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

Please hand-deliver your completed grant proposal (cover page, 4 pages, plus attachments), the original plus 15 copies, to:
Susan DeWoody, 1530 Wallace (Bldg 5)
by 4:30 p.m.
Friday, May 1, 2009.
No hand written proposals will be accepted.
Notification of awards will be made by Friday, May 29, 2009.

Development of a Pilot Honors Course to Address Issues of Local and Global Interest with Agent-Based Modeling

Applicant(s):

<table>
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<th>Name</th>
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<th>College</th>
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<tbody>
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<td>Science/Student Innovation Center</td>
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Summary of Proposed Project

The world students will face upon graduation consists of many interdisciplinary problems of varying complexity and importance. As they pursue their chosen careers they will learn that often they only have some of the tools and knowledge to solve their required career assignments. As the problems become more complex, often termed “Wicked Problems”\(^1\), they will need increased multidisciplinary knowledge and approaches developed through teamwork and interdisciplinary collaboration.

This course will be designed and developed to give students experience in multidisciplinary problem solving, teamwork, collaboration, and project management while producing meaningful research results and problem resolution.

The subject course will have a different annual focus on local and global issues such as Urbanization, Global Warming, Immigration and Migration, Crime and the US Prison System. For the 2010 -2011 academic year, as an Honors pilot course, the focus most likely will be **Collaborative Innovation** or **Greening of RIT**.

Agent-Based Modeling will be used as a tool to integrate the concepts and address problem resolution. Although ABM is a relative simple concept to grasp and takes minimal computer programming and mathematical skills to implement, it has yielded meaningful results to some very complex problems. Although it is beyond the scope and page limit of this grant application to discuss ABM and give a full treatise, a brief summary is given in the Appendix.

Targeted Learners or Population

Potentially any student that has the initiative, interest, and drive to be creative and work on complex problems can participate. This course will be offered and taught through the Student Innovation Center with a Principal Instructor and guest lecturers from various disciplines to augment the resources available to the class.

Affected Students

Most likely third year and above students that have successfully taken many of their core courses in their major and are interested in applying their studies to “real world problems”. Course criteria such as prerequisites, class standing, GPA will be established. An honors pilot course will be taught in the 2010 – 2011 academic year.


Osher Lifelong Learning Institute October 24, 2007 Bill Destler, President Rochester Institute of Technology
**Project Rationale**

RIT is rapidly becoming a university of, and a laboratory for, innovation. Recently, the President also made an ambitious commitment to the “Greening” of RIT. We want to further accelerate these developments and expose students to the practice, and the study, of innovation, by developing a series of courses that will empower students to use agent-based modeling to study and stimulate collaborative innovation at RIT. Under the proposed PLIG grant, Michael Long in the School of Mathematical Sciences will work with one or more faculty in the Interactive Games and Media department to develop a curriculum and a framework for undergraduate learning, research and scholarship into a variety of phenomena, beginning with collaborative innovation at RIT.

Interestingly, Nicholas Negroponte, director of MIT’s Media Lab observes that

> “the ability to make big leaps of thought is a common denominator among the originators of breakthrough ideas. Usually this ability resides in people with very wide backgrounds, multidisciplinary minds, and a broad spectrum of experiences.”

But in contrast,

> “Academia rewards depth. Expertise is bred by experts who work with their own kind. Departments and labs focus on fields and subfields, now and then adding or subtracting a domain. Graduate degrees, not to mention tenure, depend upon tunneling into truths and illuminating ideas in narrow areas.”

With increasing urgency, we need to cultivate and empower technologists who are synthetically perceptive, creative, collaborative, innovative…and technically adept. Unfortunately fewer and fewer American youth are actually enrolling in science, technology, engineering, and mathematics (STEM) programs, and those who do are trained to see themselves as specialists in technical fields. Better they should see themselves as technical adepts trained and empowered to perceive opportunities wherever they may exist, and to create innovative solutions in sympathetic collaboration with those who will benefit from them.

It is equally urgent that people in other fields be able to communicate and collaborate with STEM-types, understand and participate in technical, policy and design discussion that will shape their world. This course will be designed to address these issues by bringing together students from across the campus in all disciplines.

**Anticipated Impact on Teaching and/or Learning**

- Increased Student involvement, dedication, and commitment to resolution of

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<sup>2</sup> Taken in part from J. Schull “Creating a Collaborative Ecology for Innovation, Invention and Creativity at RIT” October 2006 and reference therein, it.rit.edu/~jis/landl/collective/InnovationCollective.doc.pdf

complex problems
• Ability to organize and quantify complex problems
• Ability to work in a collaborative atmosphere as a contributing member of a diverse and empowered team
• Ability to participate and manage complex project with improved understanding of time commitments and deliverables
• Understanding and practice in the entire innovation process (conceptualization, experimentation, iteration, feedback, realization, etc.)
• Understanding and appreciation of historical, cultural, social, environmental contexts as guideposts to future innovation
• Ability to join, contribute or lead multi-disciplinary and inter-disciplinary teams
• Understanding of, and proficiency in, technologies of communication and collaboration
• Ability to take risks, expose works-in-progress, improvise, admit ignorance and explore
• Ability to shape processes to achieve goals and produce realizations
• Understanding and appreciation for other disciplines and diverse perspectives

Impact on Student Success, Retention, Innovation & Society

Students will be guided through the process of formulating ideas, quantifying project goals, and developing a process to model a situation, question or problem leading to resolution. Instructional style will vary by speakers, topics and tools. Since these will not be required courses, enrollment will be because of student interest with interest, effort, and success increasing as the course progresses.

The curriculum will focus on the definition, quantification, attack and resolution of complex problems. Using ABM as a mechanism of problem resolution students will address pertinent social and economic issues such as global warming, epidemics and pandemics (e.g. AIDS, Swine Flu, Obesity), social welfare and taxation, migration and immigration, ecology and environmental sustainability.

Measurement and Dissemination

The following key indicators will measure the course impact:
• Student enrollment, initial and continued
• Research proposals generated
• Student papers published
• Conference presentations
• Internal and external funding secured

RIT community will be informed of student learning outcomes and success through department colloquiums and Student Innovation Center presentations, conferences, and poster sessions.
**Project Schedule**

Under this PLIG grant, the coming year would be spent developing
- a platform for modeling,
- a preliminary model of a first focal domain—*Collaborative Innovation*, or the *Greening of RIT*, and
- a curriculum that would make it possible for students to learn by doing
  - using the models
  - augmenting and developing alternative models, and
  - collecting and analyzing empirical data to test the models.

The courses would be offered for the first time in 2011-12, probably focusing on Collaborative Innovation or the Greening of RIT, and in subsequent years the technical and pedagogical platforms would be pointed at different focal domains.

The approximate schedule is

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<tr>
<th>Time Period</th>
<th>Deliverable</th>
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<tr>
<td>6/1 – 12/15</td>
<td>Develop a general platform for modeling</td>
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<td>9/1 – 10/15</td>
<td>Draft of detailed course outlines⁴</td>
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<td>10/15 – 12/15</td>
<td>Review course concept with RIT faculty</td>
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<td>1/15/10</td>
<td>Select course focal issue</td>
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<tr>
<td>1/15/10 – 6/15/10</td>
<td>Develop preliminary model, suitable for classroom work</td>
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<tr>
<td>6/15/10 – 8/15/10</td>
<td>Finalize model</td>
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<tr>
<td>8/15 – 11/15</td>
<td>Final course outlines</td>
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<tr>
<td>9/15 – 11/15</td>
<td>Develop course material, schedule speakers</td>
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<tr>
<td>2010 – 2011</td>
<td>Pilot course (Honors)</td>
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<td>Winter or Spring</td>
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**Appendix**

Agent-based modeling simulates the interactions of autonomous individuals in a network. “The models simulate the simultaneous operations of multiple agents, in an attempt to re-create and predict the actions of complex phenomena. The process is one of emergence from the lower (micro) level of systems to a higher (macro) level. The individual agents are presumed to be acting in what they perceive as their own interests, such as reproduction, economic benefit, or social status, and their knowledge is limited.” ([http://en.wikipedia.org/wiki/Agent_based_modeling](http://en.wikipedia.org/wiki/Agent_based_modeling)). Three of the best-known triumphs of agent based modeling are Axelrod’s game theoretical work on the Prisoner’s Dilemma game, Thomas Schellings work on segregation, and Reynold’s work on flocking in “boids”.

This work has continued at RIT. **Michael Long** recently started an agent-based

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⁴ See School of Mathematical Science for example of course outline [http://www.rit.edu/cos/math/Academics/outlinelist.html](http://www.rit.edu/cos/math/Academics/outlinelist.html)
modeling research program. Supported by a COS Faculty Development Grant to explore the suitability of ABM for undergraduate Research, he identified numerous original research opportunities. Further, in his past life as a biological psychologist, Jon Schull did some related game theoretical work on the evolution of sexual reproduction. In recent years, Kurtz and Doubleday have been studying the teaching students to develop models of 3D flocking in a variety of domains, and find students develop extraordinary interest and insight into the content and the methodology of the simulations. More recently, Schull was surprised to have a student point out that Reynolds’s flocking model provides valuable insight into the dynamics of collaborative innovation as occurs in his class on innovation and invention (the idea here is that collaborative innovation can be likened to flocking through idea space). And past theoretical work by Schull on adaptation in evolving species, and recent theoretical work by Scott Page in his groundbreaking book, “The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies” all indicate that the time is right for developing courses and a research program that can create an ongoing opportunity for undergraduate learning, research and scholarship into a variety of phenomena amenable to agent-based.

So what is Agent-Based Modeling?
Agent-Based Models use individual computer objects as players or agents. Governed by a set of rules, these agents are turned loose in a computer-generated landscape to perform their appointed task such as trading, segregating, spreading disease or minority opinions, reacting, creating mayhem, bank fraud, or any number of other mischievous endeavors. Often, their resultant behavior has a remarkable similarity to observed reality and can also lead to an understanding of emergent behavior.

Agent-based models, ABM, are non-deterministic in that the outcome itself is not modeled nor often known. In conventional modeling, equations that fit the final stage are often developed and used to model not only the final state but also the development thereof. However, in ABM individual “players” or agents with a basic set of rules each act as “individuals”. The holistic behavior of these agents is the result of the interaction of each individual agent with other agents and with the environment that in turn acts upon the individual agent. The advent of sufficient computational power in the last decades has allowed the incorporation of sufficient number of agents and a large enough landscape to provide interesting and meaningful results.