LAND USE AND EXURBAN GROWTH:
A Look at Project SLUCE By Derek T. Robinson

A recent headline in the New York Times ("Second Homes That Put Ecology First") suggests that second homeowners are trying to reduce the ecological effects of their land use. (Article continued on page 6)

CARL SIMON COMPLETES TEN YEARS

In June 2009, Carl Simon completed ten years of exceptional service as the first director of our Center. Under Carl's leadership CSCS grew from an informal program into a thriving, interdisciplinary research center. Carl's many achievements include an expanded Graduate Certificate program in complex systems as well as numerous grants which he helped develop, including a $3 million NSF IGERT award to support PhD students.

Perhaps Carl's greatest achievement is his success in recruiting outstanding new interdisciplinary faculty to UM, including three who are now Collegiate Professors: Scott Page, Mark Newman and Mercedes Pascual. In 2008, Carl served as the lead on a joint LSA-Ford School of Public Policy proposal to hire three new faculty in social science and energy. The proposal was among the first approved for funding under the UM President's Interdisciplinary Junior Faculty Initiative. Most recently, Carl was instrumental in hiring four new interdisciplinary faculty: Lada Adamic, Elizabeth Bruch, Robert Deegan and Pejman Rohani. We are deeply grateful for Carl Simon's leadership and commitment to CSCS. Although he has stepped down as director, we look forward to Carl's continued involvement in complex systems and CSCS.
Greetings,

The Center for the Study of Complex Systems (CSCS) is an interdisciplinary center comprised of scientists with an interest in understanding complex phenomena. Our research covers broad topics that fan out across multiple disciplines – such as network and pattern formation, path dependence, contagion, tipping points, robustness, dynamic systems, agent-based models, and emergence -- as well as specific topics like racial segregation, ecosystem management, cartography, thin film growth, exurban sprawl, renewable energy, and vibrated particulate suspensions.

CSCS strives to be an intellectually lively place where faculty and students share ideas and methodologies across disciplines. We organize a formal seminar series, host conferences and meetings, and encourage the formation of small research groups on topics of common interest. We aim to be the place for interdisciplinary modeling on campus and to offer a welcoming environment in which people can hang out, grab a handful of M&M’s, and discuss self-organizing systems.

Complex Systems is a growing field with applications both inside and outside the academy. To maintain our vibrancy, we devote significant time and effort to establishing ties outside the university. We have an ongoing relationship with the Santa Fe Institute, a leading think tank on complexity science, and we’re increasingly engaged with local and regional businesses and non-profits.

CSCS is officially part of the College of Literature Science and the Arts, and we offer a Graduate Certificate through Rackham. Our graduate course
offerings include introductory courses in complex systems and agent-based modeling as well as courses on networks, dynamic systems, mathematical biology, game theory, and statistical mechanics. Last year, we began teaching a handful of undergraduate courses. Those courses were so successful that we have expanded our offerings this fall. And, I am happy to announce that we have begun a partnership with Oberlin College funded by the NSF to develop an undergraduate core in complex systems.

I am just starting in my role as director for the Center of the Study of Complex Systems. In that capacity, I have some rather large shoes to fill. Over the past nine years, Carl Simon has transformed what was a loose collection of scholars with overlapping interest occupying borrowed space into a vibrant research center with stellar faculty and a suite of offices in West Hall. His accomplishments are a testament to his passion and effort. He has transformed CSCS by making exceptional faculty hires – Mark Newman, Lada Adamic, Elizabeth Bruch, and Robert Deegan. He negotiated our move into the College of Literature, Science, and the Arts and got CSCS established as an LSA Enhanced Program, giving us faculty lines and the opportunity to offer undergraduate courses. He participated in and oversaw the writing of numerous successful grants. And, he was the lead person on the LSA Energy Theme Semester organized by CSCS. Despite devoting what appeared to be all of his time to helping others, Carl somehow has kept up an active research agenda and his productivity earned him the College’s 2007 Russell Lectureship, a fitting honor. Fortunately for CSCS, Carl will continue to be actively involved and helping to chart our course for the coming years.

Our doors are open to any member of the University or local community with an interest in complexity. Stop by. We’d love to have you join our community of scholars.

Scott Page
CSCS PROFILE

Kate Anderson
CSCS Student and IDEAS-IGERT Fellow
PhD candidate, Economics

My work looks at the interplay between individual behavior and social networks in the context of collaborative problem solving and group formation. Social network structure governs a wide range of human interactions, while simultaneously reflecting the nature of the interactions that created it. A growing body of literature has highlighted the effects of social network structure on behavior, welfare, and equilibrium outcomes. These results have, in turn, generated interest in how these structures came about, and how the nature of interactions affects the topology of social networks. A new and exciting literature has begun to look at the role of dynamics and heterogeneity in network structure. This literature has tremendous potential when combined with the literature on diversity and collaborative problem solving. My thesis consists of three papers related to collaboration, problem solving, and network formation. In one recent paper, I construct a model of collaboration network formation in which players with heterogeneous skill sets form collaborative links in order to solve problems that none of them could solve alone. I use this model to examine how an individual’s set of skills affects her position in the collaborative community. Taking a step back, I can also use this model to examine the structure of the collaboration network as a whole. I look at how the nature of the problem being faced and the distribution of skills in the population of problem solvers affect the structure of the collaboration network as a whole. In a second paper, I use a model of problem solving and innovation to look at the role of specialists and generalists in a problem solving community. Skills in this model are divided into disciplines. Players can either specialize in a single discipline, or acquire skills across a range of disciplines. Given a distribution of problems, we look at the equilibrium distribution of problem solvers in the community—specifically, the proportion of specialists and generalists.

In a final paper, I look at the effects of existing collaborative networks on the assembly of new teams. In this model, players form teams to maximize their payoffs. However, a player can only join a team if that team contains someone the player has worked with before. I use this model to show that in absence of a cultural or institutional limit on team size, teams will tend to be much too large, relative to the ideal size. The Center for the Study of Complex Systems and IDEAS-IGERT fellowship have greatly contributed to my success as a researcher. Working in an interdisciplinary environment has added new modeling skills and mathematical techniques to my tool box, but it has also

*The IDEAS-IGERT Fellowship is funded by the National Science Foundation through its Integrative Graduate Research and Education Traineeship (IGERT). CSCS won an NSF-IGERT award in 2003 to support PhD students through the Institutions, Diversity, Emergence, Adaptation and Structures (IDEAS)-IGERT fellowship program. The program is now in its final year.*
given me an important perspective on social science, in general, and economics, in particular—the interdisciplinary environment requires me to think carefully about the assumptions of my model, and talking with people outside of my field has forced me to find new ways to communicate my ideas without relying on the jargon of my field. It is this perspective that makes me confident in my work, and is perhaps the greatest gift the Complex Systems group has given me.

CSCS PROFILE

Dana Jackman
CSCS Certificate Student

I am a Ph.D. student at the School of Natural Resources and Environment, an M.A. student in the Department of Economics, and a Certificate student in the Center for the Study of Complex Systems. I study the human dimensions of climate change and plan to incorporate greater behavioral realism into climate-economy models. In my modeling efforts, I seek to capture the heterogeneity of decision makers and to recognize the limits on rationality imposed by the complexity and deep uncertainty in the climate system. A behavioral approach to climate-economy models has the potential to improve understanding of the emergence and effectiveness of uncoordinated climate policies. This approach could reveal incentives and motivate policy innovations that transform uncoordinated efforts into an effective system of interacting policies. My highly interdisciplinary work draws from economics, the behavioral sciences, environmental policy, and the physical sciences, and invites opportunities to employ fundamental concepts (e.g. emergence, heterogeneity), tools (e.g. agent based models), and avenues of research (e.g. networks) embodied by complex systems research.

My academic and professional journey began as an enthusiastic student of mathematics. After earning a B.A. in Mathematics from the College of Wooster and an M.A. in Mathematics from the University of Virginia, I began a career in actuarial and management consulting in Washington DC where I specialized in actuarial valuation, survey research, and computer programming. In addition to my professional and academic pursuits, I am an avid outdoors person. I have travelled all over the United States to hike, backpack, run, and bike. I climbed Long's Peak in Rocky Mountain National Park, waded in Bright Angel Creek at the bottom of the Grand Canyon, walked 1,000 miles of the Appalachian Trail, and ran the 2009 Napa to Sonoma Half Marathon. I am also an enthusiastic gardener and delight in the lush and unruly native plants of Michigan.
LAND USE AND EXURBAN GROWTH:  
A Look at Project SLUCE (Article Continued)

A recent headline in the New York Times ("Second Homes That Put Ecology First") suggests that second homeowners are trying to reduce the ecological effects of their land use. Like second-home developments, low-density residential development, known as exurban growth (or urban sprawl), consume large areas of farmland and exact increasing social costs because utility and infrastructure services are needed at greater distances from urban centers. However, these larger properties also have increased amounts of open space and sometimes more natural areas than the farms they replaced. Under these circumstances, what are the actual ecological costs of exurban growth? Do recent behaviors among second homeowners and exurbanites offer hope in combating global climate change and are they realistic on a large scale?

Project SLUCE (Spatial Land-Use Change and Ecological Effects) is a research group based at CSCS and the School of Natural Resources & Environment (SNRE) that addresses these types of questions. The focus of the team's research is on understanding how complexity plays a role in structuring land-use patterns as well as estimating how those patterns effect ecology. Members of the project are constructing agent-based and simple mathematical models and integrating them with ecosystem process models to analyze the myriad mechanisms that act and interact with each other to affect household ecological decisions and the changing patterns of exurban growth and ecosystem function around cities such as Ann Arbor, Michigan. As illustrated in Figure 1, Project SLUCE uses agent-based models that act as a medium for interdisciplinary discussion and provide a platform to computationally formalize their assumptions. Starting with a simple toy model of residential location (http://www.cscs.umich.edu/slage/education/sluce_ed.htm), the group slowly added additional complexity and data into new higher-fidelity models that illustrate the iterative cycle of modeling and data collection. The flexibility of the agent-based approach allows the group to integrate a variety of data collected from social surveys, fieldwork, and spatial analyses such that their models are now helping improve understanding of the interactions and feedbacks among land use, land cover, land management, land markets, policy, and ecosystem function. Exurban growth processes present interesting tradeoffs between low-density developments that typically produce more natural areas.
than previously existed on cultivated lands, and increased levels of impervious surface and transportation-related fossil fuel usage. To address this tradeoff and improve our knowledge of ecosystem functions in exurban residential parcels, members of the project are conducting social surveys and collecting field data in exurban residential parcels to determine how development types and land management behavior affect ecosystem function, and in particular carbon storage. The idea is to use those data to calibrate an ecosystem process model that would be coupled to the project’s agent-based models of land-use and land-cover change to evaluate the ecological effects of land-use development policies.

"the group is breaking new ground both empirically and computationally"

Members of Project SLUCE have used agent-based models to address a variety of real-world problems and to gain insight into how the themes of complexity science play a role in exurban growth. For example, the project used a simple agent-based model of residential location, named SOME to show how the degree to which greenbelts control sprawl is affected by their width and distance from the city center (Brown et al. 2004).

The project extended this simple model and tightly integrated it with empirical data to show how variability in people’s residential preferences can increase the level of urban sprawl, compared with models that assume constant preferences (Brown and Robinson 2006). Using a more complicated agent-based model that consisted of farmers, developers, residential households, and township planning boards, Zellner et al. (2009) demonstrated that land-use policies in neighboring townships can interact to produce opportunities for regional coordination, even when the townships are simply considering their own revenue generation through taxation and the creation and preservation of natural amenities like forest cover. Methodological advances developing linkages between agent-based models and GIS (Brown et al. 2005 and Robinson and Brown 2009, Figure 2) and agent-based models and ecosystem process models are also being pursued to address the ecological consequences of residential and policy choices.

Project SLUCE brings together a wide array of researchers both on and off campus who are interested in the coupled human-environment system of land-use and land-cover change. Focused in exurban areas, the group is breaking new ground both empirically and computationally and uses agent-based models as tools of integration to provide new insights into how the drivers of land-use and land-cover change interact and feedback to influence patterns of exurban growth and ecosystem function in Southeastern Michigan. Please visit our website (www.cscs.umich.edu/sluce/) for more information on the project and its associated research.
After completing a Master's degree in social work and an internship with social service agencies for people living with HIV, I began to see that there was a lot of important research to be done at the intersection between social networks and disease transmission systems. Much work done by infectious and chronic disease epidemiologists does not pay adequate attention to the underlying social processes driving epidemics and the social patterning of chronic illness. Similarly, sociologists have contributed a tremendous amount to our understanding of the determinants of health and illness, but the biological systems driving the patterns we see are often not explicitly modeled in these studies. For effective intervention in these systems, however, we need a detailed understanding of the integration between the social and biological systems that give rise to outbreaks, epidemics and pandemics.

As a CSCS student and IDEAS-IGERT Fellow*, I have been lucky to have ample opportunity and encouragement to explore the connections between these elements and to work on theoretical and empirical projects that address the questions that are most important to me. I have built close relationships with faculty in both the Sociology department and the School of Public Health, and this has deeply influenced by work and interests.

To this end, my dissertation research is composed of three related papers that look at problems in infectious disease epidemiology through a dynamic and social lens. One of my dissertation projects focuses on the way social relationships between households are formed in an urban context and explores the impact of socioeconomic status and geography on the generation of connections between households, and the way these connections mediate the spread of Shigella Sonnei, a gastrointestinal pathogen, through Chicago neighborhoods. Another of my dissertation projects focuses on the factors that generate social relationships in a group of 21 villages in rural northern coastal Ecuador and the association of these social networks with the dynamics of gastrointestinal illness in this area.

These are important and interesting questions that fall very much between sociology and epidemiology as we typically understand them. My affiliation with CSCS and my IDEAS-IGERT Fellowship has allowed me to explore these questions and has given me a home on campus that has been integral to making my graduate career a success. As I get ready to go out on the job market, I'm sad to leave but also excited to be bringing the truly multidisciplinary and dynamic perspective I've picked up here with me.

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CSCS will host a “Celebration of John Holland’s 80th Birthday”, Wednesday, Sept. 30, 2009

Public Event at 4:00 p.m. in Annenberg Auditorium, FSPP. Refreshments will be served.

Speakers will include:
Geoffrey West, Melanie Mitchell and John Holland

John Holland has devoted his life to interdisciplinary study. He was one of the first in the world to earn a PhD in computer science. His invention of genetic algorithms and, more generally, evolutionary computation, led to the growth of a new sub-discipline of computer science with applications in areas ranging from engineering design to biotechnology. His book Adaptation in Natural and Artificial Systems (1975) is a classic in the field. He was instrumental in developing interdisciplinary research at the University of Michigan and is a founding member of CSCS. We are pleased to host this special event in honor of a great friend, scholar, and pioneering thinker in complex systems.

CSCS Fall 2009 Seminar Series Speakers

12:00 Noon, Room 335 West Hall

Monday, Sept. 14  Lada Adamic, University of Michigan
Thursday, Sept. 17  Matthew Jackson, Stanford University
Monday, Sept. 21  Wendy Zhang, University of Chicago
Monday, Sept. 28  Domitilla Del Vecchio, University of Michigan
Monday, Oct. 5  M. Shane Hutson, Vanderbilt University
Monday, Oct. 12  Michael Solomon, University of Michigan
Monday, Oct. 26  Alexander Shingleton, Michigan State University
Monday, Nov. 9  Doug Weibel, University of Wisconsin
Monday, Nov. 30  Eric Smith, Santa Fe institute
Monday, Dec. 7  Sonya Bahar, University of Missouri at St. Louis
Mark Newman
In 2008, Mark Newman was named the Paul Dirac Collegiate Professor of Physics. He is also an External Faculty member of the Santa Fe Institute. He directs one of the Center’s primary research projects called “Networks and Contagion Among People and Computers” with funding from the James S. McDonnell Foundation. He also received an NSF award last year to support research on the “Structure and Dynamics of Social Networks.” His latest publications include co-authorship of a book called The Atlas of the Real World: Mapping the Way We Live published in 2008 by Thames & Hudson. His web site is: http://www-personal.umich.edu/~mejn/

Rick Riolo
currently serves on several CSCS research teams including the NSF-funded Project SLUCE and two other NSF projects exploring environmental governance and international forestry. His recent publications include co-authorship of “Simulating Closed Regimes with Agent-Based Modeling” published in Complexity (Sept/Oct 2008) and “Exurbia from the Bottom-Up: Confronting Empirical Challenges to Characterizing a Complex System” (GeoForum 2008), as well as co-editorship of the book series Genetic Programming Theory and Practice published annually the last six years by Springer.

Charlie Doering
directs several NSF-funded research projects on topics ranging from modeling stochastic and nonlinear dynamical phenomena in physical, chemical, and biological systems, to the mathematical analysis of chaotic and turbulent fluid flows. As a member of the Board of Governors of the National Science Foundation’s Institute for Mathematics and Its Applications, he is spending the 2008-09 academic year participating in the research program “Complex Fluids & Complex Flows” at the University of Minnesota http://www.ima.umn.edu/2009-2010/.

Scott Page
In 2008, he was named the Leonid Hurwicz Collegiate Professor of Political Science, Complex Systems and Economics. He is also a member of the External Faculty of the Santa Fe Institute. His book “The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools and Societies” was published in 2007 by Princeton University Press. His current research focuses on diversity and culture and was featured in The New York Times on January 8, 2008. His web site is: http://www.cscs.umich.edu/~spage/index.html

CSCS Welcomes New Faculty Member
Pejman Rohani joined CSCS this term as Professor of Complex Systems and Ecology and Evolutionary Biology (EEB). Dr. Rohani is one of the world’s leading researchers currently working on the interface of ecology and infectious disease dynamics. His recent publications include co-authorship of the book Modeling Infectious Diseases published in 2007 by Princeton University Press. He has been a Guggenheim Fellow and previously served as Professor at the University of Georgia’s Odum School of Ecology.
Lada Adamic


Robert Deegan

Between Laboratory and Large-Scale Open Systems" and is funded for five years. In 2009 he received an NSF award for three years to study pattern formation in vibrated particulate suspensions. This work was recently featured on NPR's Science Friday (http://www.sciencefriday.com/videos/watch/10206). His research group page can be found at http://www-personal.umich.edu/~rdeegan/index.html. He recently published the following paper: P. Brunet, J. Eggers, & R. D. Deegan, "Motion of a drop driven by substrate vibrations", European Physical Journal, 166, 11 (2009).

Irv Salmeen

currently teaches a new undergraduate-level course, CMPLXSYS 250 Social Systems and Energy (with Carl Simon). He is part of a DOE-funded team building an agent-based model for the evolution of plug-in hybrid electric vehicle markets and is a member of UM's SMART (Sustainable Mobility and Accessibility Research and Transformation) initiative.

Elizabeth Bruch


Carl Simon

is currently part of two major NIH-funded projects. One focuses on the spread of HIV and is led by Jim Koopman. The other is developing models of smoking behavior and is headed by David Mendez. In addition to completing 10 years as Director of CSCS, Carl recently joined the Michigan Memorial Phoenix Energy Institute (MMPEI) as Associate Director for Social Science and Policy. He is also part of a team of researchers studying "Plug-In Hybrid Electric Vehicles" with funding from the Dept. of Energy.
The Center for the Study of Complex Systems (CSCS) is an interdisciplinary program at the University of Michigan designed to encourage and facilitate research and education in the general area of nonlinear, dynamical and adaptive systems.

It's more than 50 participating faculty represent nearly every college of the University. Researchers at the Center share a recognition that many different kinds of systems that include self-regulation, feedback or adaptation in their dynamics possess similar underlying structures despite their apparent differences. Their goal is to exploit these deep structural similarities to transfer methods of analysis and understanding from one field to another.

CSCS supports a diverse body of research, training and educational initiatives. These include an active computer laboratory focused on agent-based modeling, a weekly seminar series, workshops and special events and a Graduate Certificate program.

For more information, please contact us:
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The Center for the Study of Complex Systems (CSCS) relies on donated funds to support ongoing activities and special events such as our seminar series, computer lab, workshops and conferences. If you would like to contribute to CSCS, please visit the University of Michigan website for online donations: www.giving.umich.edu
To specify a gift for CSCS, select “Giving Areas,” click on “Other” and write “Center for the Study of Complex Systems” in space provided. We appreciate your support!

ALUMNI
We would like to hear from you!
If you received a Graduate Certificate in Complex Systems, we’d like to know what you’re doing!

Please contact us at cscs@umich.edu with the following information:
Name, Degree/Major, Graduation Year, Name of Current Employer, Job Title, Current E-mail Address, Current Mailing Address, Comments