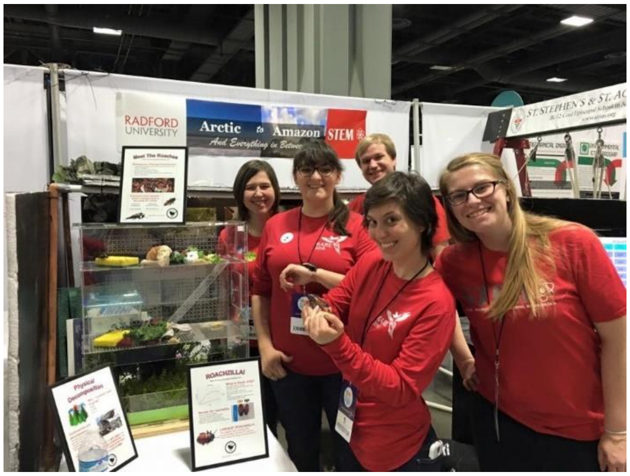
Featured Project

A team of scholars including Iain Clelland (business), Jason Davis (biology), Laurie Bianchi (nutrition), Andrew Ray (computer science), and Nate Bicak (design) began developing the BioTransformer project in the summer of 2015. Coming together from disparate backgrounds, the team was brought together by a common interest in the problem of food waste. Food waste is a major, though lesser known, challenge for materials conservation. Based on some estimates, 30-40% of all food is wasted, ending up unused and uneaten, often moldering in landfills. As a result, food waste is a major contributor to soil and water pollution and to greenhouse gas emissions. On a financial level, the cost of producing, transporting, housing and eliminating food waste comes to a staggering $218 billion **per year**.

The team rapidly came to the conclusion that the primary problem with food waste lies in transforming it efficiently into more usable materials, rather than burying it in the ground. This conversion process is far too complex to be effectively accomplished through artificial means, but natural organisms in the wild deal with the problem of biowaste on a daily basis. The team found themselves well-positioned to explore and expand on this natural process, working to harness it for human use. Work on the metabolic processes and mass-housing of hormonally modified Madagascar hissing cockroaches was already being conducted in the Davis lab, Bianchi's expertise in food science provided an ideal way of assessing food and waste nutrient content and the work of Ray and Bicak provided an ideal mechanism for developing custom-fabricated, computer integrated "smart housing" that could measure and modulate the input and output of the process. In combination with Clelland's expertise in market exploration and system analysis, the team was ideally situated to attack this problem.

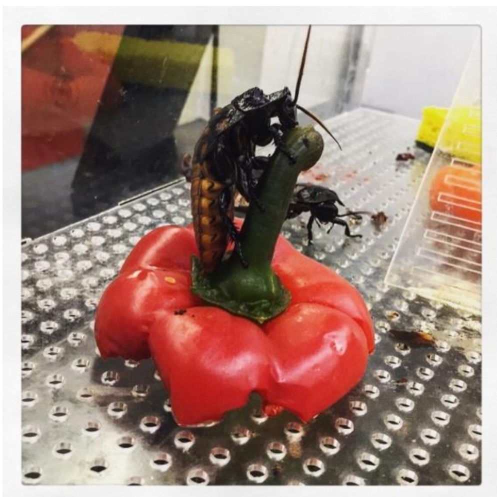
After several fruitful meetings, the team finalized an overall goal of developing a sustainable insect-based system for the conversion of food waste into useable materials – specifically protein and fertilizer. In addition, the team sought to develop their work into a project incubator capable of spawning a variety of independent 'mini-projects' for both faculty and students. Incorporation of both scholarly inquiry and scientific exploration into the pursuit of a single solution facilitates opened up a number of possible avenues for research and pedagogy, while still moving forward to the goal of improved food waste recycling. To undertake this task, the faculty invited a multiple students from across several disciplines to join them in their work, forming a multilevel interdisciplinary, super-group.



The team began their work by identifying problems: how rapidly and effectively could the roaches turn food waste into both roach mass and fertilizer? What types of food waste could and couldn't the roaches consume? How could animals be housed in high numbers in a highly regulated and controlled environment? How could waste be introduced to the system and how could the end products be removed? How could this be developed into a marketable process and procedure? The team has been working diligently to address these questions over the last year.

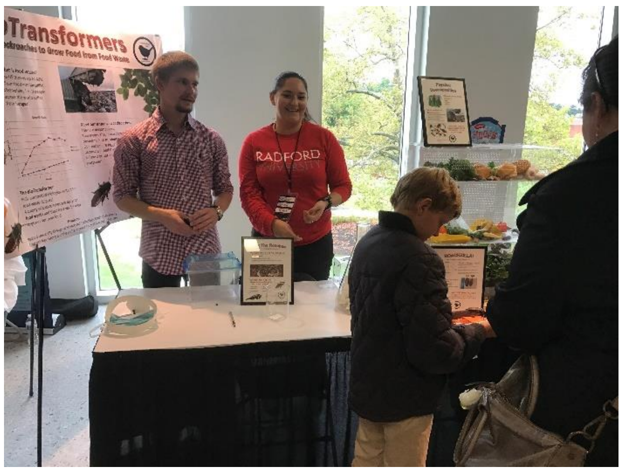
Work began with a number of investigatory discussions and meetings both on campus and beyond. In collaboration with the Chartwell's corporation, the team was able to analyze the constituents of the food waste produced by Radford University's Dalton cafeteria, and to compare that with both home food waste and the types of food-related waste generated by various agricultural practices. Through visitations and consultations with various regional greenhouses, fish farms and rendering plants, the team was able to assess the limitations, challenges and requirements of industrial scale waste processing and high intensity agriculture, and to generate a variety of ideas about how to monetize food waste. These data points provided an excellent frame of reference for understanding the obstacles and impediments, both regulatory and practical, facing them in their overall task.

Alongside their investigations into pre-existing businesses and infrastructure, the team began to conduct research on the roaches themselves, with a particular focus on their diet, growth and waste output. Initial findings showed that roaches have a broad dietary range but are ideally situated for the recycling of relatively unprocessed foods, with a marked preference for simple fruits, vegetables and meats. Hormonally accelerated roaches are able to transform these foods at an impressive rate, converting them rapidly into both mass and a compact, low-water, high nutrient frass (solid insect waste). Chemical analysis studies indicate that roach frass produced in this fashion has the potential to serve as a powerful fertilizing agent. Even better, in contrast to vertebrate-based agriculture, roach frass creates very few potential pollutants. In addition, early nutritional analysis suggests that roaches fed biowaste are themselves an excellent source of protein with potential use as a food source in aquaculture and animal feed.



At this point the team is well on its way to final construction of a large BioTransformer test system. The base unit will occupy a space of 54 square feet, and be capable of housing several thousand roaches. With a computer controlled and monitored environment, along with a treadmill for moving waste through the system, it is hoped that it could remove several dozen pounds of food waste per day. In addition, it will provide an ideal test engine for ongoing student-focused research in biology, design, computer programming, and nutrition.

In addition to their work exploring the underlying questions, the team has also been active in both academia and outreach. Members of the team have given presentations and demonstrations at a variety of regional and national venues, including the Virginia Tech Science Festival, the Virginia Science Museum, Hokie Bugfest, and the National Science and Engineering Festival held at the Smithsonian Institute in Washington, D.C. In addition, scientific findings on roach metabolic rate under various nutritional and hormonal conditions will be presented by research student and senior biology major Erin Dudley at the 2017 international meetings of the Society for Integrative and Comparative Biology, in New Orleans, LA.



Work on this project is still very much underway, and in many ways the team has only just begun to scratch the surface of the issue. Their goal is to develop a solid foundation of pilot data on which to base long term grant and project development plans – with the goal of applying to several national grants over the coming year. Food waste will likely remain a problem for the foreseeable future, but with hard work, cooperation and methodical inquiry the team hopes to make a real difference in how we approach this issue. Who knows…in 20 years you might find roach-based recycling systems incorporated into farmyards, college campuses and business parks, suburban gardens, or even your own kitchen.