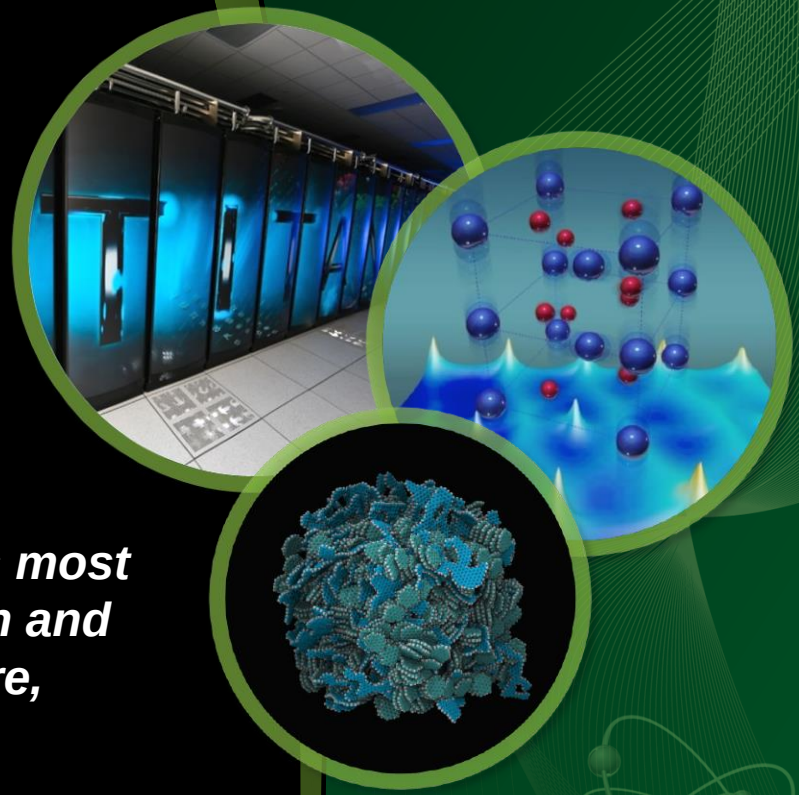
Scrum4Life:
A Tale of 2 Journeys

Mark A. Buckner, PhD
Power & Energy Systems Group Leader
bucknerma@ornl.gov

FIRST Robotics Mentor
FRC Team 4265 Secret City Wildbots



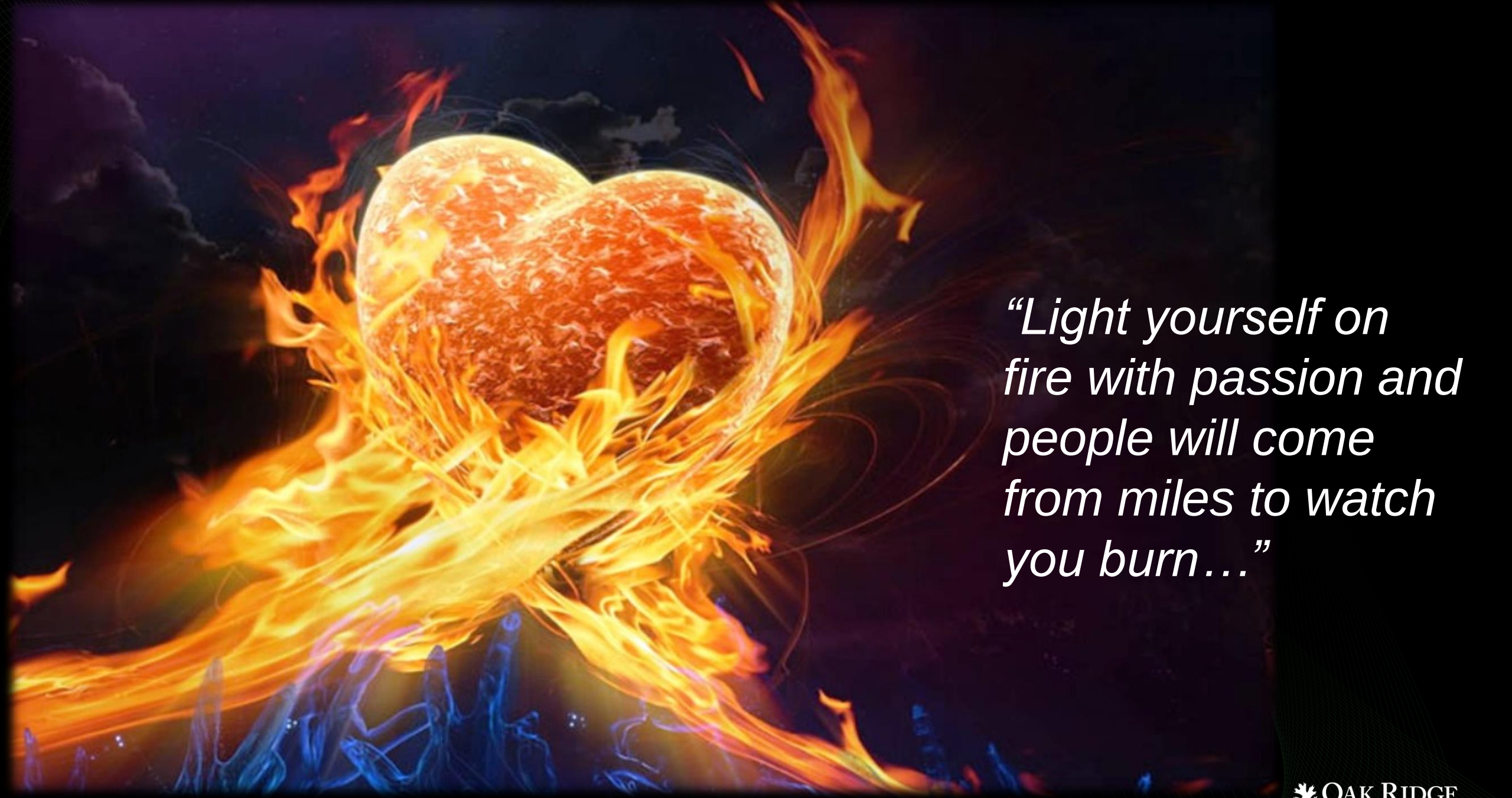
P&ES Mission: Provide innovative solutions to the nation's most challenging energy problems, accelerating the investigation and transition of science into practice for a cost-effective, secure, resilient, and sustainable electric grid of the future.

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.

"Passionately Pursuing Perfection … Catching Excellence!"

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

OAK RIDGE National Laboratory



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“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 ....

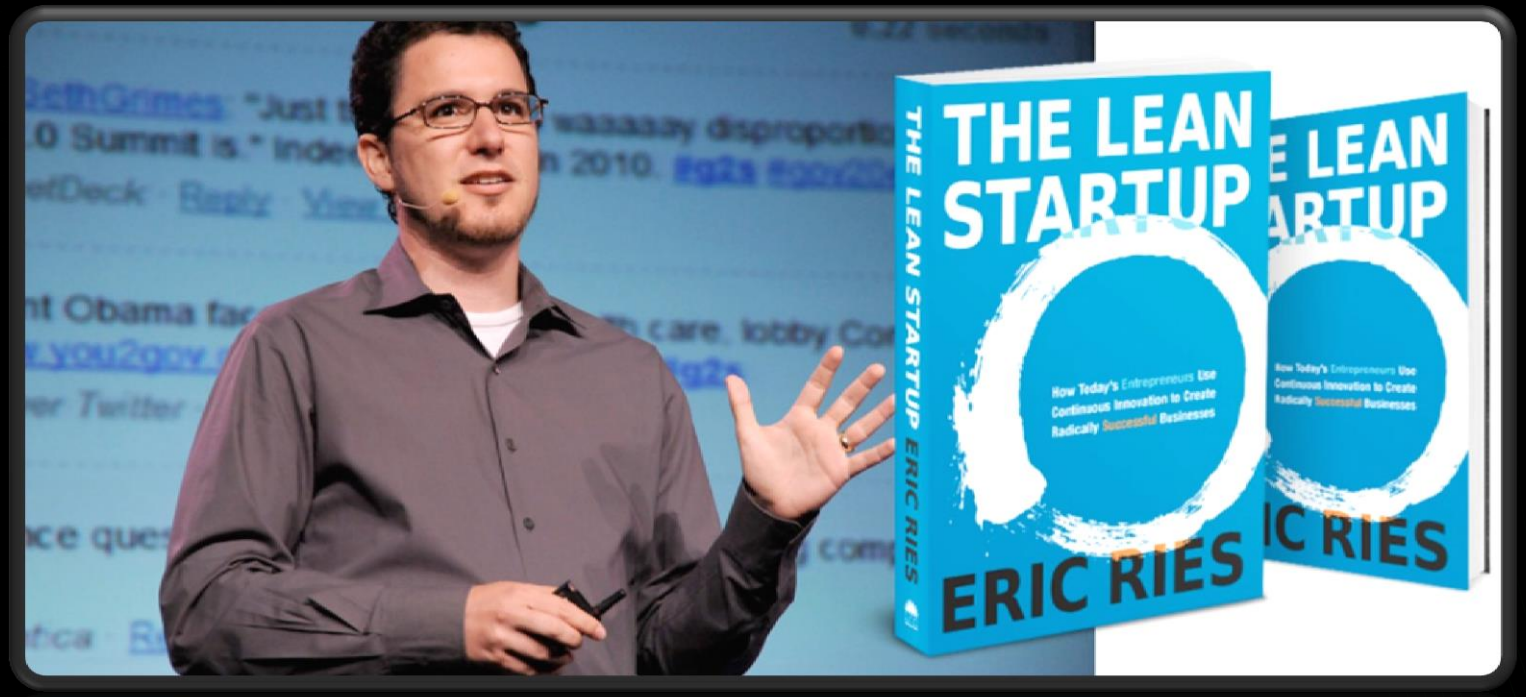
Deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security, and in doing so create economic opportunity for the nation.

OAK RIDGE National Laboratory

A little about me…

- @ORNL 29 years
- Group Leader, Power and Energy Systems
- 11th 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

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

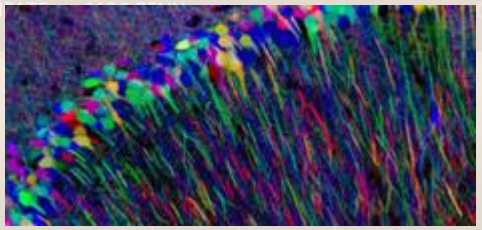
USAID Grand Challenges

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

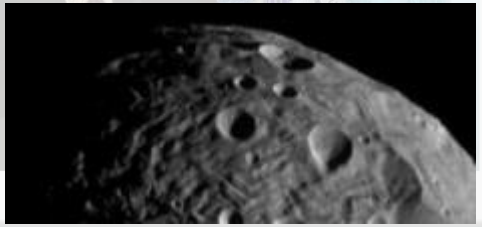
21st Century Grand Challenges

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

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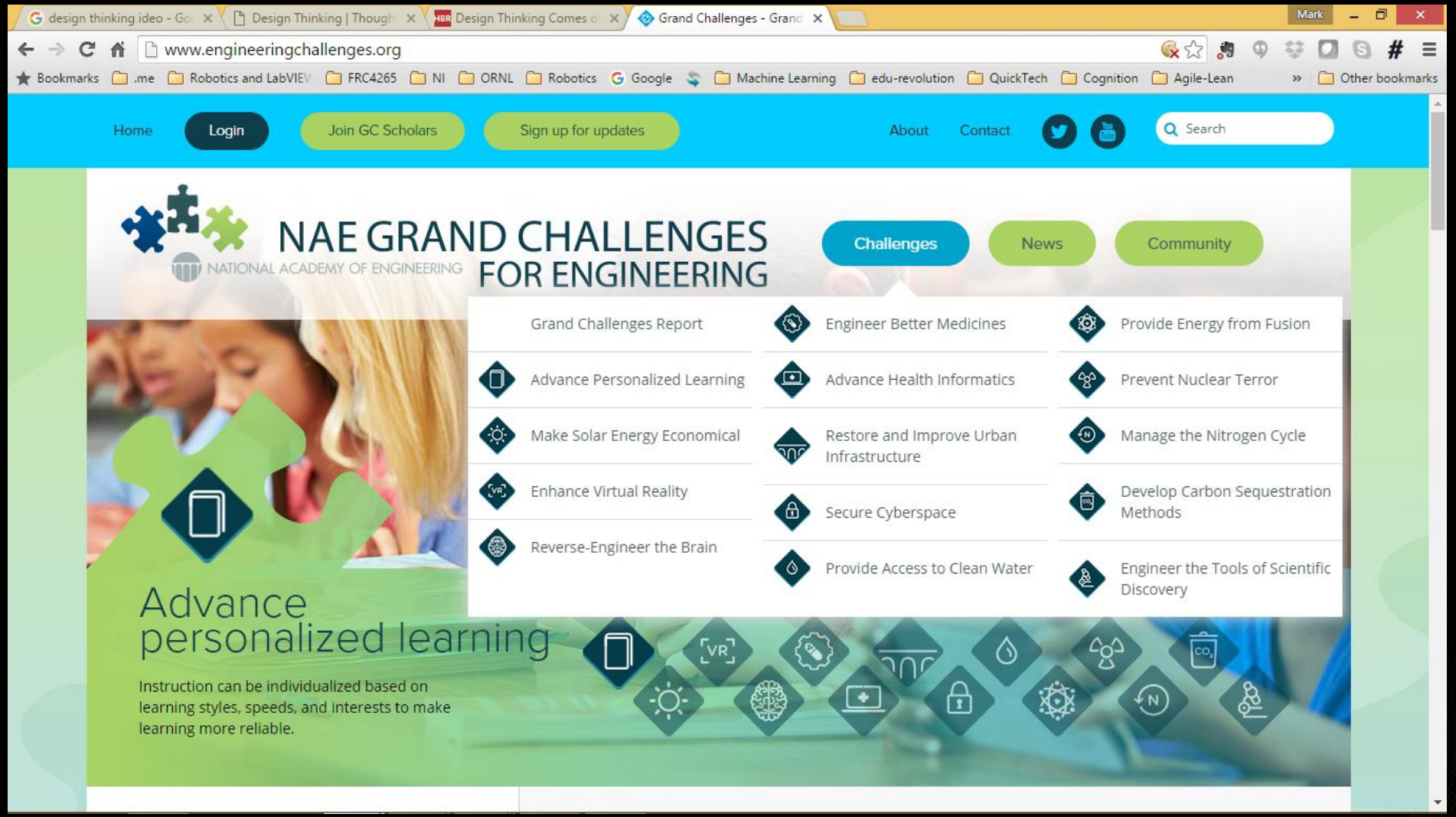
The Big Hairy Audacious Problems (BHAP) facing the world require high performing cross-functional teams…



http://www.engineeringchallenges.org/

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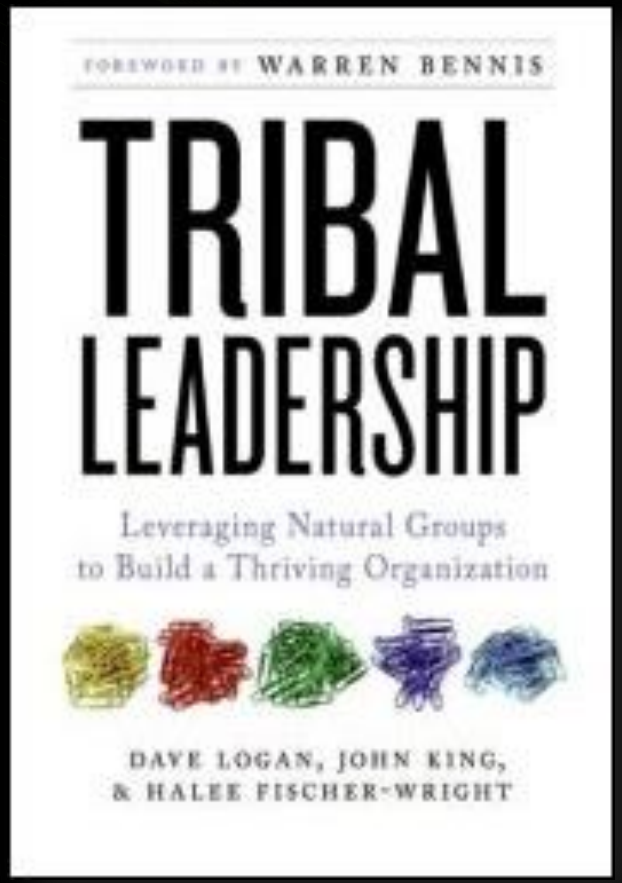
ORNL Power & Energy Systems Team

- 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

OAK RIDGE National Laboratory

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

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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

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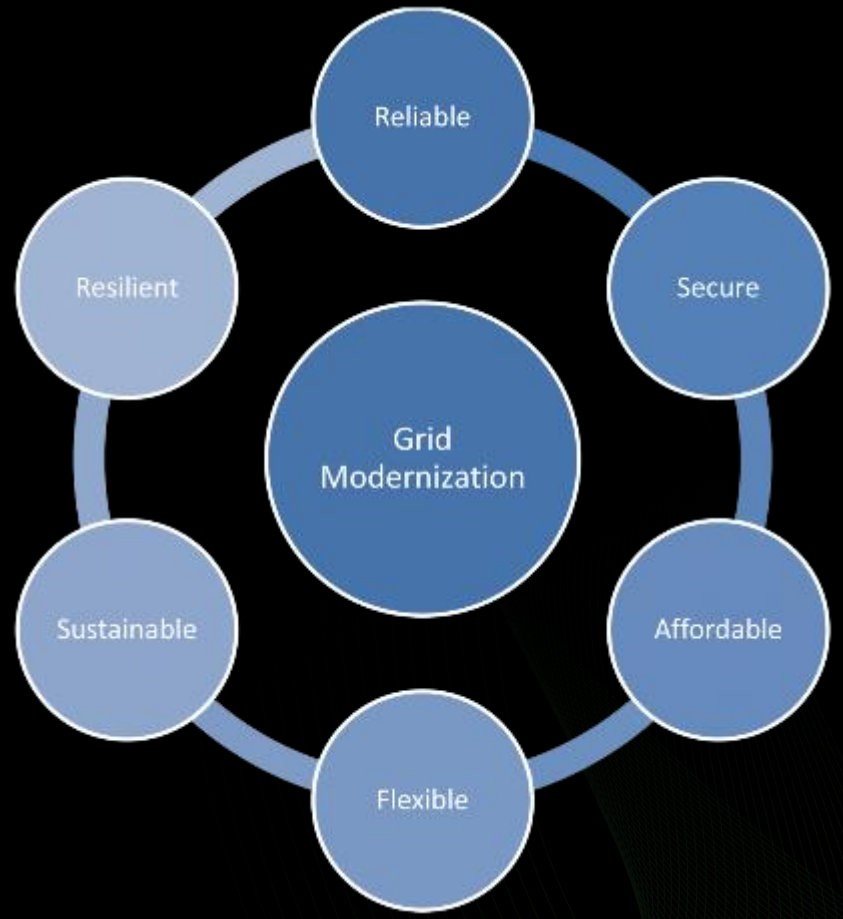
Grid Modernization Initiative

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

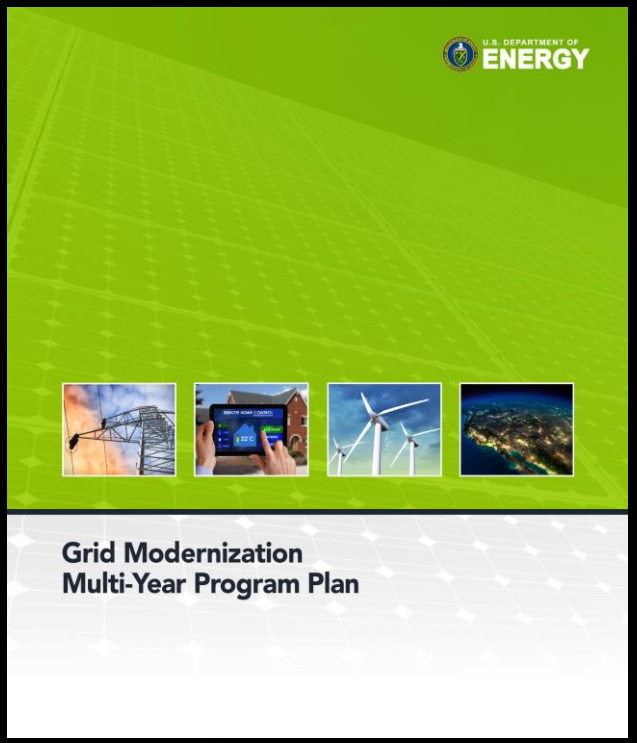
- A future grid that will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation.
- The future grid as a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.
- A future grid 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 21st Century economy needs a 21st Century grid.

U.S. DEPARTMENT OF ENERGY



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

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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.

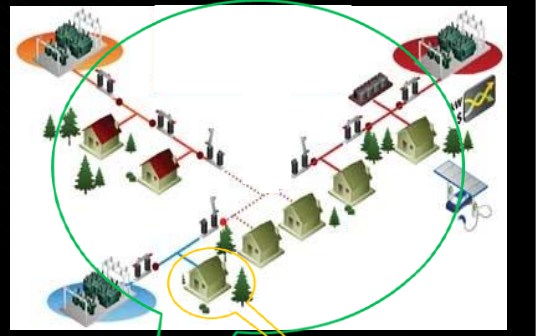
Top 50 Internet of Things Technology Company. **Most Influential** Industrial IoT Company.

ThingWorx is the most widely adopted IoT technology platform.

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**).

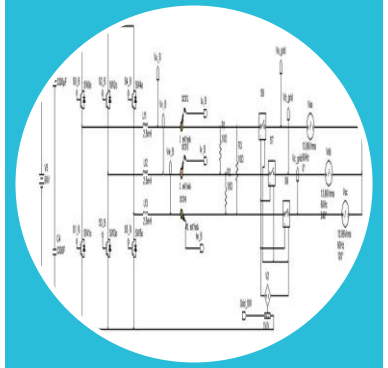
Our Prototyping Platforms

Approach to rapidly prototype different generations of microgrid systems.



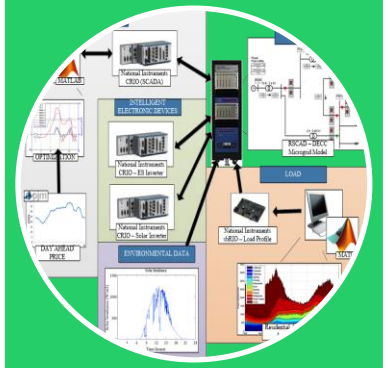
Microgrid
(<1MW*)

Nanogrid
(<150kW*)



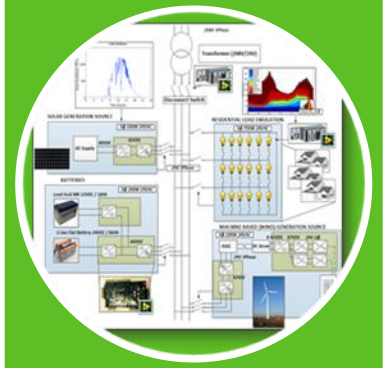
Multi-Sim

- Initial Proof of Concept on Controls



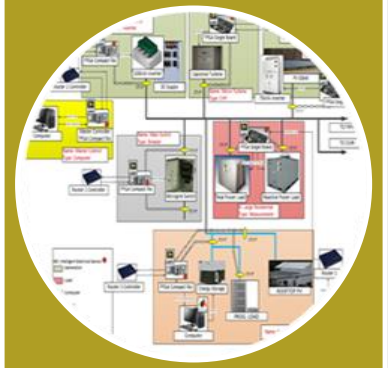
Grid-SEER

- Real Time Digital Simulation



SI-GRID

- Low Power System Testing for Validation



DECC

- Full Power System Development and Testing

Demo Site

- Full Prototype deployed

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

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P&ES's Scrum Journey

Declaration of Intent Sept'15

CSM for Hardware Jul'15

LDRD Kick-off Meeting Dec'15

CSPO Training Dec'15

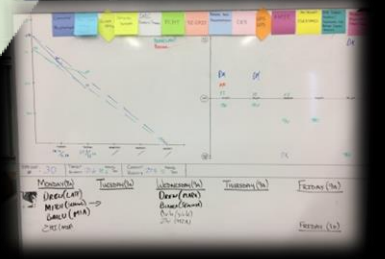
CSM Scrum4Hardware Train the Trainer Feb'16

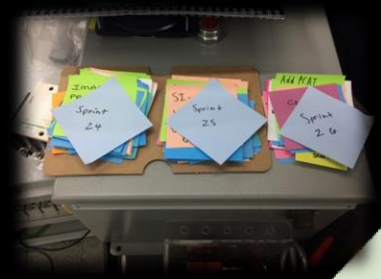
2016

Intro to Aggressive Scrum

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

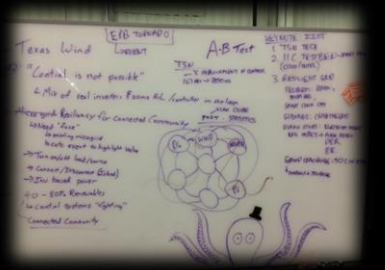




2015

Scrum-but…

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



Intro to Scrum and Kanban

- Lightning Talk
- Nov'14

Agile Innovation Lunch-n-Learn

2014

Took Group Leader Position

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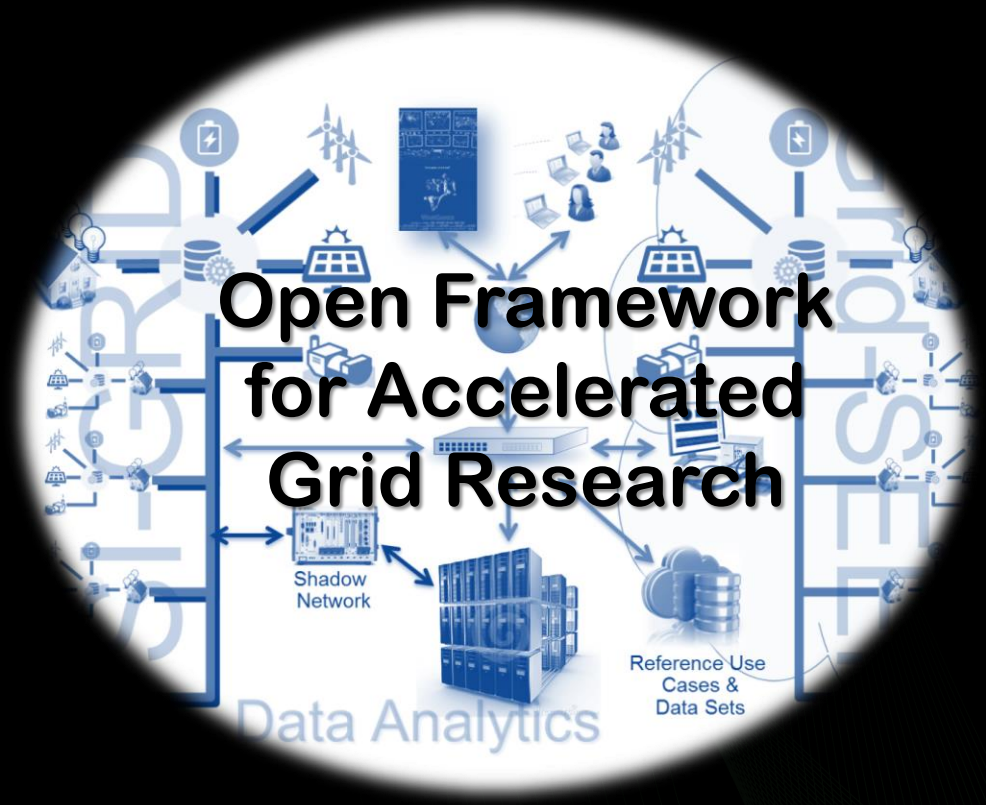
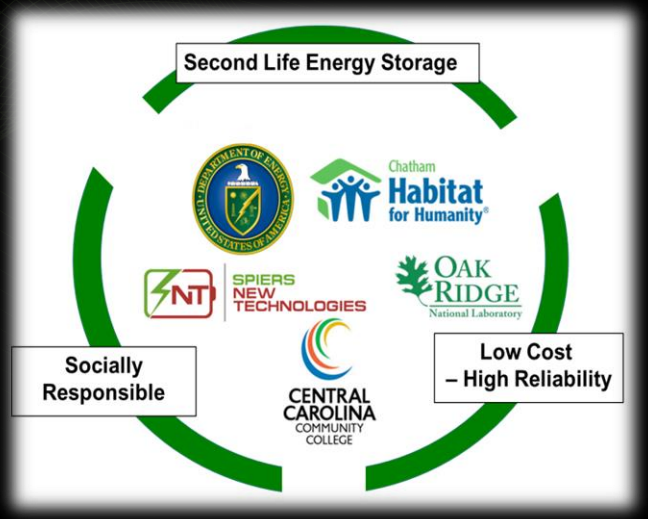
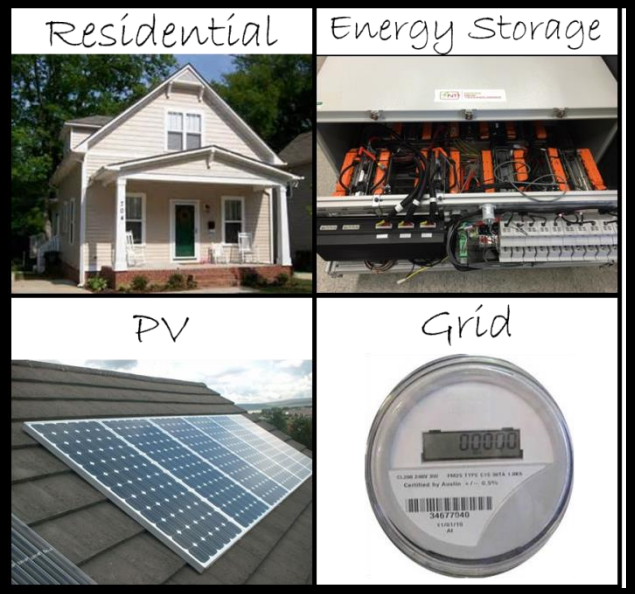
Additive Manufacturing
Integrated Energy


Open Framework
for Accelerated
Grid Research
Shadow
Network
Reference Use
Cases &
Data Sets
Data Analytics

AMIE – Additive Manufacturing and Integrated Energy





starkemr@ornl.gov

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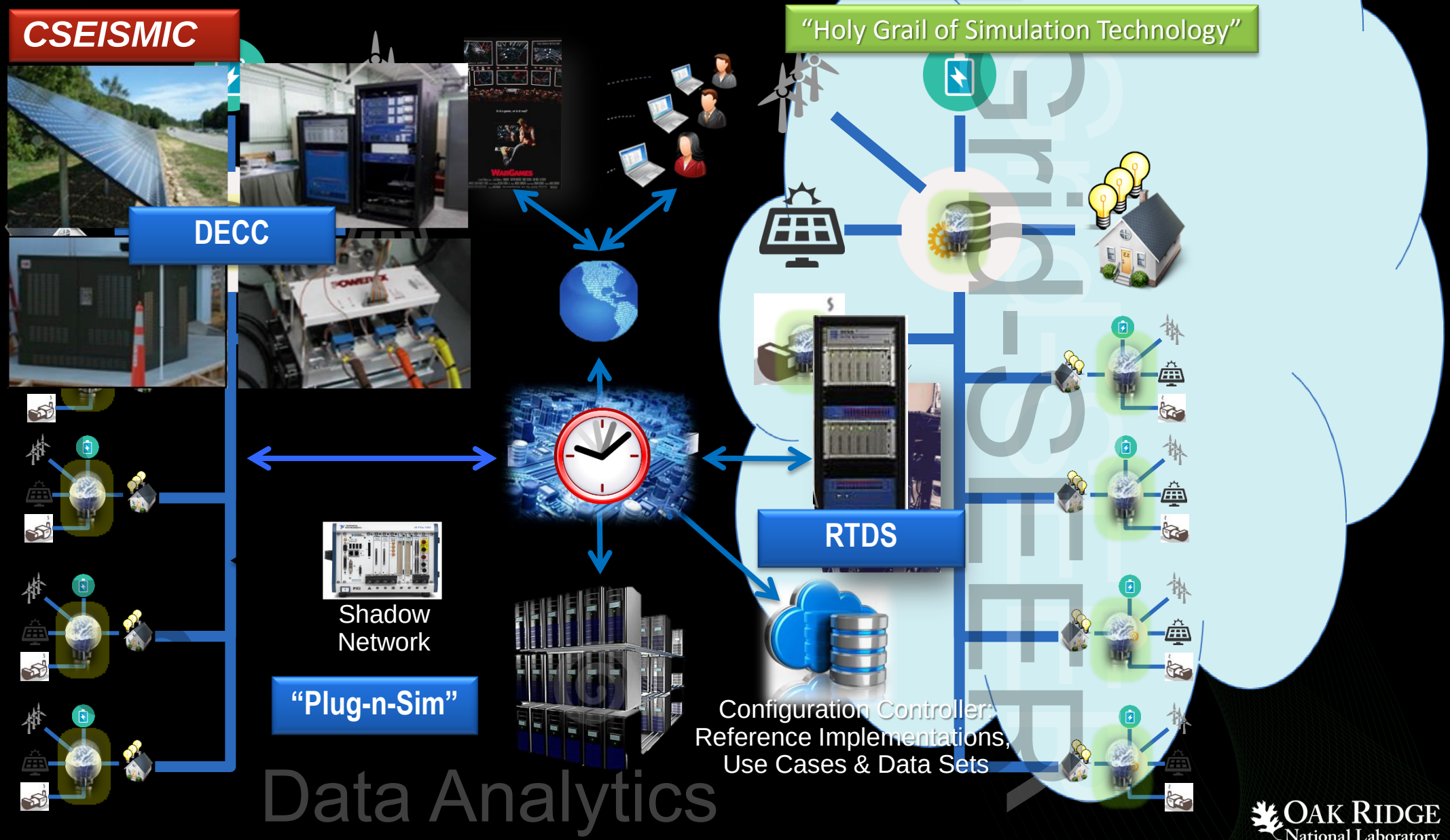
An open framework for advanced grid research…



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Time Sensitive Networking Demonstration at NI Week 2016

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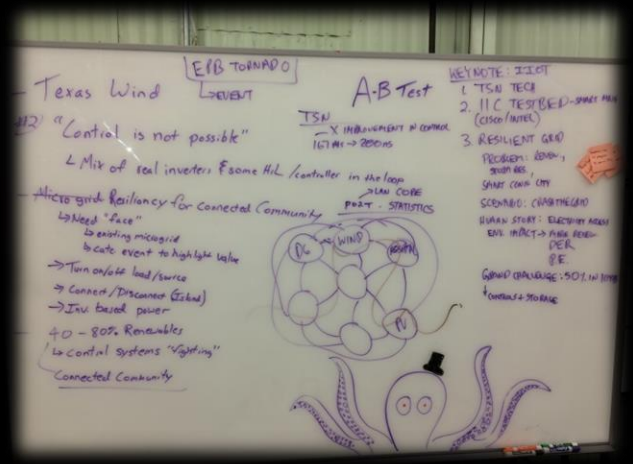
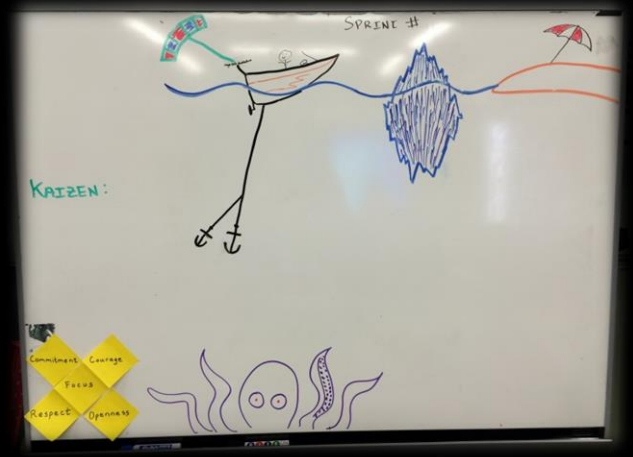
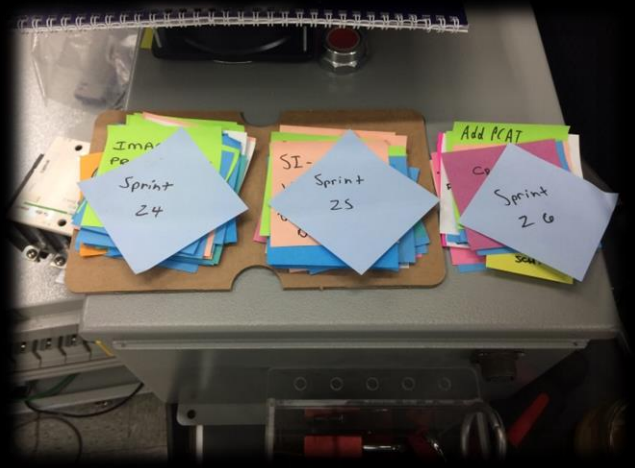
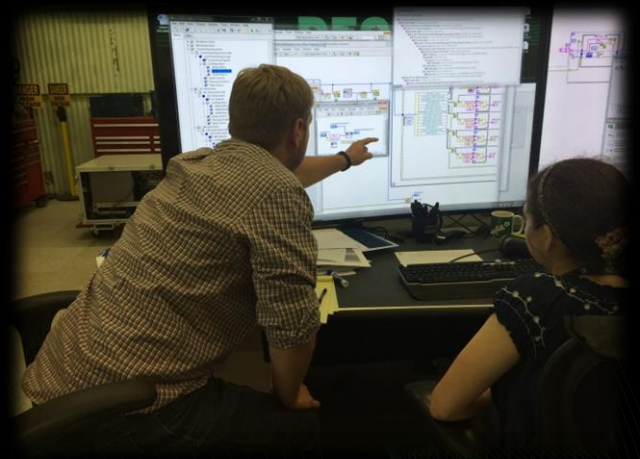
Some of our “Tools”









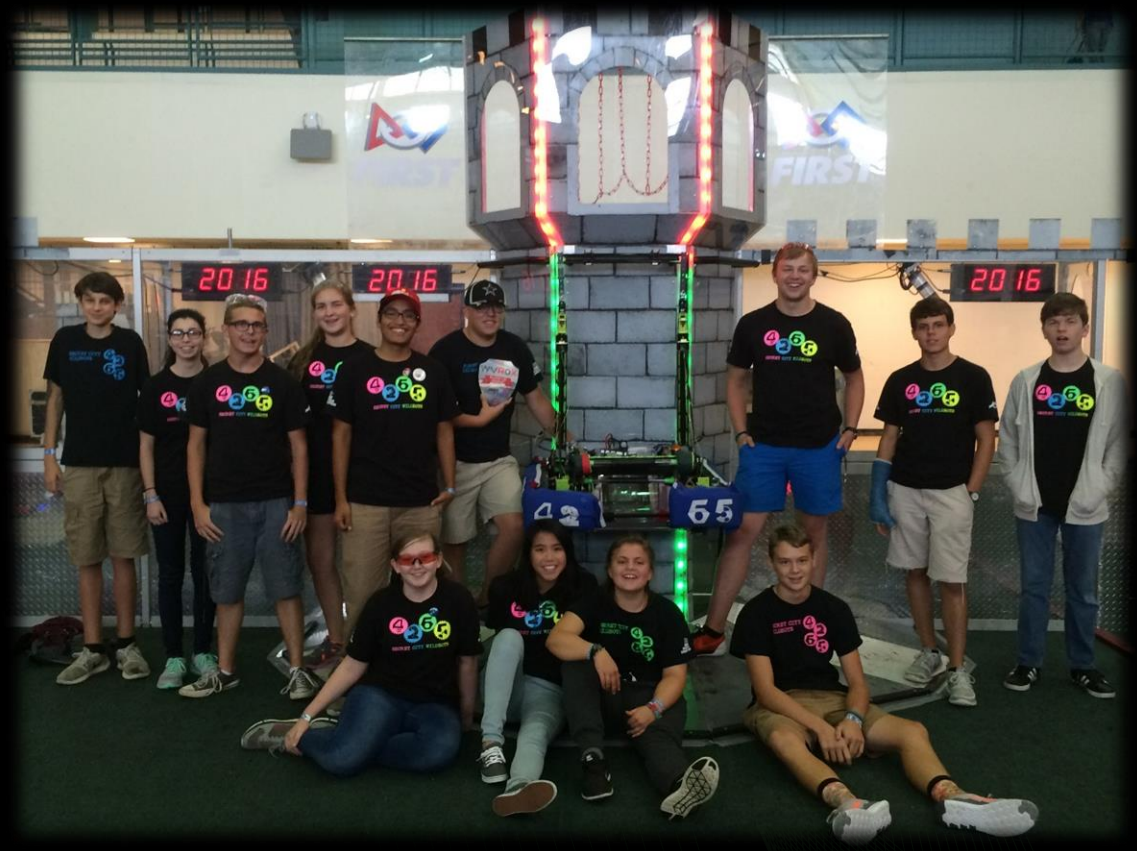
JIRA

slack

axosoft

FRC Team 4265 Secret City Wildbots

2015-2016 Season



2016 Off-Season

OAK RIDGE National Laboratory

What is FIRST?

Igniting young minds.

Teaching life skills.

Nurturing passions for science and technology.

Practicing "Gracious Professionalism®."

FIRST®

FOR INSPIRATION AND RECOGNITION OF SCIENCE AND TECHNOLOGY

SMOKY MOUNTAINS REGIONAL TN FIRST

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®

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®

FIRST Progression of Programs

FIRST®

25 years EXCEEDING EXPECTATIONS & CREATING REAL IMPACT

A decade of data and research shows that exposing kids to fun, exciting *FIRST* programs builds 21st 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.

STEM EXPOSURE

- ***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 →

STEM INTEREST & SKILLS

- ***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 →

EDUCATION & STEM CAREERS

- ***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 →

LONG-TERM OUTCOMES

- ***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

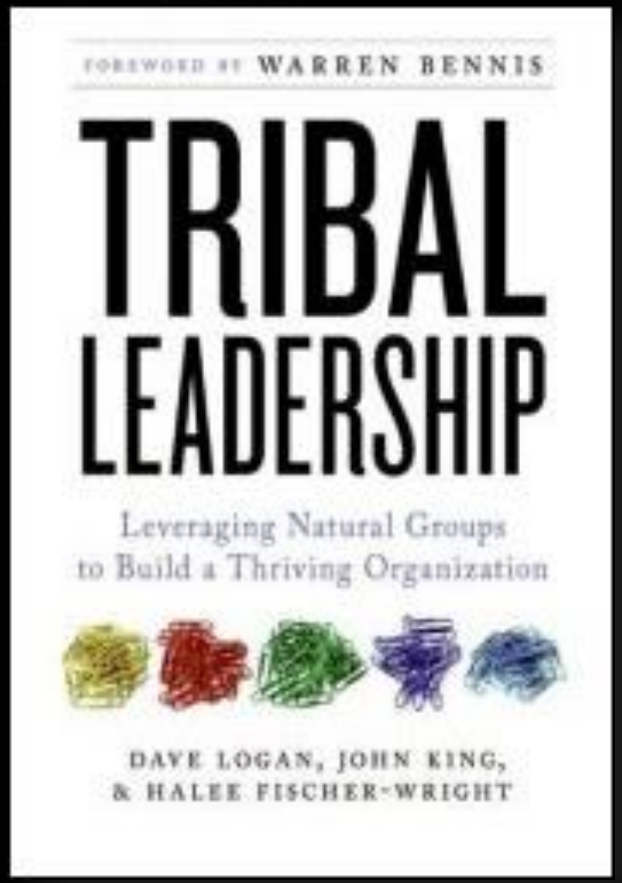
ULTIMATE IMPACT →

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

Inspired to learn more?
www.usfirst.org/aboutus/impact

FLL® = *FIRST*® LEGO® League
FTC® = *FIRST*® Tech Challenge
FRC® = *FIRST*® Robotics Competition

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

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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 …

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Challenge #3 … our resources

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

After being part the 2nd place alliance at the 2015 World Championship we were downsized from a shop w/ 4 lathes, 3 mills and ½ field to a classroom …

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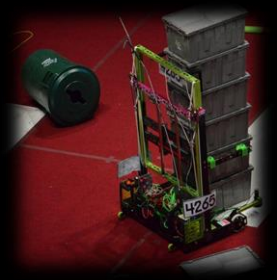
4265's Scrum Journey

SECRET CITY WILDBOTS



2015

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

Scrum-but…

2014

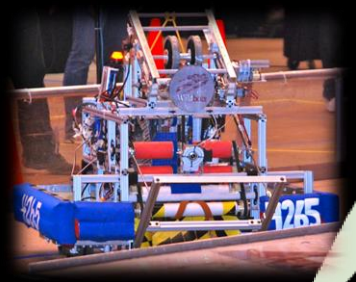
Kanban

- Flow
- Pull
- Make Work Visible

2013

eXtreme Manufacturing

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



Lean Startup

- MVP
- BML

2012

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

People/Joe.Justice x

Joe Justice <info@wikispeed.com> 11/2/13

to me

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!

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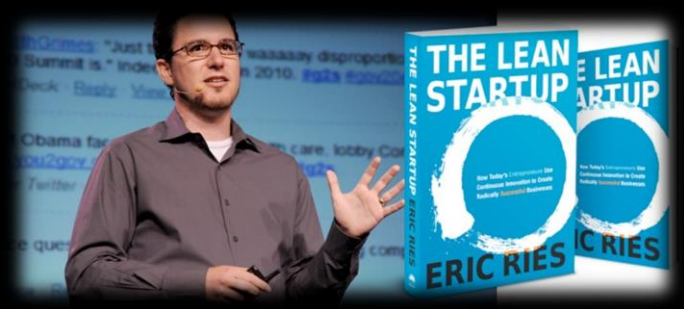
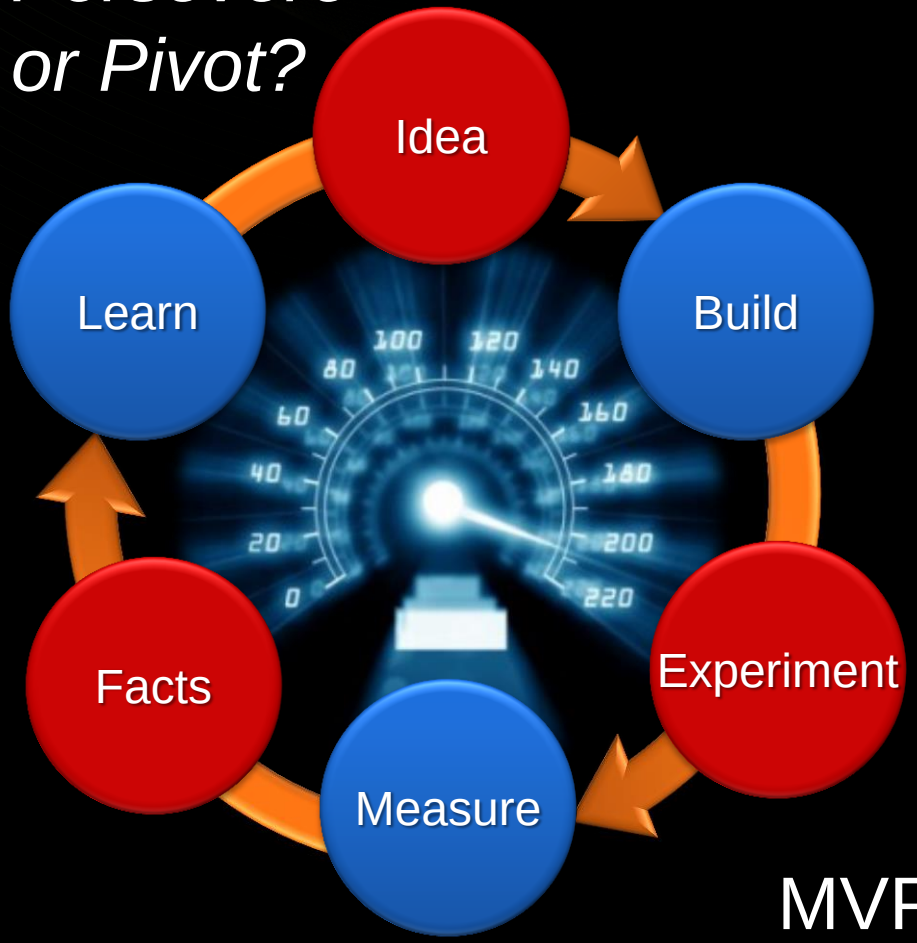
Build-Measure-Learn Feedback Loop



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

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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

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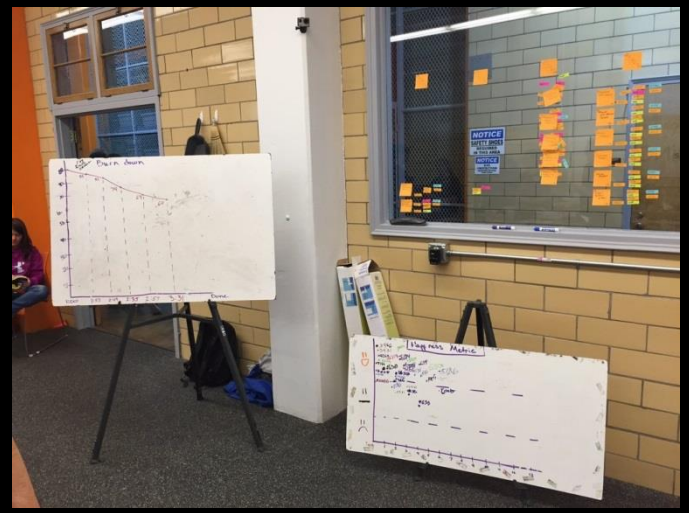
Scrum at the 2016 FRC Kick-Off Quick Build



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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

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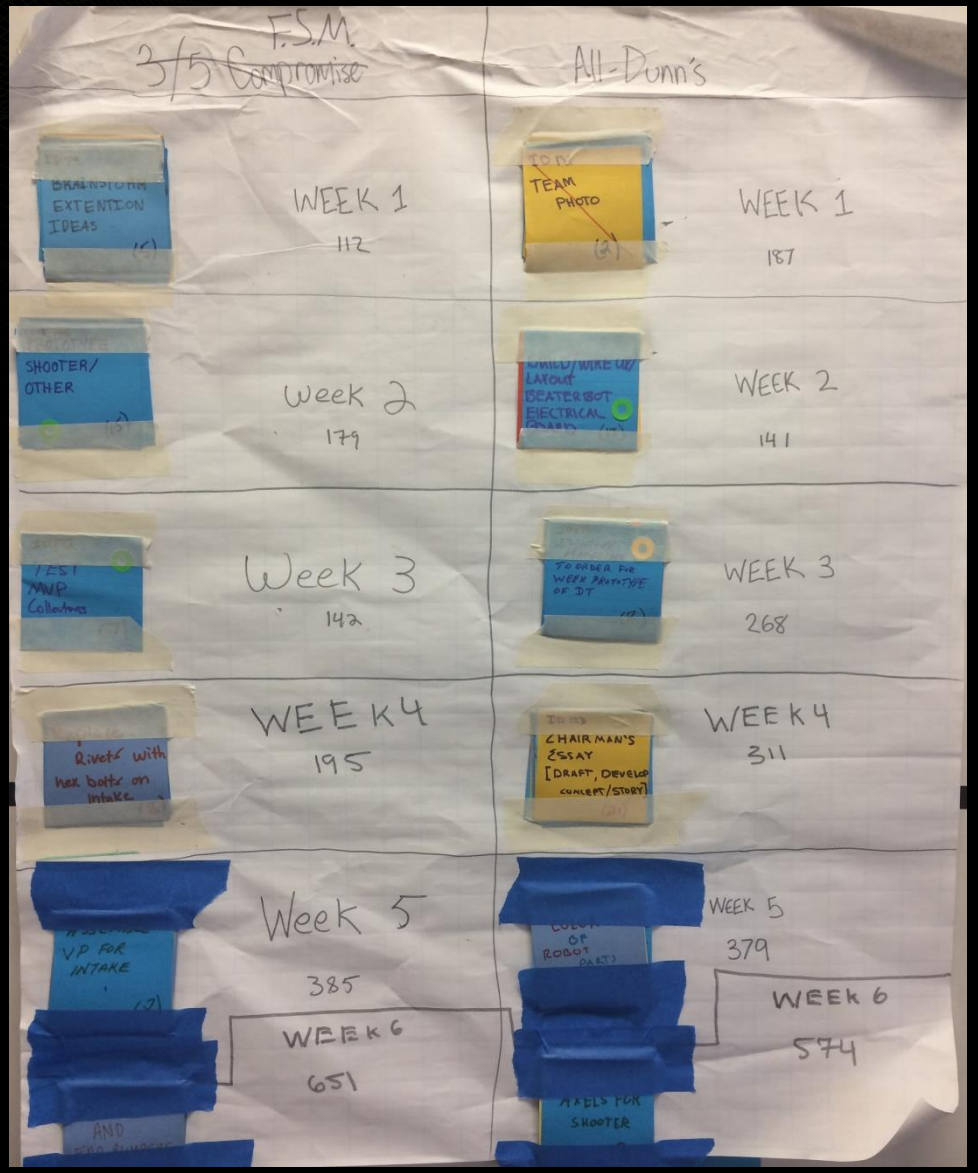
Scrum works



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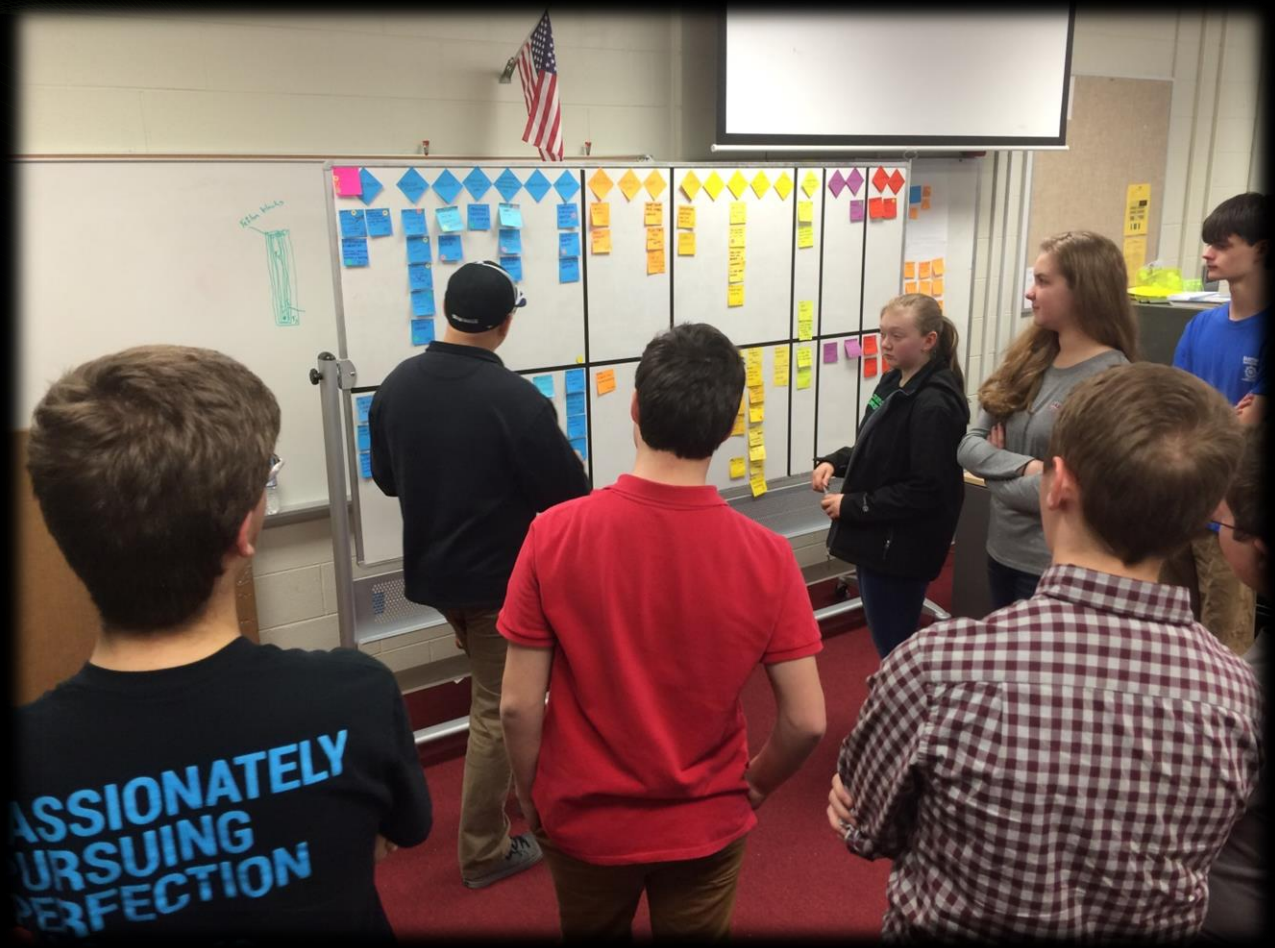
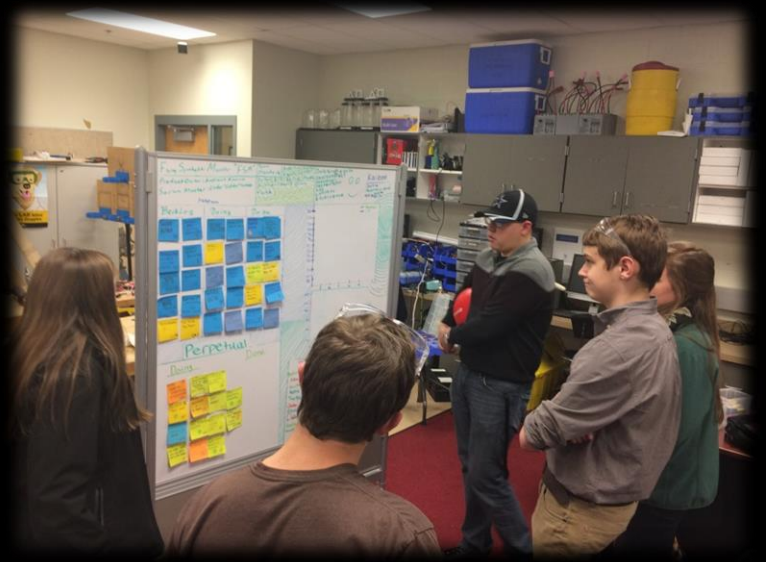
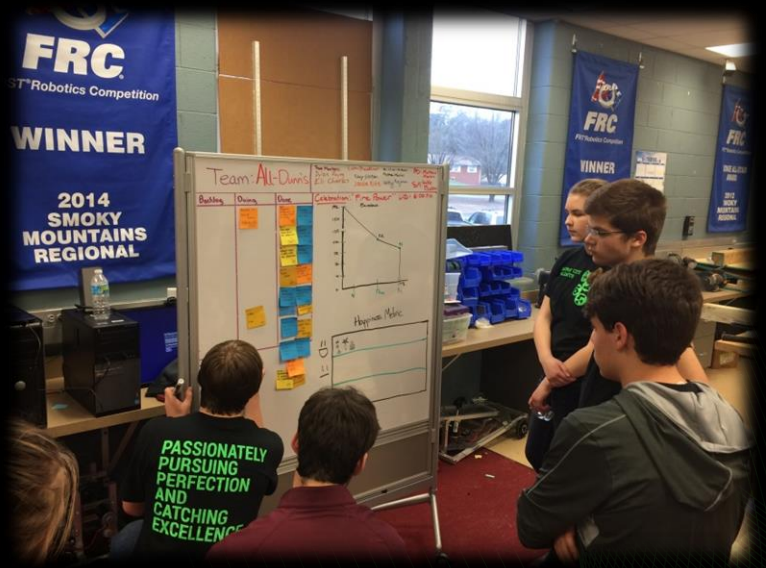
Scrum in Action







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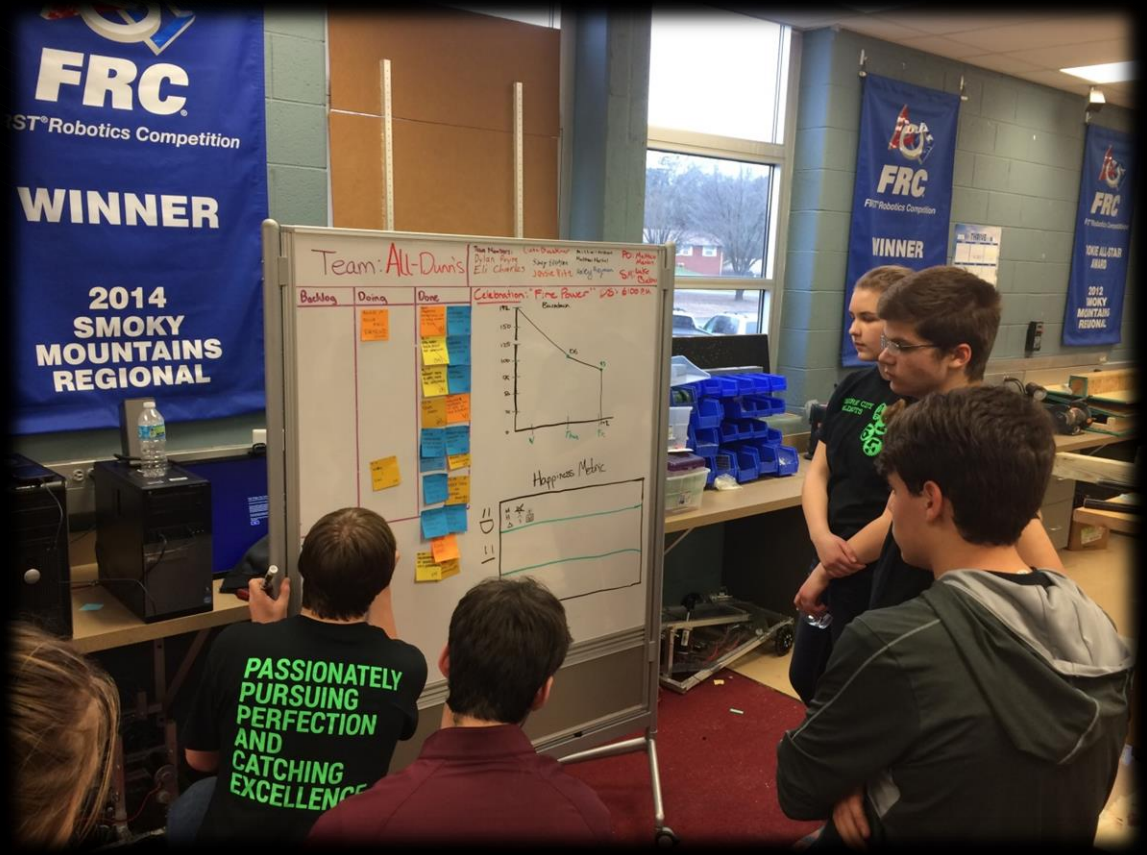
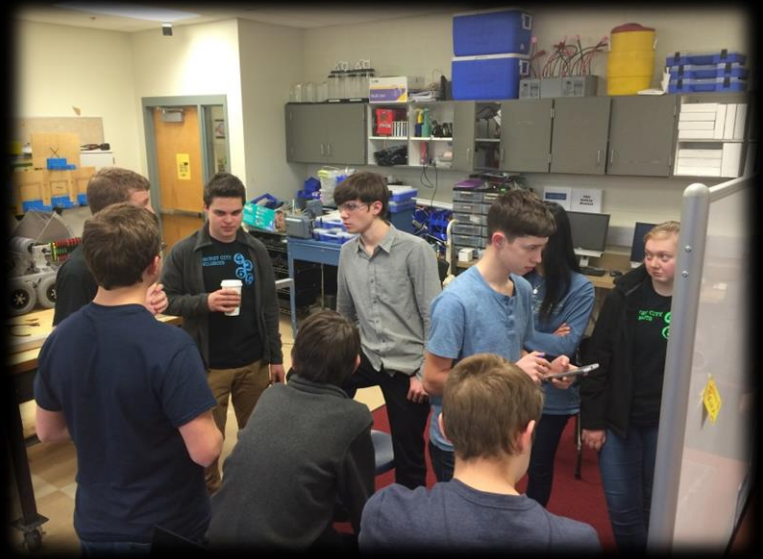
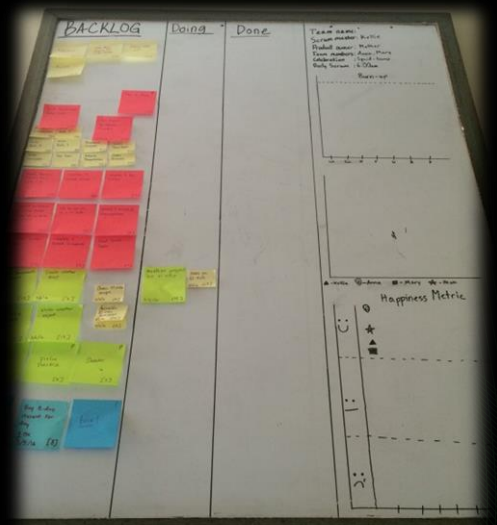
Scrum in Action







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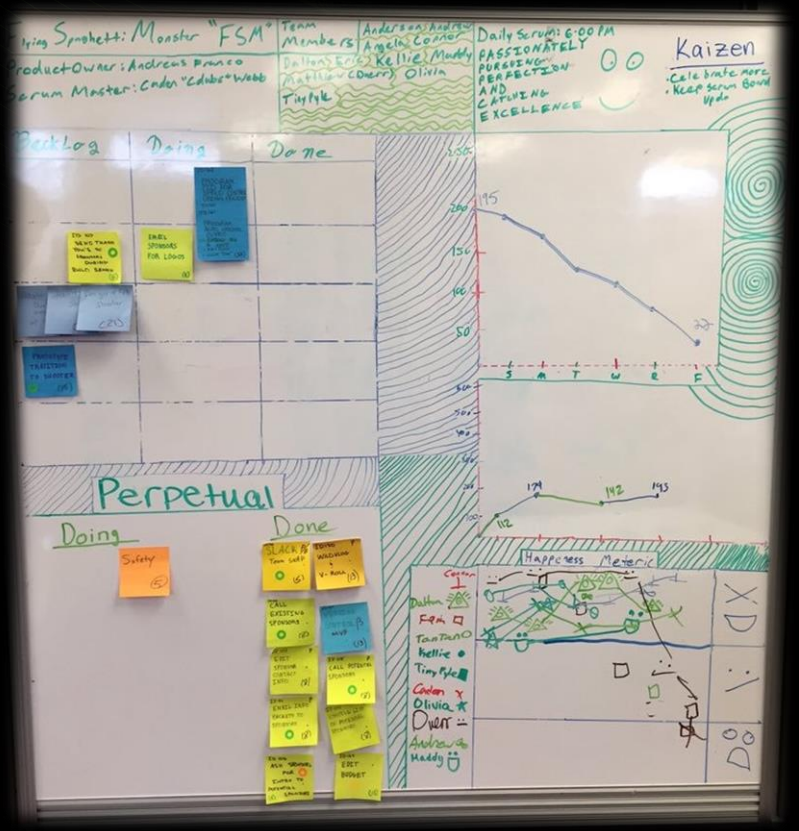
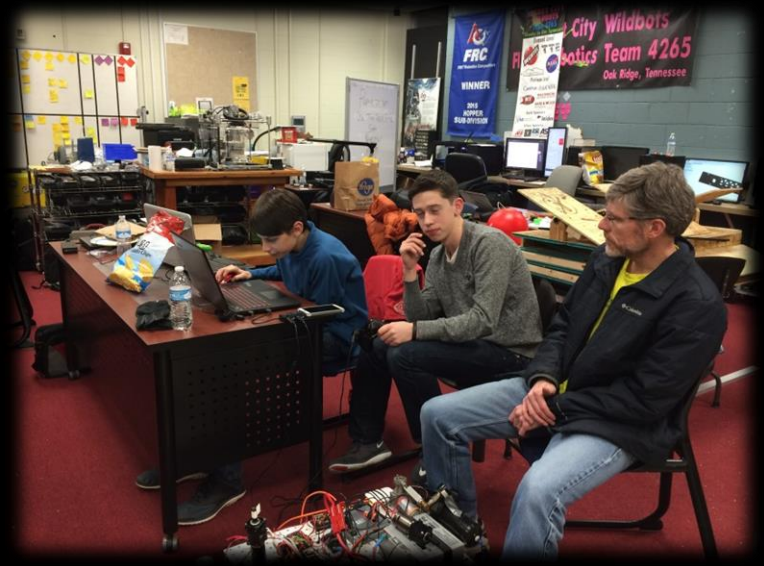
Scrum in Action





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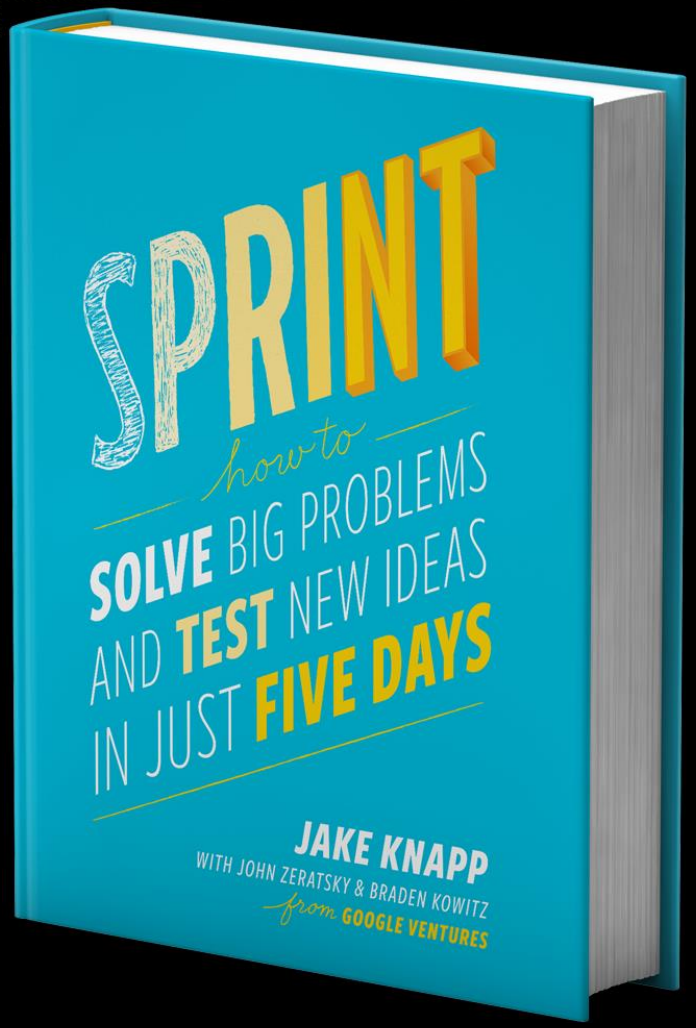
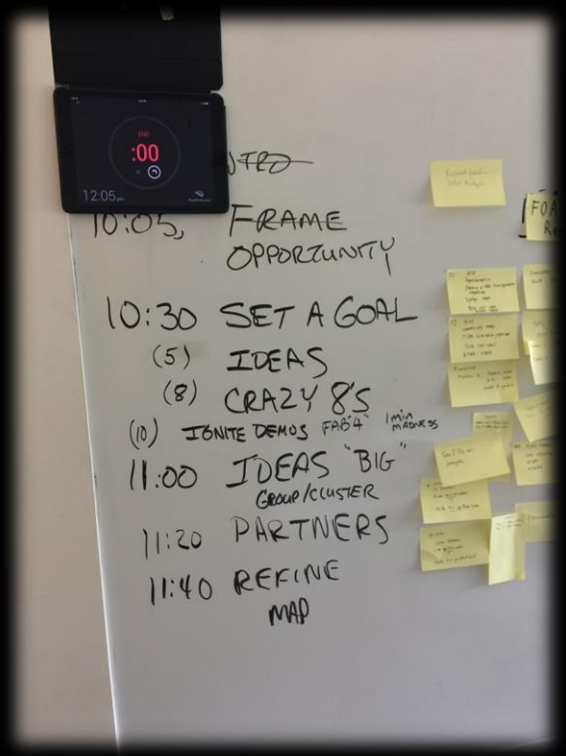
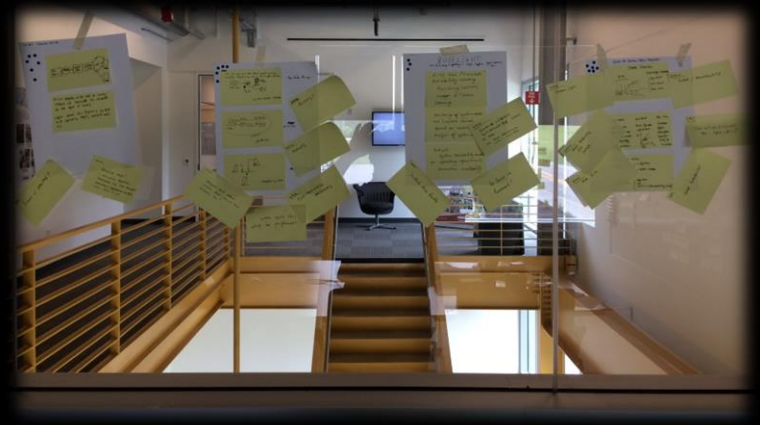
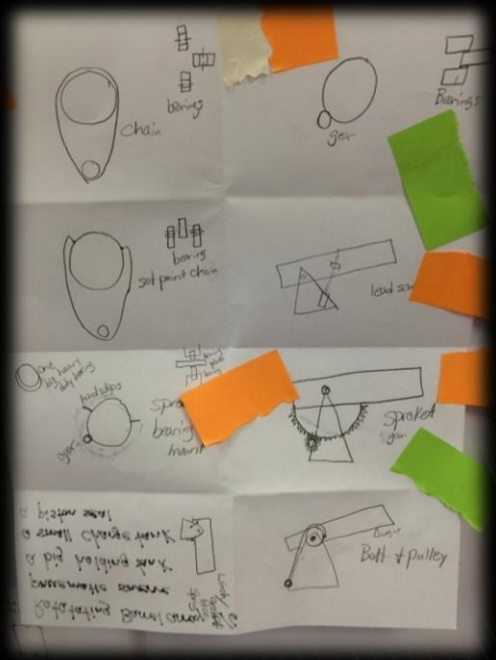
Introduced a Modified Version of the GV's Design Sprint









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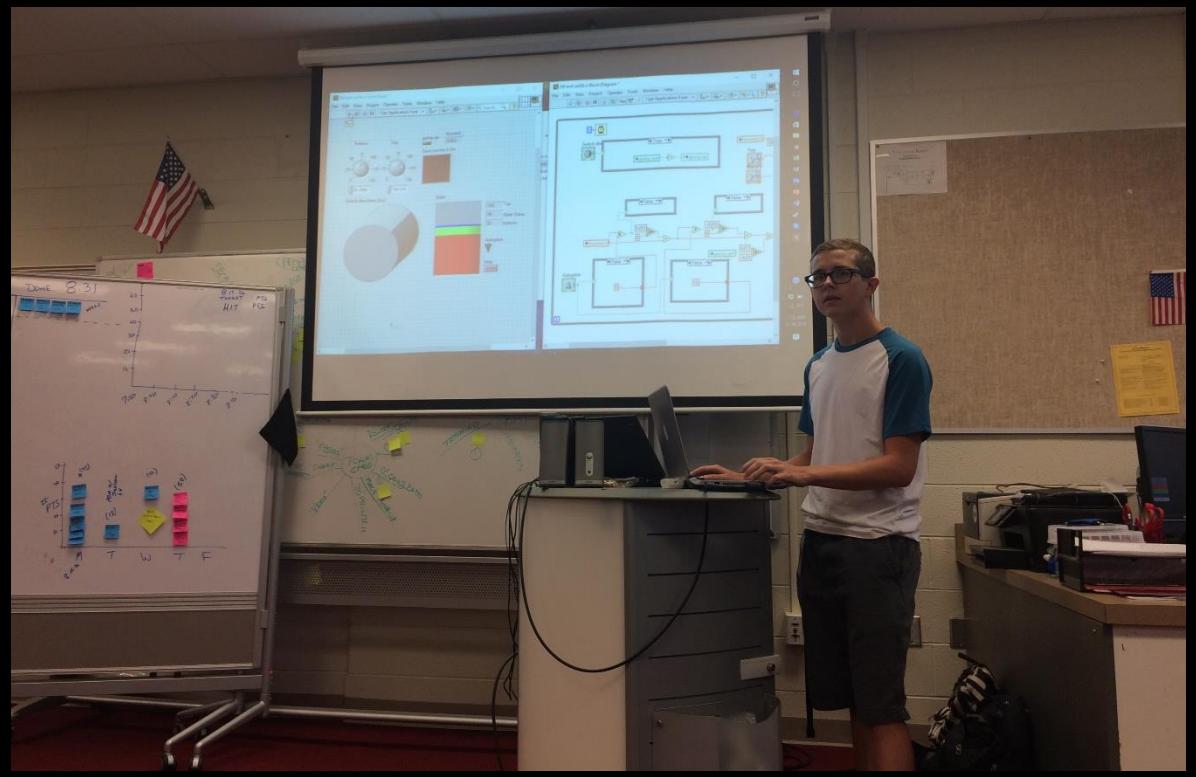
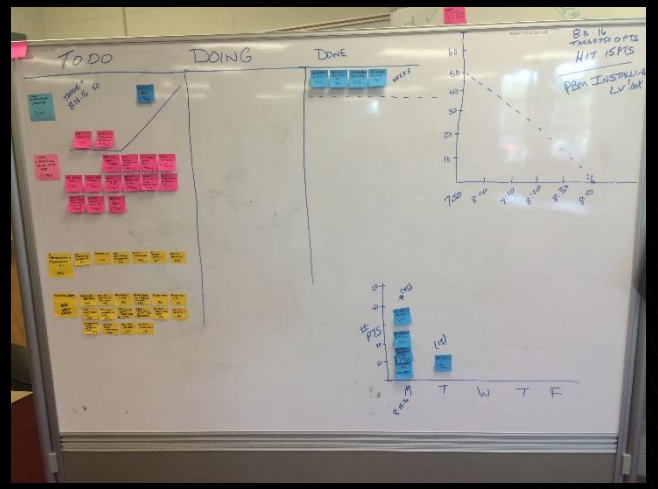
Scrum in the Classroom





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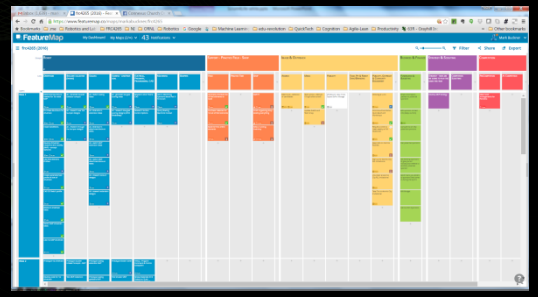
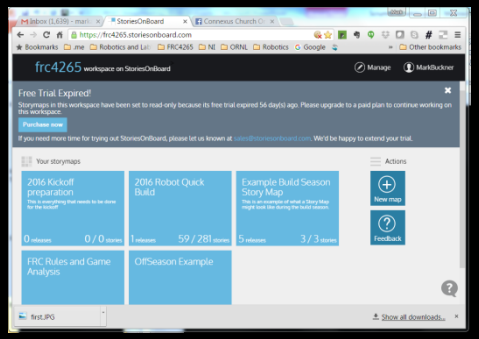
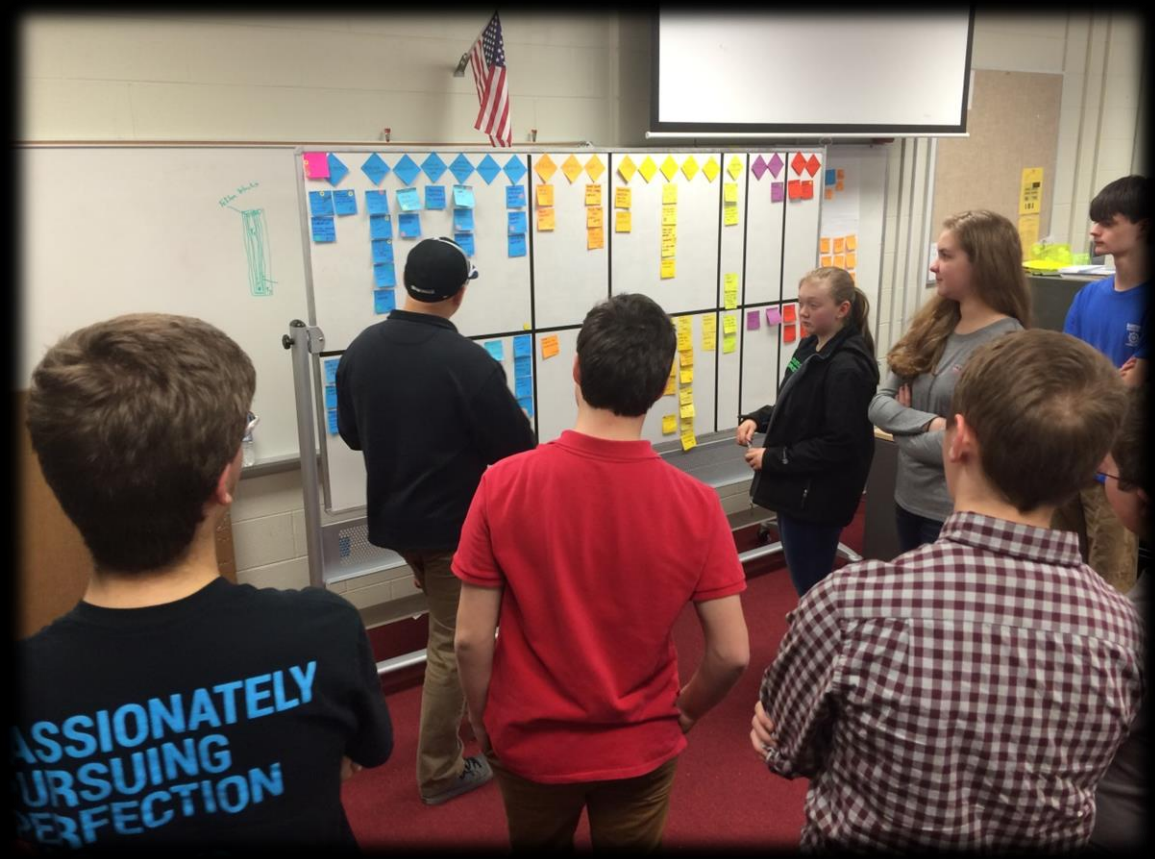
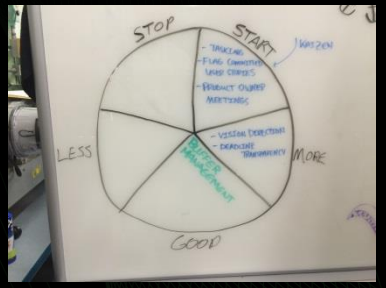
Some of our "Tools"









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FRC4265 has produced 3 Certified Scrum Masters

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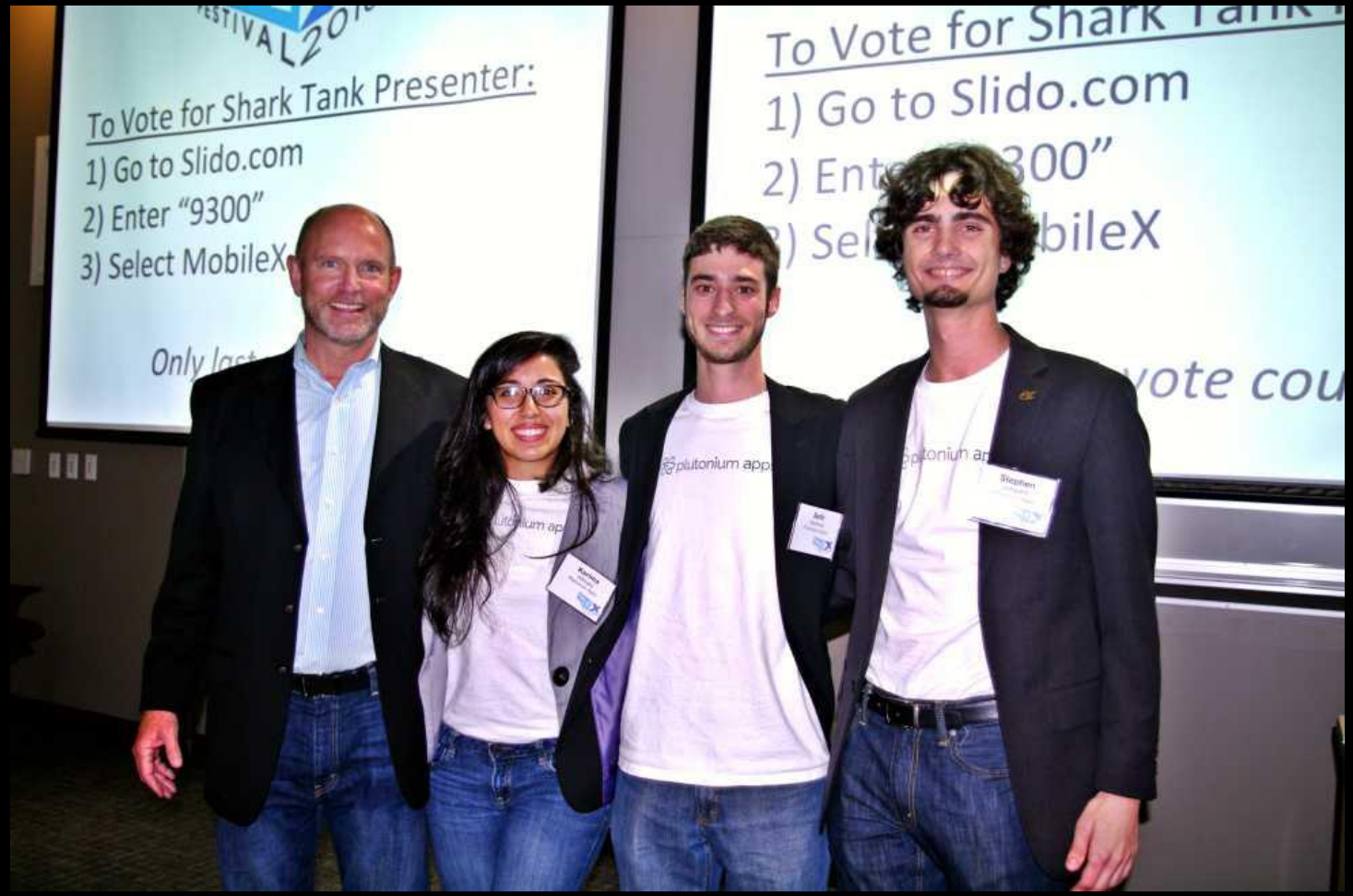
FRC4265 Alumni using Scrum…



"Tech-based startup Plutonium Apps, invited to audition for season eight of ABC's hit show "Shark Tank."

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Joe’s Advice for Secret City…

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What's Next…?

STEM Gym
Innovation Accelerator

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*

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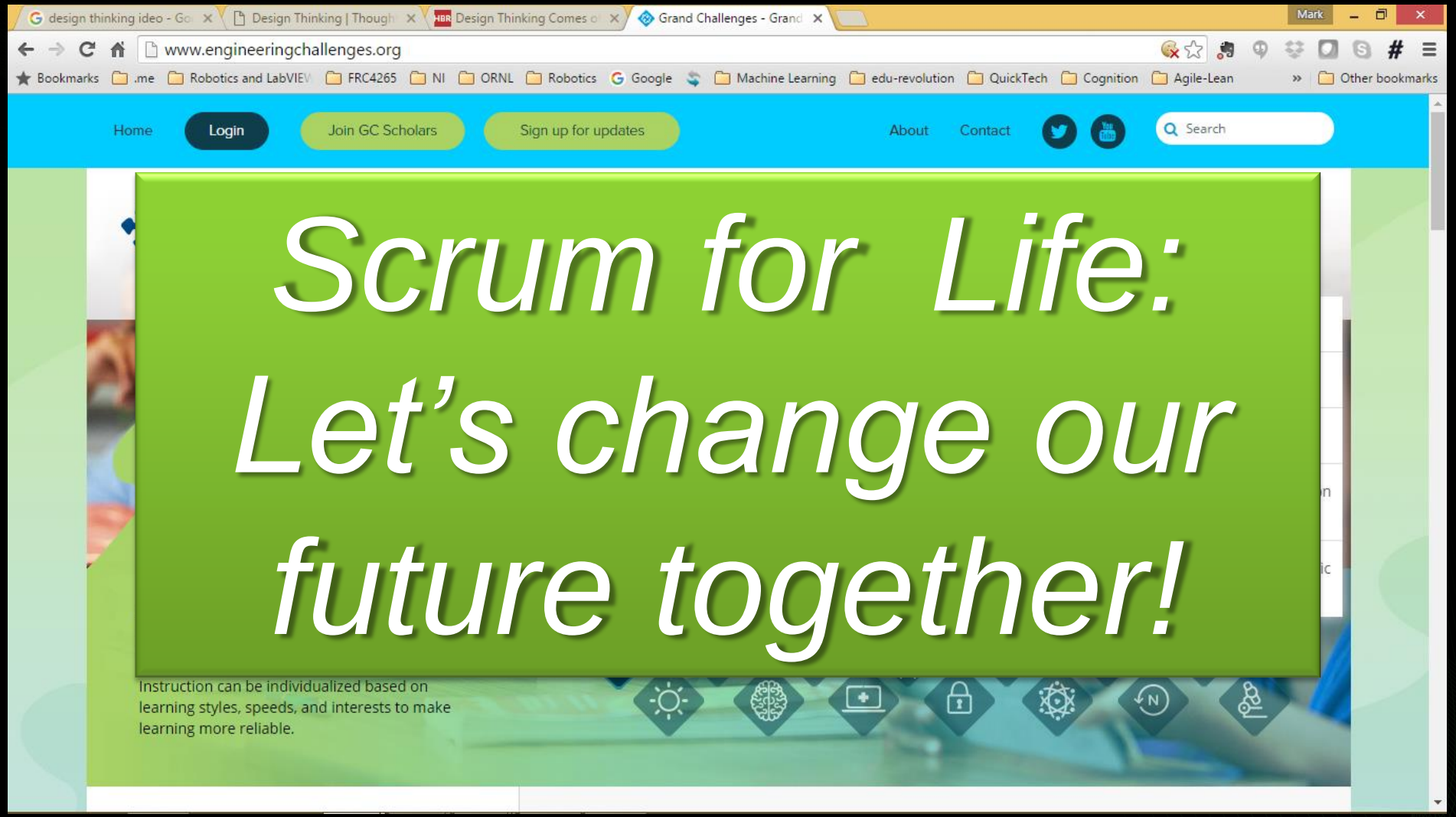
The Big Hairy Audacious Problems (BHAP) facing the world require high performing cross-functional teams…



http://www.engineeringchallenges.org/

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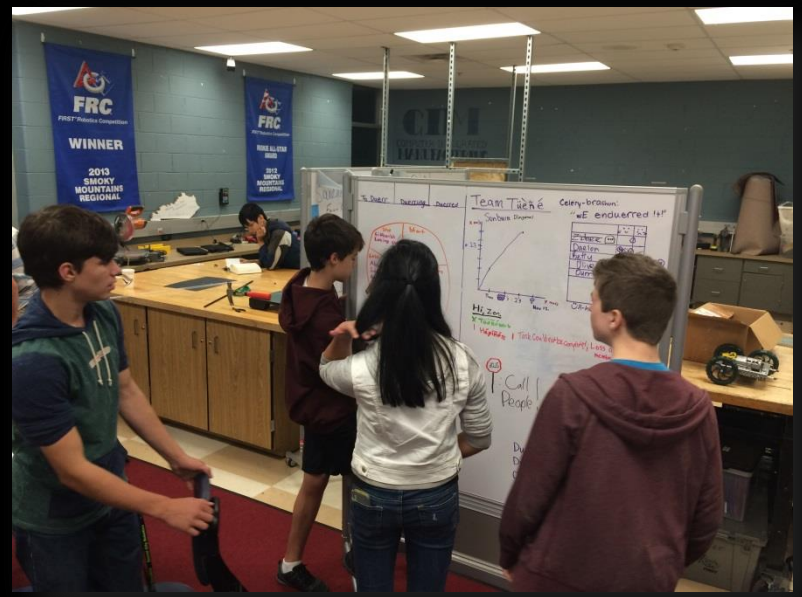
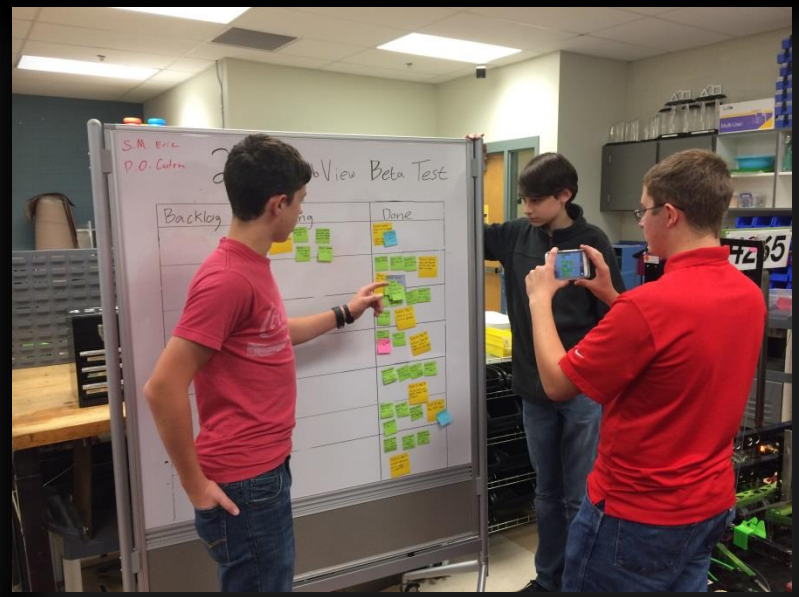
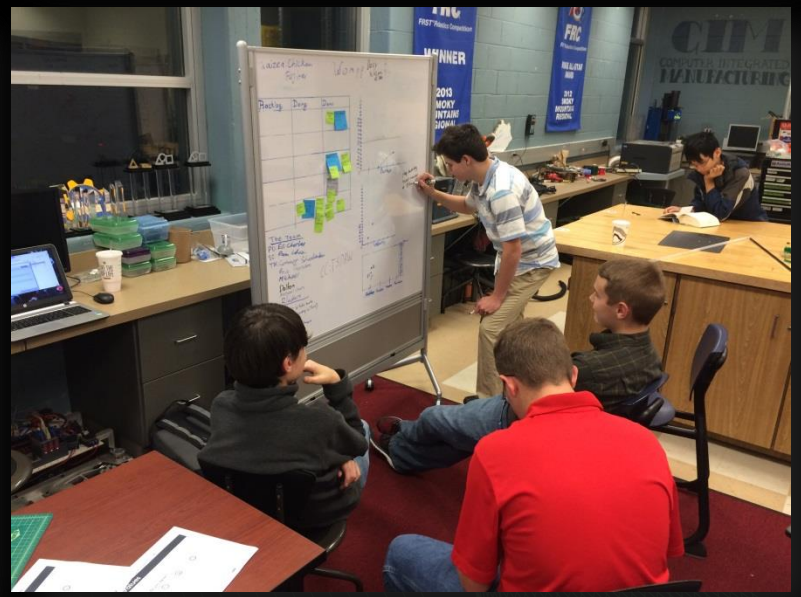
Questions?







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