APPLIED RESEARCH INSTITUTE

College of Engineering | University of Illinois, Research Park

Sandia-UIUC relationship

As a part of the continued alliance between the Sandia National Laboratories (SNL) in



Albuquerque, New Mexico and UIUC, ARI carried out a summer internship pilot project through Sandia's internal funding sources. The SNL-UIUC alliance was established in 2014 with a goal to foster research partnership in the area of data science, complex systems, digital manufacturing and on-demand power.

A team of five undergraduate students majoring in Computer Science and Engineering and Engineering Physics worked with a team at SNL as a full time summer internship at ARI. The students, from rising sophomores to seniors at the UI, worked collaboratively in teams on projects evaluating hardware for deep learning, building better tools to visualize data, and cloud computing for digital elevation model.

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From the Director

Greetings! As the university celebrates its sesquicentennial, the Applied Research Institute (ARI) turns five this year. ARI was established to further applied research and development which might be considered beyond the traditional scope of the discoverydriven university enterprise and to support economic development with our partners, consistent with our land-grant mission. A brief timeline of our organizational evolution is summarized on the following page.



Rakesh Nagi, Interim Director of ARI

In November of 2016, I had the

distinct privilege of being appointed as the interim director of ARI. The following March a successful 5-year review with a distinguished group of external reviewers was conducted. We prepared an 80 page self-study report and provided presentations and posters to the committee, which then resulted in a strong recommendation for the second phase of ARI. This past summer, with support from the campus, OVCR and the College of Engineering we have secured a three-year commitment.

In January 2017, under the leadership of Magdi Azer (ARI) and Deborah Thurston (ISE), we were awarded Tier 1 membership in a new \$70M DoE "REMADE Institute" (Reducing Embodiedenergy and Decreasing Emissions). REMADE is a national coalition of leading universities and companies which aims to "dramatically reduce the embodied energy and carbon emissions associated with industrial-scale materials production and processing." Rochester Institute of Technology is the lead institution. To further engagement between ARI researchers and faculty experts, we organized ARI seminar series in spring 2017 with 13 experts from MechSE, ISE, CS, ISTC, OPD and OTM. Topics included testing and modeling of materials, digital manufacturing, control and dynamical systems, development of proposals and transfer of technology. This has resulted in new collaborations across unit lines.

In the summer, ARI launched a strong partnership with Sandia National Labs; this seedling effort has resulted in new projects with Sandia to the tune of \$1M for AY17-18. ARI serves the mission of national security and developing human capital in areas of national importance. PI Jagadeesh Yedetore and Heather Filippini continue to fund talented US students in CoE departments, and I highly encourage you to partner!

In addition to the above, ARI was awarded \$1.75M (PI Santanu Chaudhuri) to improve corrosion and adhesion properties using atmospheric plasma on surfaces and at nanoscale. ARI continues to flourish with its ICRT – Indoor Climate Research & Training group which helps train the professionals that keep our indoor spaces healthy and safe. ICRT PI Paul Francisco leads the national agenda through a Technical Advisory Committee for DoE and LBNL on indoor air quality in new homes.



I invite you to read more about and engage with ARI's laboratory situated in research park. The lab has developed unique material processing and testing capabilities, including additive manufacturing and corrosion testing.

Sandia-UIUC relationship (...continued from page 1)

The undergraduate students at UI worked on the following three projects during their internship at ARI.

- 1. Hardware Evaluation for Deep Learning: The project focuses on characterization of hardware components of a system and their performance while running Deep Learning Algorithms.
- 2. Web based Data Visualization portal: The project involves creating tools for a web application to visualize, modify, and save data of multiple file formats.

Affiliation with MatSE

Daniel Krogstad, research scientist at ARI is now affiliated with the Materials Science and Engineering (MatSE) department



as a Research Assistant Professor. Dan's research focuses on incorporating processing into the design of soft material systems for a wide range of applications. He has worked on projects ranging from automotive and military coatings to drug delivery platforms. We hope that the affiliation will lead to more collaborations between ARI and MatSE department.

Call for workshops

ARI will work with Illinois faculty and researchers, who are looking to align a group that works in an area of applied research, to deliver value to external organizations in the form of targeted workshops/seminars/ lectures. Please contact the Outreach and Engagement Coordinator at ARI for conversations, design and organization of events.

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3. Web based service for Digital Elevation model Geolocation correction service: The project subsection provides a user interface for the Digital Elevation Mapping Service which will provide sensor geolocation corrections. The user interface contains multiple features to provide a simple, secure, and scalable product that can be easily modified by developers.

The different skill sets of students were helpful in learning from each other when they collaborated in teams. "Even being in Computer Science, the problems were not trivial and classroom learning was not enough," said one of the interns. "We learned a lot as needed while working on projects in applied sense, something we do not learn in classes". The above comments highlight how a work experience in applied research adds value to the learning in classroom.



Team of undergraduate students with their mentors who worked at ARI for the Sandia National Laboratories in summer of 2017

The student interns, adopting an Agile software development model, worked to successfully deliver near-production level code and reports for all the projects.

Based on the success and the quality of work delivered, Sandia has extended their collaboration with ARI to include "direct funded projects" continuing for another year through fall of 2018. This extension gives students an opportunity to work on projects of national interest and encourages them to consider making SNL a career choice. The SNL-ARI relationship is slowly folding in greater engagement of faculty on campus to participate in on-going research opportunities with the Sandia National Laboratories.

ICRT partners with MRCC

Radon is a naturally occurring gas that enters buildings through the soil. It is also considered by the US EPA to be the second leading cause of lung cancer after smoking. It is possible to test for radon; however, most people test for less than one week, and radon is highly variable over time. It is possible for radon levels to vary by an order of magnitude over the course of the year. Therefore, the short-term test is



simply a snapshot.



One of the

factors thought to influence radon levels is outdoor temperature. Conventional wisdom has held that radon levels would be higher as it got colder outside. However, previous work by ARI's **Indoor Climate Research & Training**

group (ICRT), which conducts

research in the engineering and public health spaces and translates knowledge to practitioners across the country through training, had found that the relationship between radon levels and outdoor temperature went in the opposite direction: while there was a lot of scatter in the data, radon levels tended to trend down when outdoor temperatures





dropped in winter.

To get further insight into environmental influences on radon, across more seasons, the Illinois Emergency Management Agency funded ICRT to do long-term monitoring of radon in 15 Champaign-area homes and to evaluate the influence of various environmental conditions on radon levels. ICRT partnered with the **Midwest Regional Climate Center** (MRCC) at UIUC on

this project. The collaboration with MRCC allowed the project team to expand the range of

environmental factors considered beyond outdoor air conditions, to include soil temperature and moisture as well as solar radiation factors.

The results, which are currently being developed for journal publication, showed that soil temperature and moisture tend to have more influence on radon levels than outdoor air conditions. Further, there are diurnal fluctuations in radon that tend to vary with seasons.

These results shed new light on the dynamics of radon in homes, and could be a first step in improving our ability to interpret short-term tests and, potentially, model long-term radon levels based on shortterm results. This long-term goal would allow residents and public health officials to greatly improve their ability to target mitigation efforts.

Paul Francisco, Senior Coordinator of ICRT





ICRT training center used for training of field practitioners

The REMADE Institute

The **Reducing Embodied-energy and Decreasing Emissions** (<u>REMADE</u>) Institute is a national coalition of leading universities, national labs and companies that will forge new clean energy initiatives deemed critical in keeping US



manufacturing competitive. The University of Illinois is a Tier 1 member of the Institute and will work in collaboration with Rochester Institute of Technology (RIT), Idaho National Lab, Argonne National Lab, and others in partnership with the US Department of Energy.

Dr. Magdi Azer, Associate Director for Manufacturing Science at ARI is also the Chief Technical Officer of REMADE Institute. "Illinois has played a critical role in the design of the Institute and the proposal itself," explained Magdi Azer. "What originally started as an invitation from RIT to speak about my experiences working with the Digital Manufacturing and Design Innovation Institute in Chicago has evolved into my role as the Chief Technology Officer for the Institute."

Magdi will be responsible for establishment and implementation of the REMADE technology roadmap that identifies early stage applied research and development projects that could dramatically reduce

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embodied energy and carbon emissions associated with industrial-scale materials production and processing.

"To make sure that we achieve a balanced portfolio of next-generation technologies and workforce development projects, I am fortunate to be able to draw upon the expertise of the five node leaders that will oversee the five nodes that form the REMADE Institute," Magdi said.

Deborah Thurston, Professor of Industrial and Enterprise Systems Engineering, will serve as the node leader for the Design for Reuse/Disassembly node.

"Product design is where fundamental decisions get made that can either doom a product to an early grave in the landfill, or ensure a second life. What materials, component forming processes, assembly technologies and business models can help us get the most out of the energy we put into manufacturing? That is what we want to know," said Thurston, who also directs the Decision Systems Laboratory at Illinois.

To help answer this question, Harrison Kim, also a professor in Industrial and Enterprise Systems Engineering, is slated to lead one of the first Institute projects, "Initial Scoping and Requirements Definition for Design for REMADE." This project will develop a framework for seamlessly integrating lifecycle design tools and methods with the traditional design tools currently available.



The REMADE Institute is one of 13 national research consortiums that comprise the "*Manufacturing USA*" federal initiative. Leveraging \$70 million in federal funding, matched by \$70 million in private commitments from partners, the REMADE Institute will address knowledge gaps that could eliminate or mitigate

the technical and economic barriers preventing greater material recycling, recovery, remanufacturing and reuse.

Drawing upon research and expertise contributed by universities, companies, national labs, industry trade associations and foundations, the REMADE Institute seeks to motivate subsequent industry investments to advance technology development and disseminate those technologies across the US manufacturing Eco-system.

Similar to other Manufacturing USA institutes, Illinois faculty and staff will also have the opportunity to get involved as they respond to project calls that will be released each year.

"This Institute will provide a strong platform for ARI and the University to expand research partnerships with both industry and external partners," Magdi noted.

The REMADE Institute recently moved into its headquarters location near Rochester, NY.

The Institute is conducting industry surveys to capture the most relevant challenges their partners face today. In parallel, they are assessing the technology and market landscape to establish a baseline for the roadmap.

Recently two workshops were organized to further refine and prioritize the knowledge gaps that must be addressed to increase material recycling, recovery, remanufacturing and reuse. The Institute will use the collected information to prepare the initial roadmap that will guide future REMADE Institute investments.

Magdi participated in a REMADE Panel Discussion at the RIC-RIT World Remanufacturing Conference in Rochester, NY during the summer. Magdi was joined in the panel by Nabil Nasr, CEO of the Institute and Michael Thurston, the Node Leader for Remanufacturing and End-of-Life Reuse to highlight the REMADE-relevant activities related to remanufacturing and communicate the goals and focus of the Institute.

Materials processing and testing lab



The ARI lab is building up its capabilities by focusing on equipment that is unique to campus to do materials scale-up, industrially relevant processing, component characterization and lifecycle testing. ARI is

interested in building collaborations on campus to together secure external funding to further develop the University technologies beyond the works of graduate students.



ARI specializes in research and development in areas of additive manufacturing, paints and coatings, alloy development and processing, corrosion, polymers and biomaterials.

Some of the equipment that is available in lab for processing includes an Induction Furnace, a Direct Write 3D Printer, a Ultimaker 3D Printer, a Paint Booth and an Airless Electrostatic Paint Gun. We also have a Q-fog Cyclic Corrosion Tester, a Corrosion Testing Cell and a Paint Adhesion Tester for materials testing and characterization.

Seminars at ARI

In spring of 2017, ARI invited faculty and staff from campus working in applied research areas to share their expertise with researchers at ARI. The weekly seminars at ARI have hosted over 13 speakers from various departments on campus. ARI staff used the opportunity to learn about and



Professor John Hart from Computer Science presenting at ARI

Applied Research Institute

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discuss the exchange of individual capabilities. Some of the conversations were followed by collaborative work ideas that will hopefully take the shape of projects/proposals in the future.

Some of the faculty members from Mechanical Science and Engineering included Kelly Stephani, Chenhui Shao, Alison Dunn, Kathryn Matlack and Pratap Vanka. Ramavarapu Sreenivas, Linwei Xin and Henrique Reis are some of the faculty members from Industrial and Enterprise Systems Engineering



Professor Henrique Reis, ISE at ARI

their

who shared



Professor Kathryn Matlack, MechSE at ARI

expertise at ARI. John Hart and Carl Gunter, both faculty in Computer Science shared some of their applied research initiatives. The director of Illinois Sustainable Technology Center (ISTC), Kevin O'Brien was one of the speakers. ARI staff members learned more about proposal development from Sheryl Goldberg, Director of the Office of Proposal Development and about software licensing and technology management from Svetlana Sowers, Senior Technology Manager at Office of Technology Management.

Training sessions at ARI Learn to write a winning proposal

In October, ARI hosted an expert consultant from the Document Lab for a workshop with ARI researchers and faculty from the College of Engineering to help improve their skills in writing a winning proposal. Holly and her team led 4 proposal-training sessions over 3 days, including an overview, the tools needed for compliance and integration, the design of strategy and messaging and the use of graphics to improve scoring. The sessions made use of examples from the real world and were personalized to address the needs of audience. The sessions were also attended by members of the Office of Proposal Development from campus.

The Document Lab is an 8(m) Woman-Owned Small Business that was founded in 1991 by Holly Coghill



President and CEO, and provides one-stop shopping for strategic planning, proposal development and preparation, marketing communications, website design and development, technical report writing and editing, and full-service document. Holly is well-known and respected throughout the government

contracts sector wherein she has established an effective network of contacts.

The first session was held in Mechanical Engineering Laboratory to provide an overview of the individual courses presented over the 3-day training period, including storyboards, compliance matrices, data calls, and template development. It was attended by over 25 faculty and staff from campus.

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In the second session, attendees learned how to develop integrated compliant outlines, and to use techniques that result in a higher-scored proposal. They actively participated in some of the RFP analysis workshops and compliance outlining exercises.

The third session focussed on how to develop a compelling storyline and to define the supporting approaches as an important element to writing a winning proposal. The attendees benefited from learning some of the methods for gaining consensus on overarching themes that underpin the contract win strategy and from use of theme imagery, pictures, and icons.

In the final session, attendees walked through some examples of graphics that directly satisfy the requirements of the RFP instructions, enhance readability, and optimize graphic formats and structures for conveying information. Holly and her team performed a comprehensive exercise on a sample proposal from within the audience to illustrate how to sketch the graphics for scope of work approaches, timelines, processes, data sets, hierarchical structures, and schedules.

The training sessions helped faculty and staff on campus better learn the use of techniques and graphics in writing proposals that will highlight the key aspects of a proposal and structure the content for a quick and easy read by reviewers.

