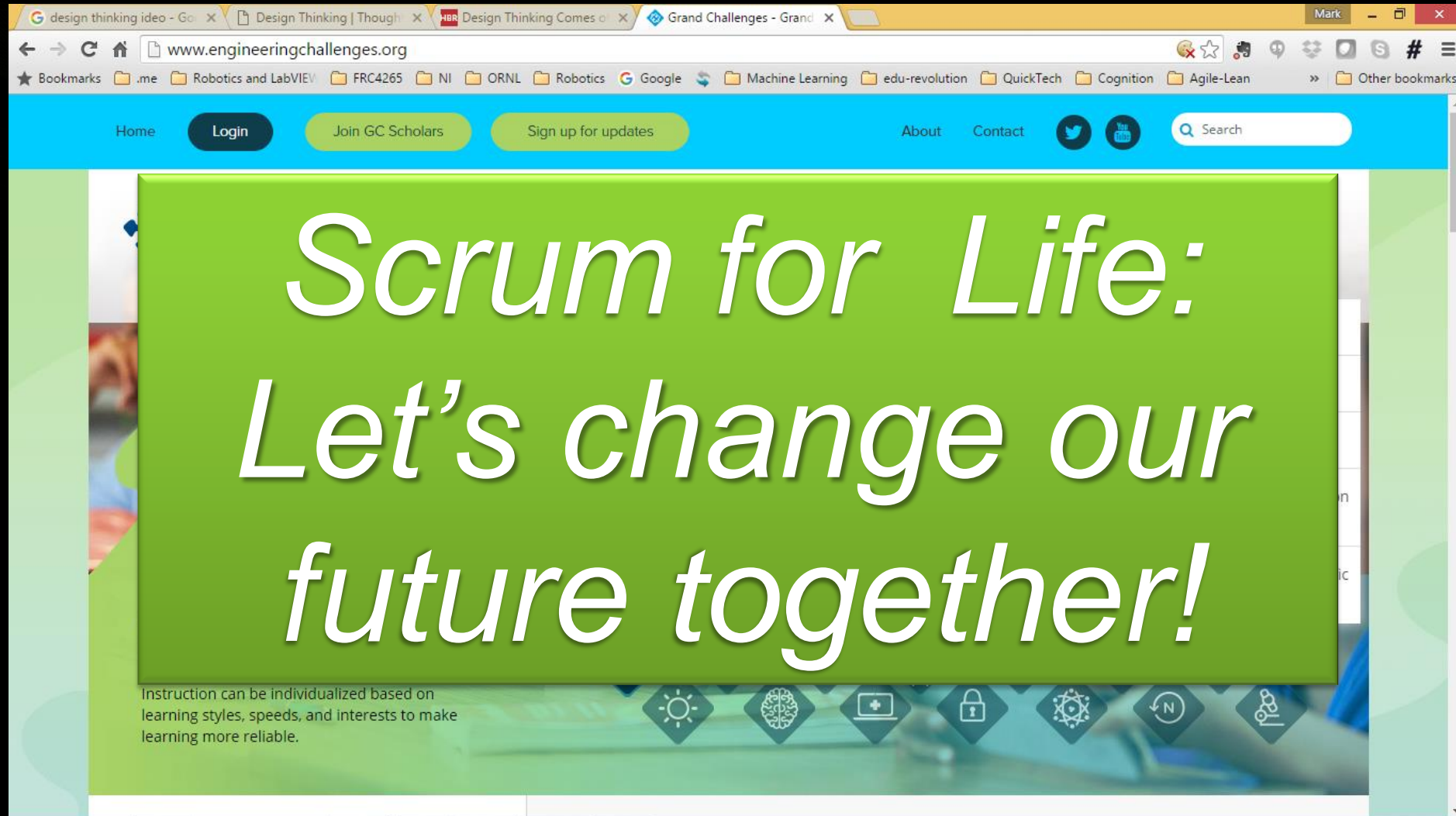
*"Learning by Doing"*

*Together we can  
"make" our perfect  
future!*

- *Idea to Implementation...and back again*
- *Abstract to Concrete...and back again*
- *Inspect and Adapt...and back again*



# The Big Hairy Audacious Problems (BHAP) facing the world require high performing cross-functional teams...



<http://www.engineeringchallenges.org/>



Questions?

