

CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Developing a Visualization System for Supporting and Increasing Recycling Around Arizona	
Sponsor Information: NAU/ASU Arizona Recycling Potential (ARP)	Richard Rushforth, Ph.D. Assistant Research Professor School of Informatics, Computing, and Cyber Systems Northern Arizona University Richard.Rushforth@email.com

Project Overview:

Why should you care? Arizona experienced a 17% decrease in recycling tonnage from 2017 to 2019; a trend worsened by China's decision to end global recycling imports in 2018. As a result, larger Arizona municipalities have invested millions of dollars in infrastructure to avoid siting new landfills. Smaller municipalities, however, have few viable solutions. While circular economy and mixed-waste solutions exist, many municipalities are skeptical of the investment required and the risks associated with new approaches. By being involved with this project, you will work with a team of researchers to develop a visualization system to help Arizona communities develop economically-viable solutions to build businesses around diverting waste from landfills.

Who are we, what are we doing, and what is the overall project? Currently, a large team at Northern Arizona University and Arizona State University are studying recycling options for Arizona and highlighting the challenges and opportunities for each community across Arizona. In the public sector, regional-scale zero waste and circular economy initiatives are starting to take hold in the U.S., mirroring similar trends in European regions. These initiatives range from regional collaboration on materials marketplaces, to regional materials recovery industrial parks, to integrated solid waste management systems at county and regional scales. A region-wide approach creates benefits from economies of scale and the associated bargaining power to attract end market processors and producers, pooling of limited resources of multiple municipal and county governments to share risk and responsibility while more effectively addressing solid waste issues, and allowing for region-wide efficiencies in developing interventions and market-driven opportunities.

The project team is starting Phase 1 of this project, which includes studying recycling services and demographics in Arizona. We will conduct desk research, surveys of communities, and interview stakeholders to gather the following information:

- Inventory all Arizona communities and their associated demographics, waste management and recycling service availability, and associated economic development metrics.
- Waste processing infrastructure and logistics of diversion, including policies, practices, and partnerships. We will get the most up-to-date information available at ADEQ regarding recycling services in Arizona.
- Knowledge gaps, which will be filled by researching service availability or directly engaging with solid waste managers in these communities.
- Community demographics (population, single-family households, multi-family households, commercial establishments, etc.) using state and federal sources.
- End markets for recyclable materials, including existing businesses and industries in the state, regionally, nationally, and potentially internationally that consume waste or recycled materials.

- Economic impact of recycling at the national and state levels for other states and regions around the U.S. The purpose of this information is to be able to compare Arizona's current recycling economic performance with other states and regions.

As a result of this initial data collection effort, the NAU/ASU team will develop a community-scale recyclable waste estimation model. Using waste generation estimation methodologies from the EPA, The Recycling Partnership, and other sources, we will develop the Arizona Recycling Potential (ARP) model to estimate the amount of recyclable material available in communities based on size and demographics. To validate the model, we will integrate any waste characterization data available for Arizona communities.

We will develop a custom visualization system for the data collected during the project's initial phase and visualize the ARP model. The challenge will focus on organizing, displaying, and distributing this information to community leaders. We propose building upon existing NAU and ASU research efforts to develop a data visualization system that provides customized recycling sector insight reports to community leaders and the general public. In doing so, our visualization system will provide Arizona communities with direct access to the research insights generated by this project.

Finally, the project team will use the visualization system to coalesce a network of state, county, and community economic development organizations to co-develop and identify hotspot markets to attract recyclable materials and businesses to Arizona. We can do this by waste material streams, industries, and local/regional needs. Examples include organic materials from agricultural industry support in the Yuma region or forestry industry development in northern Arizona. Examples also include:

- Inorganic materials from textile corporations in the Flagstaff region;
- The aerospace industry in Maricopa and Pima counties; and
- Beverage manufacturers in Maricopa County.

The Problem: We want to build a visualization system, but we are building a first-of-its-kind system, so many design decisions surrounding what is visualized and how it is visualized remain under explored. Similarly, while the Project Team has an idea of the ideal web development stack, we have not fully explored all of the technology solutions for our visualization system.

Solution Overview: We seek a C.S. Capstone team to conduct a design review for building a web-based visualization system. The capstone team will achieve this by interviewing relevant stakeholders to identify the visualization system's desired characteristics, feature sets, and capabilities and then identify the best available web development stack for the visualization system. After the design review, the C.S. Capstone team will be encouraged to build wireframe diagrams of the visualization system and, after approval by the Project Team, an alpha version of the visualization system for further development during subsequent years of the project.

Key Features:

The basic system, and minimum viable product (MVP) would include,

- A Technical Design Review based on project stakeholder input, justifying a decision around a web development stack.
- A web-based visualization system with interactive panes to graph data a simple map and standard chart templates: pie, stacked area, line graphs, etc.

An advanced system would include,

- The ability for users and stakeholders to upload data into the visualization system for on-the-fly data interaction capabilities.
- A web-based visualization system that will be able to import and visualize local infrastructure data.

A really nice system would include,

- A web-based visualization system that will dynamically map community-level recycling, economic activity, and demographic data.
- The ability to map timeseries data.

There are many more possibilities for other extensions that we can discuss once we get started!

Knowledge, skills, and expertise required for this project:

We need a full stack development team.

- Database skills
- Server skills
- UI/UX skills
- GIS/mapping skills
- Product design through stakeholder consultations.

Equipment Requirements:

- There should be no equipment or software required other than a development platform and software/tools freely available online.
- The project team has secured a virtual server for this project, and it is ready to go!
- However, if the team identifies a software solution that requires a license, this should not be an impediment to progress.

Software and other Deliverables:

Deliverables:

- A strong as-built report detailing 1) the design and 2) the implementation of the product (the visualization system and wireframe components that utilize real data) in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- If a backend/data storage system is used, a clear, written description of how to transfer the code and materials to a client system if this is not already part of the project
- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket, or some other version control repository; and as a physical archive on a USB drive.

Bonus Eye Candy

The project team will be able to contribute readily to a high impact project that has already been extensively covered by local media, including front page coverage by the Arizona Republic on 5/24/22. See next page.



DON'T TRASH RECYCLING



RICK KONOPKA/USA TODAY NETWORK; AND GETTY IMAGES

ASU, NAU researchers studying if it can be done in a sustainable – maybe even profitable – way

Alison Steinbach Arizona Republic | USA TODAY NETWORK

There are far more recyclable goods out there than actually make it in the blue bin.

And Arizonans throw out much of what they use, even though most of the material doesn't have to go to a landfill. Now, university researchers want to show that a future is possible where recycling is both a profitable local industry and good for the planet.

If everything that is recyclable actually was — and with new regional systems designed to support that — recycling could be economically feasible for local communities, the researchers from Arizona State University and Northern Arizona University say.

A new \$1.6 million grant from the Arizona Board of Regents will allow for groundbreaking statewide research on the issue.

Recycling has seen rising costs and lower buy-in from cities in recent years after China in 2018 stopped importing many recycled materials and local options dwindled, leaving cities skeptical as they faced rising costs for selling paper and plastic goods.

A handful of Arizona cities stopped recycling altogether or limited what could go in blue bins. Many municipalities don't know what their future of recycling looks like.

See **RECYCLING**, Page 4A

“If we're going to make a difference for generations to come, we have to start thinking about the circular economy, recycling.”

Laura Malone,
director of the waste programs division at the Arizona Department of Environmental Quality