



## INDUSTRIAL AND SYSTEMS ENGINEERING

### Student Research and Design Projects

**SENIOR DESIGN PROJECT:** Students begin working on their senior design project in the spring semester of junior year where student teams research and select a challenging design problem to pursue. The final projects incorporate building prototypes and developing the technology systems to support the project. Students also present their research to a panel of judges that include industry representatives and faculty.

#### Smart Tennis Ball Collector

##### SENIOR DESIGN PROJECT

This mobile and intelligent tennis ball collector uses field aerial images to pinpoint the location of balls at a tennis court, and the nearest neighbor and A\* path-planning algorithms to optimize the path to collect the balls.

#### Delivery Network Management for Autonomous Vehicles

##### SENIOR DESIGN PROJECT

This system is designed to process orders, update delivery routes hourly to catch nearby orders, and minimize empty vehicle travel time by utilizing demand-based zoning and network-based routes of driverless delivery vehicles. The team partially solved a series of NP problems, formulated a viable and competitive business model, designed a user-friendly product, and created a physical minimum viable concept.

#### Rutgers Automated Pipeline Inspection Device (RAPID)

##### SENIOR DESIGN PROJECT

This highly versatile robotic inspection system locates and inspects pipeline defects. The robot uses a rotating arm with sensors to measure defects and a Machine Learning (ML) model to analyze, fix, and repair alternatives.

#### InSecurity: A Strategic Game on Infrastructure Security

##### SENIOR DESIGN PROJECT

A team of four students designed and developed a web-based two-player search and capture game using *Node.js*, *P5.js*, *Express.js*, and *Socket.io*. The game data is collected and analyzed via *MongoDB*.

## Robotic Storage and Retrieval System

SENIOR DESIGN PROJECT

Students designed and built a small replica of a storage and retrieval system with a robotic hand, a vertical two-dimensional motion control platform with addressable cells where items are stored. The robot hand moves between its home position and the cells to fetch items required to serve an order. In real-world applications, these systems are typically used in large warehouses and distribution centers to store consumer products, spare parts and components, and more.

## Robots for Applications in Security Environments (RASE)

SENIOR DESIGN PROJECT

Students first designed and programmed a robbery simulation tailored to several specific Rutgers dorms and buildings using the Python programming language. This simulation was then used to determine the optimal patrol route for a security guard given the specific layout of each building. TurtleBots and interchangeable maze pieces were also utilized to create a physical representation of the simulation for demonstration purposes.

## Managing Traffic Flow — Union Pacific Railroad

SENIOR DESIGN PROJECT

Students created a detailed model of the bi-directional train flow for Union Pacific's train corridor from Pocatello, Idaho to Portland, Oregon. The project simulated the train flow with crossing and passing, delays, gridlocks, and with various cargo types. The model also simulated how speed change can help reduce delays. The system is fully animated so that essential personnel can observe the movement of trains and provide insight into how Union Pacific can reduce train congestion delays and avoid gridlock.

## Flexible and Versatile End Effector Design

SENIOR DESIGN PROJECT

Students created a versatile end effector that bridges the gap between expensive, task-specific end effectors designed by large-scale companies and inexpensive, fragile, multipurpose end effectors designed by hobbyists. The end effectors were entirely 3D printed, making them easy to repair, reproduce, and quickly interchanges depending on the task at hand.

**UNDERGRADUATE RESEARCH PROJECT:** Undergraduate research usually involves a student, an ISE faculty, and/or a graduate student(s). The research is carried out as part of a summer internship, funded research, or an elective course.

## Energy Smart Communities

SENIOR DESIGN PROJECT

UNDERGRADUATE RESEARCH PROJECT

Students used the Rutgers ISE energy modeling and analysis platform to build a digital model of a small community of buildings to optimize energy use. The students also built a simulator of electric vehicles and developed a model to manage EV charging in the community. Another undergraduate student participated on a sponsored summer internship program and used the platform for energy efficiency analysis in different community environments.

## Reliability and Life Prediction of 3D-Printed Human Joints Replacement

UNDERGRADUATE RESEARCH PROJECT

The project aimed to minimize the current rate of revision after artificial joint replacements by conducting fundamental research on the design and fabrication of highly reliable artificial joints. The project focused on hip joint replacement—it modeled its failure modes, fabrication by 3D metal printer, and reliability testing.

## Optimization of Vehicle Routing and Scheduling

UNDERGRADUATE RESEARCH PROJECT

The objective of this project was to retrieve customer orders and schedule deliveries, ensuring that all orders are delivered on time. The team developed efficient solutions to address minimizing late delivery, batching orders by weight and volume, and optimize scheduling—all validated using system simulation.