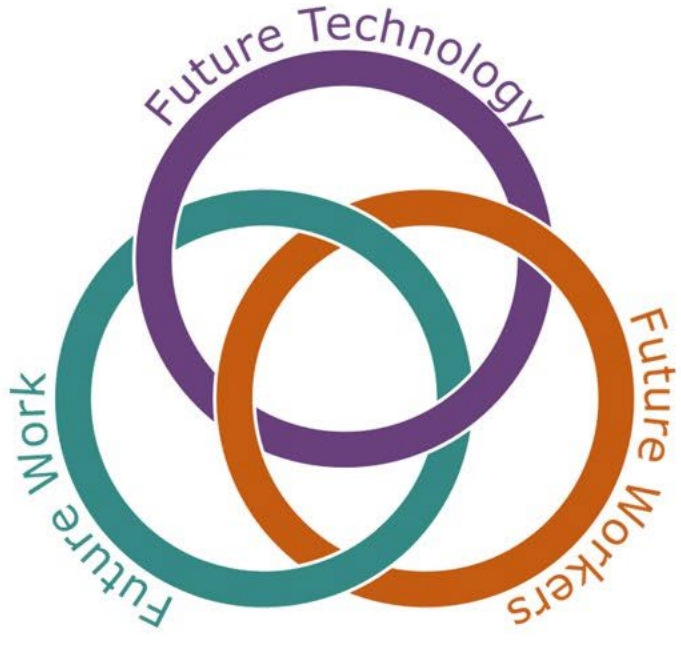
Panel 1:
Construction; Infrastructure; Agricultural Sustainability; Food



- Anthropocentric Robot Collaboration in Construction
- Anticipating Risks and Benefits of Precision Agriculture (PA) or the Future of Agricultural Work and Workforce: A Multi-Stakeholder Research Agenda
- Co-worker Robots to Impact Seafood Processing (CRISP): Designs, Tools and Methods for Enhanced Worker Experience
- Cultivating Capacities and Confidence in Open Access Technologies through Anticipatory Workforce Development for the Future of Digital Agriculture
- Future of Construction Work at the Human-Technology Frontier
- Integrating Cognitive Science and Intelligent Systems to Enhance Geoscience Practice
- Shared Autonomy for the Dull, Dirty, and Dangerous: Exploring Division of Labor for Humans and Robots to Transform the Recycling Sorting Industry

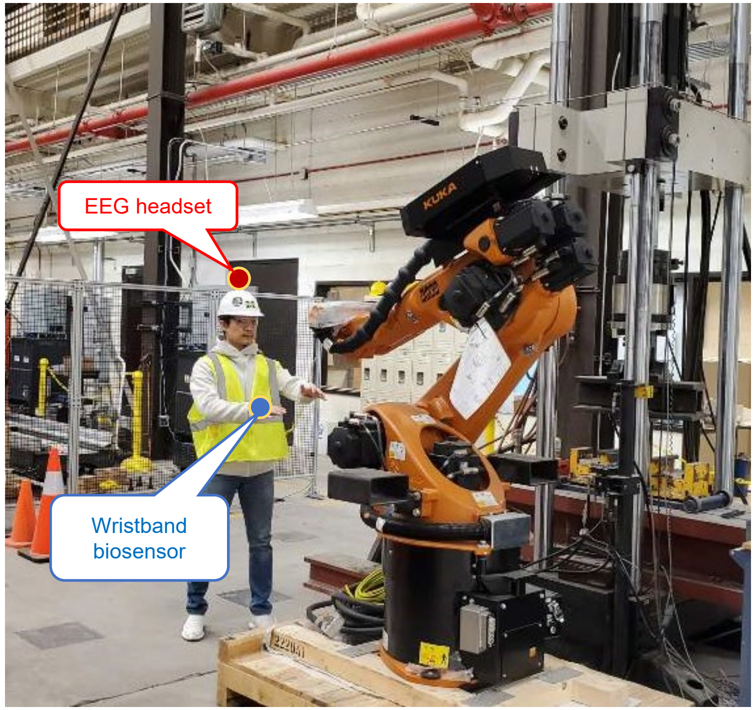
FW-HTF-P/Collaborative Research: Anthropocentric Robot Collaboration in Construction (#1928501 & #1928602)

PIs: SangHyun Lee (University of Michigan, shdpm@umich.edu) &
Changbum Ryan Ahn (Texas A&M University, ryanahn@arch.tamu.edu)

Place Presenter's Zoom Image/Video Here

Goal: Anthropocentric robot collaboration to better understand how workers respond to co-work with robots to improve human robot team performances in construction.

Non-invasive human response monitoring

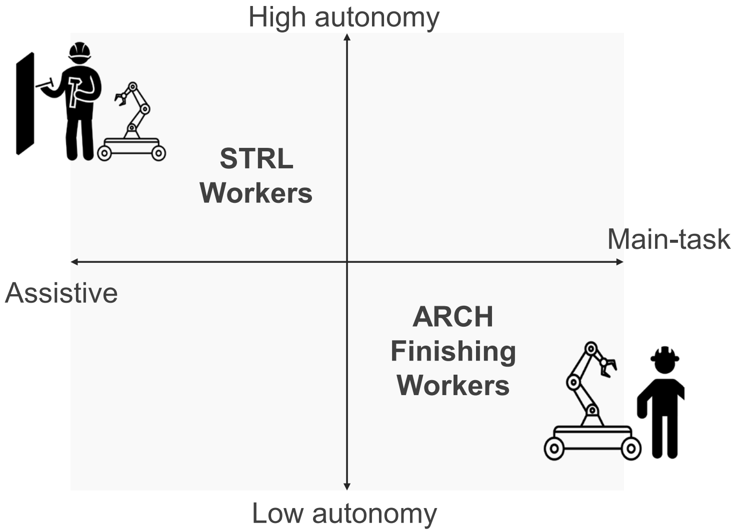


Different stakeholders' view on robot collaboration

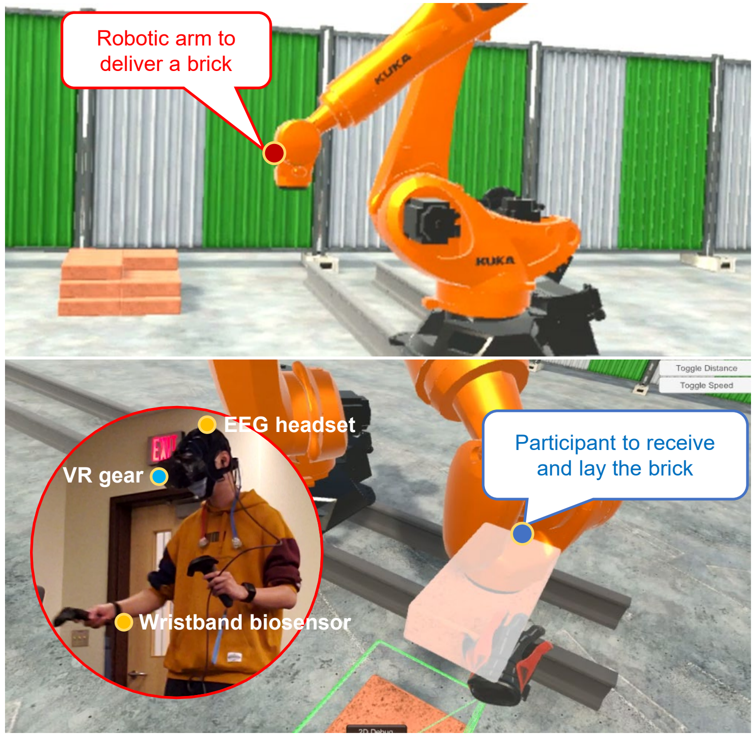
Structural Work
Required Dexterity: Low
Perceived Risk: High

Vs.

Architectural Finishing
Required Dexterity: High
Perceived Risk: Low



VR for worker training



NSF #1929814 FW-HTF-P: Anticipating the Risks and Benefits of Precision Agriculture for the Future of Agricultural Work and Workforce

PIs: Maaz Gardezi, South Dakota State University, (SDSU) maaz.gardezi@sdstate.edu; Asim Zia, University of Vermont (UVM); Sharon Clay, SDSU; Donna Rizzo, UVM; Dr. Semhar Michael, SDSU

- Participatory approaches to anticipate the risks and benefits of precision agriculture technologies (Big data, AI-based decision support systems, machine learning algorithms, sensors) for future farming and farmers.
- Study sites: South Dakota State University and University of Vermont.
- Participants represented: Software and hardware developers; state and field extension specialists, farmers, non-profit and government agencies, and academics.
- Discussion on the potential challenges and solutions for technologies to become more responsive to societal and environmental demands.
- Findings used to develop a successful large research grant proposal under same program ($3M, 4 years). Award #2026431.

Future technology: Precision agriculture

South Dakota State University

The University of Vermont

Figure 1- Future workers: Farmers/Ag support personnel

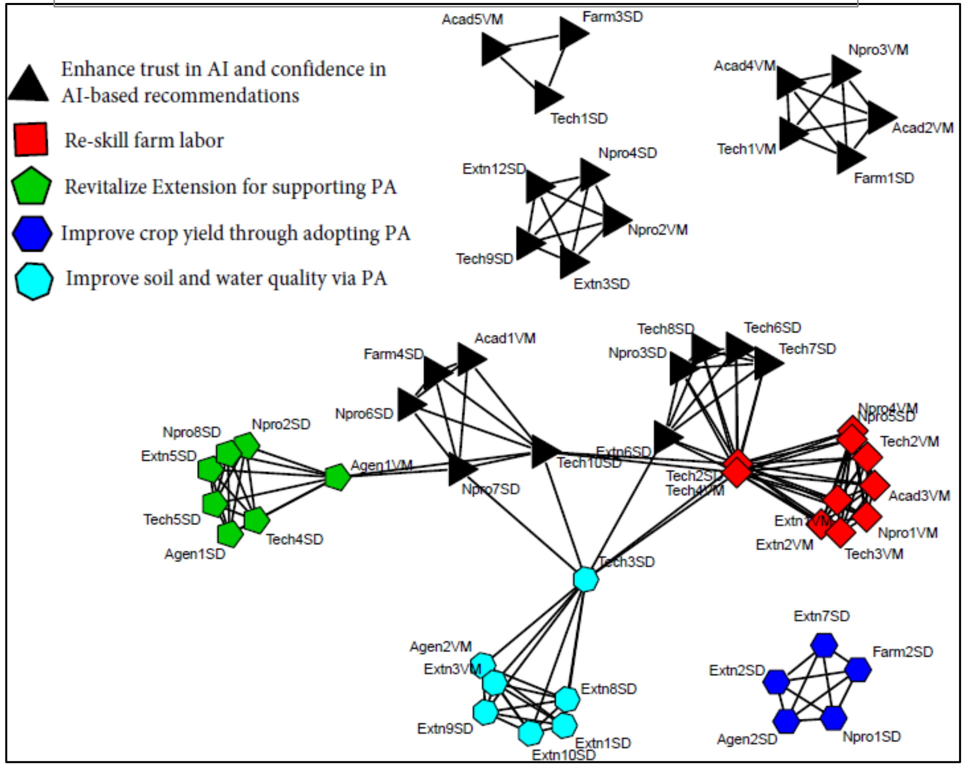
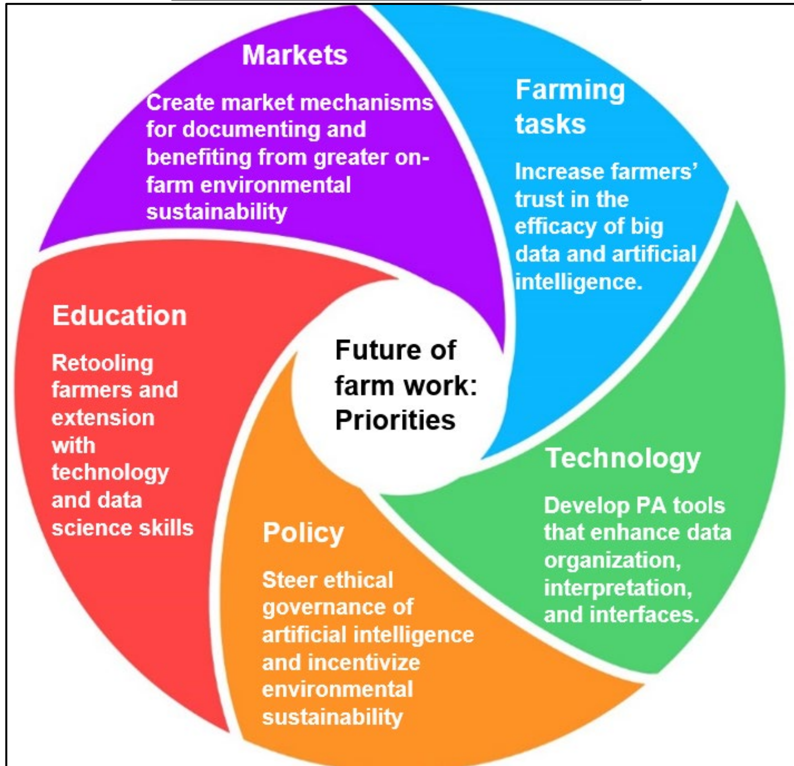


Figure 2 - Future work: Farming



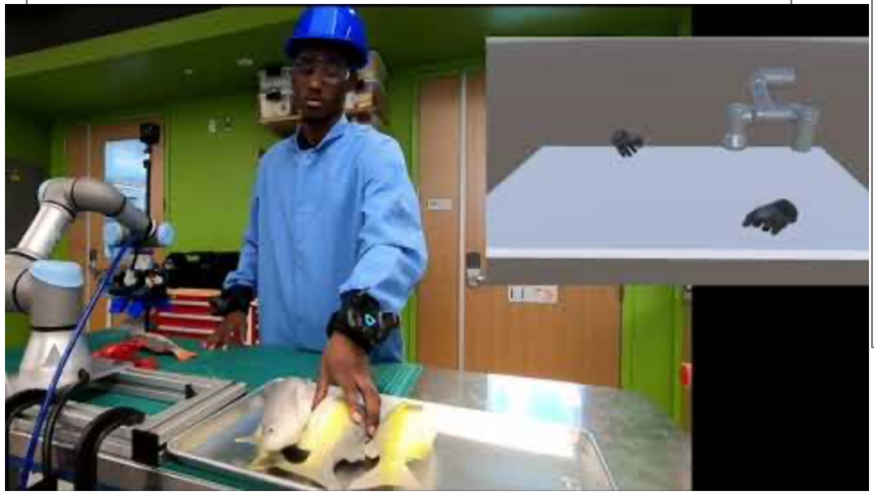
1928654 and 2031326: FW-HTF-RL: Co-worker Robots to Impact Seafood Processing (CRISP): Designs, Tools and Methods for Enhanced Worker Experience

Taskin Padir, John Basl, Kemi Jona, Kristian Kloeckl, Alicia Sasser-Modestino
Northeastern University, Boston, MA
{t.padir, j.basl, k.jona, k.kloeckl, a.modestino)@northeastern.edu

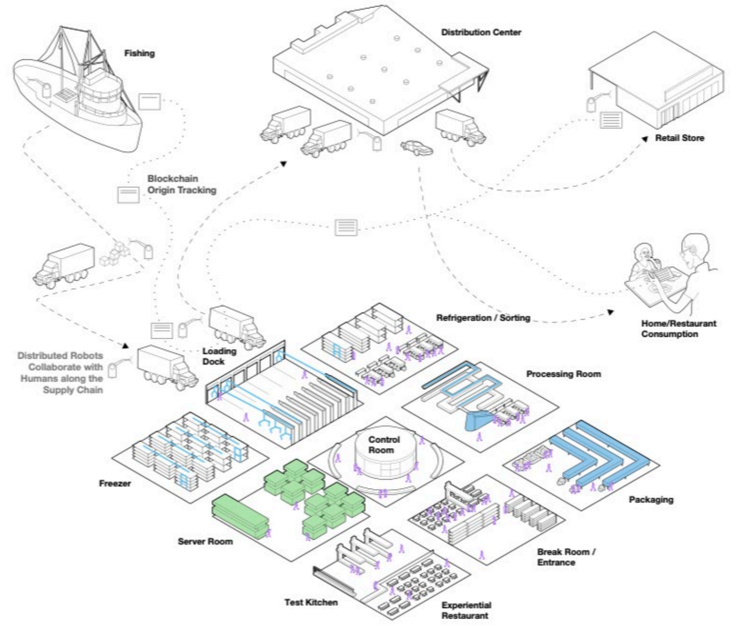
Place Presenter's Zoom Image/Video Here

Reinventing the future-of-work in seafood processing industry with collaborative robots to impact productivity, worker safety, quality of work life and immigrant labor economics in the workplace.

Future Technology
Multi-use collaborative robots



Future Work
Seafood Industry 4.0



Future Workers
Better experiences, safer work conditions

NSF#1928582: “Cultivating Capacities and Confidence in Open Access Technologies through Anticipatory Workforce Development for the Future of Digital Agriculture

PI(s): Jacqueline Hettel Tidwell, University of Georgia, jacqueline.tidwell@uga.edu
Co-Pis: Emily Grubert (Georgia Tech), Don Edgar (New Mexico State University)

Place Presenter’s Zoom Image/Video Here

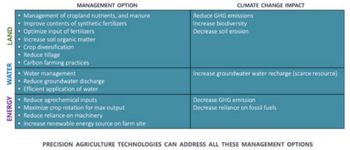
Goal: Advance the science of anticipatory workforce development through American digital/precision agriculture. Cultivate capacities and skills for developing, using, and re-using Open Access digital agriculture technologies. Develop an immersive undergraduate research experience to bring students and farmers together to co-produce future agricultural workforce development learning materials and technologies.

Progress Addressing Future Technology

- Performed an environmental scan of emerging tech in precision/digital agriculture and noticed a significant pattern that most of these technologies have made the data within them proprietary.
- Currently conducting a more robust environmental scan to confirm these patterns from both the literature and a cursory market assessment to inform which technologies are viable for inclusion in the project’s immersive Undergraduate Research Experiences in future years of the project.

Progress Addressing Future Work

- Highlighted the impact increased Open Data standards and data science training could have on both management and environmental dimensions for all scales of farming—despite the current industrial-scale focus of data-driven agriculture: representing 6% of farming operations.



	MANAGEMENT OPTION	CLIMATE CHANGE IMPACT
LAND	• Management of cropland nutrients, and manure • Improve contents of synthetic fertilizers • Optimize input of fertilizers • Increase soil organic matter • Crop diversification • Reduce tillage • Carbon farming practices	Reduce GHG emissions Increase biodiversity Decrease soil erosion
WATER	• Water management • Reduce groundwater discharge • Efficient application of water	Increase groundwater water recharge (scarce resource)
ENERGY	• Reduce agrochemical inputs • Maximize crop rotation for max output • Reduce reliance on machinery • Increase renewable energy source on farm site	Decrease GHG emission Decrease reliance on fossil fuels

PRECISION AGRICULTURE TECHNOLOGIES CAN ADDRESS ALL THESE MANAGEMENT OPTIONS

- Designing a text-based corpus of Precision Agriculture End User License Agreements to understand the current landscape of data rights in this space and investigate how EULAs can be made more readable and usable for both telematics (machinery) and agronomic (crop) data.

Progress Addressing Future Workers

- Constructing an instrument for assessing comfort and receptivity of agriculturalists at all levels of production scale with data, data science, sensors, and new ways of working.
- Survey data will be used to determine the most viable topics for the co-production of AR/VR modules by students and farmers in subsequent summers as part of an immersive, study-engaged learning experience.
- Currently designing and procuring mobile classroom and laboratory for facilitating collaboration between undergrads and agriculturalists in skill development at the intersection of data science and agriculture.

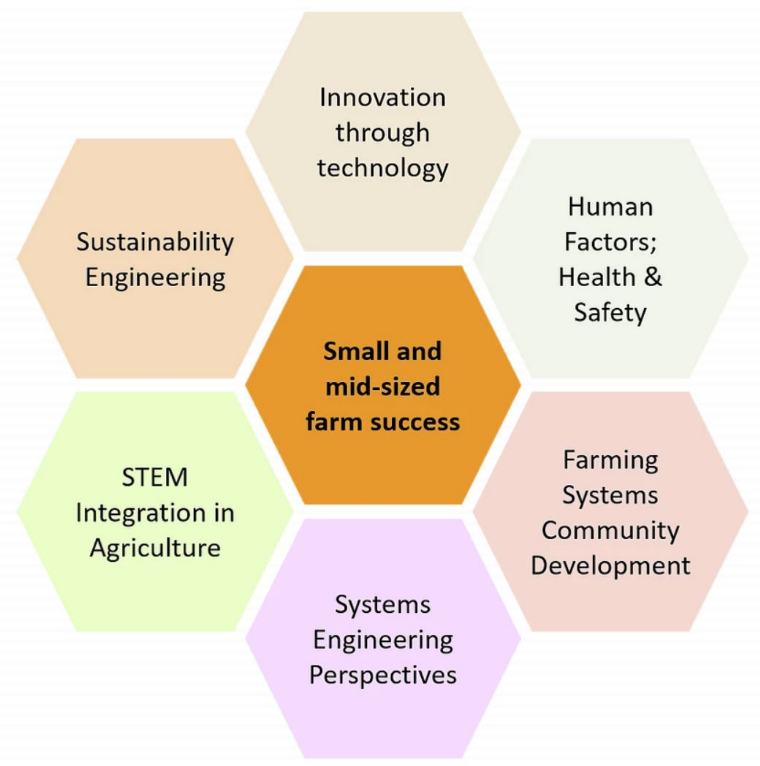
FW-HTF 1745477: Helping Agriculture Remain Vital through Engineering, Science and Technology (HARVEST)

PIs: Divya Srinivasan sdivya1@vt.edu, Alexander Leonessa aleoness@vt.edu and Kim Niewolny niewolny@vt.edu

Place Presenter's Zoom Image/Video Here

HARVEST is a Research Coordination Network (RCN) that brings together scientists from various research disciplines to enhance the productivity and viability of small- and mid-level farms. We do this by linking systems-based research in technology, human factors, and sustainable development with education and practice.

Future Work, Workers and Technologies



- **Monthly HARVEST Speaker Series to engage HARVEST scientists in inter-disciplinary collaborations**
- **AgrAbility and HARVEST: Innovating through research and outreach to Promote Wellness and Viability for Virginia Agriculture, focusing on beginning farmers and farmers with disabilities in Appalachia**
- **Exploring the use of Blockchain to Create Demand for Nutritious Foods through Social Networks**
- **A study on integration of STEM and Agricultural Knowledge through qualitative research on student and faculty cohorts involved in Ag-robotics competition**
- **The physically enhanced FARMER: Developing and exploring the use of exoskeletons for agriculture and forestry workers**

Industrialized and **Ro**botic **C**onstruction **S**ites

Grant Nos. 1928626 (PSU); 1928415 (UFL); 1928527 (Clemson)

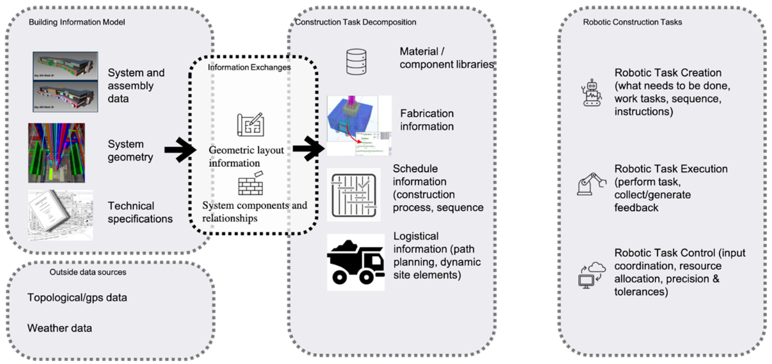
PI(s): Rob Leicht, Penn State, rml167@psu.edu; Bryan Franz, University of Florida, bfranz@ufl.edu; Marissa Shuffler, Clemson University, mshuffl@clemson.edu

The Industrialized and Robotic Construction Sites (IRoCS) project will redefine construction tasks to advance the adoption of ***semi-autonomous robotic systems on construction sites***. The technology focus will be in converting current design information from design documents and standards into defined tasks and "sub-tasks." Robots require precisely organized steps broken down into much smaller, well-defined plans. We believe that this technology is crucial to overcoming barriers to the broader adoption of robotic systems and the creation of effective human-robot teams on construction sites.

Progress Addressing Future Technology

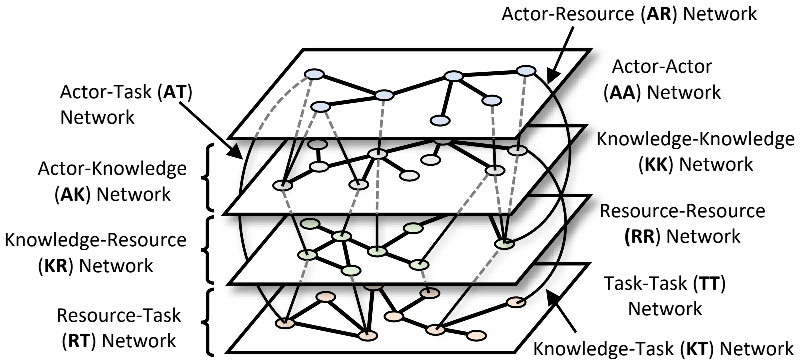
- We are developing and testing the workflows, and supporting data requirements, for translating facility design information into construction tasks and supporting robotic actions. The progress includes developing and validating a process model and the supporting system architecture.
- We are using these workflows to develop a series of algorithmic steps that translates these tasks into instructions for what the robot will do and how to do it, as well as the preconditions for performing an action.

ROBOTIC CONSTRUCTION SYSTEM ARCHITECTURE



Progress Addressing Future Work

- We are modeling the interactions between human workers, the robotic technologies they collaborate with, the jobsite resources they can access, and the construction tasks they must perform. The first step is understanding whether human workers view available robotic technologies as a tool (akin to hammer) or as a teammate, and how the characteristics of the robot itself and the context of its use may change that perception.

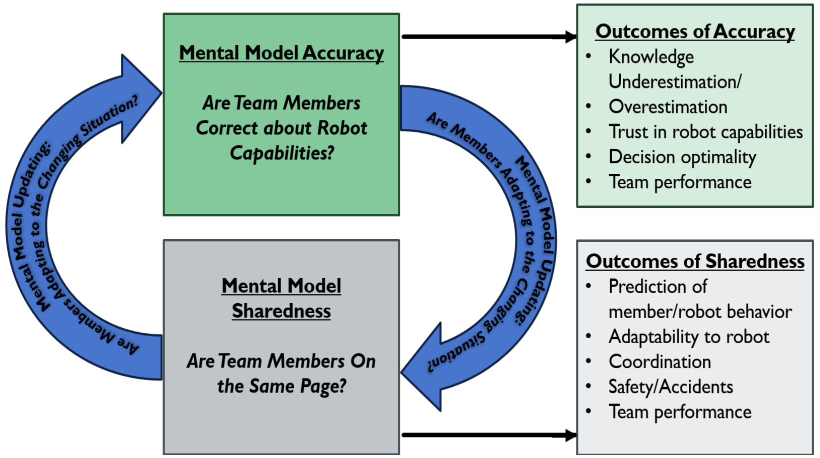


- We have identified an initial set of potential risks, supports, and barriers to coordinating in human-robot teams on construction sites.

Progress Addressing Future Workers

- We have developed initial models to represent how coordinated human-robot teaming and knowledge sharing may operate on industrialized construction sites. These models will inform the task design and training needs of future construction workers who will collaborate with robots on the jobsite.

Onboarding Robots in Teams: A Model of Team Cognition



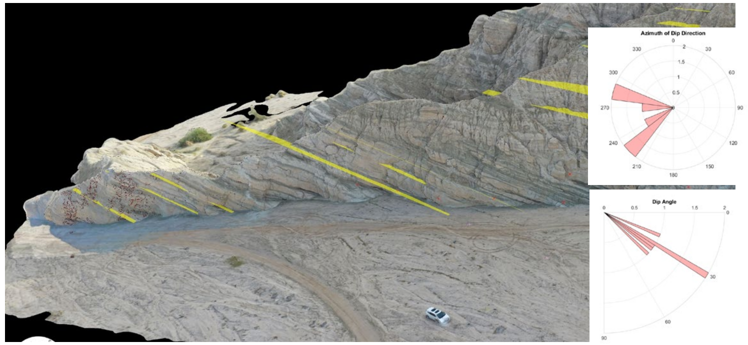
DUE-1839705, Integrating Cognitive Science and Intelligent Systems to Enhance Geoscience Practice

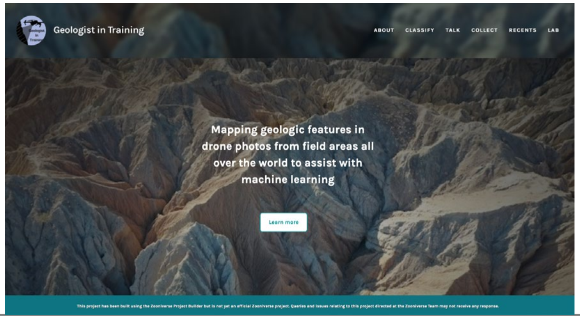
T. Shipley (Temple U), A. Davatzes (Temple U), A. Hsieh (U of Pennsylvania), & B. Tikoff (U of Wisconsin); tshipley@temple.edu

Place Presenter's Zoom Image/Video Here

The project aims to support geology field work by developing autonomous vehicles to collect data on 3D features and develop protocols to record uncertainty in data and models.

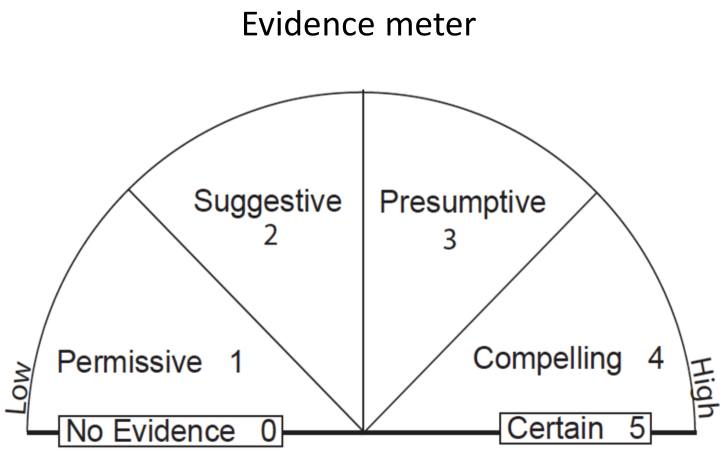
Teaching a robot to identify sedimentary rock layers using citizen science.





Supporting decision making with uncertainty in field collected data.

Developing a technology for communicating and recording uncertainty in qualitative field data.



#1928506: Shared Autonomy for the Dull, Dirty, and Dangerous: Exploring Division of Labor for Humans and Robots to Transform the Recycling Sorting Industry

PIs: Berk Calli[1] (bcalli@wpi.edu), Aaron Dollar[2], Kate Saenko[3], Co-PIs: Vitaly Ablavsky[4], Marian Chertow[2], Brian Scassellati[2], Barbara Reck[2], Jacob Whitehill[1], Amy Wrzesniewski[2],

Scope

- **Focus:** materials sorting for recycling
- **Recycling:** $117B economy, 530k workers in US
- Tight profit margins, inefficient, high injury rates

Goal: Best division of labor for humans-robots

Profitable Industry	Safe and Meaningful work	Environmentally Sustainable Economy

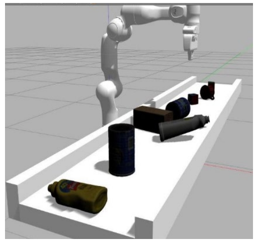
Berk Calli, Worcester Polytechnic Institute

Future of Waste Sorting Technology

Waste Type Recognition

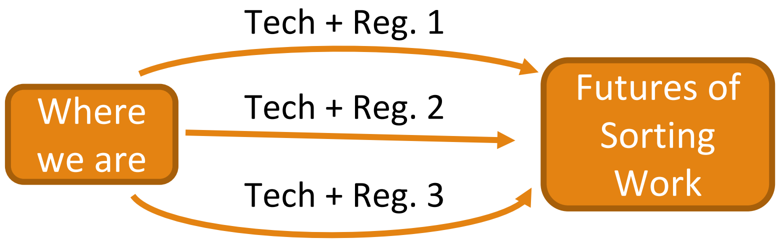
Picking Algorithms

Simulation and Experimental Setups



Future of Waste Sorting Work

Scenario Analysis Framework

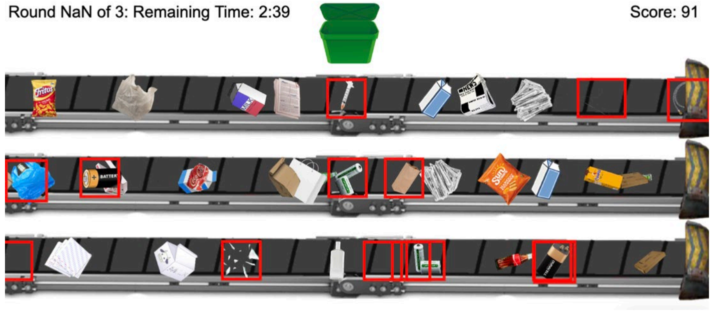


Future of recycling workshop

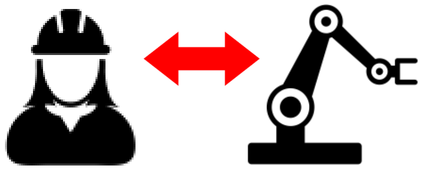
Sorting Facility Visit Casella Waste Systems

Future of Waste Sorting Workers

Machine Learning Assistants



Two-way Learning



New Roles

- Design of worker interviews as an intervention study
- Role of workers in the scenarios

[1] Worcester Polytechnic Institute, [2] Yale University, [3] Boston University, [4] University of Washington