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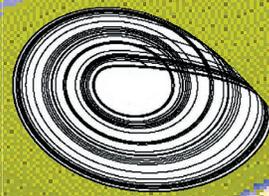
Abstracts to the
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Alphabetical by Author

Keynote Speakers

Mohammed Dore

The Economic Downturn of 2007-2008

The world has a history of financial crisis and business cycle downturns. Linear models of business cycles cannot explain these repeated crises and downturns. Each time, rational agents are persuaded that "this time it is different." While the crises repeat, there is also emerging novelty that linear models cannot handle. This presentation describes nonlinear dynamics of business cycles, how they were evident in the credit crisis of 2007-2008, and legislative foibles associated with empirically determined turning points or singularities in the economic time series. A vector autoregression model confirms the crucial role played by credit.

Guy Van Orden

Living in the Pink

Purposeful acts appear pre-prepared as propensities to act. Propensities anticipate possible actions appropriate to the context at hand and consistent with the history of the actor. Anticipation, in this sense, situates the actor in the future, so far as circumstances allow. A conceptual tool to make sense of anticipation is self-organized criticality. The embodiment of anticipation self-organizes to stay close to critical points or choice points for possible actions. This hypothesis explains a growing body of research, focused on patterns of variation in sickness and in health, to gauge the anticipatory poise that precedes repeated actions.

Pre-Conference Workshops

Terrill L. Frantz
Agent-Based Modeling and Social Networks

This workshop introduces participants to the network-oriented, agent-based model developed by Carnegie Mellon University to study organization and group behavior. The model is embodied in a software program called Construct. Construct simulates and models groups and organizations as complex social-technical systems and captures the variability in human and organizational factors; these characteristics are modeled as multi-level social networks. The nonlinearity of the model generates complex temporal behavior due to dynamic relationships among agents. These dynamic relationships are grounded in structuration theory. The changes in the social system are defined and analyzed through the lens of social and dynamics network analysis. The techniques and simulation model presented have been scientifically validated several times. By combining individual and social considerations, the Construct model was able to predict observed changes in real-world human organizations. The latest validation found significant correlation between communication patterns within real-world organizations and agent interactions within the model. These techniques have been used for analysis and consulting in industry (health care, aerospace, consulting, professional associations, financial), non-profit and emergency response (charity foundation, American Red Cross), higher education (universities), military (DARPA, ONR) and government (NSF, NASA). Participants will be introduced to the theory behind the model in a lecture-format and will be shown operational aspects of the simulation software in a demonstration-format.

Stephen J. Merrill
Using Markov Chains for Modeling, Simulation, and Analysis

Markov chains can be used to model dynamical processes, analyze general time series, provide simulations of time series with the same properties as a given series, and for 1-d dynamical systems with a parameter, uncover the bifurcation structure. In this workshop, all of these topics will be discussed with examples. All participants will receive a CD with data and algorithms in MATLAB (m-files) to facilitate their own use of these methods.

Sara Nora Ross
The Nonlinear Model of Hierarchical Complexity:
How Order is Constructed in the Process of Emergence –

With an emphasis on dynamics of emergence, this workshop introduces a general theory and its methods, the nonlinear Model of Hierarchical Complexity, which accounts for and measures emergence. As a math-based formal theory, the Model applies to all information-organizing tasks, from simple organism behaviors to the most complex human behaviors. Its nonlinearly-increasing orders and discrete state transition steps result in an inherent power law, a fractal dimension of 1.37. Its theory and a breadth of applications are published in a 2008

special issue of *World Futures: The Journal of General Evolution, 64*(5-7), co-edited by Ross with Michael Commons, originator of the Model. The workshop is relevant to anyone who wants to analyze and measure behaviors, whether in consulting or research, whether quantitatively or qualitatively. Participants will apply the new skill to their own examples to reinforce learning and understand the broad applicability of the measure. Methods include presentation, individual and group exercises, reflection, and discussion.

Julien Clinton Sprott
Self-Organization

Complex patterns are common throughout nature, from the distribution of the galaxies in the Universe to the organization of neurons in the human brain. It is generally assumed that such complex structure must have a complex cause, but it may be that the patterns spontaneously arise through the repeated application of simple rules. This workshop will provide examples of self-organization in nature and will describe six simple computer models that can replicate the features of these patterns. The models typically produce fractal spatial structure and chaotic temporal dynamics characterized by power laws and unpredictability, even when the models are simple and purely deterministic. Workshop participants will be challenged to propose simple models of complex systems that potentially exhibit self-organization in fields as diverse as physics, ecology, political science, economics, sociology, and art.

Papers, Symposia, and Posters

Imran Abbasi, Carroll University
Michelle Burgard, Carroll University
Christopher May, Carroll University

Understanding Complexity Theory through Participation in a Self-Organizing Process

Complexity theory, with its associated concepts like emergence and self-organization, is fascinating precisely because it can be so unintuitive how systems obtain "order for free". To help students fully appreciate these concepts, a course on complexity theory was designed to not only be about complexity, but itself embody complexity. The principal tool for achieving this objective was a course wiki. By requiring students to contribute to the wiki for at least one hour per week, students became participants in an interesting self-organizing educational process. Student use of this wiki did indeed embody complexity, as characteristics of the wiki conform to power law distributions. Here, we discuss the methods used in integrating the wiki into the course, present both quantitative and qualitative analyses of several emergent phenomena, and suggest recommendations and future directions for the use of wikis in teaching complexity theory.

Steve Axley, Western Illinois University
Tim McMahon, University of Oregon

May I Have this Dance? Strange Attractor, Self-organization, and Barack Obama's Presidential Campaign

In the mid '90s, Monsanto morphed from a stodgy "chemicals" bureaucracy into a leaner, adaptive "life sciences" company. Pascale et al. (2000) document the story, arguing that a confluence of latent contextual forces, catalyzed by CEO Robert Shapiro's complexity science-based approach to change, helped create a powerful strange attractor that energized Monsanto to self-organize--fast. How does this concern the 2008 presidential election? Late in the Bush presidency, political observers wondered whether socio-political dynamics could coalesce into a "perfect storm" that might re-shape the political landscape. Among them, Frank Rich compared the times to the late 1950s-early 60s, when JFK emerged from relative political obscurity to the presidency, partly because he spoke to--i.e., tapped--the nation's inchoate restlessness and unease, its appetite for challenge, and a simmering frustration at the time. Rich suggested that America, 2008, was similarly ripe: "America is screaming for change." In 2008, Barack Obama aimed to deliver. Obama was touted as a charismatic new voice, resonant with the nation's worries, frustrations, and challenges. His campaign demonstrated legendary speed, agility, resilience, and unprecedented efficiency in grassroots (self-) organizing. Pascale et al. assert that a strange attractor is not something a leader "does" or "gives" to others; rather, it is co-generated from what is already present, "...emergent" and formed "...because it resonates from sympathetic chords in the environment, the times, the organization's members, and a leader who can express the challenge in a way that invites others into a dance that is being choreographed as it is performed" (p. 75). This paper explores such a dance--the presidential campaign and contextual dynamics promoting the emergence of a strange attractor, energizing Barack Obama's candidacy.

Mike Castillo, Dept. of Biology, Marian University
Balamurugan Pandiyan, Dept. of MSCS, Marquette University
Merrill Stephen, Dept. of MSCS, Marquette University

Hashimoto's Thyroiditis: Model and Simulation

Simulations of a model of autoimmune thyroiditis are presented. This disease results in progressive hypothyroidism eventually requiring thyroid hormone replacement. Changes in the operation of the thyroid gland control due to the inflammation present in the disease are simulated over a period of years. Of special interest are short-term large

amplitude excursions from feedback control due to the development of goiters and the resulting autoimmune destruction of this thyroid tissue. During these times, a subject becomes hyperthyroid during these ' thyroid storms.' Although the end product of the disease is destruction of thyroid tissue is not in doubt, these excursions present a real challenge to clinical management of this disease.

Aydin Cecen, Central Michigan University
Richard Baillie, Michigan State University
Cahit Erkal, U. of Tennessee

Normal Heartbeat Series are Nonchaotic, Nonlinear, and Multifractal: New Evidence from Semiparametric and Parametric Tests

We present new evidence that normal heartbeat series are nonchaotic, nonlinear, and multi- fractal. In addition to considering the largest Lyapunov exponent and the correlation dimension, the results of the parametric and semiparametric estimation of the long memory parameter (long range dependence) unambiguously reveal that the underlying process is nonstationary, multi- fractal, and has strong nonlinearity.

Alhaji Cherif, Arizona State University

Nonlinear Stochastic Models of Interpersonal and Romantic Relationships and Strange Attractions

More than 50% of the United States adolescents have been in some form of romantic relationships. Current theories from biosocial (e.g.: the role of neurotransmitters in behavioral features), ecological (e.g.: cultural, political, and institutional conditions), and interpersonal (e.g.: attachment) frameworks are grounding romantic relationships in normative social experiences. However, these theories have not been developed to the point of providing a solid theoretical understanding of the dynamics present in romantic relationships, and integrative theories are still lacking. In this paper, mathematical models are use to investigate the dynamics of romantic relationships, which are examined through ordinary and stochastic differential equations, in order to provide insight into the behaviors of love. The analysis starts with a deterministic linear model and progresses to nonlinear stochastic models capturing the stochastic rates and the environmental factors (e.g.: ecological factors, such as historical, cultural and community conditions, that affect proximal experiences) that shape the patterns of romance. Numerical examples are given to illustrate various dynamics of romantic behaviors (sustained oscillations, transitions between locally stable equilibria) that are observable in stochastic models (closely related to real interpersonal dynamics) but absent in a deterministic nonlinear model.

Shannon Cribaro-DiFatta, School Association for Special Education of Du Page County

The Disconnect between Two Paradigms of General Educators and Special Education through a Chaos Theory Lens.

Chaos theory has implications when it comes to general education and special education. This presentation will look at the disconnect of two paradigms using a chaos theory lens. The lens will allow us to look at the disconnect between the two paradigms through the operations of their own organizational system which creates barriers of beliefs and communication. Chaos Theory gives us another way to look at the facilitation and reorganization on linear systems such as teacher preparation programming to reduce or eliminate these differences. Collaboration is one way to facilitate working together. Chaos Theory postulates the two systems can become more flexible, creative, and cooperative in order to deal with new possibilities and become more adaptable to meet the needs of all learners. Current structure and operation of educational training and operations finds that each paradigm operates from its own organizational system. Each system differs from one another which causes a disconnect which creates challenges for the two paradigms, and lead to the linear practice of exclusion. Subtle differences in understanding are indeed creating what Robinson and Buly (2008) termed a "polite polarization" between general and special education. Even a bifurcation of mainstreaming special needs students into regular education classes failed to change perspectives of general educators who believe that it is not their responsibility to teach special education students. It is important that all members of school organization, e.g., teachers, principals and related service staff, need to take ownership of teaching all students. Chaos theory teaches us that in organizations which are flexible, there is collaboration. This is not just a token collaboration, but one in which all parties are responsible. Chaos theory postulates that both paradigms can become more flexible. Collaboration can be seen as systems like a chaotic river which is dominated by positive feedback loops which are turbulent and disorderly. When negative and positive feedback loops are coupled together, they can create a new dynamic balance, a bifurcation point where chaotic activity suddenly branches into a new path, a new order. This may not be accomplished easily by all school organizations. But it is well to keep the "butterfly effect" in mind- the power of the flapping of the butterfly's wings can be felt and have impact on the other side of the world.

Oscar Criner, Texas Southern University

Shock and Nonlinear Oscillations in Financial and Economic Time Series

Time series are widely used to analyze and forecast financial and economic conditions and events. Usually these series are analyzed using some variety of regression polynomials or systems of linear difference equations. Many times a technique called seasonal adjustment is used to remove obvious periodicities from the data. Smoothing of the data using these techniques removes much of the fine structure from the data in many instances. A light smoothing, utilizing higher degree filters, does not remove as much of the underlying information.

This paper demonstrates the existence of a fine structure that shows the existence of vibrations which were previously unknown in the time series of some economic processes. We have observed oscillations in the derivatives of financial and economic time series that should be useful in identifying potentially strong financial and economic events when interpreted by employing an analogy with physical nonlinear dynamical systems. We assume that a financial or economic time series x(t) is the output of a nonlinear dynamical system whose form is an ordinary differential equation with smooth functions, then we can numerically calculate at least two derivatives. When we do so, we observe significant vibrations in the resulting data. The derivatives are very similar to vibrations of mechanical or electrical systems. In some cases the vibrations appear to become unbounded, although we have no specifications as to the bounds on the system. However, since a major systems failure has occurred, we can infer that there are bounds which these functions should not have exceeded.

Alexander Dawoody, Marywood University

Mutual Causality and the Global Economic Crisis

Mutual causality is a paradigm with the sciences of complexity that interprets causal effects in a more complex way than the linear analysis of Newtonian science. It looks at a phenomenon as a function of corresponding dynamics, with one element impacting the other in a network of interconnectedness that foster positive or negative feedback. By viewing the global economic crisis, that was visualized with the mortgage problems in the United States and led to a worldwide economic recession and is threatening of global economic collapse, this article will examine such a phenomenon from the prism of mutual causality and offer better perspectives that underline the complex nature of network in creating feedback and the approaches that may seem necessary in order to avoid artificial engineering (such as the multiple stimulus packages by the Bush and Obama administrations) in order to prepare for a natural collapse dynamic and the emergence of a new order out of the dissipation of the current global capitalist structure. In doing so, chaos will shift the disequilibrium toward a new structure through autopoiesis and self-organization that will yield a better response to the kicks in the environment and produce a new order that is better capable in dealing with the emerging dynamics.

Albert Dietz, Texas State University
Keith Owen, Somerset Consulting Group

To LEARN is Human; To ADAPT Divine: Information Use and Organizational Openness

This presentation will discuss the relationship between learning and adaptation. The discussion will be framed by developing concepts concerning how information is gathered and used in complex human systems, how this use determines the openness of the system, and how this openness determines the ability of the system to learn and adapt. Examples from organizational studies will used to demonstrate the learning adaptation relationship.

Niles P. Engerman, National Louis University

Applying Chaos Theory to Bilingual Education

This analysis examines how Chaos theory may be applied to furthering bilingual educators' classroom success. Chaos theory applied to the classroom may be defined as the nonlinear interdependence of events that effect students, bringing them to higher forms of organization. In analyzing Chaos theory and its application to the formation of the Spanish-bilingual classroom, one must address the role of Deficit Thinking theory, and how to link Vygotskian thought as a parallel to Chaos theory, in addition as a means to thwarting Deficit Thinking theory. The Chaos Theory portion will examine the seemingly nonlinear classroom experiences of Spanish-bilingual students, with hopes of shedding light on the actual patterns and paths bilingual educators and their students follow in order to facilitate learning. The Deficit Thinking section will focus on the "blaming the victim" tenet of Deficit Thinking theory, which posits students are to blame for lack of cognition due to linguistic, racial, ethnic, fiscal, or gender deficiencies. The Vygotsky section will point to the deficiencies of bilingual programs that focus too much on either English or Spanish. This section will examine the best ways for students to develop metaphorical thinking in both languages. Student behavior and reorganization relate to Chaos theory, as no single student is the same, and they all need to be approached as individuals who will not respond to a cookie cutter version of the curriculum. In order to understand this, educators of Spanish bilingual students must realize how Deficit Thinking affects their perceptions of what their students are capable of doing. Looking at Chaos theory, educators will realize how Vygotskian thought is necessary to fully understand how Chaos theory applies to students and their need for individual attention to their learning styles. The necessity of the mediated learning experience will be examined as a means of nurturing the chaotic nature of the bilingual classroom. The salient points this paper/discussion will draw upon are the nonlinear interdependence of student behaviors, student behavior—social and academic—as fractals, and addressing Deficit Thinking theory in order to confront prejudices, thus opening the doors to understanding how the chaotic nature of students' lives affects teachers' perceptions about their ability levels.

Albert Erdynast, Antioch University Los Angeles
Amanda Donenfeld, Antioch University Los Angeles
Michael Wolper, Antioch University Los Angeles
Dikla Soffer, Antioch University Los Angeles
Teresa Xiong, Antioch University Los Angeles
Craig Finley, Antioch University Los Angeles

Nonlinear Developmental Conceptions of Three Sets of Motivations for Generosity and Magnanimity

This paper reports empirical results and methodological procedures in the research study of generosity and magnanimity. The central research objectives of the cross-sectional structural-developmental study with subjects

examines three distinct criterion-based types of generosity in the use of one's talents to benefit others: a) generosity motivated by individuals' conceptions of worthwhile aims, or the ' good,' b) motivations based on natural duties of mutual aid, the duty of helping another when s/he is in need or jeopardy, without excessive risk or loss to oneself, or the 'right,' and c) magnanimity, generosity that goes well beyond any requirements and involves excessive risk or loss to oneself. The study examines nonlinear hierarchical developmental levels of generosity using two sets of developmental instruments. The first measure assesses developmental stages of moral development (Colby and Kohlberg) and the second measure assesses developmental conceptions of compassion (Erdynast and Rapgay). Findings include: a) Discrete levels of conceptions of the three types of generosity; b) Relations between the three types along with associations to a) age, b) educational level, and c) gender; d) Correlations between a) Colby and Kohlberg measures of justice reasoning, b) measures of developmental conceptions of the good, c) conceptions of mutual aid, and d) conceptions of magnanimity.

Kyle Findlay, TNS

The Fundamentals of Market Share: Power Laws and Preferential Attachment

This paper looks at how market share forms. Market share is a ubiquitous measure that forms the basis of most marketing initiatives and metrics. However, the dynamics that lead to the formation of market share are generally taken for granted. The author summarises the background thinking behind how market share forms, introduces the reader to the mechanics at play, looks at how closely 46 real-world market datasets adhere to the theory and suggests areas for future research. The paper covers concepts drawn from a diverse range of disciplines including physics, network theory, mathematics, statistics, biology, linguistics and economics, and specifically covers the Pareto Principle, the Rich-Getting-Richer effect, the Matthew effect, the Long Tail, double jeopardy, cumulative advantage, power laws and preferential attachment." Essentially, the paper summarises the thinking behind power laws, suggests preferential attachment as the mechanism behind how brands gain market share and tests to see whether power laws exist in 46 TNS datasets from around the world in a variety of different categories.

Terrill Frantz, Carnegie Mellon University

Kathleen Carley,, Carnegie Mellon University

Organizational Complexity and Post-Merger Integration

This presentation reports on computer simulations conducted to develop theory and hypotheses on the organization behavioral aspects of post-merger integration. Experiments were conducted using the Construct model of social interaction to explore the effects of the pre-merger characteristics of the two organizations on the post-merger process. This study investigated the broad construct of organizational complexity as it applies to organization and work unit size and the effect on knowledge-based organization performance. Results suggest interesting hypotheses for further empirical investigation.

Jay Friedenberg, Psychology Dept., Manhattan College

Bruce Liby, Physics Dept., Manhattan College

Time Series Analysis of Picture Rating Data

Twenty-nine undergraduates rated 200 paintings in terms of their aesthetic value using a 1-9 rating scale. The paintings consisted of 50 images each of landscapes, abstracts, still-lives and portraits. A plot of the mean ratings versus trial number demonstrated rhythmic fluctuation without overall trend, i.e., the data were stationary. The autocorrelation in the correlogram for a lag of one was 0.3398 and was significant by the Durbin-Watson test (DW = 1.382, $p < .0001$). We conclude that the participant's current response on any given trial is significantly influenced by their response to the previous trial. The partial autocorrelation of 0.2029 was also significantly different from zero at a lag nine. We next estimated the parameters of the autoregressive process. In addition, we calculated spectral density plots that showed several amplitude peaks at periods between 1-7 and between 9-14. The data thus clearly show the presence of multiple frequency components. We hypothesize a fatigue model of aesthetic judgment, whereby stronger ratings induce longer "refractory periods." People seem to "conserve" judgments of beauty, withholding high ratings if one has recently been given and conversely allowing higher ratings if low ratings have recently been given.

Eystein Glattre, Norweigian School of Veterinary Science

The Climatologic CO2-Hypothesis Tested by Methods of Fractal Epidemiology: Discussing Complexity Principles and Procedures

One of the tentative explanations of global warming is the CO-hypothesis (S. Arrhenius) that there is a deterministic relationship between global CO air concentration and global surface air temperature. We have for fun tested this hypothesis by methods excerpted from our recently published book on fractal epidemiology and annual, global data published by databanks HadCRUTgl and NOAA ESRL. Annual, global CO concentrations for - were computed by linear interpolation. Our analysis shows that the CO-series of annual, global CO concentration covering - with corresponding values for - as reference is borderline fractal while the Tp-series of annual, global surface air temperatures for - with - as reference is fractal. We show that the fractal Tp-series is a 1/f noise reflecting a background system in Self-Organized Criticality

(SOC) and that global air temperature is influenced by a complexity of causal factors. This means inter alia that a change in global CO will not by necessity be succeeded by any noticeable change in global surface temperature and a change in the latter will not by necessity have been preceded by any noticeable change in the former. We also show that global CO is only moderately, statistically correlated with global surface temperature: By stabilizing global CO concentration Tp-series continues to reflect a climate in SOC, but now somewhat less pink.

Stephen J. Guastello, Marquette University

Adam Myers, Marquette University

Unemployment and Inflation Dynamics Prior to the Economic Downturn of 2007-2008

This research revisits a long-standing theoretical issue as to whether a ' natural rate' of unemployment exists in the sense of an exogenously driven fixed-point Walrasian equilibrium or attractor, or whether more complex dynamics such as hysteresis or chaos characterize an endogenous dynamical process instead. The same questions are posed regarding a possible natural rate of inflation along with an investigation of the actual relationship between inflation and unemployment for which extent theories differ. Time series of unemployment and inflation for US data - were analyzed using the exponential model series and nonlinear regression for capturing Lyapunov exponents and transfer effects from other variables. The best explanation for unemployment was that it is a chaotic variable that is driven in part by inflation. The best explanation for inflation is that it is also a chaotic variable driven in part by unemployment and the prices of treasury bills. Estimates of attractors' epicenters were calculated in lieu of classical natural rates.

Stephen J. Guastello, Marquette University

Leadership Emergence in Engineering Design Teams

Leaders emerge from leaderless groups as part of a more complex emerging social structure. Several studies have shown that the emerging structure is aptly described by a swallowtail catastrophe model where the control parameters differ depending on whether creative problem solving, production, coordination-intensive, or emergency management groups are involved. The present study explores creative problem solving further where the participants were engaged in real-world tasks extending over several months rather than short laboratory tasks. Participants were engineering students who were organized into groups of to people who designed, built, and tested a prototype product that would solve a real-world problem. At the th week of work they completed a questionnaire indicating who was most like the leader of their group, second most like the leader, along with other questions about individuals' contributions to the group process. Results showed that the swallowtail model exhibited the strongest advantage over the linear alternative model for predicting leadership emergence. The three control variables were control of the task, creative contributions to the group's work, and facilitating the creative contributions of others.

Gary Gute, University of Northern Iowa
Deanne Gute, University of Northern Iowa
Jeanne Nakamura, Claremont Graduate University
Mihaly Csikszentmihalyi, Claremont Graduate University

Early Lives of Highly Creative People: The Influence of the Complex Family

Over the last fifty years, theoretical, speculative, and empirical scholarship has examined the influence of early family context on subsequent accomplishments in children of high ability. Complexity Theory's processes of differentiation and integration form the only dialectical framework that has been empirically demonstrated to explain families' contributions to the development of creativity across the lifespan. Building upon forty years of creativity literature focusing on optimal experience, this study applied the Complex Family Framework, derived from Csikszentmihalyi's Complexity Theory, in a systematic analysis of creative adults' recollections of their early family lives. This study identifies evidence of how the seemingly oppositional processes of differentiation and integration serve as a catalyst for individual optimal experience in the families of creative exemplars who have made significant contributions to contemporary culture. Five participants represented the Arts and Humanities, three the Social Sciences, and one the Physical Sciences. The study demonstrates the utility of the Complex Family Framework in understanding families' contributions to children's later creative achievement.

Joseph Jacobsen, Milwaukee Area Technical College

Service and Trade Group Performance: Linear and Nonlinear Models and Optimal 3D Surface Performance

Service and trade group performance data were examined for linear and nonlinear models and optimization. Expert system software was used to collect proactive and reactive work order histories and performance records concerning 120 services for several years in a large municipal government where technician and trade group employees work in an operations division. Both linear and nonlinear models were supported by the data, regions of optimal performance were identified and system capacity is used to improve. Not so surprisingly, it became apparent that the rank and file wanted to change but management stood in their way.

Arlindo Kamimura, IEE/USP - Sao Paulo University
Geraldo Burani, IEE/USP - Sao Paulo University

Basic Equations of Motion for Productive Living Systems

This paper is an attempt to describe the main dynamical behavior of a complex productive social organization seen as a living system. The productive organization is understood here as a social system cell with goods and services production aims and it can be any aggregate entity like a family, a company, a transnational corporation, a country state, a country or even the whole planet. The basic mathematical structure utilized is a set of nonlinear differential equations connecting the physical productive capacity and the correspondent production both expressed in the same monetary basis. The example presented in this paper is the case of a country and the basic variables are the Capital Stock and the Gross Domestic Product. In this case, classical diminishing returns, increasing returns, dissipative structure, economic non-equilibrium, rebound effect, multiperiodicity and irregularities in business cycles, can be viewed within this simple approach. The model can be useful to analyze investment policies from an aggregated perspective. An application of the model is presented for Brazilian data, which shows not only the macroeconomic behavior but also the intrinsic difficulty to make economic prevision, even in this reduced model.

Cathy Kozlowicz, University of Phoenix
Theories of Social Cognition in the Complex Social System

In psychological and sociological research, employers, social advocates, psychologists and politicians believe that the broader universe and larger systems impacts people' s ability to remember, process and interpret their daily and life experiences. This results in a circular effect as people interpret their broader environment differently, yet their reconstructive experiences change their broader environment. Robert Rosenthal, a groundbreaking social psychologist defined the self-fulfilling prophecy effect as, 'one's beliefs, biases and expectations can have an influences on a phenomena under investigation.' Yet, people and research of all disciplines have these expectations which interpret how they interpret, remember, and interact with the broader environment. Along with the self-fulfilling prophecy effect, other social perception theories that will be explored will be reconstructive memory, the confirmation bias, dissonance theory, attitude formation and the schema effect. As incorporated with complexity theory and self-organization, there are several social and environment issues which people's social perception can create. For instance with the stock market crash which followed the Great Depression, people's individual beliefs and their interpretations and interaction with the broader spectrum impacted the results of the stock market. This can also be applied to our current economic crisis. This presentation will analyze the self-fulfilling prophecy effect and how it relates to the theories of social cognition in the complex social system and its application to broader social events.

Stanley Krippner, Saybrook Graduate School
Ruth Richards, Saybrook Graduate School
Fred Abraham, Silliman University

Chaos and Creativity during Dreaming and Waking States

Everyday creativity, or "the originality of everyday life," involves bifurcations to previously unexplored attractors, whether driven by curiosity or by problems requiring solutions. The ease by which these bifurcation points can be approached and surpassed depends on a variety of personal and environmental factors, and poses one of the major challenges for the growth of individuals, organizations, and communities. Usually, chaotic attractors of mid-dimensional complexity are involved with a balance between divergent and convergent thinking. This process self-perpetuates those chaotic elements that it needs to sustain creativity. This process occurs both during waking and sleeping states. In the latter, random stimulation of the visual-motor cortex can evoke dream images and memories, connecting them with an unresolved issue that may serve as a chaotic attractor. This process may then lead to resolution within the dream or during the waking state. During both sleeping and waking states, mid-dimensional chaos may be a necessary condition for creative bifurcations. Divergence or difference from the norm (so-called "abnormality") need not imply pathology because even here, creativity tends to work in the service of health and balance. Therefore, everyday creative divergence may not only be healthy, but might well be adaptive, serving as an essential survival capability.

Sue Kunz, Marriot Hotels
Albert Dietz, Texas State University

Understanding Employee Turnover in Context and Culture

The purpose of the research project is to better understand the nature of employee turnover in the hotel industry from the perspective of human resource directors as it relates to organizational context. To accomplish this purpose the research addressed several specific research questions. The questions where grounded in the earlier work of Woods et al. and the results were examined through a systems theory framework. The research data were collected through in-depth, in-person qualitative interviews with hotel human resource directors. Four major themes were identified from the analysis of the interviews. These were: what employee looks like, selection process, factors related employee retention, and factors related to employee turnover. The areas are described in the presentation, and used to address the research questions. Recommendations for understanding the context

that surrounds the phenomena of turnover and managing within that context are presented.

Krystyna Laycraft, Center for Chaos Studies
Book of Changes and Chaos Theory

During the last two years I have studied I Ching or Book of Changes. It is the oldest and greatest Chinese classic and became the foundation of the Taoist and Confucian philosophies. The main idea of I Ching is the continuous change and transformation of all beings expressed by a system of archetypal symbols, called the hexagrams. I look at this system of hexagram through the prism of Chaos Theory. For better understanding the meanings of hexagrams I created 64 collages applying my own photographs of nature. Hexagrams reflect all human situations as a sequence of continual transformation from chaos to order (self-organization) and an order is replaced by new chaos (self-disorganization), and this goes on. The idea of the transition from one kind of order to another through a state of chaos is developed in the process of self-organization. I analyze in details some hexagrams like: Fellowship, Humility, Grace, Love, Family, and Happy Union and describe them as dissipative structures. The hexagrams: Resolving Order, Disintegration, Dispersion, Revolution, Conflict, and Oppression are the chaotic states. Some hexagrams like: Break-through, The Turning Point, The Shock, Progress, and Transition can be described as bifurcation points or self-organized criticality where the system spontaneously develops into a critical state and minor perturbations lead to a qualitative change of behavior.

Krystyna Laycraft, Center for Chaos Studies
Organized Multilevel Disintegration as an Emerging Order

Theory of Positive Disintegration describes patterns and explains mechanisms of human development and has been successfully applied to understanding of gifted individuals. The process of positive disintegration is the mental development described by the process of transition from lower to higher levels of mental life and is stimulated by tension, inner conflict, struggle, and anxiety. We introduced a conceptual model of this process as the sequence of bifurcation points where sensitivity to perturbation increases, and new patterns of organization (attractors) emerge as developmental potential changes. This sequence is: a point attractor (primary integration), a cycle attractor (unilevel disintegration), a chaotic attractor (spontaneous multilevel disintegration), an emerging order (organized multilevel disintegration), and an order (secondary integration). Actually, we concentrate our study on the transition from the spontaneous multilevel disintegration (chaos) to the organized multilevel disintegration (an emerging order). We apply the concept of self-organization to describe this process. The period of organized multilevel disintegration can be compared to dissipative structures, which maintain their existence by interaction with their inner and outer environment. This is a period, directed and controlled by highly conscious and autonomous developmental processes. These processes of complex growth help young people to take the development into their own hands and create better conditions for protection and prophylaxis against serious mental disorder. The intellectual, emotional, and imaginational functions interconnect and reciprocally advance the level of the other functions, producing greater psychic complexity, higher levels of creativity, self-awareness, empathy, and social responsibility.

Jay-Shake Li, Department of Psychology, National Chung-Cheng University

A Mathematical Model of Chinese Macro History: The Rise and Fall of Dynasties.

The term "macro history" refers to the study of the general direction of history, but not all its specific details. In this regards, history shall be an instrument by which laws of social development are discovered. Numerous theories have been formulated. They focused on this or that general tendencies in history. Deductions from these theories, however, are far from straightforward, since historical developments usually have multiple causes. History, as a dynamic system, often contains feedback processes, which can, under some circumstances, lead to oscillation or even chaos. One way to overcome this difficulty is to perform simulation experiments. It can reveal how important variables evolve with time and shape overall patterns of historical progressions. In the present study, we built a mathematical model of Chinese macro history and presented results of simulations. Ancient China is relatively isolated and autonomous in comparison to the Mediterranean-European region, thus simplifying the model building. On the other hand, it is complex enough, so that the model will evoke more interests than, for example, the study of Easter Island, a totally isolated island in Pacific Ocean. The model was based on hypotheses summarized by Ray Huang in his monograph "China: A macro history". We demonstrated how interactions of Empire's ruling strength and governing abilities determined the quasi-periodic rise and fall of dynasties in Chinese history, and how the process could be influenced by competitions between central power and regional warlords.

Colleen Mullen, Psy.D., Alliant International University
Darryl Freeland, Ph.D., Alliant International University
Steve Brown, Ph.D., Alliant International University
Brandon Silverthorn, Ph.D., Alliant International University

Ecosystemic Integration of Chaos, General Systems and Family Systems Theory Applied to Therapist Anxiety and Trauma during Individual and Family Life Cycle Discontinuous Transitions

This theoretical study presents a union of chaos theory, general systems theory and family systems psychology, contextualized as ecosystem processes. Consistent with chaos/complexity theory, individual and family life cycle discontinuous change is viewed as a far-from-equilibrium transitional period or phase

space with potential for developmental transformation. Utilizing chaos theory as metaphor from physics and natural living systems studies, the family system is depicted as a nonlinear complex adaptive system capable of autopoesis (self making) at the edge of chaos, transforming through a chaotic transitory period. Utilizing interdisciplinary literature spanning selected materials from Greek mythology to sources published in the last 15 years, focus is on therapist anxiety and vicarious trauma when psychotherapy addresses individual and family system far-from-equilibrium developmental change processes. The theoretical examination sets the stage within a scholar-practitioner model for further theory building and empirical research in marital and family therapy applied to clinical psychology practice.

Dominic Nathan, *Marquette University*
Stephen Guastello, *Marquette University*
Dean Jeutter, Dept. *Marquette University*

Exploring EMG Pattern Detection Using Symbolic Dynamics during the Performance of Functional Upper Extremity Tasks

Functional recovery of reaching-to-grasp from chronic upper extremity physical dysfunction brought about by neurological pathologies such as stroke, spinal cord injury, dystonia etc. are often dismal. The central nervous system (CNS) is responsible for the selection, application and control of appropriate strategies, to ensure accurate and meaningful reaching-to-grasp. An understanding of neural information flow from the CNS is much sought after for the development of rehabilitative interventions, as these neural signals are responsible for the actuation of muscles that dictate hand posture during reaching and grasping. In this study, we examine an analysis method that uses principles of symbolic dynamics to provide information retrieval, classification, entropy and Lyapunov dimensionality. The data examined consists of biceps and triceps EMG recordings collected from neurologically intact volunteers performing goal oriented tasks (N=7, 63 trials). Our preliminary results suggest that the analysis method is able to categorize the EMG data and furthermore show the emergence of common and distinct frequency components of each task, across all subjects. The information from this study is significant as it provides insight regarding the correlates of the strategies used by the CNS with functional reaching and grasping. Furthermore, this approach could potentially be used for the analysis of other physiological signals such as FMRI, EEG, etc.

Balamurugan Pandiyan, Marquette University
Stephen Merrill, Marquette University
A Staging Model of Hashimoto's Thyroiditis os Developed Using Fast-Slow Dynamical Systems

Hashimoto's thyroiditis, or chronic lymphocytic thyroiditis, is an autoimmune disease in which the immune system slowly attacks the thyroid gland resulting in inflammation of the thyroid. Hashimoto's thyroiditis (HT) interferes with the thyroid gland' s production of thyroid hormones, triiodothyronine (T) and tetraiodothyroxine (T). This in turn disrupts the function of the Hypothalamus-Pituitary-Thyroid (HPT) axis controlling this feedback system. Thyroid stimulating hormone (TSH), a key hormone, is secreted from Pituitary gland, which stimulates the follicle cells of thyroid gland both in terms of growth and thyroid hormones synthesis. Clinically, TSH changes in a faster time scale and thyroid hormones T changes in a slower time scale. This forms a fast-slow dynamical system. Hashimoto disease not only disrupts the HPT axis but also a fast-slow dynamics between TSH and T. A staging model is developed to capture the dynamics of thyroid gland undergoing immune attack based on the measurable quantities TSH, T, and the size of thyroid gland. Our main goal here is to use a staging model to investigate the thyroid gland under abnormal conditions. This staging model will be a patient-specific and helpful for physicians to extract information about the course of Hashimoto disease.

Adhil Patel, Market Research, TNS, Cape Town, South Africa

Making Use of the Butterfly Cusp Catastrophe to Establish Brand Commitment and Explain Consumer Behaviour

The world of marketing has long been plagued by linear thinking and simplistic models of consumer behaviour. In this paper, an approach is outlined that utilises the butterfly cusp catastrophe, together with a psychological theory of religious conversion, to create a nonlinear framework for thinking about brands and the relationships they have with consumers. This approach has been widely validated, and has to date been used in over 10,000 market research studies worldwide, covering the full spectrum of consumer sectors, including financial, automotive, healthcare, consumer goods, technology and even political and social. Real world data will be shown from various research studies, drawing on experience with some of the world's strongest brands. In particular, longitudinal data will be shown, which will illustrate the applicability of nonlinear thinking in the marketing research industry, and the insights that can be gleaned from this unique approach to managing brands. The link between the academic thinking and the practical application and interpretation is also provided, to ensure usefulness of the approach, especially in a difficult economic environment, when brands are looking for the most efficient ways to get return on investment for their marketing spend.

David Pincus, Chapman University
Otto Cadsky, University of Alberta
Andrea Kavajian, Chapman University
Christine Chung, Chapman University
Kyle Horst, Chapman University
Catherine Asuncion, Chapman University

Fractal Dimension in MMPI-2 Reaction Times as a Correlate of Psychopathology

For more than two decades, mainstream social psychology investigations of self-complexity and psychopathology have

produced contradictory results. These results are likely the result of a lack of theoretical and methodological grounding in complexity theory. The current study proposed that the self has an interconnected fractal structure, and that this structure may be reflected within a fat-tail (e.g., log-linear or power-law) distribution of response times to self-related questions. MMPI-item response sets (N = 100) were selected from a larger pool of forensic administrations. Self-complexity was operationalized as the inverse of the shape parameter of the frequency distribution of reaction-times to MMPI-2 items (n = 567) for each participant. It was predicted that (a) these distributions would be "fat-tailed," and (b) that individuals with more rigid response times (more short-times relative to long-times) would display higher MMPI-2 psychopathology scores. The results confirmed that a log-linear distribution provided a strong fit for each individual's response-time distribution (mean R^2 = .95). Furthermore, significant correlations were found between rigidity and the various MMPI-2 psychopathology scales. These results may provide a first step toward a more robust approach of measuring self-complexity and a more theoretically grounded view of the self as an emergent and self-organizing system.

Rao Pippalla, Vignan Institute of Pharmaceutical Sciences
Enoch Bijjiga, Vignan Institute of Pharmaceutical Sciences

Zipf's Law and Its Applications in Pharmacy

The main objective of the study was to explore whether pharmaceutical literature obeys the Zipf's law. Besides, the behavior of Zipf's law was studied in populations of selected cities in India and the world and in some editorials of English dailies in India. Selected words were counted in pharmacist's oath of USA and India, ranks were assigned and their frequencies were recorded. The same procedure was repeated for English Editorials and the project for cities and populations. Graphs were drawn using logs of ranks and frequencies. We observed that Zipf's Law is obeyed by the pharmaceutical literature, in selected editorials in the English dailies in India, and in population of selected cities in India and the world. Experiments are underway in our labs to explore whether Zipf's Law is followed in emulsion technology.

Rao Pippalla, Vignan Institute of Pharmaceutical Sciences

My Life Became Chaotic after I Embraced Chaos Theory and Complexity Science: A True Tale of a Pharmacist.

On one fateful day in the year (July), I was given a 'boarding pass' to take the flight to Tallahassee, Florida. As a faculty candidate, I was supposed to present a talk in the college of pharmacy, Florida Agriculture and Mechanical University. Due to the sudden storm at the Dallas International Airport, the flight was diverted to Washington Reagan National Airport. I was informed, after some time, the scheduled flight was cancelled for the day. The next available flight would be announced soon. I returned to my home at Gaithersburg, Maryland. When I was checking my mail I saw a brochure on the annual international conference of Society for Chaos Theory in Psychology and Life Sciences, going to be held at Philadelphia. It was turning point in my life when I took the flight to Philadelphia to attend the chaos theory conference. I have engrossed myself in listening to the lectures, presentations. I was totally excited about this new science which I had no knowledge before that. I have attended six symposiums and two workshops. I have purchased a quite a good number of books to baptize myself into this new science. It took couple of months for me to digest this new science. I was equally excited in the meeting when I came to know that I was the only pharmacist attended that international conference. I felt elated when senior 'chaoticiens' and 'complexologists' observed that I was the first pharmacist to attend the international conference and complex theory and it was good addition to the society. The concept of 'increased returns' I have applied to my own specialty: Pharmaco-economics, though I am a charter member of international society for pharmaco-economics. Not many of my fellow pharmaco-economists were convinced on this. Not in my wildest dreams, I can imagine that PHRMA (Pharmaceutical Research Manufacturers Association) would welcome the concept of 'increased returns'. I am also interested to explore complexity concepts in my other area of interests: Pharmaco-epidemiology (what happens to the drug after it is marketed). There was a silver lining to all these cloudy days. I have suggested a new paradigm to the health related quality of life module. It was a podium presentation (Chaos Theory and Quality of Life: A New Paradigm?) in the International Society for Quality of life Research meeting at Vancouver, Canada (October). I have been very passionately presenting these concepts in all of my job searching activities. I came to know later that the main reason I was not offered a faculty position was that I am proposing new paradigms which have roots in Chaos Theory. Whenever a podium chance came in, I tried to capitalize it by speaking about my newfound land--land of Chaos and Complexity Science. Many of my professional and personnel friends here in India and USA are telling me that ever since I started talking about these theories, I have been offending my colleagues if not antagonizing them. I don't know why?

Constance Porter, St. Edward's University
Albert Dietz, Texas State University

Theory to Application -- Practice, Practice, Practice: Developing the Complexity Practitioner

This presentation will discuss the challenges associated with developing the complexity practitioner. The presenters have been teaching a graduate-level course in Systems Theory for a number of years and through this process they have developed a method for allowing students to experience the practical

application of complexity concepts to complex adaptive human organizations. The process is grounded in the Mink-Dietz Systems Model (2005) which looks at organizations based on connectedness of agents; identification, validation and use of information; and the development of shared understanding within a context. Students have applied this process to a wide breadth of organizations including government, pubic not-for-profit, and private sector. Examples of how data is collected within the constraints of this model, what it looks like, how it is interpreted, and the results will be explored in the presentation. Implications for the Complexity Practitioner will be discussed.

Constance Porter, St. Edward's University

Creation of Social Value with a Systems Theory Perspective

The practical application of complexity concepts in social entrepreneurial organizations is the focus of this presentation. Two social entrepreneurial organizations based in Austin, Texas; American YouthWorks and the Basic Needs Coalition will be presented from a systems theory perspective. Both organizations are highly successful at creating social value. A systems framework will be used to describe the organizations and in particular explain the interactions between agent relationships, valid information and how it is used, and the emergence of shared ideals within the context of the case organizations. Even though the organizations are both considered traditional not-for-profit (Massetti, 2008) social change groups, the two organizations could not be more different. The findings of these two case studies suggest that definitions and models used to explain social entrepreneurial organizations may need to be expanded. In addition, traditional not-for-profit groups are not a one-size fits all collection of organizations and this presentation will suggest that new more complex systemic models need to be developed to better understand the variation that exists within this sector.

Eric Schroeder, US Army

Albert Dietz, Texas State University

Understanding Internal Consultant-Client Interactions: A Systemic look at the US Army's Red Team in Afghanistan

This presentation describes the results of a systemic analysis of an internal consultant-client relationship called Red Team that has recently been introduced in the US Army for units deployed in Iraq and Afghanistan. Red Teams in the Army are highly trained units who act as an internal consultant to the command staff of an operational unit Division or higher. The Red Team program has only been in place for a few years and this is one of the first formal evaluations of the program. The evaluation process examines the effectiveness of training, retention and application of concepts learned through a team's life cycle of training, team formation (expectations), and team resolution and re-assignment. The data is examined through a systemic model that constrains the data to agent connectedness; sourcing, validation and use of information; and learning and adaptation (emergence) within a specific context (cell or shared space). Recommendations will be made for the systemic evaluation of organizations specifically the organizational consultant-client relationship; processes for determining organizational openness; and the meaning of life.

Barbara Smiley Sherman, National Louis University

Through the Lens of Chaos Theory

This paper proposes a model for teaching diversity within secondary school systems as seen through the lens of Chaos Theory. The purpose of this inquiry is to evaluate interventions used by school systems that influence the attitudes and behavior of students towards equity and justice. The principles of Chaos Theory are stated with supporting research by Henri Poincare (1890), Cutright (1997), Gleick (1987), and Rita Weinberg (2009). Chaos theory is first presented as a lens to look through in creating assumptions about the occurrence of prejudice and discrimination in schools and the role that these injustices play in bullying. Principles such as force, points of bifurcation, fractals, stability, and order are discussed. These principles are then applied to social injustices and inequalities in education systems as a way of looking at instability and order, causes and effects. The forces of migration and immigration and their affects on creating instability and disorder in schools are investigated. The resulting components of intolerance with respect to race, religion, gender, sexual orientation, disability, and class are supported with statistical data from the Gay, Lesbian, and Straight Education Network (GLSEN) surveys of schools, the U.S. Department of Education statistics on bullying and violence in schools, and the news media which records current events of bias motivated crimes. The responses of school systems to these incidences of discrimination, bullying, and violence are varied and their effectiveness, in turn, culminates in mixed reviews. This paper of inquiry takes a look at various attempts by schools to stop discrimination and bullying while evaluating their effectiveness using the principles of Chaos Theory. Interventions such as policy making, character education, bullying programs and multicultural education will be explored in terms of how their goals, implementation and effectiveness comply or contradict the principles of Chaos Theory. Within multicultural education, a closer look is taken at diversity training, diversity workshops, and classes developed for the study of diversity issues. In particular, a case study by Lauren Holland (2006) is explored in an attempt to identify the critical components necessary to create a class for high school students to study diversity issues and intolerance as a way of teaching respect, equity, and justice. Taking the study of diversity a step further, the paper discusses the key components that are necessary for

curriculum focused on diversity to have an impact on student's attitudes, beliefs and behavior consistent with the principles of Chaos Theory. In conclusion, this paper supports the need for multicultural education to be part of the required school curriculum due to the presence of prejudice, discrimination and biased motivated violence in our communities and schools. It acknowledges that, according to Chaos theory, there is no final solution as all systems continue to move by force on paths to points of bifurcation and instability creating fractals that become new ordered systems. As a result, multicultural education is seen as a temporary intervention to produce more respectful citizens, yet be flexible so that it can evolve as the needs of school systems evolve.

Meg Spohn, University of Denver

Growing in the Shadows: World War I Alliance Building and Cosmic Birth Clouds

It would seem that alliance building in the international system should behave much like a dynamical gravity model, with alliances eventually settling around two or more poles' in this case, political ones. What of alliance building in such complex instances as the time period leading up to World War I, though? Fueled in no small part by the machinations of Otto von Bismarck, a number of seemingly unpredictable elements emerged, and some rather complex alliances formed. Gravity models with two ultimate poles have trouble describing the motion of the system of World War I alliance building, even if it seems like they should: the Central and Allied powers (and their respective colonies). This study suggests that the behavior of World War I alliance building is closer to that of a different kind of gravity: the way cosmic birth clouds form stars, under the pressure of light as it pushes its way outward in all directions, also pushing atoms of gas, molecules and dust motes. As motes that fall in each other's shadows are drawn together by lesser light pressure between them, groupings become denser, and clump. As the process accelerates sharply, gravity, pressure, heat and mass cause the ever-increasing clumps to begin to glow, becoming stars. In many ways, this model better describes and explains such World War I alliance behavior as the amassing of the German Empire, through conquest and realpolitik, eventually joining with two other empires into the Central powers' and not just because shadow made both possible.

Dick Thompson, High Performing Systems, Inc.

A Catastrophe Model of Leadership Performance Failure

This poster presentation uses catastrophe theory to visualize, explore and predict the dynamic relationship among emotional intelligence, stress and leader performance. In a series of simulations, data were collected on these three variables. In one case, leaders responded to the BarOn Emotional Quotient-Inventory, a self-report instrument that measures emotional intelligence, in either a ' normal' mindset or a 'stressed' mindset. The results indicated that with a simple set of instructions asking respondents to assume a stressed mindset, significant downward changes in the total emotional intelligence and all subscale scores were observed. The significant main effect for mindset has numerous implications, the most obvious being that individuals should not complete the instrument while in a stressed mindset. A second finding of this research is that the relationship between emotional intelligence and stress seems to be such that stress actually reduces an individual's ability to use his/her full emotional intelligence ability. The combination of high stress and low emotional intelligence may cause unexpected catastrophic leadership failures. The results, implications and applications are presented using a cusp model response surface.

Dick Thompson, High Performing Systems, Inc.

Visualizing the Emergence and Dissipation of Conversational Attractors using the BOBs Simulation

One technique for studying Jungian typology is to look at the mind as a complex adaptive system. In this approach, psychic patterns (personality) are the result of complex behaviors generated by agents (functions, archetypes, complexes, etc.) following a set of simple rules. In this session we report the results of the first operational model of Jung's typology using complexity theory and artificial intelligence technology to create an interactive computer simulation. The Basic Orientation in Behavioral Systems (BOBs) model will be used to show how conversational attractors emerge and dissipate within a stranger group reception scenario. The real time simulation demonstrates sensitive dependence on initial conditions as well as the robust mediation effect of psychological Type. This research illustrates the power of the BOBs simulation for use with management teams, individual counseling, problem solving teams and other general types of research. Attendees will agree that the BOBs model opens up a new paradigm for studying human interaction as we enter a new level of human complexity in the 21st century.

Mickie Vanhoy, University of Central Oklahoma

Aaron Likens, University of Central Oklahoma

Eye Movements Reveal the Fractal Nature of Visual Search

People routinely perform rapid visual search tasks of great complexity. One method for studying visual search is to monitor eye movements as people view a scene. Such studies generate large quantities of time series data that contain substantial variability from trial to trial. Analyses of such data often rely on statistical models that treat trial-to-trial variability as error variance (noise). Dynamical systems theory suggests that variability in time series data from a visual search task may contain colored noise consistent with $1/f$ dynamics when subjected to an iterated function systems (IFS) clumpiness test if visual search is memory-dependent. Thirty-six undergraduates located a target within a novel scene while researchers recorded standard measures of visual response (e.g., fixation duration and gaze trajectory). Participant eye movement coordinates served as inputs to IFS clumpiness tests. These data displayed $1/f$ microstructure indicative of long-term

correlations (pink noise) and short-term correlations (brown noise) as expected when memory affects visual search.

Toru Yazawa, Tokyo Metropolitan University

Tomoo Katsuyama, Numazu National Institute of Technology

DFA on Heartbeat in Animal Models and Humans: Alternans, a Characteristic Pattern as the Harbinger of Death, Lowers the Scaling Exponent

The aim of our study was to quantify the condition of the heart: sick or not, in numerical order, with physiology, together with heartbeat-interval-fluctuation analysis: a significant experimental effort and careful data analysis. "Alternans" is an arrhythmia exhibiting alternating amplitude/interval from beat to beat on the electrocardiogram and was first described in 1872 by Traube. Recently alternans was finally recognized as the harbinger of a cardiac disease, when an ischemic heart exhibited alternans. The abnormal pattern, alternans, arises spontaneously. A mechanism must contribute to it. It probably arises through a repeated application of a simple rule in a complex, nonlinearly connecting biological network, though the details about underlying physical laws are unknown. Abnormal behavior of the heartbeat must guide us to the interpretation of the heart control system, in terms of the concepts underlying nonlinear dynamical systems. In animal models we detected alternans at various experimental conditions, including the heart with injury, the heart under emotional stress and the heart of a dying specimen. We have tested the detrended fluctuation analysis (DFA) on alternans and revealed that in both, animal models and humans, alternans rhythm lowers the scaling exponent (1.0 in health). We concluded that the scaling exponent can reflect a risk for the "failing" heart, especially when the low scaling exponent (about 0.6) and alternans are concurrently present. The DFA provides analytical strategies, focused on patterns of variation in sickness and in health, if models and human beings live on all functions under the same set of physical laws.

Rita Weinberg, Chair, National-Louis University

Barbara Smiley Sherman, National-Louis University

Niles P. Engerman, National-Louis University

Jeannie Zeitlin, National-Louis University

Shannon Cribaro-Difatta, National-Louis University

Chaos Theory, Educational Systems, and Social Justice

This symposium is about Chaos Theory and Education. Educational systems are undergoing major bifurcations, and re-organizations, from No Child Left Behind, to issues of inclusion of all regular and special needs students. We look at education which does not provide social justice towards all students. We will explore these issues from the perspective of Chaos theory. It will help us understand how linear practices may be limiting educational outcomes for students and lead us to thinking about how these systems could move forward in nonlinear ways.

Rita Weinberg, National Louis University

Chaos Theory, Change, and Educational Systems

According to Chaos theory, change is to be expected in non-linear systems. Many think of change as evolving gradually but it often occurs unpredictably at different speeds and times. Gould called it "punctuated equilibrium". We are addressing change in educational systems through the lens of chaos theory. Given that change is an ongoing process, are there conditions which facilitate or deter change? What are the roles of attractors, of complexity? Can change be propelled forward, and if so, how can it be done. Change is a neutral word-it can mean positive or negative change or paradoxically, both at the same time. Large systems, such as educational organizations, may be locked into linear and hierarchal practices. If something is not working, let us do more of it and become even more standardized in structure and function. People react differently to changes. The majority of the population want some stability, and some change-a little, not too overwhelming-as in having many changes all at once. Looking at educational systems changes through aspects of nonlinear properties: 1.Patterns. What appears to be chaotic, upon closer inspection, are patterns.. Non linear patterns are holistic. Some patterns are tied to beliefs. In education, patterns occur in student placement, curriculum design, teacher assignments, etc. 2. Bifurcations occur quickly as control parameters are accessed and increased. Energy seeks to flow as fast as possible and structured flow moves energy as increased levels of ordered complexity are reached and change is expedited by the attractors. External environmental factors are significant in facilitating or deterring change. 3. Attractors-.We could look at attractors metaphorically- they lead to greater linearity or to more chaos in the system. We should aim at more flexibility and more adaptation in the system, instead of the regularity , precision, predictability and fixed outcomes 4. No Child Left Behind (NCLB) is a national law which was passed under the Bush administration to make schools more effective and more accountable. This law has penalties for failing to obey it s rules and for falling below set standards. It is a good example of a linear model, and this law is placing school systems under considerable pressure to conform to its rules or face penalties. Can change be regressive? Can the effect of this law lead non-linear systems to become more linear? Can it lead to a rise in reading competencies at a set standard? What aspects of NCLB should be kept? What effect does this law have on school systems in terms of operation and organization? Finally we discuss which type of change should educational systems make.

Jeannie Zeitlin, Brookfield-LaGrange Park School District #95

Chaos Theory and Metaphors in Inclusive Education

Chaos theory suggests that we liberate ourselves from the constraints of modern and post-modern society and embrace rather than resist life's uncertainties while looking for the possibilities they hold. We shall be looking at Educational Systems. Briggs and Post suggest that we embrace chaos in

our society and discuss seven lessons with themes surrounding the topics of Control, Creativity, and Subtlety. Instead of resisting life's uncertainties chaos theory asks us to embrace joining forces with chaos and living as a creative partner. "Categories and abstractions constitute our human knowledge and are certainly necessary for practical survival, but our categories can dominate us to the point where we ignore the finer, uncategorizable inner nature of human situation". Chaos Theory as a metaphor might assist us in the inclusive movement by aiding us in the understanding that" beyond and between our attempts to control and define our reality lies the rich and perhaps even infinite, realm of subtlety and ambiguity where real life is lived. A good or useful metaphor supplies the nutritional and ecological support for productive investigation into new areas. A generative metaphor is one that effectively facilitates the process of transferring over arable semantic frames, concepts, and modes of interpretation from one conceptual domain to another; a highly generative metaphor also facilitates critical evaluation of status qui theory and practice within a discipline and promotes opportunities for reassessment of the prior conventions within the field. T may set the stage for a process of cognitive restructuring within the discipline, including new theory development. Special education today is seen as a system of systems, a conglomeration of fragmented services delivered in isolation from one another and rarely integrated within the general education environment. Education is a nonlinear system that is being forced into a linear model. Complexity theory reminds us that the sum cannot be reduces to the total of its parts. We cannot continue to view children as a "disability, "category", "label" or "diagnoses.. The most critical issue in special education and in all of disability policy is the issue of classification. In education we witness a powerful push toward stability by the forces of wishing to maintain control, security, certainty and adaptation to the present environment. Additionally, we see a powerful push in the opposite direction with division, decentralization, excitement and innovation. The push and pull must be maintained. We must learn to reside in the border of stability and instability in that place called chaos. Chaos/Complexity theory is inherently systematic-both a blend of positivism and post-modernism. The good news about chaos in our lives is that it is natural and in fact a key component of the universe. Although chaos my cause uncertainty as a natural by-product, it also creates opportunity for hope and change. Educators need to prepare for chaos and accept uncertainty as a universal condition. We need to embrace uncertainty, realizing that we can indeed make an impact on a small section of the universe in which we reside in spite of the chaos.