Provost’s Learning Innovations Grant for Faculty
Special Request for Proposal
Course Development
2009-2010

Project Title: Wandering Campus Ambassador

Applicant(s):  

<table>
<thead>
<tr>
<th>Name</th>
<th>Telephone</th>
<th>Dept.</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Slack</td>
<td>55105</td>
<td>Electrical Engineering</td>
<td>COE</td>
</tr>
<tr>
<td>Stan Rickel</td>
<td>54745</td>
<td>Industrial Engineering</td>
<td>CIAS</td>
</tr>
<tr>
<td>Daniel Phillips</td>
<td>52309</td>
<td>Electrical Engineering</td>
<td>COE</td>
</tr>
<tr>
<td>Ferat Sahin</td>
<td>52175</td>
<td>Electrical Engineering</td>
<td>COE</td>
</tr>
<tr>
<td>Wayne Walter</td>
<td>52925</td>
<td>Mechanical Engineering</td>
<td>COE</td>
</tr>
</tbody>
</table>
1. Title
   Wandering Campus Ambassador to raise awareness of self-sustaining energy and showcase student's creative and technical abilities.

   Summary
   This is a Multidisciplinary Senior Design (MSD) project that will raise awareness of self-sustaining energy possibilities and publically showcase our student's capabilities. The idea is to create curiosity through this Wandering Campus Ambassador which will be a robot like device with a living, growing and self-sustaining plant. This Ambassador will have the ability to actually wander around campus in a nice, slow, autonomous fashion, searching out the best sun, water, fellow plants and friendly passers-by. From an environmentally friendly perspective, the Student Team will consider some replenishable energy sources for both the robotic-like device and its plant which is not only along-for-the-ride but may guide the robotics’ autonomous decisions in search of being able to sustain the plant (i.e. water, sun, temperature, food).

2. Targeted learners or population
   Senior students are from CIAS Industrial Design Department and four departments within KGCOE. The following table describes the targeted learners by discipline. The first column lists the college, department and number of students for this project. The second column is a brief description of the student’s interest/ contribution.

   Once the project is completed, the targeted population will be students, faculty and visitors using the campus Quad Area.

<table>
<thead>
<tr>
<th>College/Department (number of students)</th>
<th>Project Development Team Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIAS/ ID -1</td>
<td>Starting with the general theme of “wandering plant”, create RIT campus awareness and motivational interest models. That is, student and faculty motivation to further study and promote self-sustaining alternatives and applications. Consider, define, select and apply novel scheme(s) to “advertise” ID and MSD student’s curriculum knowledge and their abilities.</td>
</tr>
<tr>
<td>COE/ ISE -1</td>
<td>Define campus trail territory, potential hazards, off- limit areas, human safety consideration, campus approval processes and so on. Campus environmental and facility needs to support the robot service and plant needs. Apply trail scenarios to current robot projects. Make recommendations to this project mission. Define developmental test stages from SD I prototyping through SD II campus test certification. List potential contacts from RIT, local, state to national organization interested in energy sustainability. Take the lead in defining and delegating design competitions applications such as RITs annual IEEE Design Competition, Circuit Cellar, Analog Devices and so on.</td>
</tr>
<tr>
<td>COE/ CE - 2</td>
<td>Based on wandering robot trail scenarios developed by ISE students, define the levels of autonomous behavior needed for this project.</td>
</tr>
</tbody>
</table>
Study algorithm needs associated the feasibility in implementing a successful solution. Consider and detail prototype and development platforms and tools. Work with EEs in defining electronics platform needs and architecture.

**COE/EE - 3**

Study and recommend a design given existing electrical design platforms and motor module platforms such as P09207 Ground Scout Platform, P09203, 4, 5 10kg, 100 kg controls, Robotics Club—“Amos”, and other robotic electronics and controls. Modifications for very slow movement. Robotic controls. Data acquisition to measure campus environmental conditions, external communications, positional determination, and plant health monitoring (i.e. moisture level, temperature). Power conversion, generation and storage electronics. Assist in the development of autonomous software.

**COE/ME - 3**

Study and recommend existing mechanical design platforms and motor module such as 10kg and 100 kg platforms, Robotics Club—“Amos”, and P09203, 4, 5 robotic platforms in development. Modifications for very slow movement and protection from the three season plant growing conditions. Study and define the design needs and feasible concepts to implement in the RIT campus environment (i.e. spring, summer and fall). Mechanical and electronic components need to be weatherproof.

3. **Number of students who will be affected**
   
   Project will be a 10 person senior level team for two 2009 - 2010 academic quarters.

4. **Rational for Project**

   This is a Multi-college and Multi-disciplinary Senior Design project to raise campus awareness about renewable energy in a self-promoting and curious nature. Perhaps the use of sustainable power such as solar, wind, even fuel cell and photo-synthesis (just postulating) can be considered by the student team. Implement a robot-like device that can “wander around” and act as a great (yet very quiet) spokesperson for RIT student’s abilities. Create a fun showcase of RIT student’s design capabilities when students, parents, alumni, and industrial sponsors visit campus. This can be a creative addition during graduation and special functions such as Imagine. This project will be built and available for 2010 Imagine Event.

5. **Anticipated impact on teaching and/ or learning**

   The anticipated impact on learning is to successfully raise campus awareness of self-sustainable energy and to showcase RIT student’s abilities. To achieve these missions, the students are given the task to create the Wandering Ambassador.

   Given the autonomous decision making will need to sustain the plant (i.e. water, sun, temperature, food), the students need to consider this partnership between the robot as a guardian and the plant’s need to thrive in a self-sustainable manner. The students will need to determine how to make maximum use of natural conditions by managing sun, shade, temperature, rain, and watering to allow the plant to grow and thrive. This project will challenge students to translate abstract features into a solution (see Appendix A – Project Suggested Needs and Features).
This project is open ended in terms of project solutions to encourage our students to be creative and innovative. That is, free to brainstorm and enhance upon the mission and features. As examples, “… _project can act as a guardian to support the plant’s growth needs_” and “… _make maximum use of natural conditions by managing sun, shade, temperature, rain, and watering to allow the plant to grow and thrive_” may lead to several interdependent design features that the students will need to discuss, consider creative solutions, agree to a design, build and debug.

This project may be a first in a series of projects to serve as an experimental platform for future sustainable themes. Biology and chemistry majors may become involved in future experimentation.

6. **Impact on student success**
   Once the project is completed and the robot is “wandering” in the Quad Area, this should create curiosity and interest in RIT’s design and technologies. Given the growing attention and interest in renewable energy, this project has promise on a number of fronts for students and faculty. The creation of a unique experimental platform may plant-the-seed for future renewable energy projects that are affordable and sustainable.

7. **Measure Impact and Dissemination**
   a. This project will follow the MSD design process steps and associated grading rubric.
      During the two quarter project development, faculty forum events occur with three Design Reviews and two Project Reviews. This involves team students, students from other similarly minded projects and faculty from all disciplines.
   b. This team will be encouraged to participate in design competitions such as RITs annual IEEE Design Competition, Circuit Cellar, Analog Devices and other design outlets.
   c. Once completed, the “Environmentally Friendly Ambassador” on RIT campus will become very public. Its impact should be clear by its observed acceptance level by RIT students, faculty and visitors. This may encourage future design features and the project itself may become self-sustaining.

8. **Project Timetable**
   This will be a two quarter Multidisciplinary Senior Design Project in the 2009 academic year.
Appendix A – Project Suggested Needs and Features:

The robot platform, motor and controls will be integrated from Senior Design projects currently in development. The robot platform, motor and controls will be added to the plant payload portion of the project. Safety, campus environment and communications will be considered with this project.

The following categories are organized by conceptual clusters: Robot Platform, Motion/Territory, Guardian, Power, Communications, Designated Service and Display Areas.

Robot Platform:
1. Stays outdoors during the plant’s growing season, except for maintenance.
2. Self-sustained for at least one week without attention.
3. Vehicle platform must carry plant, one week’s supply of water and power source to sustain energy.
4. If there is maintenance needed (i.e. more water, battery charge), robot will return to home position and solicit a service request.
5. Platform must consider plant drainage needs.
6. Expensive cargo devices will be limited to discourage vandalism.
7. Robot will have a leash if robot can not return to home position.
8. Team may want to consider methods to discourage vandalism (safely).

Motion/Territory
1. Movement is primarily needed to support the plant’s photo-synthesis, rain and temperature needs.
2. Periodic “wandering” motion is also needed to the capture the attention of pedestrians while ensuring the plant’s photo-synthesis and robot power needs are being met.
3. Robot will return, if requested.
4. Robot may not need to move for long periods of time particularly at night.
5. Safety: Given the robot is low to the ground (plant-like) and with autonomous wandering movement, the robot may wander into high traffic areas where pedestrian could potentially trip on it. Specific motion limits may need to be defined for Pedestrian safety.
6. Safety: The use of beacon(s) to warn pedestrians. Given NTID students, warning sound alone is not singularly sufficient.
7. Suggested Travel Speed: Maximum speed of 10 inches per minute to support a wandering motion needs. Exception: For safety reasons, team may determine the robot will need to move at “slow human speeds” to cross busy crosswalks or when manually returned for service.
8. Robot will detect and maneuver in such way as to minimize the opportunity of becoming trapped or lodged. As an example, steering may rotate on a near zero radius and/ or consider reverse drive.
9. Stays on paved areas.
10. Stays clear of doorways or other potentially dangerous situations for pedestrians or RIT maintenance carts.
11. Stays on campus in and around the Quad area. Team and Stackholders to define exact territory based on needed factors.

Guardian:
Note: Robot’s autonomous controls will react in part to meet the plant’s photosynthesis and moisture needs. See Motion/Territory.
1. A direct or an indirect monitoring and logging scheme to ensure the plant’s photo-synthesis needs are being met within its healthy limits. As examples: a. Monitor and log plant moisture.
b. Monitor and log temperatures.
c. Monitor and log sun and shade.
d. Monitor and log platform on-board water reserve level.
e. Monitor and log platform robot energy level.

2. A water dispensing device if rain is insufficient to maintain safe moisture levels.
3. Using data parameters above, determine dispense watering needs and rates.
4. Using data parameters above, determine robot autonomous motion and territory needs.
5. Through general observation of the plant’s health during service, the user’s ability to adjust Guardian parameters to better sustain the plant’s health.

Power:
1. Manage self-sustaining energy when and where possible.
2. Reserve sufficient robot power to return home and to sustain plant during journey.

Communications:
1. Project Mission: Be able to advertise Senior Design Sustainability mission. Message may be as simple as a plaque or more advanced display or sound.
2. Pedestrian: A warning if robot is in a walkway. Given NTID students and RIT service golf carts a warning sound alone is not singularly sufficient.
3. Device will have a back-up communication scheme such as a beacon when in peril due to a number of reasons such as plant parameters are out of range, low robot power or need for service.
4. Optional: Robot will stay in remote communications for the purpose of unexpected service needs.

Designated Service Area:
- Periodic refresh of renewed fresh water and renewed battery charge, if necessary.
- General observation of the plant’s health and potentially necessary to adjust Guardian parameters to better serve the plant.
- If robot can be carried, then 4th floor on Senior Design bay for re-charge, any data recovery and any potential upgrades.
- If too heavy to be carried, then electro-mechanical leash is needed.
- If robot is unable to return to Service Area, then a leash is needed to recover the robot back for service.

Display Areas:
- Plant will need a summer time temporary “service designated area” on the campus garden area. Sufficient posting or signing is needed so RIT maintenance with not inadvertently discard the plant while robot is in maintenance.
- Winter time display of Plant in a public location along with a Poster and other information. Perhaps junior plant(s) “in-training” so multiple sites or buildings can be selected for display.