Producing Cyber-Physical System Cybersecurity Talent: Lessons from the CyberTruck Challenge

Dr. Jeremy Daily
Maj. Martin “Trae” Span

SYSTEMS ENGINEERING
COLORADO STATE UNIVERSITY
Motivation and Purpose of the CyberTruck Challenge
A Tale of Two Markets
It was the worst of times……….
Really, really worst of times…
Our way of life is dependent upon transportation.

Ships share resources across continents.

Cars give us local mobility.

Airplanes give us national and global mobility.

And **TRUCKs** fuel every aspect of our consumer-based society, enabling our culture’s approach to logistics.
Without Trucks

Day 1:
- Medical supply delivery stops
- Fuel stations not resupplied
- Mail stops
- Just-in-time model breaks

Day 2-3:
- Food shortages & hoarding
- Bottled water, milk - gone
- ATMs / Cash – gone
- Fuel stations – gone
- Garbage collection – stops
- Rail & Port operations

Day 7:
- Car travel stops (no fuel)
- Hospitals run out of oxygen

Day 14:
- Clean water almost gone

Day 30:
- Clean water gone
What if it would be purposeful?
Who Wants to Hack a Truck?
Cybersecurity as a Systems Engineering problem

- Cybersecurity affects all phases of the lifecycle
  - Acquisition Phase
  - Utilization Phase
  - Production
  - Maintenance and Support
Mission Statement

**Develop talent** for the next generation workforce by bringing awareness, excitement, professional involvement, and practicum-based training to the heavy vehicle cybersecurity domain.

**Establish community** of interest for heavy vehicle cybersecurity that transcends individual companies or departments and reaches across disciplines and organizations to make a more universal and experienced base of engineers and managers.
Class of 2022

Photo taken on June 22, 2022 in the Sports and Expo Center of Macomb Community College, Warren, Michigan
2022 Student and University Participation
44 Students from 20 Universities

- Western Governors University, 2
- Virginia Tech, 3
- University of West Florida, 1
- University of Texas at Arlington, 3
- University of Michigan, Dearborn, 1
- University of Louisiana at Lafayette, 1
- University of Detroit Mercy, 2
- University of Colorado, Colorado Springs, 3
- University of California, San Diego, 1
- University of Arizona, 1
- University at Buffalo, 1
- Tennessee Technological University, 1
- Purdue University, 2
- Penn State Harrisburg, 1
- California Polytechnic State University, 1
- Colorado State University, 6
- Colorado Technical University, 1
- Eastern Michigan University, 3
- Northern Michigan University, 4
- The Ohio State University, 6
Student Participation Growth over 5 Years

<table>
<thead>
<tr>
<th>Year</th>
<th>Students</th>
<th>Universities</th>
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<tbody>
<tr>
<td>2017</td>
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CyberTruck Challenge Participation

Number

Year

2017 2018 2019 2020 2021 2022

Students Universities
Student Expectations

All student expenses are covered, including:
  – Travel
  – On-site Meals
  – Lodging

Student participants are expected to:
  ▪ Apply to the program in the spring
  ▪ Address the importance of the mission
  ▪ Answer a technical question on J1939
  ▪ Attend the entire program
  ▪ Actively participate in the assessments
  ▪ Present results at the end of the week
  ▪ Become ambassadors for the CyberTruck Challenge and vehicle cybersecurity
Thank you to the CyberTruck Challenge sponsors
Description of Activities

Real Vehicles
Sponsors bring new vehicles as assessment targets. Company engineers work with students and mentors.

Real Hackers
Experienced mentors from professional security firms help coach students through exercises and security related assessments.

Real Fun!
Students have a unique opportunity to solve challenging problems, learn from experts and experience engineering in the heavy-duty industry.
# Cybertruck Challenge 2022 Schedule

<table>
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<th>Sunday, 19 June</th>
<th>Monday, 20 June</th>
<th>Tuesday, 21 June</th>
<th>Wednesday, 22 June</th>
<th>Thursday, 23 June</th>
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<td><strong>Group A</strong></td>
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<td><strong>Breakfast</strong></td>
<td><strong>Legal Briefing</strong></td>
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<td><strong>Ghidra</strong></td>
<td><strong>Vehicle Network Security</strong></td>
<td><strong>Assessment</strong></td>
<td><strong>Student Team Briefs (30 minutes each group)</strong></td>
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<td><strong>Cryptography</strong></td>
<td><strong>Evaluation</strong></td>
<td><strong>Assessment</strong></td>
<td><strong>Assessment</strong></td>
<td><strong>Awards</strong></td>
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<td><strong>Software RE</strong></td>
<td><strong>Truck Systems and J1939</strong></td>
<td><strong>Android</strong></td>
<td><strong>Embedded Firmware Patching</strong></td>
<td><strong>Assessment</strong></td>
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<td><strong>Ghidra</strong></td>
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<td><strong>Assessment</strong></td>
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<td><strong>Introduction to Learning Platforms</strong></td>
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## Snacks
- Snacks will be served each afternoon.

## Survey
- All participants:
  - Welcome and Review
  - Embedded Firmware Patching
  - Decompilation with Ghidra
  - Software Reverse Engineering
  - Truck Systems and J1939
  - Android
  - Cryptography
  - Vehicle Network Security
  - Trucking Industry

## Instructor, Affiliation
- Karl Heimer [MEDC] & Sponsor Representatives
- Ang Cui, Edward Larson [Red Balloon Security]
- Justin "Ozzie" Osborn [JHU-APL]
- Erin Cornelius [GRIMM]
- Jeremy Daily [Colorado State University]
- Eduardo Novella [Now Secure]
- Ben Gardiner [NMFTA]
- Hannah Silva [Leviathan Security]
- Urban Jonson [Serjion]

## Verified
- Yes

## Legend
- **Lecture / Demo**
- Interactive lecture and activities
- Meals will be catered on-site
- On vehicle assessments
- Can hack, study, rest, leave, etc.
- No access the facility
- Limelight Grill on VanDyke Ave
# CyberAuto Challenge Example Schedule

## Welcome & Inprocessing

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<th>0700-0730</th>
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<th>Tuesday 23July2019</th>
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<td>Welcome</td>
<td>CANBUS 1</td>
<td>Software RE</td>
<td>Sleep / Recover / Clear Hotel</td>
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<td>Site Opens</td>
<td>Lab Orientation</td>
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<td>RDE and Planning</td>
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Truck Systems and SAE J1939

By Jeremy Daily

Associate Professor of Systems Engineering at Colorado State
Software Reverse Engineering
By Erin Cornelius
Senior Security Researcher
Trucking Industry
By Urban Jonson
SVP Information Technology and Cybersecurity
Cryptography
By Ben Gardiner
Researcher, National Motor Freight Traffic Association, Inc.
Heavy Vehicle Network Security

By Hannah Silva
Security Researcher
Using Ghidra
By Justin “Ozzie” Osborne
Security Researcher
Android Security
By Eduardo Novella
Mobile Security Researcher
Patching Embedded Systems

By Wyatt Ford and Andrés Hernández

Software Engineers at Red Balloon Security
Assessment Period: Forming Teams

A typical team would include

- 4-6 Students
- 1-2 Mentors
- 1-3 Industry
- 1-2 Government
- 1 named Vehicle Boss

Vehicle Bosses can stop an assessment at any time.

Results and presentations only go to the vehicle boss.

Students from the same school are encouraged to join separate teams.

In 2022, 8 teams were formed

Each team has 30 minutes to present their results at the end.
Assessment Period: Applying the hands-on lecture content
Assessment Period: Students Explore with Mentors
Student Presentations

Results from the assessment are presented to the other participants.

This is a CLOSED event; only participants who have agreed to the non-disclosure agreement can attend.

Student reports are not archived or available to be released.

Results from the assessment are communicated to the equipment engineers.
Industry Perspective of the CyberTruck Challenge
CyberTruck Challenge Experience

Students learned

Students had fun
Typical Student Team and Project
CyberTruck Challenge, How was it?

Students learned...
Students had fun ...
Industry left with action items

Action items, redacted
## Why Participate?

<table>
<thead>
<tr>
<th>Why Participate</th>
<th>Details</th>
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<tbody>
<tr>
<td>Workforce Development</td>
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<tr>
<td>Demonstrate high-tech nature of commercial vehicles</td>
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<tr>
<td>Attract top students to the industry</td>
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<tr>
<td>Improve Current Workforce</td>
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<tr>
<td>Continuous Product Improvement</td>
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</tbody>
</table>
Industry Perspective

What to bring?
- Truck, trailer
- Electronic systems
- Bench setups
- Diagnostic tools
- Telematics

Who to bring?
- People who can mentor
- People who need to learn
- Throughout Organization

Network
- Industry peers
- Academics
- Security researchers
- Students
- Fleets
Industry products will be there …

… even if they are not.
Save the Date

CyberTruck Challenge 2023
June 12 – 16, 2023
Macomb Community College
Warren, Michigan

www.cybertruckchallenge.org
Additional CyberX Events

- Cyberboat Challenge 2022
  - 1st Time Offering
  - 14 Students from 5 Universities

- CyberAuto 2022
  - 32 of students from US, UK, and Germany
  - Sponsored by Ford, GM, and Toyota

- CyberTractor 2022
  - 1st Time Offering
  - Sponsored by John Deere

CyberBoat Challenge Recap from 2022

Snow in Colorado, May 21, 2022, starting trip to Michigan.
Great Lakes Research Center, Michigan Technological University, Houghton, MI
CyberBoat Challenge, Lessons
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<td>RF Protocol Exploitation (Libertas &amp; Fathom5)</td>
<td>M-Tech staff time</td>
<td>REPORTS</td>
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<td>Water Safety (USCG)</td>
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<td>Maritime Sensor Exploitation (Fathom5)</td>
<td>Maritime J1939 Demo (Daily)*</td>
<td>Release</td>
<td>1330-1400</td>
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<td>How to Conduct an Assessment* (AIS)</td>
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<td>Assessment Preparation and Planning</td>
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<td>Informal Welcome Reception (Bonfire Grill)</td>
<td>Dinner (Bonfire Grill)</td>
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<td>After 2100</td>
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Version:20220513
CyberBoat Challenge, Indoor

Smart Beacon

“Grace” training aid
CyberBoat Challenge, Outdoor

Students connecting to the ski boat J1939 network.
CyberBoat Challenge, Testing

On water testing produced fault codes...
CyberBoat Challenge, Presentations

Students show off their learning from the week.
Takeaways and Systems Engineering Considerations

- Traditional IT security doesn’t keep up with the demand for cyber-physical system security talent
- Strong need for cybersecurity engineering talent
  - Formal degree programs insufficient
- Need a model to train and excite a cyber-physical systems workforce
  - Requires community sponsorship and mentorship
  - Each cyber event needs a champion
- What future cyber challenges are of interest?
  - CyberDrone, CyberRail, CyberGrid, CyberSat, CyberGrid?
THANK YOU!

Contacts:
Jeremy Daily, jeremy.daily@colostate.edu, +1 937.238.4907
Karl Heimer, karl.heimer@outlook.com, +1 248.270.0117
Typical Slide Title (2 Column)

- Level 1 bullet text 1
  - Level 2 bullet 1
    • Level 3 bullet 1
    • Level 3 bullet 2
  - Level bullet 2
- Bullet text 2
- Bullet text 3

- Level 1 bullet text 1
  - Level 2 bullet 1
    • Level 3 bullet 1
    • Level 3 bullet 2
  - Level bullet 2
- Bullet text 2
- Bullet text 3