Faculty Innovator Grant 2006
Center for Learning Technologies

Final Report Form

Primary Faculty Name:	David C Earnest
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Email Address:	dearnest@odu.edu
Office Phone Number:	683-3934
Project Title: (10 words or less)	Beyond the Butterfly Effect: An Introduction to Simulation

Collaborating faculty:

Faculty Name:	Department	Email Address	Office Phone Number
Ghaith Rhabadi	Engineering Management and System Engineering		

Final Report Form

1. Describe the specific teaching and learning issues being addressed by the proposal.

The experimental course substantially accomplished the objectives delineated in the original proposal to the Center for Learning Technologies. The course introduced nine undergraduate students to concepts and methods for understanding nonlinear systems. These students had diverse majors: criminal justice, geography, history and political science. The course taught students complex systems theory, an interdisciplinary approach to understanding dynamic systems, as well as agent-based modeling and simulation methodologies derived from complex systems theory. Overall, by the end of the semester students exhibited a broader understanding of nonlinear dynamics as well as of modeling and simulation methods. Given ODU's growing research in modeling and simulation, it is a substantial accomplishment that undergraduates now benefit from this research.

2. Describe the revised specific teaching and learning issues being addressed by the proposal (if applicable):

The original proposal original proposal sought to include graduate students in the experimental seminar. In the end, however, the final course included only undergraduates. Though a number of graduate students expressed interest in the seminar, they face program requirements that limit the number of 500-level seminars for which they can receive credit. Accordingly, the course revised its learning issues and outcomes to focus on the needs and challenges of undergraduate students.

3. Describe the development activities involved addressing the learning or teaching issue.

Dr. Earnest and Dr. Rabadi developed an entirely new course. This required a full set of development activities, from identifying appropriate texts and readings, to developing PowerPoint slides for lectures, to crafting exercises for students.

Given that two departments cross-listed the experimental course (Department of Political Science & Geography and the Department of Sociology & Criminal Justice), Dr. Earnest and Dr. Rabadi took special care in developing a course that emphasized a multidisciplinary approach to complex systems theory. Students enjoyed readings in politics, economics and geography in addition to foundational readings on complex systems theory and concepts. The attached copy of the syllabus (appendix A) details the course readings.

The instructional faculty also developed four exercises in modeling in simulation for the students. These exercises taught the students basic computer programming language and provided a foundation of skills for students to construct their own research project.

Faculty worked closely with individual students to help them learn the course's modeling and simulation software. We designed the course with the expectation that students had little or no background in computer programming. For this reason, the course used an easy-to-learn simulation program (NetLogo). The course schedule also allowed for intensive one-on-one work with students. The course met twice weekly in the BAL 1014 instructional laboratory. This schedule generally allowed for a Tuesday lecture followed by a Thursday session during which students would work on their exercises or final projects using the NetLogo software. During these Thursday sessions, the instructor of record (Dr. Earnest) assisted students with whatever challenges they experienced.

Finally, OCCS staff provided considerable assistance in configuring the BAL 1014 instructional laboratory for the course. OCCS staff installed NetLogo v. 3.1.4 on all 20 workstations in the lab plus the faculty instructional station. The software performed flawlessly, with no technical difficulties during the semester.

4. Describe the learning outcomes attained by the project.

Each student demonstrated his or mastery of course materials with an original final project. For this project, each student identified a complex problem of interest to him or her. Students then used their computer programming skills to create a simulation of the system and to study its properties inductively. Final projects modeled systems ranging from beach erosion to gang violence in prison. This illustrates the course's relative success in achieving a multidisciplinary approach to modeling and simulation. Appendix B lists students' final projects; one may also view and run the student simulations at http://www.odu.edu/~dearnest/clt_final_report.htm.

5. Describe unexpected outcomes, if any.

One unexpected outcome was the difficulty students had in learning computer-based modeling. Although all students had satisfied ODU's general education requirements in mathematics and computer skills, it appears neither requirement provides students with a working familiarity with logic. Because Boolean logic is prevalent in many computer languages (including the Logo language of NetLogo), this unfamiliarity challenges students who are learning computer programming. Consequently, students required an unexpected amount of individualized instruction.

6. Describe the impact of the completed project on your colleagues, department, college, or community.

The experimental course had three impacts on the Department, College and University community as a whole.

First, the project provided an innovative new course for students majoring in political science, geography, sociology and criminal justice. Now that the instructors have developed this course, departments may offer it periodically in the future. Given the methodological nature of the course, furthermore, it strengthens each department's offerings in research methodology. Consequently, each department has broadened its available methodology offerings for its majors.

Second, the Graduate Program in International Studies (GPIS) is considering using the experimental course as a template for a complementary graduate seminar in social science modeling and simulation. GPIS plans to offer a new "track" in modeling and simulation in international studies that masters and doctoral students may choose as a field of concentration for their studies. Dr. Earnest will offer a seminar on agent-based modeling for this new track. Because of the CLT's innovator grant, GPIS will not have to develop this course from the ground up; with minor modifications, GPIS can use the course funded by CLT. This will save GPIS considerable time and effort.

Finally, the experimental course relates directly to ODU's mission to become a leading national university in modeling and simulation (M&S). Given the prominence of M&S industries in the Hampton Roads area and ODU's relationship with the Virginia Modeling, Analysis and Simulation Center, ODU is poised to educate the next generation of modelers and simulators. The course illustrates that these ideas and methods no longer are strictly the purview of physicists, computer scientists and engineers. Rather, ODU can plausibly claim that modeling and simulation informs its curriculum in the social sciences and humanities as well. This considerably enhances ODU's claim as the vanguard of M&S research and education.

7. Describe how the project can be a model, template, or prototype for use by other instructors.

Because M&S technologies and theories evolve rapidly, the experimental course will require revision to keep up with changes in the state of the art. Nevertheless, the course's emphasis on practical learning through hands-on exercises should inform any future course in M&S. Likewise, other instructors would benefit from using the course's template of lecturing one day a week followed by one-on-one instruction in the computer labs.

8. Describe the technology used to help address the issues described in the proposal.

The course made extensive use of instructional technologies. Indeed, every class session convened in BAL 1014, the instructional laboratory in the College's large computer lab. The instructor used PowerPoint and the lab's projectors to lecture each Tuesday. Students not only followed these lectures, but also occasionally would conduct exercises on their workstations to follow along with the lecture.

Second, the course used NetLogo, a free agent-based modeling and simulation software developed by the Center for Connected Learning at Northwestern University (see http://ccl.northwestern.edu/netlogo/). This software uses quasi-parallel processing to simulate massively parallel complex systems. The software has much to commend: not only is it free, but it also has a library of sample models and free code, extensive documentation, several free tutorials, and an easy-to-learn language when compared to object-oriented languages such as Java and C++.

OCCS provided commendable support to the project, ensuring that each workstation had a working copy of NetLogo.

9. Describe products, if any, that are a result of the project.

Three products resulted from this experimental course. First, students developed workable models that may inform their future research. Indeed, one of the course's students (Melissa Curtiss) graduated and enrolled in the graduate program in geographic and cartographic sciences at George Mason University. As part of her course work, during the fall of 2007 she took Introduction to Computational Social Science. As the attached email from Ms. Curtiss indicates (see appendix C), the course prepared her and others for advanced graduate study.

A second product will be a conference paper. Dr. Earnest will present a paper that discusses the course at the 2008 annual convention of the International Studies Association annual convention this coming March. This paper will discuss the course's teaching and learning objectives, its technology, outcomes and future lessons. Dr. Earnest hopes subsequently to publish this paper in the *Journal of Political Science Education*.

Finally, the course suffered from the absence of a suitable textbook. This reflects in part the immature and rapidly changing nature of modeling and simulation. Nevertheless, most available texts are suitable for graduate students only. Accordingly the course relied on a text that was eight years old (Resnick 1999; see appendix A) and that offered no help with the NetLogo simulation software. One future product of this course may be a text on social science modeling and simulation that targets nontechnical undergraduates as its audience.

10. Describe the future plans for this project, if any.

The Department of Political Science & Geography may offer this course periodically when departmental resources and student demands permit. Given its specialized and methodological nature, the course is a "boutique" course that appeals to a relatively small number of students. It is best offered once every two or three years. Yet this in no way detracts from the tertiary benefits of the course to the department, college and university (see point 6 above).

11. Attach a financial report with updated Budget Plan Matrix.

The faculty innovator grant released Dr. Earnest from one of his regular courses. With teaching constituting 40 percent of his obligations, and a teaching load of five courses a year, the cost of releasing Dr. Earnest from one course is his base salary $\times$ 0.4 $\times$ 0.2 = $4,183.47. The award was $3,000. The College of Arts & Letters and the Department of Political Science & Geography provided the remaining $1,183.47 to release Dr. Earnest from his teaching obligation.

Final Budget Matrix

			Source of Funds	
Budget Item (equipment, personnel, software, etc.)	**Qty**	**Total Cost**	**Amount from FIG**	**Amount from Other Source**
Faculty performance release time	1	4,183.47	3,000.00	1,183.47

POLS/GEOG/SOC 495
Introduction to Social Simulation—Beyond the Butterfly Effect
Spring 2007

Mondays and Wednesdays, 3:00–4:15 p.m.
Batten Arts & Letters 3058
Computer Lab: Batten Arts & Letters 105-20

Assistant Professor David C. Earnest, Ph.D.
Department of Political Science & Geography
Office: Batten Arts & Letters 7010

Contact:
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Phones: 757-683-3934 (direct)
757-683-3841 (POLS office)

Spring 2007 Office Hours:
T 9:00–11:00 a.m.
W 1:30–2:30 p.m.
Or
By Appointment

Blackboard and Lab Technical Support (OCCS)
http://www.odu.edu/dl/clt/bb/student_help_page.html
757-683-3192

Syllabus

Catalogue Description

This course introduces upper-level undergraduates to complex systems theory and to the application of agent-based modeling technologies to a variety of social systems. The course seeks to train undergraduate students how to use basic computer simulations as a tool of inference for their research interests. Topics include the principles of chaos and complex systems, the epistemological foundations of simulation, object-oriented programming for the beginner, basic genetic algorithms, and the inferential challenges of nonlinear systems. The course emphasizes the interdisciplinary nature of complex systems theory and welcomes students from a variety of disciplines, including physics, chemistry, geography, biology, engineering, sociology, economics and political science.

Discussion

The interdisciplinary study of complex systems represents an important intellectual movement that challenges both traditional boundaries between disciplines in academia and conventional methods for understanding "systems," whether they are physical,

biological or social. "Complex systems" share a number of properties that belie our disciplinary distinctions: they consist of a large number of autonomous actors, interacting independently in the absence of central authority. This decentralized structure allows complex systems to evolve, change, grow, adapt and even to anticipate, producing surprising dynamics. Examples are numerous: ecologies thrive or collapse depending on the interactions of species; particles produce waves and turbulence; social networks propagate disease; voters create electoral instability. As scientists have come to understand the behavior of complex systems, however, we have faced the simultaneous challenges of developing new methods and of training students in these techniques. Fortunately, as computing technology has evolved the methods of complex systems theory are more accessible to students than ever. This course seeks to acquaint students with the theories, methods, and epistemological claims of complex systems theory by applying the theory to problems from their own discipline.

This course introduces student to chaos and complex systems theory and reviews applications of the agent-based modeling methods to a variety of problems. It also teaches the student some basic techniques for simulating systems using an agent-based modeling repertoire called NetLogo (http://ccl.northwestern.edu/netlogo/). Though a number of agent-based simulation tools are available, NetLogo is ideal for our purposes because it is easy to learn and yet is a powerful simulation tool. **The goal of the course is for the student to use NetLogo, in conjunction with his or her knowledge of complex systems theory and their own discipline, to simulate the behavior of a complex system and to test a number of hypotheses.** Students are expected to present their model to their classmates at the end of the term. Students uncomfortable with computer program may choose to write a research paper in lieu of developing a computer model.

The course plan is divided into three sections. The first section introduces students to the theoretical claims of and ontology of chaos and complex systems theory. Once students are familiar with the complex systems paradigm, the second section introduces them to the techniques, algorithms and software theorists use to model complex systems. Finally, the third section reviews existing applications of the principles and methods of complex systems theory to contemporary questions about a variety of social, geographic, economic, and political systems.

Since complex systems theory represents a new way of thinking about nonlinear systems, it likely will feel unfamiliar and intimidating to some students. The course seeks to help students in two ways. First, the course introduces students to the vast resources of the modeling and simulation community, including the NetLogo User's Group and library of community models. We also seek to uphold the norms of this community, which emphasizes the open source nature of the work we do. For example, the course encourages students to share their source code for the models they develop. Students will maintain their own "page" on Blackboard in which they will provide both the source code for their models as well as a Java applet of the model that other students can use. In this way the students and course instructors alike learn from each other's modeling ideas.

Second, the goal of the course is to develop an understanding of how complex systems work, not how to write a program in NetLogo. The software should not be a barrier to the student's learning. Accordingly, I encourage students both to work with each other and to work with me. During the semester, we will have ten sessions in the computer lab dedicated to learning how to get NetLogo to model the systems that interest you. I will be present to help you learn the software, to work with you on writing code for your

exercises, and to help you develop your final model. Students should feel free to call on me for help.

Prerequisites

Students are expected to have completed introductory courses in their major departments. Students must be familiar with the basic theoretical debates and methods of their discipline or sub-discipline. Students must also be comfortable using a computer and have internet access for the class exercises.

Students should also have internet access through campus computer labs, their major department, or through their personal computers. Internet access is necessary both to acquire the open-source software we use (NetLogo) and for students to share their modeling ideas with their colleagues.

Programming experience is not a prerequisite.

Course Books and Software

Required Books

Epstein, Joshua M. and Robert Axtell. 1996. *Growing Artificial Societies: Social Science from the Bottom Up.* Washington, DC: Brookings Institution.

Resnick, Mitchel. 1999. *Termites, Turtles and Traffic Jams: Explorations in Massively Parallel Microworlds*. Cambridge, MA: MIT Press.

Strogatz, Steven. 2003. *Sync: The Emerging Science of Spontaneous Order*. New York: Hyperion.

Recommended Book

Woolridge, Michael. 2002. *An Introduction to MultiAgent Systems*. Chichester, England: John Wiley & Sons.

Software

All students will need a simple spreadsheet program like Microsoft Excel or Corel Quattro Pro.

All students should download a free copy of the NetLogo software, available from http://ccl.sesp.northwestern.edu/netlogo/

Course Requirements and Assessment

Student grades are based upon four computer-based assignments (15 percent of your grade each) and a final project (40 percent). Students are expected to complete their computer-based assignments on their own computers or those of the computer lab. As

in any course, students are expected to have completed the course readings prior to class.

1. **Exercises** (15 percent each X 4 = 60 percent): The four computer-based assignments are **due in class on January 24th, February 14th, March 21st, and April 4th**. Students will post their results to the discussion forum on our Blackboard page.

2. **Final project** (40 percent): The student has three options for the final project. Students may create an agent-based model of a complex system of their own choice, and **present their findings to the class on either April 18th or April 23rd.** This option gives the student the opportunity to integrate the course's theoretical materials, the methodologies of agent-based models, and a problem of interest to him or her.

   Alternatively, students may choose to write a final paper of no more than 20 pages on a topic either of their choice or from the suggested list below. **Research papers are due in-class during week 15**. Students who choose to write a research paper must receive the instructor's approval for his or her topic. Some suggested topics are:

   - In what ways do social systems differ from physical and biological complex systems? What do these differences imply for the applicability—or lack thereof—of complex systems theory to social science questions? Is complex systems theory better suited for agent-based models of economic systems than of political systems?
   - Using a contemporary example from your field of study, explain what advantages complex systems theory offers over existing theoretical approaches. What does complex systems theory explain that other theories cannot? What does complex systems theory fail to explain?
   - How does one use agent-based models to make inferences? How does one assess the validity of inferences made from agent-based models?

Late Work

I will accept exercises that are overdue but will penalize you five percent for each day the assignment is late, including weekend days. To avoid this penalty, you must obtain from me an extension of the due date no later than 48 hours before the assignment is due, at which time we will agree to a new due date. I reserve the discretion to grant or withhold no-penalty extensions, and will do so only for serious reasons.

Academic Integrity

I expect all students to understand and to abide by the University's Honor Code:

> "I pledge to support the Honor System of Old Dominion University. I will refrain from any form of academic dishonesty or deception, such as cheating or plagiarism. I am aware that as a member of the academic community, it is my responsibility to turn in all suspected violators of the Honor Code. I will report to a hearing if summoned." *ODU Student Handbook, 2005-2006*, p. 5.

You should understand your rights and obligations, what constitutes a violation of the honor code and academic integrity, what disciplinary procedures and sanctions you may face, and what options I have should I suspect a violation. If you are unfamiliar with the honor code and disciplinary procedures, I suggest you visit the Honor Council's web page (http://studentservices.odu.edu/hc/). You may also refer to the Code of Student Conduct, Sanctions, and Disciplinary Procedures in the Old Dominion University Catalog 2006-2008, pp. 14-18.

I take the Honor Code seriously, and will pursue vigorously the adjudication of any violations I may perceive or suspect. If I suspect a student has committed a violation, I work only with the University Hearing Officer to determine whether or not a violation has occurred. Under no circumstances will I discuss allegations of academic dishonesty with the individual student.

Students with Disabilities

In accordance with the University's policies and procedures, I will work to accommodate students with disabilities. If you require such accommodations, please contact me by email, phone or during office hours as early in the semester as possible.

Sexual Harassment

It is the policy of Old Dominion University to provide students and employees with an environment for learning and working that is free of sexual harassment, whether by members of the same sex or the opposite sex, which is prohibited by Title IX of the Education Amendments of 1972 and Title VII of the 1964 Civil Rights Act. I expect all students to understand and abide by the University's sexual harassment policy and procedures, as detailed at http://web.odu.edu/webroot/orgs/AO/PO /eoe.nsf/pages/eoehome.

Course Evaluation

The syllabus is a contract between the professor and students regarding course requirements, expectations, and assessment, which establishes my obligations to you in teaching this class. I also take this contract to include your obligation to evaluate the course at the end of the semester. Student evaluations provide important feedback for me, and they are essential for measuring teaching effectiveness in the profession. Chairs and Deans see course evaluations every year when reviewing faculty performance, and committees at all levels of the University rely on the evaluations in making decisions regarding faculty retention, promotion and tenure. ODU takes your input very seriously, and a high rate of student response is necessary for a meaningful assessment of teaching effectiveness. Therefore, I ask you commit yourself to filling out the online course evaluation when prompted at the end of the semester.

Course Plan

PART I: BASIC CONCEPTS

January 8th: Course Objectives and Design—What is "social simulation?"

January 10th: Introduction to Chaos and Complex Systems Theory

Reading:
- Strogatz, Preface and Chapter 1.

Model:
- "Fireflies" in the NetLogo library of biology models

January 15th and 17th: Chaos on a Spreadsheet (Lab)

Reading:
- Kiel, L. Douglas and Euel Elliot, "Exploring Nonlinear Dynamics with a Spread Sheet: A Graphical View of Chaos for Beginners." *Chaos Theory in the Social Sciences: Foundations and Applications,* edited by Kiel and Elliott (Ann Arbor, MI: University of Michigan Press, 1996) pp. 19-30.

Model:
- "Chaotic Dynamics: The Log Map" at http://www.odu.edu/~dearnest/abm/logmap.html

January 22nd: Self-Organization and Emergence

Reading:
- John H. Holland, "Complex Adaptive Systems," *Daedalus* 121, 1 (Winter 1992): 17-30.
- Resnick, chs. 1-2, pp. 68-75.
- Strogatz, pp. 171-176.

Models:
- "Traffic Basic" in the NetLogo library of social science models
- "Traffic Grid" in the NetLogo library of social science models
- "Flocking" in the NetLogo library of social science models

January 24th: Introduction to NetLogo (Lab) **Exercise #1 due**

January 29th: Social Systems as Complex and Chaotic Systems

Reading:
- Strogatz, ch. 10
- James N. Rosenau, "Many Damned Things Simultaneously: Complexity Theory and World Affairs," in *Complexity, Global Politics and National Security,* David S. Alberts and Thomas J. Czerwinski, eds. (Washington, DC: National Defense University 1997).

Models:
- "Mavens and Connectors" at http://www.odu.edu/~dearnest/abm/mavens.html
- "Buttons" at http://backspaces.net/Models/buttons.html

January 31st: (Lab—begin exercise #2)

PART II: MODELING COMPLEX SYSTEMS

February 5th: Agent-Based Models

Reading:
- Epstein and Axtell, Ch. 1
- Owen Densmore, "Complexity Workshop Tutorials: NetLogo and RePast" at http://complexityworkshop.com/tutorial/
- Gerald Balzano's "Turtle Epidemic" tutorial at http://ccl.northwestern.edu/netlogo/resources/Turtle_Epidemic_Handout.pdf

Model:
- "Sugarscape" at http://backspaces.net/Models/sugarscape.html (experiment #1)

February 7th: (Lab—work on exercise #2)

February 12th: Adaptive Systems

Readings:
- Epstein and Axtell, Ch. 2
- Resnick, pp. 50-68

Models:
- "Sugarscape" at http://backspaces.net/Models/sugarscape.html (experiment #2)
- "Slime" in the NetLogo library of biology models
- "Ants" in the NetLogo library of biology models

February 14th: (Lab)

Exercise #2 due

February 19th: Intelligent and Learning Systems

Readings:
- John H. Holland, "Genetic Algorithms," *Scientific American* 267 (July 1992), pp. 114-16.
- Resnick, pp. 75-81

Models:
- "Termites" in the NetLogo library of biology models
- "Peppered Moths" in the NetLogo library of biology/evolution/genetic drift models
- "PD Basic Evolutionary" in the NetLogo library of social science/(unverified)/Prisoner's Dilemma models

February 21st: (Lab—begin exercise #3)

PART III: APPLICATIONS

February 26th: Networks

Reading:
- Strogatz, ch. 9

Model:
- "Small Worlds" at http://www.odu.edu/~dearnest/abm/SW2.html

February 28th: No class (International Studies Association Annual Convention)

March 5th and 7th: SPRING BREAK

March 12th: Actors, Agency and Contingency

Reading:
- Epstein and Axtell, ch. 3

Models:
- "Sugarscape" at http://backspaces.net/Models/sugarscape.html (experiment #2)

March 14th: (Lab)

March 19th: Politics

Readings:
- Thomas Schelling, *Micromotives and Macrobehavior* (New York: W. W. Norton, 1978) pp. 137-155.
- Resnick, pp. 81-88.

Models:
- "Segregation" in the NetLogo library of social science models
- "The Tragedy of the Commons" at http://www.odu.edu/~dearnest/abm/commons.html

March 21st: (Lab) **Exercise #3 due**

March 26th: Economics

Readings:
- W. Brian Arthur, "Positive Feedbacks in the Economy," *The McKinsey Quarterly* 4, 1 (Winter 1994): pp. 81-96.
- Epstein and Axtell, ch. 4.

Model:
- "Wealth Distribution" in the NetLogo library of social science models

March 28th: (Lab—begin exercise #4)

April 2nd: Geography

Readings:
- Brown et al., "Spatial process and data models: Toward integration of agent-based models and GIS," *Journal of Geographical Systems* 7 (2005): 25-47.
- Resnick, pp. 103-110.

Models:
- "Grand Canyon" in the NetLogo library of earth science models
- "Fire" in the NetLogo library of earth science models
- "Segregation in Norfolk" at http://www.odu.edu/~dearnest/abm/Norfolk_Seg4.html

April 4th: (Lab—work on final project) **Exercise #4 due**
Visit Research Expo 2007

April 9th: Epistemological Challenges of Complex Systems

Readings:

- Thomas B. Pepinsky, "From Agents to Outcomes: Simulation in International Relations," *European Journal of International Relations* 11, 3 (2005): 367-394.
- Charles S. Taber, "Of Spells, Potions and Computational Social Science," *The Political Methodologist* 10, 1 (Fall 2001): 23-26.

April 11th: (Lab—work on final project)

April 16th: Beyond the Linear Mind Frame

Readings:

- Epstein and Axtell, ch. 6
- Resnick, chs. 5-6.

PART IV: STUDENT PROJECTS

April 18th and 23rd: Presentation of Student Projects

Appendix B: Student Final Projects
You may view and run the student simulations at
http://www.odu.edu/~dearnest/clt_final_report.htm

1. Rate of Employment in a Competitive Marketplace

The focus of this project is to predict the difference of the full employment in a population given the skills sets that potential job seekers can offer to the workforce. The actors in this stimulation are the employers and the job seekers. The rules of the procedure are that all employers have a set budget to employ as many job seekers with specialty skills. They will show network connections of the combination of specialty skills in a general marketplace, as the rate of unemployment decreases the employed will stop, and its color scheme will change.

2. Evacuation of a Building on Fire

This model simulates the evacuation of a building on fire. It utilizes the floor plan of The Station nightclub in West Warwick, Rhode Island, which burned down with the loss of 100 people on February 20, 2003. The simulation illustrates how architects and safety engineers can use modeling and simulation to improve safety in public spaces.

3. Power Grid Disruptions

This simulation investigates how disruptions to the power grid may propagate through the system. The model creates a notional power grid with electricity flowing to "cities." The user may disrupt the grid by disabling substations and watch as brownouts and blackouts "flicker" across the power grid. The simulation shows how network effects may propagate in surprising ways.

4. Competition and Combat over Scarce Resources

This project refines the "sugarscape" model of Axtell and Epstein (1996) with an enhanced model of warfare. In this simulation, agents or "turtles" compete for scarce sugar resources. Turtles may attack if their sugar is low, and their success is affected by their metabolism and not just how much sugar they already have. The model includes a retaliation mechanism to illustrate how group "warfare" may emerge from such competition for scarce resources.

5. Isle of Wight County Rainfall

This model simulates the drainage of rainfall over a small portion of terrain in Isle of Wight County, Virginia. Using digital terrain elevation data (DTED), the model illustrates how geographic information systems may augment agent-based modeling and simulation methodologies. By creating virtual rain droplets and using a minimum-energy algorithm, the model predicts actual drainage patterns toward the James River, in the upper right-hand corner of the visualization.

6. Level of Education and Voting Behavior

This project illustrates how voter turnout is directly correlated with the level of education obtained by registered voters. The simulation consists of a population of 200 voters. Some of the voters hold a high school diploma, a Bachelor's Degree, a Master's Degree, an Advanced Degree or had had at least some college experience. The sliders may be set to allow the population to be mixed to varying degrees based on the level of education obtained. The goal was to show that no matter how the population was mixed; the most educated voters would be more likely to vote than their counterparts would.

7. Prisons and Gang Violence

This simulation studies how competing prison gangs ("reds" and "blues") recruit new members. It includes a procedure to allow gangs to "fight" in areas where one gang might hold a numerical advantage. The simulation also explores the role of prison guards, allowing the user to increase or decrease the number of guards. It illustrates a surprising finding: while increasing the number of guards minimizes violence between gangs, it increases the rate at which gangs recruit new members. Thus, efforts to reduce violence between gangs may paradoxically increase the number of gang members in prisons.

8. Beach Erosion

This simulation explores how wave energy reshapes and erodes a sandy shoreline. The user may vary the periodicity and energy of waves to explore how quickly or slowly the shoreline erodes. When combined with geographic information systems, the simulation illustrates how planners and ecologists may predict future patterns of erosion of actual shoreline.

9. Traffic Congestion

This model illustrates how traffic jams emerge naturally on a traffic grid. The simulation includes controls for the number of vehicles, their acceleration, the periodicity of lights at intersections, and whether or not vehicles may turn and switch lanes. Plots display the average wait times of all vehicles. The simulation shows how urban planners may use agent-based modeling to study changes in traffic flow, to predict jams, and to plan new roads to minimize congestion.

Email from GEOG 495 student Melissa Curtiss, September 4, 2007
Used with Permission

Melissa M Curtiss
<mcurtis6@gmu.edu>
09/04/2007 12:37 AM

To DEarnest@odu.edu
cc
bcc
Subject Axtell's Syllabus

History: This message has been replied to.

Dr. Earnest,

How are you doing?

As promised, I will get you a copy of Axtell's syllabus. Unfortunately, we did not receive electronic copies of the syllabus. However, I will be on campus at ODU tomorrow to return a book to the library--plus, I am around because I "commute" to GMU for classes. So, I will stop by your office tomorrow (Tuesday) and if you are not there I will just leave the syllabus in your mailbox.

Well, I decided that I wanted to get the graduate certificate in Computational Social Science. So, this semester I am taking 2 CSS classes--Intro to Computational Social Science and Origins of Social Complexity.

Just in case I do not catch you in your office, here is a quick review...

I really think Axtell is going to be a good teacher and he seems really nice. The first day of class Axtell went over a lot of introductory information that I already knew--and of course he showed us his Sugarscape. I am so glad that I took your class because I definitely feel like I have an advantage. This class will definitely reinforce a lot of things that I learned in your class. In addition, we are going to be working Netlogo and I definitely feel comfortable using the software. In class, he briefly discussed the final project... we will have the oppurtunity to compare/analyze a model that is already made or we can create our own model. I got the impression that he didn't expect to know how to program in Netlogo and that along the way he would give us the opportunity to learn for those of use who are interested. So, I am hoping to create my own model for the final project.

Just thought I would let you know...In my Origins of Social Complexity class (Dr. Cioffi-Revilla), we did the typical introduction around the class and I said that I have taken an undergraduate class in Social Simulation/CSS-- and he said that I was probably one of the first students in CSS that has had an introductory undergraduate class in CSS. Dr. Cioffi-Revilla seemed quite impressed and asked me which university I went to, etc. Well, just in case you are interested, I will go ahead and leave a copy of his syllabus for you as well. By the way, have you ever read anything by Dr. Cioffi-Revilla?

Anyway, feel free to write back. If you want, I can definitely keep you updated on these classes.

Hope classes are going well for you,

Melissa Curtiss

P.S. Just in case....If I decide to create my own model for my final project, would you mind if I emailed you or stopped by if I needed some additional advice or help?