

IGEM Grant Report

Progress (due Jan. 1) Annual (due Jul. 31) Final (due Aug. 31)

IGEM Grant # 23-001 Principal Investigator Michael Haney

Submission Date 12/29/2022 Primary Institution University of Idaho

Section 1: Summary of project accomplishments for the reporting period and plans for the upcoming reporting period.

“Library of Reconfigurable Immersive Attack and Defend Scenarios for Cybersecurity Research and Workforce Development“

The University of Idaho and Idaho State University are collaborating to build a new Reconfigurable Attack-Defend Instructional Computing Laboratory (RADICL) at the University Place campus in Idaho Falls. This novel, immersive environment is integrating real physical processes, full-scale enterprise IT systems, and Internet-scale cyberattacks on-demand to offer researchers, students, and trainees a controlled live-fire environment like no other currently available. The laboratory will be a hybrid virtual and physical environment allowing access from across the state through the Idaho Cyber Range.

The new lab spaces and equipment are already being used to train cybersecurity professionals, including full and part time students, active professionals, and high school students and teachers, via scenario based live-fire exercises in an immersive research environment. This is an important step in building the workforce necessary to secure Idaho’s industry and government and to making Idaho a leader in the field of cybersecurity.

Initial efforts have resulted in multiple industry partners and academic institutions engaged along with UI and ISU students and faculty, multiple grant proposals and research papers submitted, and significant equipment acquisition and deployment. Plans for the upcoming reporting period and near-term future will meet our goal of creating a state-of-the-art research and training facility for the benefit of all Idaho academic institutions and industry partners.

Section 2: High-level summary of budget expenditures for the period just completed.

- Funding of \$693,000 for FY23 is split between UI and ISU co-PIs to manage (\$300,000 to ISU as sub-award, \$393,000 allocated to UI).
- Overall this project is ahead of schedule and on budget.
- Focus during this initial grant reporting period has been on acquisition of equipment, materials, supplies, and renovation of available facilities, having expended or encumbered just under \$474,000:
 - Private Cloud Computing
 - Cyber Shooting Gallery
 - Operations Technology (OT) Training Workstations
 - Information Technology (IT) Training Workstations
 - Nuclear Balance of Plant and related energy sector research capabilities
- Student and faculty support, post-doctoral fellow search, and related human capital expenses are on target.

During the initial period of this grant, our plan has been to focus on the renovation of our existing laboratory spaces and acquire necessary materials and equipment to enable future

training and research. The budget plan explicitly called for the support of one full-time Master's of Science student, and several specific purchases. We have been able to successfully combine our funds with other sources available and strategically address facilities upgrades, including expanding into an additional laboratory space of 600 square feet for "Balance of Plant" and power substation equipment, which will be connected via networking in the next reporting period. This brings the total laboratory and training space supported by this grant to 3000 sf. at the University Place campus in addition to our plans to incorporate available space at the CAES and Cybercore Integration Center facilities. We were also able to engage multiple other students to support these efforts, as discussed in Section 4 of this report. These resources combined to make our team more successful and ahead of plans in this initial period.

Facilities, materials, and equipment under this FY23 HERC IGEN grant specifically fall under one of several categories. In order to support the backbone of our "cyberspace" environment, we have created a private cloud environment that will support the reconfigurable virtual spaces for cybersecurity and energy research and training. This was done first through the immediate acquisition of refurbished computing equipment to expand our existing environment. Secondly we had a significant outlay of \$100,000 in the first weeks of the project to purchase new cloud computing equipment which, due to supply chain constraints, has only very recently arrived. Combined, the computing capacity is many times greater than previously available. Current spending on our private cloud computing environment is over \$137,000. Remaining funds will be allocated to improve our network equipment and connecting to the Idaho Cyber Range.

Next, we focused on the acquisition of the materials and supplies to begin building our "Cyber Shooting Gallery". This environment will consist of 15 to 20 platforms of small-scale cyber-physical systems for students to design, attack, defend, and reconfigure. As we are prototyping these platforms, only three have initially been built. We are also facing significant supply chain constraints, specifically with the Raspberry Pi computers we hoped to employ, and this has forced us to reconsider some design elements. Nonetheless, our initial prototypes were unveiled and met with great enthusiasm at the "BSides Idaho Falls 2022" cybersecurity conference held in October. Our prototype boards can be seen in this article: https://www.postregister.com/news/local/more-than-200-attend-idaho-falls-cybersecurity-conference/article_664ec6f2-4666-11ed-a46e-3f8e96e066a2.html To date, we have expended \$10,500, about one-third of our budget in this area.

Additionally, we have acquired both information technology (IT) and operations technology (OT) equipment to outfit sixteen student "workstations". This equipment features state-of-the-art computing capabilities as well as industry-leading cyber-physical control systems. Our spending in this area is largely complete at \$315,000, which equates to just under \$20,000 per student station. The details of the many components that make up this research and training equipment are included in the attached spreadsheets under Section 6 of this report.

Another major component of this grant effort is on the design, acquisition, and implementation of the larger scale "Nuclear Balance of Plant" equipment. As proposed, each year of our effort we will focus on a different primary critical infrastructure sector, and in this initial year we are developing capabilities for cybersecurity research and training on nuclear power plants. This grant is facilitating the expansion of our existing Western Services Corporation nuclear power plant simulator and its coupling to our electric power systems research equipment. In this initial period, we have focused on design elements and

renovation of necessary space to house the equipment. To date, we have expended only \$2,000 of the \$75,000 budgeted. Completion of this element is scheduled for the spring and summer of 2023, and will include the faculty and student support expenses to build and deploy this major component during the summer months.

The balance of our expenditures to date falls either under materials and supplies or salary and related expenses. These expenses are on budget and in accordance with the HERC IGEM requirements and the UI's Office of Sponsored Programs.

Section 3: Demonstration of economic development/impact:

- Multiple journal and conference papers published in initial period
- Multiple external funding opportunities currently submitted or in development.
- Multiple engagements with private sector partners as well as other academic and research institutions.
- Post-doctoral fellowship positions created to be filled in future reporting period.

We highlight the initial impact of our intellectual property in Section 4 of this report, and discuss our model for sustainability through external funding in Section 5. In this section, we briefly describe our engagement with industry and academic partners and our plans for further strengthening these relationships. The co-PIs of this grant are all involved in the ongoing development efforts of the Idaho Cyber Range to make the Idaho Falls-based laboratories and equipment interoperable with research laboratories and training facilities across the state, including at the Idaho National Laboratory's Cybercore Integration Center and the Center for Advanced Energy Studies. Additionally, we are now working with Montana State University on the development of training and education curriculum for hands-on cyber-physical systems security. The cadence of our engagement is weekly. We have begun regular meetings with industry partners to form an advisory group for our efforts. These partners include SEL, Siemens, Intel, Wesco, Western Services Corp, Mickelsen Farms, CLOAKED Cybersecurity, Shadowscape, and CourseOps.

Section 4: Number of faculty and student participants as a result of funding, and brief description of student efforts.

- 1 Master's student directly funded in initial reporting period,
- 1 PhD student directly funded in next reporting period (Spring 23).
- 12 additional undergraduate and graduate students directly involved in supporting initial project efforts.
- 7 principle investigators supported by this grant.
- Future HERC IGEM funding will substantially shift from equipment and materials acquisition to student education and research involvement by directly supporting multiple graduate students and post-doctoral fellows each year.

This grant effort is by design both multi-disciplined and collaborative. We have set out to create a state-of-the-art research and training facility for advanced cyber-physical systems security. Together, over 20 faculty and students from both UI and ISU have been working together on multiple facets of this grant effort: from selection of components and shopping for available new or refurbished equipment, to designing network architecture and cyber-physical

systems platforms, working with vendors and contractors, IT support, university procurement, and facilities personnel, installing and configuring software, running wiring and connecting gadgets, building up, tearing down, and building up again the various platforms and elements to support our vision. Their contributions both small and large have been innumerable and invaluable. We draw special attention to a number of academic papers submitted and accepted directly related to this grant effort during this initial reporting period:

1. Taegan Williams, Tiffany Fuhrmann, and Michael Haney, "Low-cost CTF Platform for Industrial Control Systems Education," 26th Colloquium for Information Systems Security Education (CISSE 2022), 14 November, 2022.
2. Tiffany Fuhrmann, Taegan William, and Michael Haney, "Cyber-physical Shooting Gallery: Gamification to Address the IT-OT Gap in Cybersecurity Education," 26th Colloquium for Information Systems Security Education (CISSE 2022), 14 November, 2022.
3. R.A. Borrelli, Samuel Root, Porter Throckmorton, Jonathan Tacke,,Jacob Benjamin, and Michael Haney, "Cyber Hardening of Nuclear Power Plants with Real-time Nuclear Reactor Operation Simulation." *Journal of Progress in Nuclear Energy*, (*accepted and in revision*).

Section 5: Updated details and/or progress on the long-term sustainability plan for the project and description of future plans for project continuation or expansion.

- Multiple federal and state grant proposals submitted, under review, or planned (currently *over \$2 million* under review)
- Multiple levels of engagement with private industry partners for workforce training

Our current development of the RADICL and related research laboratory and training facilities are designed to enable sustained education, research, and workforce development in Idaho Falls. This will come with significant engagement with our industry partners, the Idaho National Laboratory, and the campuses across the state of Idaho connected via the Idaho Cyber Range, as well as through current and planned external funding from federal and state funding agencies. Initial plans for sustained growth and expansion of our capabilities include several grant proposals recently submitted or currently under development. We have also begun development of our model for industry engagement and workforce training opportunities.

Recently, we the team of co-PIs, led by Dr. R.A. Borrelli, submitted a robust grant proposal to the National Science Foundation entitled "Cyber-informed Design, Education, and Training for Energy Resiliency with Real-time Nuclear Reactor Operation." This grant proposal for \$1.2 million will provide for expansion of our nuclear power plant simulation environment, including licensing fees for our current simulator software, expansion of hardware and supporting equipment, and the funding of many students in several disciplines (e.g. computer science, computer engineering, nuclear engineering, electrical engineering) to continue the development of this important platform. The preliminary results necessary to submit a viable NSF grant of this size were made possible by the students and equipment funded during this initial period of the HERC IGEM grant.

Additional grant proposals in development and expected to be submitted in the upcoming reporting period include grants led by Dr. Roberson to the Department of Energy's Nuclear Energy University Programs (NEUP) program (invited proposal for \$800,000), as well as the DoE's Office of Cybersecurity, Energy Security, and Emergency Response (CESER), by Dr. Koliass to the NSF's Computer and Information Science and Engineering (CISE) Directorate, and Dr. Haney's proposals to the Department of Homeland Security and Cybersecurity and Infrastructure Security Agency's (CISA) programs. The team led by Dr. McBride also has

current and planned proposals to the Department of Labor and Department of Education for ongoing workforce development efforts. Details of these and other proposals will be forthcoming in the next reporting period.

The model for our Idaho Falls facilities and capabilities centers on our engagement with the community and industry partners here and across the region. The initial funding has enabled multiple engagements with current and potential industry partners, as discussed in the previous section, and we are in the initial stages of formalizing an advisory group to support this engagement. With the development of our multiple spaces, our private cloud computing environment, our shooting gallery, and the data created and collected for running multiple reconfigurable cyber wargame scenarios, we expect to engage and train a wide variety of industry professionals in different roles and vertical critical infrastructure industries. This engagement will allow for a revenue stream designed not for profit but to sustain our staff, equipment, software licensing and other operating expenses indefinitely.

Section 6: Expenditure Report

See attached spreadsheets for tracking of acquisitions and expenditures of materials, supplies, and equipment, and excluding salaries and post-doctoral expenses. Student and faculty salaries are determined and tracked in accordance with HERC IGEM funding guidelines and the policies and procedures of the University of Idaho's Office of Sponsored Programs.

Materials and Supplies

Item Number	Item	Description/Purpose
*****COMPUTER STATION*****		
1	CISCO IE-2000U-8TC-G SWITCH	Student Station Net
2	Dell Computer Monitors	For viewing from cc
3	Dell OptiPlex 3090 Micro Home & Business Mini Desktop (Intel i5-10500T 6-Core Computers	
4	Amazon Basics USB Wired Computer Keyboard and Wired Mouse Bundle Pack KeyBoard and Mou	
5	CKLau KVM Switch HDMI 4 Port with USB Hub, Audio and 4 KVM Cables, 4 Por 4 input KVM Switch	
6	Newest Webcam Lighting Stand for Live Steaming, NexiGo Selfie Ring Light with Webcam Stand	
7	Logitech C920e HD 1080p Mic-Disabled, certified for Zoom and Microsoft Team: Webcamera	
8	WALI Triple Monitor Mount, 3 Monitor Stand Desk Mount with Premium Gas Spr Three Monitor Stan	
9	Power Strip, ALESTOR Surge Protector with 12 Outlets and 4 USB Ports, 6 Feet Surge Protector	
10	Computer Monitor Mounts	Mounting Micro C
****LEVEL 1 COMPONENTS****		
11	Student and Instructor Station PLC Equipment CompactLogix PLC with 4 Cards, RIO Chassis with 4 cards PLC Chassis with PLC and Network.	Digital Controls for
****SYSTEM 1&2*****		
12	Amatrol Manufacturing System (2 Systems in One)	Smart Manufacturir
****NET CABLES*****		
13	CAT6 Plenum (CMP) Cable 1000FT Network Analyzer Test Passed 23AWG 4 Yellow Cat6 Cable	
14	Cat6 RJ45 Ends, CableCreation 100-PACK Cat6 Connector, Cat6 / Cat5e RJ45 RJ45 Cat6 Connec	
****OSCILLOSCOPE*****		
15	Hantek DSO5102P Digital Storage Oscilloscope USB 100MHz 1GSa/s 40K,2 Ch Oscilloscope for re:	
STANDS FOR DIN RAIL/COMPUTER MOUNTS FOR DIN RAIL.		
16	Tripp Lite 13U 2-Post Open Frame Rack, Network Equipment Rack, 800 lb. Cap Rack to house DIN	
17	6U Rackmount short depth SOLID Panel	Panels for installing
18	50 Pack M6 x 16 mm Rack Mount Cage Nuts, Screws and Washers Stainless S Screws to attach p:	
19	2 Piece DIN Rails, 35mm Aluminum Top Hat Slotted DIN Rail with RoHS, Extra 1 DIN Rail	
20	NVVV DR-120-24 AC to DC DIN-Rail Mount Power Supply, 24V, 5Amp, 120W S 120 VAC to 24 VDC	
21	Jingchengmei 1U Disassembled Vented Cantilever Server Rack Mount Shelf 12' Shelf for Electronic	
****TERMINAL BLOCKS****		
22	Dinkle UL Every Color DIN Rail Terminal Block Kit 20 DK2.5N 12 AWG Gauge 2 Terminal Blocks fo	
**** VOLTAGE XFER *****		
23	Control Transformer 40VA, Primary 120, 208, 240V Secondary 24V, HVAC Furn Step Down 120 VA	
****WIRE ****		
24	18 Gauge Primary Automotive Wire - 10 Roll Assortment Pack - 100 Ft of Coppe Wire for terminal bl	
25	16 Gauge Multi-Color Primary Wire 6 Pack Combo 100 ft per Roll Stranded Copj Wire for terminal bl	
****BREAD BOARD*****		

- 26 Makeronics Solderless 3220 Breadboard Ultimate Kit - 3220 Tie-Points Experiment Breadboard with gc
- 27 AstroAI Multimeter 2000 Counts Digital Multimeter with DC AC Voltmeter and Ohm Measuring on Breadboard

*******ELECTRONICS KITS*******

- 28 Complete Ultimate STEM Electronic Projects Starter Kit for Arduino with Mega2560 Microcontroller with Breadboard
- 29 Keyishbot Electronic Component Super kit with Resistor Transistor RGB Capacitor Additional Electronics
- 30 SunFounder Ultimate Sensor Kit Compatible with Arduino R3 Mega2560 Mega328P Sensors for Arduino
- 31 Kootage 2600pcs Metal Film Fixed Resistor Kit 130 Values 1 Ohm-3M Ohm 1/4W Resistors
- 32 9V 2A Power Supply AC Adapter 110-240V AC to DC 9Volt 2Amp Fit for Arduino Power Supply for M
- 33 Bridgold 40pcs(20pcs 74HCxx+20pcs 74LSxx) Series Logic IC Assortment Kit IC Chips
- 34 AUSTOR 560 Pieces Jumper Wire Kit 14 Lengths Assorted Preformed Breadboard Spare Wires

		Total Budget	\$286,271.00	BTD	\$286,212.32	Remaining	
Model #	Price/each	Quantity	Tax/shipping	Total Price	Added	Purchased	
IE-2000U-8TC-C	\$1,774.26	16	0	\$28,388.16	9/9/2022	10/18/2022	
E2221HN	\$122.00	50	0	\$6,100.00	10/3/2022	10/11/2022	
OptiPlex 3090 I	\$708.36	36	0	\$25,500.96	9/9/2022	10/3/2022	
se	\$15.17	36	0	\$546.12	9/9/2022	9/28/22	
CKLau-64Hua	\$61.75	18	0	\$1,111.50	9/9/2022	9/28/22	
B08FZP122B	\$19.99	16	0	\$319.84	9/9/2022	9/28/22	
	\$59.99	18	0	\$1,079.82	9/9/2022	9/28/22	
GSDM003	\$94.49	16	0	\$1,511.84	9/9/2022	9/28/22	
PS951	\$20.88	16	0	\$334.08	9/9/2022	9/28/22	
N/A	\$65.00	33	0	\$2,145.00	10/18/2022	11/2/22	
N/A	\$76,150.00	1	0	\$76,150.00	10/3/2022	11/3/22	
N/A	\$120,000.00	1	0	\$120,000.00	9/28/2022	11/9/22	
N/A	\$156.49	2	0	\$312.98	9/28/2022	9/29/22	
N/A	\$13.96	3	0	\$41.88	9/28/2022	9/29/22	
DSO5102P	\$249.99	18	0	\$4,499.82	9/28/2022	9/30/22	
N/A	\$171.25	16	0	\$2,740.00	10/2/2022	10/3/22	
N/A	\$174.00	32	\$435.17	\$6,003.17	10/2/2022	10/6/22	
N/A	\$13.99	4	0	\$55.96	10/2/2022	10/3/22	
B088FC2KB8	\$6.99	32	0	\$223.68	9/9/2022	9/28/22	
B093BYBMZC	\$29.99	35	0	\$1,049.65	9/9/2022	9/28/22	
N/A	\$22.99	16	0	\$367.84	11/13/2022	11/18/22	
N/A	\$26.50	60	0	\$1,590.00	10/2/2022	10/3/22	
C to 24 VAC for	\$24.24	18	0	\$436.32	10/2/2022	10/3/22	
N/A	\$39.59	4	0	\$158.36	10/2/2022	10/3/22	
N/A	\$29.41	4	0	\$117.64	10/2/2022	10/3/22	

N/A	\$49.20	16	0	\$787.20	10/2/2022	10/3/22
N/A	\$12.73	18	0	\$229.14	10/2/2022	10/3/22
N/A	\$72.74	25	0	\$1,818.50	10/2/2022	10/3/22
N/A	\$21.99	25	0	\$549.75	10/2/2022	10/3/22
N/A	\$51.51	25	0	\$1,287.75	10/2/2022	10/3/22
N/A	\$19.49	4	0	\$77.96	10/2/2022	10/3/22
N/A	\$12.88	18	0	\$220.25	10/2/2022	10/4/22
N/A	\$13.49	25	0	\$337.25	10/2/2022	10/3/22
N/A	\$11.99	10	0	\$119.90	10/2/2022	10/3/22

\$58.68	Spent	\$286,212.32	\$58.68
tes			
ETA	Received	Spent Item Value	NOTES

2/27/2023		\$28,388.16	
10/19/2022	11/15/22	\$6,100.00	
10/11/2022	10/25/22	\$25,500.96	
9/30/22	10/3/22	\$546.12	
9/30/22	10/3/22	\$1,111.50	
9/30/22	10/3/22	\$319.84	
9/30/22	10/3/22	\$1,079.82	
10/3/22	10/4/22	\$1,511.84	
9/30/22	10/3/22	\$334.08	
11/17/22	12/6/22	\$ 2,145.00	
11/30/22		\$76,150.00	
3/21/23		\$120,000.00	
10/13/22	10/7/22	\$312.98	
10/3/22	10/4/22	\$41.88	
10/3/22	10/17/22	\$4,499.82	
10/14/22	11/15/22	\$2,740.00	
10/17/22	10/19/2022	\$6,003.17	
10/19/22	10/20/22	\$55.96	
10/5/22	10/6/22	\$223.68	
10/3/22	10/4/22	\$1,049.65	
12/1/22	12/1/22	\$367.84	
10/11/22	10/17/22	\$1,590.00	
10/7/22	10/7/22	\$436.32	
10/6/22	10/7/22	\$158.36	
10/6/22	10/7/22	\$117.64	

10/6/22	10/10/22	\$787.20
10/6/22	10/7/2022	\$229.14

10/13/22	10/17/22	\$1,818.50
10/13/22	10/17/22	\$549.75
10/7/22	10/17/22	\$1,287.75
10/7/22	10/10/22	\$77.96
10/6/22	10/7/22	\$220.25
10/13/22	10/17/22	\$337.25
10/6/22	10/7/22	\$119.90

HERC IGEM23-001**Library of Reconfigurable Immersive Attack and Defend Scenarios for Cybersecurity Research and Workforce Development (Equipment and Supplies)**

	Budget	Spent	Remaining
Materials and Supplies	\$20,000	\$2,625.82	\$17,374
Nuclear Balance of Plant	\$75,000	\$1,793.89	\$73,206
Private Cloud Computing	\$150,000.00	\$137,092.57	\$12,907.43
Shooting Gallery	\$30,000	\$10,548.99	\$19,451
Workstations	\$32,000	\$35,639.12	(\$3,639)
Total	\$307,000	\$187,700.39	\$119,299.61

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