

**Society for Chaos Theory in Psychology & Life Sciences**

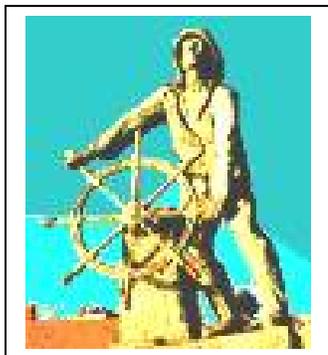
*Dedicated to the development of  
nonlinear science worldwide  
since 1991*

**Abstracts to the  
13th Annual International  
Conference, Boston, MA**

**2003**



13<sup>th</sup> Annual International Conference of the  
Society for Chaos Theory in Psychology & Life Sciences<sup>1</sup>  
Boston, MA, USA Aug 8-10, 2003



SCTPLS 2003 Conference Abstracts  
Alphabetical listing by First Author

NOTE: Abstracts for Keynote speakers Clifford T. Brown, Walter J. Freeman, and H. Eugene Stanley appear in this alphabetical listing.

**Where Are We Natural - Creativity as Exemplary of Human Action Removed from Natural Patterns**

**Susan C. Aaron**  
University of Toronto

If novel structure is the product of an act of creativity that emerges by breaking a chaotic pattern, then is the propensity of creativity in human beings evidence of a knowledge structure that is constructed continually apart from the natural as a chaotic pattern is considered to be based on natural structures? And if digital technology is continually linking creative actions does it increase this network in abeiance of chaotic patterns to arrive at some new form of stability or homeostasis? Perhaps one might make this observation in the example of a human technologically mediated performance, where the concurrent patterns of persons broadcast globally but reoriented in the transmission by technologies alter the nature of creating patterns so that the notion of patterns itself as the basis for knowledge created from the proprioception of human bodies is altered, Does this action emphasize this removal from "nature" as the human body in their creation? What are the implications of this? Does this tell us about the nature of knowledge, creativity, and reflect on humans as doers of nonnatural acts while bearers of natural dynamics, and does this information allow us to be more aware of what we are calling natural and what is otherwise for the clarification of both?

**Linguists Can't See the Forest for the Trees**

**Charles Adamson,**  
School of Nursing, Miyagi University

What is language? In order to solve this tough problem, linguists develop models of language (grammars) based on perceived regularities in the language they observe. Applied linguists then try to find ways of teaching these regularities to students or apply them to other fields such as natural language

processing on computers. This model is based on three simple observations: (1) all linguistic features have prerequisites, (2) language input must be meaningful to become internalized, and (3) language features are fuzzy. The resulting model is a complex network of interlocking trees, technically a forest, which represents Chomsky's language acquisition device (LAD). The model will be presented and then some of the implications will be discussed.

**Avatamsaka Game Dynamics**

**Eizo Akiyama**  
University of Tsukuba,

Avatamsaka game is investigated both analytically and by means of computer simulations. (Two-person) Avatamsaka game is a game where each agent's payoff completely depends not on her own decision but on the other player's, thus any combination of mixed-strategies is Nash equilibrium. However, the experimental data using human subjects have shown that the distribution of players' actions in this game has a certain tendency. The mechanism to reveal the origin of the empirical distribution is presented from viewpoint of game dynamics including agents' cognition update process.

**Pleasing Form: Complex Aesthetics in Beowulf**

**Gary Bodie**  
Department of English, University of Oregon

This paper will use recent advances in the applications of chaos and complexity theory to examine the poetic text of Beowulf. Cognitive science, linguistic theory, narrative theory and literary criticism are all beginning to use complexity theory to explore the ways in which a text transmits (and a mind constructs) meaning; it is my argument that these disparate fields converge through this common approach into a new understanding of how aesthetic appreciation operates. Because Beowulf has long been valued as a work of art and is

<sup>1</sup> © 2003, 2008 Society for Chaos Theory in Psychology & Life Sciences. Cover fractal graphic by J. C. Sprott, used with permission.

also known to be a complex and chaotic text (in the traditional, nonscientific sense), it provides an ideal subject for this study. By mapping the narrative in both its macro- and micro- scales, I will demonstrate the fractal structure of the text and will argue that it is this structure which contributes to its reception as an aesthetically pleasing work of art. Because chaos theory describes natural systems across all scales, from molecular to galactic structures—in other words, is a mathematical formulation of the forms and motions of nature—I argue that it also describes the forms which underlie this text (a text which may be more representative of a natural poetics than any other in the English canon) and the motions of the cognitive process of aesthetic reception.

### **What Is Information? Information Is Fractal and Chaotic**

**Don M.M. Booker**

Pace University, NY

This paper will review several mathematical models which answer the question, "What IS Information?" and suggest that they may share a common framework which is characterized by recursive and self-similar aspects. Shannon Weaver communications theory, dynamical systems models, computational complexity models, Chaitan Kolmogorov algorithmic information theory, Renyi information, and Demski's specified complexity model will be briefly reviewed and discussed. Issues related to the contextualization of meaning will also be discussed in the context of statistical methods such as Demski's aimed at assisting in this effort.

### **Is Information Conserved? Can 'New' Information Be Created?**

**Don M.M. Booker,**

Pace University, NY

This paper will examine several approaches to formulating and proving a conservation theorem for information, using Boltzman entropy and the second law of thermodynamics, perspectives from "Physics from Fisher Information", Chaitan algorithmic information theory, 'no free lunch theorems' and evolutionary search and learning arguments. The implications of an information conservation theorem for the 'creation' or origination of 'new' information will be explored and some proposed sources of 'creative' or 'new' information will be examined including random and parallel search algorithms and methods, symmetry breaking, prior pattern based or genetic heuristics, and information viewed as an experiment or measurement, and as a symmetric and asymmetric game.

### **Dynamics and Patterns in the Rise and Fall of States: Problems and Data**

**Clifford T. Brown**

Middle American Research Institute, Tulane University

Theories of human cultural evolution, and in particular those that purport to explain rise of the state, have been slow to integrate nonlinear dynamical systems theory (NDS). Nevertheless, it does appear to be necessary to include NDS in any satisfactory description (much less explanation) of the general trajectory of cultural evolution. I discuss prevailing theories of cultural evolution and their weaknesses; I describe the characteristics that I believe an adequate model of cultural evolution should possess; I explain some of the fundamental problems with the archaeological and historical data; and I suggest ways in which nonlinear science can contribute to the empirical solution of these complex problems.

### **Fractality in the Main Characters of a Long-Range Literature**

**Gerardo Burkle-Elizondo**

Universidad Autónoma de Zacatecas, México

**Ochoa-Santos Miguel**

Universidad Autónoma de Zacatecas, México,

**Terán-Elizondo Isabel,**

Universidad Autónoma de Zacatecas, México

The quantitative information about the use of words in the structure of a text had been studied using the Zipf's analysis. There are complex hierarchies at micro and macrostructures of long-range language to get a coherent message. Some of them belong to syntactic and grammar rules. The place and link of grammatical figures like pronouns, verbs, nouns, articles etc. with fractal correlations distribution are well known. The aim of this work is to investigate if in a very long-range sequence of literary corpora, in the use of the word that is the name of the main character in the text, this is a dynamic distribution in the quantitative and statistical way. To make it we choose the first two chapters of a novel, with a total number of words in the set up to 11 126, from Vincenzo Consolo's "La sonrisa del ignoto marinero". Like an axis the two main characters are the "Barón" that appears 71 times, and the "marinero" (the same that "Interdonato" and the "comerciante") 63 times. In the first analysis we calculate the fractality of a series about the occurrence of anybody of the "Barón" or the "marinero", and the number of words between each time that one of them appears. We found a  $D_f 1.929 \pm 0.357$  with  $r^2 0.806$ . In a second analysis we calculate the fractality of a series about the way that the "Barón" and the "marinero" mix each other, counting the words number between each time that the "marinero" appears, and the same about the "Barón". We found  $D_f 1.827 \pm 0.669$  with  $r^2 0.882$ . This novel is an historical one. It breaks with linearity with a "polyphony" narrative style. The recursive frequency design could have linguistic relevance in the brain codex system and the communication process.

### **Complexity in the Mesoamerican Myth of Quetzalcoatl**

**Gerardo Burkle-Elizondo**

Universidad Autónoma de Zacatecas, México

In the Mexica and the Mixtec traditions from Mesoamerica about the genesis, the Quetzalcoatl god, the plumed serpent moves along different dimensions in his travel to the underworld (Tlalocan). He dies, but to bring back to life with a human soul in a holy nature, because he is a man that becomes a god through self-sacrifice. He was born like the "star of the morning" (Venus) in order to become one with the Sun in the process of creation that gets moving from the upper world (Tamoanchan). Archaeologists make the description of the relationship between this myth present in the prehispanic codex of Borgia, Féjerváry-Mayer and Florentino, with the ritual space of "Tula" city like a place in which in the earth, the adventure of Quetzalcoatl come true like a holy and ritual architecture that represents here, the upper and the underworld. I found a relationship of self-similarity between these three spaces: the mythic one, the codex and the Tula city with its pyramids and ball game like the trajectory of an attractor that is Quetzalcoatl himself—who dies and bring back to life- Venus- the Sun- the life, all this inside a 52 year period (xiuhmolpilli). From this recursive process with these space-temporal patterns of cusp catastrophes life-death-resurrection in which we find chaos, entropy and turbulence, finally the morphogenesis on brow appears with the born of Venus, the Sun, the man and the world. A complex space has now

structure in a trajectory of a cosmic-creative space myth-codex-Tula that, like a process of cosmic movement, emerges in a nonlinear time. The aims of the present study is to show the complex relationships that exist between this prehispanic knowledge with some concepts of Complex Dynamic Systems, making a comparison between the images of the codex, the buildings and structures of Tula city and the myth.

### **Complex Patterns in the Oil Market**

**Sary Levy Carciente,**  
Central University of Venezuela

**Hector Sabelli,**  
Chicago Center for Creative Development. Chicago, IL

**Klaus Jaffe,**  
Universidad Simón Bolívar,

**Rafael Rodriguez,**  
Universidad Central de Venezuela

Nonlinear dynamic analyses show that the pattern of the time series for the prices and volumes of Brent crude oil sold in the London International Exchange shows asymmetry, diversification, low recurrence, novelty, nonrandom complexity, and defined periods where specific attractors are at work. The series of differences between consecutive terms in oil prices and sales volume show biotic-like pattern, demonstrating that changes are not random nor chaotic. These results suggest that oil markets may be more influenced by human decision-making processes than by physical constraints in supply and demand. Nevertheless, they show highly structured organization that are detectable with unconventional methods of analysis explored here.

### **Fractal Dimensions in Interorganizational Alliance Networks**

**Ken Colwell,**  
LeBow College of Business, Drexel University, PA,

**Alan D. Meyer,**  
Lundquist College of Business, University of Oregon

Much attention has been given in recent years to the "scale-free" topology of networks. A scale-free network is one in which the distribution of links between nodes is not normally distributed. Such a network consists of a few densely connected "hub" nodes, while most nodes have few connections. This structure has been found to be persistent in a variety of networks comprised of very different node and link types. In a prior study, we found that the scale-free topology is also present in the alliance network of organizations in the nascent field of nanotechnology. In this study, we suggest several ways of describing the dimensions of a complex interorganizational network and show that the scale-free topology is self-similar with respect to these dimensions. Methodological implications for the study of organizational alliances are discussed.

### **Demographically Induced Land Fractals and Political Tension**

**Dimitar Dimitrov,**  
Institute for Advanced Studies, Vienna

**Victor Dorofenko,**  
Institute for Advanced Studies, Vienna,

**Yuri Yegorov,**  
Institute for Advanced Studies, Vienna

We study the phenomenon of land fragmentation in the process of inheritance given heterogeneous fertility across population. In this framework, initially homogeneously

distributed land evolve and asymptotically form a fractal with power law within wide range of wealth. When the smallest land endowments touch critical values, the process of land redistribution and accumulation via market and non-market mechanisms starts, and leads to increased political tension. We analyse the data of land distribution for different countries and find power laws there as well as correlation between powers and political situation.

### **Workshop: Modeling Longitudinal Dynamics in Textual Data**

**Kevin Dooley,**  
Arizona State University

**Steven Corman,**  
Arizona State University

Many social phenomena create a time series of texts. Emergent social events and processes are captured in newspaper articles, emails, reports, and conversations. Theoretical insight can be gained by studying the underlying dynamics of the longitudinal textual data. For example, thematic periodicities may indicate strong institutional influences. We shall present a general methodology for the analysis of such data, and demonstrate it in a number of contexts.

### **Healing Through Sentience - Breaking the Cycle of Intervention**

**Mark R. Filippi,**  
Living Lessons - An Instructional Self-Care Center

This spring, I am conducting a 90-day preliminary trial of a nonverbal skill transference program developed through the intervening years that uses visual and postural development as resources in guiding clients to regaining their vitality and recuperative power. The central feature of this system involves directing the client to an awareness of their visual-postural dynamic (VPD). The VPD consists of six discrete interactive tasks the doctor and client perform to access an undifferentiated consciousness, AKA, sentience. The unique contribution of the VPD is that it places the emphasis on interpersonal aspects of healing. This takes the myope, amblyope, what have you, beyond their limitations, literally into the living mirror of their daily lives. This clinical application, which has been dubbed, Behavioral Chiropractic, uses several aspects of nonlinear dynamics to study and evaluate the client's level of integration. I'll discuss how this was accomplished on a low-tech level, using psychomotor performance parameters and other simple somatic markers. A composite summary of my trial's results to date will also be presented.

### **INTERACTIVE DEMONSTRATION: Elicitation to a Deconstructed-System for Human Behavior Study**

**Charles A. Fink,**  
Behavioral System Science Organization, Falls Church, VA

I give a brief scientific introduction, with coupling to SCTPLS interests, and then an interactive demonstration of eliciting ("canned" for privacy) from a volunteer functional determinants of his/her behavior for a given event, situation, or condition. Elicitation is recorded within functions of the author's Human Behavior System on preprinted whiteboard and captured electronically in real time to computer, where a researcher or other professional annotates whiteboard elicitations as they are computer-displayed so as to highlight potential problems in behavior-determining processes. Then the researcher plays back on computer a more-or-less a movie

of whiteboard elicitation and annotations so that he/she and the volunteer may discuss problem areas uncovered.

### **Control Or Not? Hegemony Through the Lens of Chaos Theory**

**Pawel Frankowski**

Department of Political Science, University of M.C. Sklodowska

Author explains what is role of the strongest actor in chaotic system of international relations. Author adopted Callen-Shapiro's theory of social imitation and Vaga's theory of coherent market for international relations and created dimensional model of IR. Author assumes that in spite of self-organizing character of international relations, system needs hegemon for stable development and exiting of hegemon sets system in state of dynamic equilibrium. Author bases on two hypotheses: (1). Accordingly to growth of state's attractiveness (in military, politic, cultural areas) and state potential, international support for its action increase; so that, state/hegemon could control system of international relations in easier way. (2). Growth of state's power means that homeostat's principle is broken because strongest state both stabilizes and destabilize system, i.e. states can control and cause chaos.

### **Where can chaos theory take us? Where do we want to go?**

**Walter J. Freeman**

University of California, Berkeley

Chaos theory hit psychology like a thunderbolt. We were blinded by the flash of insight and enthralled by arcane technologies borrowed from deterministic chaos. We stumbled badly over correlation dimension and the rigidity of basin-attractor theory. Now these youthful excesses are behind us. We have a wonderful opportunity to document the creative dynamics by which brains organize themselves in assimilating their environments. Advances can come by applying chaotic dynamics to brain images from subjects who report the meanings of their experiences. The greatest source of new knowledge is the scalp EEG: inexpensive, easy to acquire, comfortable for subjects, and incredibly rich in heretofore unintelligible detail.

### **Scalp EEGs Reveal Large Spatial Patterns with the Texture of Gyri in Frames Flickering at the Speed of Thought**

**Walter J. Freeman**

University of California, Berkeley

Sensation and perception both require dendritic currents and axonal action potentials of neurons that are widely distributed in the forebrain. The spatiotemporal neural activity patterns in sensation differ dramatically from those in perception. Sensation is mediated by action potentials of feature-detector neurons observed with microelectrodes and modeled with neural networks. Perception is formation of large-scale patterns of coordinated action potentials from millions of neurons. Patterns are modeled as densities in a continuous sheet and observed with electrode arrays to record the EEG from the dendritic currents that control the action potentials. A two-stage mechanism is proposed by which sensory cortical activity that is stimulus-driven by receptor input induces hemisphere-wide, self-organized patterns of perceptual neural activity within 300-500 ms of stimulus onset. In the 1st stage sensory input destabilizes the primary receiving areas, so that the random microscopic action potentials condense into a wave packet, like a raindrop formed from water vapor. The 2nd

stage occurs as wave packets from all sensory areas are carried by action potentials through the forebrain. The dendritic integration of activity destabilizes much or all of each hemisphere, and a global pattern emerges. Such patterns have been observed in animals by intracranial recording of EEG from multiple areas, and noninvasively in normal humans by multichannel scalp EEG. Observation with common clinical equipment is facilitated by dense electrode arrays for high spatial resolution and the Hilbert transform for high temporal resolution. The patterns provide access to the synchrony used by the brain in high-level cognitive functions involving perceptual experience.

### **Synchronous Period-doubling in Flicker Responses of Retinal Neurons**

**Kenkichi Fukurotani**

Engineering, Toyama University,

**Dusit Thanapatay,**

Toyama University

We studied nonlinear dynamics of horizontal cells and transient-type amacrine cells in the goldfish retina. We recorded intracellular responses of horizontal cells and amacrine cells to periodic flashes of light. The neurons exhibited period-doubling bifurcation and chaos when periodic frequency of the light flashes varied as a parameter. The period-2 orbit appeared at frequency of 25 Hz for monophasic-type horizontal cells, 20 Hz for biphasic-type horizontal cells, and 15 Hz for triphasic-type horizontal cells. Transient-type amacrine cells bifurcated at the same frequency as that of monophasic horizontal cells for period-2 orbit. The bifurcation phenomenon of horizontal cells did not depend on spot size of flash light. Therefore, we concluded that the bifurcation originated at postsynaptic level of horizontal cell dendrites at ribbon synapses between cone photoreceptor basal ends or even at cone photoreceptor level.

### **Lyapunov Tests for Short Time Series**

**Ricardo Gimeno Nogués,**

Universidad Pontificia Comillas,

**Ruth Mateos de Cabo,**

Universidad San Pablo-CEU

**Michael Angel Pelacho**

University of Seville

**Elena Olmedo Fernández**

University of Seville,

**Lorenzo Escot Mangas,**

Universidad Complutense,

**Pilar Grau Carles,**

Universidad Rey Juan Carlos

Lyapunov Exponents are common tools in order to characterize a dynamical model and to look for chaotic behavior. Computation of the Lyapunov Exponents of a model is well known, and there are also many articles referred to its estimation in the case of time series. But it has not been resolved yet the problem of the estimation error inherent to any calculation with real data. This estimation error plays a key role in testing the hypothesis of positive exponents, as a signal of chaos in the time series, mainly working with short time series, noisy time series, or low positive values for the exponents. Some works has appeared in recent years that tried to give an answer to this problem. Some of them are parametric, and some are non-parametric. In the present paper we compare the results of using these methods with short, noisy time series obtained from the Spanish Economy.

## **Chaos, Complexity, and Metaphysics**

**Jeffrey Goldstein**

Adelphi University,

**Robin Robertson,**

Alhambra, CA

**William Sulis,**

McMaster University

Einstein once asserted in an article (co-written with Leopold Infeld), "The results of scientific research very often force a change in the philosophical view of problems which extend far beyond the restricted domain of science itself. Schopenhauer had voiced a similar point concerning scientific findings, "...the corrected, extended, and more thorough knowledge of nature is the very knowledge that always undermines and finally overthrows the metaphysical assumptions that until then have prevailed." Indeed, the varied fields constituting the sciences of complex systems have been touching many of the most salient philosophical issues of the last century including such formidable subjects as the origin and nature of life, theories of consciousness, the soundness of reductionist explanations, the need to update traditional views of causality and determinism, the course of evolution, implications of thermodynamics and statistical mechanics, the relation of parts to wholes, and other equally thorny matters. Simply concentrating on the empirical findings themselves would forfeit the conceptual opportunities offered by them. In this symposium we would like to present several metaphysical implications drawn from the study of complex systems. The format will be a cross between individual presentations and a panel discussion. That is, one person will be presenting at a time but the other two panel members will chime in when appropriate. In particular, we will discuss the following topics: (1). Archetypal dynamics and the nature of emergence. Presented by William Sulis, MD., "Archetype" is here being used in a sense influenced by but also different from that of Jung. (2). Emergence and self-transcending constructions. Presented by Jeffrey Goldstein, The construct of emergence will be discussed as a means of access into a wider, more basic metaphysical construct, that of self-transcending constructions which can be used to replace such earlier metaphysical notions as Whitehead's process. (3). The Case of the missing 3rd. Presented by Robin Robertson, How is it that form arises out of chaos? How do we reconcile mind with body? In attempting to deal with these primary questions, time and again a "missing third" is posited that lies between extremes. The problem of the "missing third" can be traced through nearly the entire history of thought. The form it takes, the problems that arise from it, the solutions suggested for resolving it, are each representative of an age. We will present several such watershed points.

## **Using Developmental Trajectories to Explore "Bios"**

**Joel F. Gordon**

MDRC

In recent papers Sabelli and his colleagues have suggested that a variant of chaos they call "bios" is useful for thinking about creativity. To model this behavior they invoke a process equation,  $x' = x + g \sin(x)$ , where increasing the parameter  $g$  ("gain") beyond a threshold drives trajectories into a quasi-random, not quite chaotic pattern "bios". This investigation employs a developmental approach in which the "gain" parameter in these equations is increased with each iteration. An easily implemented spreadsheet model is used to demonstrate assorted types of "biotic" trajectories. Results indicate that there may be scattered regions where these trajectories reveal novel characteristics, reinforcing the

proposal that there are ways in which bios can be seen as distinct from chaos. In addition, this report will explore ways in which replacing the 'sin(x)' term of the process equation with a Fourier expansion can result in an enhanced range of behaviors within biotic systems. The discussion will address how looking at trajectories developmentally reveals characteristics of systems that are not apparent from standard bifurcation diagrams and also consider the unexpected stability found at high settings of the gain parameter. I will conclude with speculations on using the bios concept metaphorically in thinking about change and creativity.

## **WORKSHOP: Accident Analysis and Prevention**

**Stephen J. Guastello**

Department of Psychology, Marquette University

The goal of this extended workshop presentation is to make the bridge between conventional thinking on this topic and what has been learned from studies in nonlinear dynamics and complex systems. Although much of the system-related knowledge has been gained from occupational accident situations, the principles generalize well to accident situations in transportation, health care, and public situations. The program will begin by considering several concepts of causation that permeate the risk analysis literature: the single cause and risk ratio, chains of events, fault tree analysis, factorial models, and catastrophe models. Basic ergonomics and stress variables can be important contributors to any of the foregoing causal structures. Fault trees, which have become known as dynamic fault trees in recent years have the capacity to track complex events as they unfold over time. Catastrophe models, which are clearly nonlinear and dynamic, describe and predict discontinuous changes of events over time. The catastrophe models characterize single accidents as well as collective accident experience. Statistical properties of accidents and catastrophes will be addressed and will be of particular interest to participants with actuarial or other research objectives. Frontier issues in accident analysis and prevention involve complex systems with multiple human and machine agents. How can task groups become coordinated or destabilized? What properties of human-machine interaction lead to stabilization? How is the concept of chaos relevant? Prevention techniques range from those that are centered on the individual human agent to those that affect complex systems. Levels of effectiveness for some benchmark systems are considered along with emergency management systems.

## **Intuitive Dynamics and Chaos**

**Christine Hardy,**

Centre Eco-Mind

Semantic Fields Theory as a cognitive theory allows us to formalize some of the dynamics of this stupendous human capacity, intuition, which comprises a variety of sophisticated non-logical thinking modes. According to SFT, the fundamental dynamics of a cognitive system is the Spontaneous Linkage Process. This connective dynamics is triggered between semantic constellations (or SeCos) by a common semantic feature (similarity of feeling, value, form or semiotics, that is, of a semantic content of any type), and may connect together different levels of the Mind-Body-Psyche system, or distinct SeCos. Using SFT's framework allows us to map sophisticated intuitive dynamics, such as Communication at a distance between the semantic fields of two linked people; sensitivity to the state of distant systems the connective process may also connect consciousness semantic fields with eco-semantic fields in the environment or objects; sensitivity to the influence

of internal SeCos as attractor-basins the SeCos, as attractor-basins are bending the probability of internal events and behaviors toward their attractors and thus inform possible future states, thoughts and events toward past trajectories; Foreknowledge of one's own transformation processes, that is, the premonition and precognition of future life companions and essential events; and finally, sensitivity to underlying thinking dynamics and logical fields the capacity to understand people through cultural and personal mental models or logfields.

### **Variability as a Variable: A Model and Measure of Behavioral Flexibility**

**Tom Hollenstein,**  
University of Toronto

Flexibility of responses to changes in the environment is a key component of adaptive behavior. In psychology, however, behavioral flexibility has received only brief attention at the theoretical level and has not been adequately defined, modeled, or measured. This presentation defines flexibility using a dynamic systems model of three nested time scales. This model defines flexibility as the moment-to-moment variability among discrete psychological states. This real-time variability at a micro scale is differentiated from variability at a meso time scale, which is the relative stability of the system. It is at this meso-scale that we can identify attractors as the recurring patterns that emerge from micro-scale variability. The third scale, or macro scale, is the developmental time scale in which the relative continuity of these attractors can be observed. The flexibility of parent-child interactions is used as an illustration of how the micro scale in this model can be measured and analyzed. This study tested the hypothesis that low flexibility in parent-child interactions is related to problem behaviors emerging in early childhood. Measures derived from state space grids (plots of the real-time trajectories of the dyadic interaction) are used to show that diminished flexibility (i.e. rigidity) is related to growth in antisocial behavior and internalizing problems in 5-6 year olds. Implications of these measures of flexibility are discussed in relation to the other two time scales in the model.

### **Creating Chaos from the Void in Mesoamerica**

**John Howie**  
Department of Psychology, Pikeville College  
**Carol Grizzard**  
Department of Religion, Pikeville College  
**Darrell Riffe,**  
Pikeville College

Many cosmogonic myths begin with a primordial unity-the void, the monad, primal chaos-that then bifurcates into a masculine and feminine pole. The feminine aspect is often then raped, flayed, torn asunder, or dismembered to create the discrete particulars of the material world while the masculine component remains spiritual, universal and heavenly. For some cultures there is a second bifurcation point, either a twinning into a better and a worse of the same gender or a reiteration of the original contrasexual bipolarity with self-similar results. Does masculine dominance necessarily require feminine dismemberment? Does such a myth of origins entail an apocalyptic ending and return to the formless beginning? We explore these issues in the context of ancient Mesoamerican civilizations, with particular emphasis upon the Aztec cosmology as symbolized by the colossal statue of Coatlicue, the decapitated ancient mother goddess of the serpent skirt. The ritual space she inhabits at El Templo Mayor,

where thousands upon thousands of human sacrifices were ritually performed, reiterates the origins of the universe as well as that of the Mexica society. For those of us who are seeking a new mythological paradigm for the twenty-first century, it behooves us to carefully examine through the lens of chaos theory what not to do.

### **Computational Analysis of Dream Motifs**

**John Howie,**  
Department of Psychology, Pikeville College  
**Ben Goertzel**  
New York.

Dream texts are notoriously nonsensical. One method for discovering their implicit order is first to identify a motif, then to seek out its recurrence in subsequent dreams, and finally to analyze the entire series for the symbolic significance of the motif. The changing manifestations of the dream motif thus form a trajectory which reflects the higher-dimensional trajectory followed by the dreaming mind as it changes through time. Is it possible for a computer program to assist in locating, collecting, and analyzing recurrent dream motifs? Can computational analysis facilitate the process of deriving a conscious meaning from the largely unconscious dream text? Can dynamical systems theory elucidate the trajectories of dreams and the dreaming mind? We have designed a software analytical process for the computational analysis of dream texts and applied a simple prototype version to a collection of several hundred dreams recorded by a single dreamer over a period of years. Although our initial prototype is based on word frequency statistics rather than more advanced natural language processing, nevertheless it has the ability to enhance the exploration of dream motifs beyond what can be done purely "by hand."

### **Why Family Physicians Provide a Lower Quality of Care Compared to Cardiologists and Psychiatrists**

**David Katerndahl**  
University of Texas Health Science Center at San Antonio,

Comparison studies suggest that the quality of care provided for specific medical conditions is poorer in primary care than in specialty settings. Purpose: To estimate the complexity of ambulatory patient encounters in family practice, cardiology, and psychiatry settings. Methods: Secondary analysis of the 2000 National Ambulatory Medical Care Survey (NAMCS) data using ambulatory patients seen in family practice, cardiology, and psychiatry settings. The measures used described the quantity of information and services exchanged between patient and, the visit-to-visit variability of these exchanges, and their overall diversity. The complexity for each variable was estimated as the quantity weighted by variability and diversity. Input and output as well as total encounter complexity were estimated. Results: Although there was minimal difference in the unadjusted complexity of encounter input of family practice and cardiology, psychiatry's input is less. Cardiology involves more input quantitatively, but the diversity of family practice input eliminates the difference. Cardiology also involves more complex. Overall, there is little difference in the unadjusted complexity of encounters in family practice and cardiology. However, when the duration of visit is factored in, the care provided in family practice becomes twice as complex relative to cardiology and seven times as complex relative to psychiatry. Conclusions: The poorer quality of care reported in studies of family practice relative to cardiology and psychiatry may reflect the increased complexity of the encounters. In addition to the use of case-mix, estimation of

input and output complexity may be another tool for adjustment in policy-relevant studies.

### **Nonlinear Effects of Concentrated Poverty on Homicide Rates: Effects and Alternatives to Log-transformation**

**Peter Knapp,**

Department of Sociology, Villanova University

**Lance Hannon,**

Department of Sociology, Villanova University

A considerable body of theory and research has suggested that concentrated poverty has accelerating effects on homicide rates, and other rates of violent crime. In sociology and criminology, these nonlinear effects are important in explaining the collapse of structures of social opportunities or social controls, and they also help explain the nonlinear interactions of other variables related to the crime rates, such as racial composition or rates homeownership. Similarly, in developmental psychology, nonlinear effects of stress, trauma and disadvantage illuminate central puzzles about discontinuities of development and processes of collapse or resilience. The findings of accelerating effects have been partly contradicted by research finding decelerating effects of concentrated poverty on homicide rates that has suggested contrasting models of the effects of concentrated community disadvantage. Part of the inconsistency of existing studies results from use of log transformation of skewed dependent variables. We resolve part of the inconsistencies in the existing findings and examine further methods of analysis, including inverse transformation and analysis using heteroscedasticity consistent standard errors. We also discuss some of the outstanding theoretical problems concerning these nonlinear effects.

### **Do Mental Illnesses Run in the Family? Two Perspectives on the Role of Family Interaction in the Onset and Course of Schizophrenia**

**Matthijs Koopmans,**

Metis Associates, New York

There are two ways in which research about schizophrenia has concerned itself with family interaction. One research tradition evolved out of the work of family process theories (e.g., Bateson, Lidz, Wynne, n-bind theory), which argue that certain types of dysfunctional family interaction occur more often in families who have a schizophrenic member than in other families. In spite of their considerable influence on clinical practice, there is little empirical evidence up to this point to support these models. A second strand of research has studied characteristics of family interaction to predict relapse among former schizophrenic patients who return to their families. The finding that certain family interaction features (e.g., emotional overinvolvement) are indeed good predictors of relapse, has been successfully replicated many times. This research has shied away, however, from the question what predicts the first onset of the disorder. This presentation examines the compatibility of these two perspectives and argue that important similarities between the two approaches about what occurs in the families of schizophrenic individuals are obscured by differences in vocabulary and by the fact that one focuses on the origins of the disorder and the other on its maintenance over time. It will be assessed to what extent the findings about relapse can be used to more effectively address etiological family process questions, and whether insights from family process theory can be used to provide greater specificity to the theories concerned with the prediction of relapse.

### **What Are the Causes of Schizophrenia? The Challenges to Family Process Theory and Research**

**Matthijs Koopmans**

Metis Associates, New York

Two factors have hampered attempts to empirically establish whether or not dysfunctional family interaction is an etiological factor in the onset of schizophrenia. First, there has been growing modesty among researchers about our ability to demonstrate such relationships empirically. Moreover, most thinking about the cause of schizophrenia takes place within the vulnerability-stress paradigm, which postulates that a constitutional vulnerability to the disorder is a necessary condition for its occurrence, and that stress from the environment may provoke symptoms in individuals who are constitutionally vulnerable. Models deemed incompatible with this general paradigm, such as dynamically oriented family process models, have been largely abandoned, under the mistaken understanding that those models are necessarily purely environmental. One of the challenges to family process research is therefore to determine its compatibility with the traditional vulnerability-stress paradigm, and assess whether modifications are required to that paradigm to accommodate hypotheses derived from family process theory. This presentation will argue that while family process models are not necessarily incompatible with the vulnerability-stress paradigm as it is, its specific proposals about what exactly individuals are vulnerable to and about how stress operates to provoke symptoms, diverge from how the vulnerability-stress paradigm is traditionally understood.

### **The Complexity of Workplace Violence: Diagnosing Organizational Awareness**

**Martin B. Kormanik**

O.D. Systems, Inc.

Strategies for addressing workplace violence are generally proactive, focused on prevention and preparation, or reactive, focused on response to an incident. Before strategies are put in place, however, the complexity of the issue demands an organizational diagnosis so that chosen strategies have maximum benefit. Awareness development is a construct for analyzing cognitive and psychosocial growth in relation to a transitional issue and planning interventions that support growth in relation to the transitional issue. This study shows that using the awareness development construct to examine individual employees' growth regarding the transitional issue of workplace violence may serve as a practical measure for organizational diagnosis; assessing the as-is condition amidst the chaos and planning appropriate intervention strategies. Implications for theory and research are discussed.

### **A Nonlinear Quantum Model of Organizations, Decision-making and Brain Waves**

**W. F. Lawless**

Paine College

The major unsolved problem in social interaction theory is the rational ability to distinguish an aggregation of individuals from a group, primarily from theory derived from individual perspectives. In contrast, the social quantum model (SQM; from Bohr) has made progress with a nonlinear mathematical model of the conjugate factors of action and observation uncertainty for entangled agents. We have made two extensions, to organization and argument theories. First, organizations grow when recruits reduce their combined energy,  $E$ , into a joint ground state; bonding increases between

recruits and a leader as vocal frequencies converge (resonance; or inversely, reactance); interaction success depends on its cross-section; and the likelihood of an interaction varies inversely with the E it requires (respectively, a well-trained recruit; close relationships; movie-line queues; popular restaurants). Second, quantum-like square E wells associate mathematically with emotion and decision-making (e.g., the optimum solutions of ill-defined problems occur when incommensurable beliefs interacting before neutral decision makers generate sufficient emotion to process information, I, but insufficient to impair the interaction). We speculate that interaction cross-sections are related to brain waves: if gamma waves ( $\approx 40$  Hz) bind sensory features into mental objects and concepts, transitions between opposing views in an argument reflect the time to apply difficult concepts to problems, linking solution "detection" to signal detection theory.

### **Nonlinear Dynamics of Occupation: A Case in Point** *Ivelisse Lazzarini,*

School of Allied Health Professions, University of Saint Louis

In this presentation we will discuss a case study from the perspective of nonlinear dynamics as it pertains to the practice of occupational therapy in an acute care psychiatric setting. Through a conceptual framework of brain dynamics, treatment interventions will be described and explained to elucidate the complexity of self-organized systems.

### **Emergent Emotional Appraisals: Theory and Data from Psychology and Neuroscience**

*Marc D. Lewis*

Program in Developmental Science, University of Toronto

*Jim Stieben*

Program in Developmental Science, University of Toronto

One of the principal aims of emotion theory is to model the relations between appraisals (cognitive or perceptual evaluations) and the emotions with which they correspond. However, the cognitivist approach portrays appraisals as causal antecedents of emotions in a oneway progression--ignoring the possibility of reciprocal and multiple causation. For several years the first author has been modeling appraisal-emotion relations as self-organizing gestalts emerging out of reciprocal and recursive interactions among cognitive, perceptual, and motivational constituents. However, this work has remained abstract and lacking in precision. In this paper, we show how many of the basic assumptions of functional neurobiology support a view of emotional appraisal as self-organizing in real time, and these assumptions can help move us toward a more detailed model. Panksepp, Tucker, Freeman and others view emotion-cognition states as spontaneous synchronization between cortical and subcortical systems. We model attention-emotion synchronization as "vertical integration" across levels of the neural hierarchy. Motivational agendas mediated by lower structures entrain cortical processes of perception and cognition, while these in turn regulate and constrain more primitive motivational activities. Hypothetically, feedback among interconnected systems at each of these levels allows the entire brain to converge to an attractor rapidly in real time, while neuromodulator release and synaptic adjustments help maintain this attractor and strengthen it across occasions. To begin to flesh out these ideas with current EEG/ERP methods, we demonstrate the existence of brief epochs of frontal-cortical coherence at the theta frequency associated with limbic activation. 128-channel data analyzed with a new source localization package will be presented. Bouts of coherence can be seen when subjects

become aware that they have made an error, suggesting an emerging appraisal of vigilant concern potentially linked with anxiety.

### **Determining the Network of Genetic Regulation from cDNA Microarrays**

*Larry S. Liebovitch*

Florida Atlantic University

*Viktor K. Jirsa,*

Florida Atlantic University

*Lina A. Shehadeh,*

Florida Atlantic University

Genes form a complex network of interactions. Protein transcription factors from some genes bind to and regulate the expression of other genes. Until now, determining these networks of genetic regulation has required multiple experiments that correlate the expression of genes under different experimental conditions. We show that it is possible to determine some properties of the network of genetic regulation from the mRNA levels of a single experiment. The mRNA levels depend, in part, on the net interactions between all the genes. We show here that different networks of genetic regulation produce different statistics of mRNA levels, as measured by the number of genes PDF(x) expressing amounts of mRNA between x and x+dx. This makes it possible to determine some information about the network of genetic regulation from the statistics of mRNA levels measured in a single cDNA microarray experiment. These results may provide: (1) a new method to analyze the tremendous amount of data from cDNA microarray experiments, and (2) a screening assay to identify the systems or sub-systems of genes that will be most productive to study by the traditional methods and the best ones for therapeutic intervention.

### **Too Beautiful: A Story of Complexity, a Family and End-of-life Care**

*Curt Lindberg,*

Plexus Institute

This is a story about how my family used concepts inspired by complexity science to inform how we worked to make the last days of my father comfortable, free of pain, and full with dignity, meaning, and love. Using such complexity ideas as self-organization, nonlinearity, information flow and feedback, diversity of agents, and simple rules, my brothers, sister and I created several organizing principles to guide our efforts. They included: honor the guidance Mom and Dad had provided us; stay in touch and share lots of information; use the wisdom and diverse skills and insights in the family; take baby steps, see how they work and adjust quickly; and provide whatever stability and certainty we could. Together we helped our father experience a "good death", an experience full of little miracles. "I am leaving under the circumstances everyone wishes for," he told us as he passed away

### **Strange Bedfellows: Frequently Confused Concepts in Interdisciplinary Writing on Nonlinear Dynamics**

*Patricia A. Lipscomb*

University of Washington School of Medicine

To paraphrase Shakespeare, nonlinear dynamics acquaints us with strange bedfellows, i.e., concepts pairs that so frequently appear hand-in-hand in interdisciplinary writing that nonmathematical readers may mistakenly infer that they are inseparable. Such pairs tend to take one of two forms. In one, the members of the pair are related but distinct concepts from

nonlinear dynamics (e.g., fractal or self-similar and theoretical versus real-life chaos). In the other form considered here, one member represents a concept from nonlinear dynamics but the other (sometimes a homograph of the first) is linked to it not by mathematical considerations but by verbal association or a plain-language reading (e.g., dynamic-dynamic and iteration or recurrence). The present discussion begins by addressing the central importance in mathematical communication of fine distinctions between related mathematical concepts (which entails a necessary distinction between the mathematical and vernacular meanings of most mathematical terms) and then distinguishes between the members of a number of such potentially confusing concept pairs. The goal is to offer nonmathematical readers a means of grasping these concepts more clearly and to encourage authors writing to a broad interdisciplinary readership to anticipate and avert misunderstanding of frequently confused concepts by making distinctions explicitly clear.

### **Qualitative and Quantitative Change in Motor Learning**

**Yeou-Teh Liu,**

Department of Physical Education, Taiwan Normal University,

**Gottfried Mayer-Kress,**

Department of Kinesiology, The Pennsylvania State University,

**Karl M. Newell,**

Department of Kinesiology, The Pennsylvania State University

The experiment examined the qualitative and quantitative change in the dynamics of learning a novel motor skill (roller ball task) as a function of the manipulation of a control parameter (initial ball speed). The focus was on a dynamical systems analysis of the relation between the rates of change in performance over practice time and the changing time scales of the evolving attractor dynamic in wrist coordination space. The results showed 3 different learning patterns to the changes in the dynamics as a function of practice that were mediated by the initial ball speed. Only the participants that learned the task showed a bifurcation in coordination mode that was preceded by enhanced performance variability. We claim that the bifurcation is of rep saddle-node type which would also imply the testable prediction of hysteresis that will be tested in future experiments. The observed multiple time scales to motor learning are interpreted as the products of the dynamical stability and instability realized from: (1) the continually evolving landscape dynamics due to bifurcations between attractor organization; and (2) the transient phenomena associated with moving toward and away from fixed point dynamics.

### **Steps Toward an Ecology of Emergence**

**Thomas E. Malloy**

Department of Psychology, University of Utah,

**Carmen Bostic St. Clair**

Quantum Leap

**John Grinder**

Quantum Leap

In terms of Bateson's Ecology of Mind framework, and given that emergence is a human mental construct (which great promise of useful application to the world), we may ask into what sort of mental ecology of ideas might emergence fit? Most, if not all, examples of emergence are construed as hierarchies of levels (cell, tissue, organ). How does emergence fit other human constructs addressing the nature of hierarchies? Inheritability and constriction define Logical Hierarchies—"duck" inherits all the qualities of "bird," moreover, "duck" is a more constricted set (that is, it has a smaller number of elements) than does "bird." In contrast, for

Part-Whole hierarchies (say a ship composed of many parts) the parts do not necessarily inherit the qualities of the whole (a ship floats while a rivet sinks) and the set of parts is not necessarily a smaller, more constricted set than the whole (there may be many rivets in a single ship). Elements of sets and parts of wholes connote "thingness," whereas we will define emergence in terms of processes within complex dynamic systems. Parallel to Part-Whole hierarchies (a ship has properties that its parts do not have), Emergent Hierarchies will be defined in terms of coupled sub-processes whose interactions generate a higher-order process that has properties that do not exist within the lower level processes. This definition will be related to Goldstein's notion that emergence is characterized by radical novelty and confoundedness among levels and will be accompanied by examples from a dynamic systems simulation.

### **Perceiving Visual Pattern in a Dynamic Universe**

**Thomas E. Malloy**

Department of Psychology, University of Utah

**Gary C. Jensen**

Department of Psychology, University of Utah

**Tim Song**

School of Computing, University of Utah

How do humans perceive shape and extract pattern from a complex, dynamic universe? Aside from ecological optics, classical vision science theories tend to be based on static stimuli (e.g., line drawings, random shapes, 2- and 3-D computer graphics, photos). We will demonstrate how a simple dynamic systems simulation can generate visual stimulation that is dynamic not static and that has complex pattern structure. Assuming that perception routinely deals with such visual inputs, we propose a theoretical mechanism that capitalizes on dynamics by making apparent motion a key to pattern perception. Visual demonstrations will show clearly how human apparent motion perception can extract in real time the basin structure, sub-basin structure, and even static shapes and other features from a system that is nonlinearly dynamic. Apparent motion phenomena are typically construed as illusions that have enabled the perception of movies and video. Perhaps they are more; surely the ability to perceive apparent motion did not evolve simply so we could watch movies and video. Rather, the ability to perceive apparent motion just might allow an organism to extract stable pattern from dynamic systems. This last point represents a departure from previous vision science approaches and offers a new theoretical toehold in shape perception.

### **The Experience of Hyperdimensionality**

**Terry Marks-Tarlow,**

Clinical Psychologist, Santa Monica, CA

**Stephen Oyer-Owens**

Humanities Concentration, University of Phoenix,

**Richard J. Bird**

Division of Psychology, Northumbria University,

The hyperdimensional experience (HDE) may be defined as a psychological awareness of a dimension beyond that experienced previously, or normally and in everyday life. Sometimes the HDE is unexpected or fleeting, the result of a drug, temporary circumstances or a physiological state e.g. illness. Sometimes it is sought as an abiding frame of mind by means of a program of training, religious discipline or meditation, or as a successful outcome of psychotherapy. By its nature the experience of hyperdimensionality means the sense of a further or higher dimension in perception, thought

and feeling. As such it may be distinguished from other altered states of consciousness (ASCs), which may be positive, negative or even pathological in their effect. As distinct from ASCs in general, the HDE is felt as a liberating, expansive or life-changing experience. Often it is linked with intellectual and/or emotional insights, which again may either be evanescent or may be capable of subsequent articulation and elaboration in a productive sense. In this symposium three speakers of very different outlooks and cultural backgrounds give their views on the significance of the HDE at a personal, societal and theoretical level. Personally, there is a need for transcendence of and liberation from the alienation of modern civilization. Societally, we need a mode of conflict resolution for some of the most intractable problems facing the world in the 21st Century.

Theoretically, a psychophysiological explanation of HDEs is required. The idea is explored that the understanding and cultivation of HDEs as a normal part of society may be a vital factor in the future personal social and religious evolution of humankind.



**PAPER 1: *Experiencing in Hyperdimensions: Model for a New World Paradigm* Stephen Oyer-Owens.**

This paper proposes that we stand at the threshold of a new world paradigm for contemporary Western culture. The paradigm arises from our potential ability to experience in hyperdimensions. Such a perspective can enable us to address fundamental societal and personal challenges in a new way, lay the groundwork for a new synthesis of the sciences, and provide new understanding of the nature of mysticism and its relationship to the sciences and daily life. I relate my own encounters with hyperdimensional experience as it has arisen from my involvement in Lakota (Sioux Indian) ritual. My involvement has been based on several years' participation in the ceremonies of the Sweat Lodge, the Sun Dance, and Crying for a Vision. These experiences have resulted in multiple visionary encounters and a radical sense of unity between self and reality that is hyperdimensional in structure. This kind of hyperdimensionality has been experienced by mystics and shamans for perhaps thousands of years, and may constitute the core transformation of self and being proposed by many of the world's great spiritual traditions. Such hyperdimensionality is characterized by the marriage of contradictions in concepts, emotions, and other phenomena which seem impossible to reconcile in the linear thinking of daily life. This hyperdimensionality also makes possible an intimate marriage between self and other. The resulting unities arise in a "place" which is "in between" the disparate, providing a hyperdimension previously invisible to perception. The new perspective can be represented in a hyperdimensional loop, bearing similarities to chaos theory and the geometry of fractals. In turn, the marriage of all such unities in hyperdimensional loops can be depicted as a Nexus Point, a powerful and holographic-like center which enfolds the whole of creation. Experiencing in hyperdimensions can make possible new solutions to diverse conundrums such as the continuing occurrence of warfare in human cultures and the degradation of our planet's environment. It can provide new pathways for individual psychological growth and lay the groundwork for a hyperdimensional psychology, based on a dynamic encounter with wholeness. These explorations can

also lead to a new understanding of our relationship with the universe, providing new meaning to the nature of human life.

**PAPER 2: *The Hyperdimensional Experience of Psychotherapy*. Terry Marks-Tarlow.**

When psychotherapy proves most successful, the hyperdimensional experience (HDE) occurs as the desired outcome of longterm, depth work. Here patients gain the capacity to sink beneath everyday surface events to the very origins of their consciousness. In this zone of expanded awareness, the external events of life are seen as meeting and fitting the internal contours of psyche like hand and glove. This eliminates all clear distinctions between inside/outside, self/other, mind/matter, and grants a wholeness to experience, a sense of "rightness" about how character and destiny intersect, even when this fit appears perfectly horrific. This paper links HDEs theoretically with Spencer-Brown's calculus of first distinctions. A state of "primordial confusion" is proposed to lie at the base of consciousness that can be modeled via re-entry dynamics by fractal boundaries between psyche and world. Within this paradoxical state, boundaries are simultaneously opened and closed, and opposites are equated. This is the stuff either of madness or of higher consciousness, depending upon the strength of the therapeutic container along with the patients observing ego.

**PAPER 3: *A Theoretical Basis For the Experience of Hyperdimensionality*. Richard J. Bird.**

The experience of hyperdimensionality (the Hyperdimensional Experience or HDE, otherwise known as the Oceanic experience, the Numinous, Unity of Opposites etc.) has specific condition of induction, occurrence, predisposition, and very specific consequences for the world view of the experimenter. Those who undergo HDEs typically emerge from them transformed in a variety of ways, personally, philosophically and morally. Like the Square in E A Abbott's "romance of many dimensions" Flatland, we return to our everyday world with a new vision of something which lies beyond. Here I discuss the possible basis for this experience of a higher dimension in terms of the processes of iteration and recursion. In our everyday lives we iterate, performing the same or slightly modified operations, but not perceiving them as located in time. When we enter a recursive viewpoint (the experience of the hyperdimensional) we can newly see the whole of our life and the lives of others from the outside as located in time. We also have an enhanced potential for the reconciliation of opposing viewpoints as aspects of a unified whole. This expanded perception typically remains even in the absence of the HDE itself. A descriptive mathematical basis of HDEs is offered in terms of iteration theory and the Boolean arithmetic of Spencer-Brown and a possible basis in brain function for the HDE is suggested in terms of the self-monitoring of the refresh-rate of thalamo-cortical loops, possibly sustained by quantum-collapse events. The ontological viewpoint most compatible with this data is a monist idealism and the consequences of this are explored.

**Slouching Towards a New Paradigm**  
**Terry Marks-Tarlow**

Clinical Psychologist, Santa Monica, CA

SCTPLS has been in existence for thirteen years. With the butterfly effect the central metaphor of the new sciences, most of us expected a broad sea change to rapidly propagate through the field of psychology. Yet this has failed to happen. This paper addresses the social politics of why this may be the case and how we can address the problem.

## **Time-Scales of Virtual and Real Conferences as Binding Events in a Global Brain**

**Gottfried Mayer-Kress,**

Department of Kinesiology, Penn State University,

**Holly Arrow,**

Department of Psychology, University of Oregon

The history of conferences is probably at least as long as that of modern civilizations and they certainly played an essential role in their evolution. In spite of thousands of years of technological progress very little has changed in the actual procedure and format: Participants gather at a common physical locations and listen to each others' aural presentations, sometimes accompanied by more or less illustrative visuals or demos. The advent of telecommunications and the Internet triggered the emergence of conferences that take place in virtual spaces but their success has been limited mainly due to the lack of direct face-to-face interactions. Here we discuss some issues related to time-scales and how they interact with the number of participants. We claim that efficient integration of virtual and traditional conferences will be essential in a continued role of conferences as cultural "binding events" in what has become to be known as "Global Brain". These are seen in analogy of cognitive binding events in biological brains that are essential for feature integration. We present data from conference web-casts hosted by Complexity Digest, a weekly electronic newsletter that also web-casts conference presentations and summaries. Preliminary results suggest that typical time-scales of conference web-casts are of the order of one week compared to a few hundred milliseconds of human brains.

## **The Web and the Cloth: Science, Consciousness and Homeodynamics - What They Are and What They Do**

**Daniel W. Miller**

Consciousness Studies, Greenwich University

The systems model for homeodynamics is drawn from the work of Bertalanffy, Kauffman and Capra, among others who have argued in favor of Systems, Chaos and Complexity theories. Homeodynamics is the driving force behind psychological and physical systemic interactions that serves to optimize relationships for the sake of each system's survival. It enters into the realm of the sciences through astronomy, physics, biology and evolution, and into phenomenology and psychology through psychotherapy and neuropsychology. Conflicted scientific and phenomenological research can be bridged when we understand that the operation of consciousness takes its many diverse forms because it is used as a tool of research that formulates observations appropriate to the needs of each field of investigation. In the life sciences, Homeodynamics, implementing its survival mandate through the agency of consciousness, provides a common baseline for the unification of mind and body. This has important consequences for the perception and treatment of mental and physical illness, for which a Range of Homeodynamic Efficiency (RHE) is formulated. This range is applied to the activity of consciousness in integrating the mind-body relationship such that mental and physical health can be evaluated on a continuum of stress and optimal homeodynamic functioning. This systematization effectively defragments the piecemeal categorizations within mental and physical illness. Society and the ecology can also be evaluated in terms of implications derived from the homeodynamic process.

## **Psychophysiological Measures of Variability in Heart-Rate and Activity in At-Risk Youth After Psychomotor Treatment**

**Susan Mirow,**

University of Utah School of Medicine,

**Robert J. Porter,**

Directions for Mental Health, Clearwater, Florida

At-risk youth who engage in violent and antisocial behaviors can show either an over-reactive or an under-reactive physiological pattern in response to stress. Those youth who have histories of childhood neglect tend to be the under-reactive ("predators"), while those youth who have childhood histories of abuse ("posttraumatic stress") tend to be over-reactive. We reasoned that these patterns might be seen in a sample of at-risk youth and that changes in physiological parameters might be observed following interventions designed to address the sequelae of neglect and abuse, i.e., difficulties with affect regulation and arousal. We present the results of a project investigating this hypothesis in a group of incarcerated male youth, ages 15 to 19. Subjects wore portable heart-rate (Rozzin © Holter monitor) and activity measuring devices (actigraph: Motionlogger ®) for 24-hour periods before and after a six-week treatment program of specially-designed, group therapy addressing psychomotor reactivity and affect regulation. In addition, both line-staff and subjects completed pre-printed computer forms rating subject's behaviors and mood variables. Data analysis techniques were designed to reveal nonlinear dynamical processes involved in the psychophysiological mechanisms regulating affect and arousal. We present an overview of psychomotor group treatment as well as the results for the first group of six youth who completed the project.

## **Using Structural Equation Modeling for Nonlinear Dynamic System Theory**

**Olga Mitina,**

Department of Psychology, Moscow State University

Structural Equation Modeling (SEM) is a collection of statistical techniques that allow to examinations between variables in social science and psychology. But as usual researchers use these techniques for usual statistics model (linear, one-to-one correspondence and so on). Meantime SEM could be very useful for analyzing data coming from nonlinear dynamic system models. For example SEM allows to analyze time-series process, nonlinear regression models, multilevel models. Applications of SEM are very adequate in social science, when we can't perform a lot of measurements what we really need to use traditional NDS methods which come from the physics, biology and so on. Usually researchers use SEM for linear analysis and just ignore "nonlinear" options. In the paper we are going to present some relevant to NDS SEM methods and ideas and also to demonstrate some examples.

## **The Introduction of a Systems Perspective to Child Welfare Workers: A Preliminary View**

**Kathleen Moffett-Durrett,**

Kent School of Social Work, University of Louisville

Kentucky has moved from traditional services perspectives to considerations which include analyzing client systems and using client directed team work aimed towards resolution of problems resulting in child maltreatment. Direct service workers are being asked to make a radical change in perspective which involves being able to form judgments utilizing a "systems lens." My work involves looking at

language and behavior changes among workers for indicators that new perspectives are being assimilated into their practice.

### **Narrating the Workings of Memory: Iteration, the Iterative, and the Paradox of Proust's "Temps Perdu"**

**Jo Alyson Parker,**

Department of English, Saint Joseph's University

This paper comes out of a larger study wherein I explore how the insights provided us by chaos science enable us to look anew at narrative structuration and meaning, especially with regard to temporally "chaotic" texts. Here I explore Marcel Proust's achievement of what I call "bounded randomness" through his use of the iterative mode of narrative frequency. Drawing on Paul Ricoeur's description of the "dynamic of emplotment," I argue for the appropriateness of the analogy between narrative structuration and the complex systems investigated by dynamicists. I then discuss the analogy between iteration and the iterative, a predominant mode in Swann's Way. Because of computer simulation, dynamicists have been able to perform the innumerable mathematical iterations that allowed them to discern deterministic chaos-to see a global pattern, such as the strange attractor, emerging from local randomness. Similarly, the iterative mode involves synthesizing related events-in effect, creating a global pattern from the various local random fluctuations that occur. Turning to Swann's Way, I argue that Proust gives us only the emergent structure of the narrator's childhood daily walks -- walks that are globally determined but subject to local randomness. Out of the iterations of many daily walks, an emergent structure takes shape, and the narrator's synthesizing memory can thereby evoke the reality of a time once lost. By examining Proust's iterative through the lens of chaos science, we can better apprehend his insights about how the random events of our lives achieve meaning through the synthesizing power of memory.

### **The Chaotic Itinerary to the First Language in Ordinary and Exceptional Circumstances**

**Annemarie Peltzer-Karpf,**

Department of Language Development, Graz University,

**Manuela Wagner**

Graz University; Harvard Graduate School of Education,

This paper features temporal asynchrony in system development. In order to come to terms with protracted phase-shifts and retarded development a model developed for the dynamic assessment in normal children is adapted to the special exigencies of children with sensory, cognitive and linguistic problems (range 1;6 - 3;1). The nonlinear approach proposed unites developmental cognitive neuroscience and dynamic systems theory. We start from the assumption that maturational factors and experience play complementary roles in forming specialized systems which display different degrees of experience-dependent modification and operate at different time scales. The chaotic itinerary to language reads as follows: (1) the initial pseudo-stable state exhibits a transition from holistic to gradual analytic decoding; linguistic behaviour is dominated by the search for coherence expressed in memorized (non-analysed) chunks and restricted variation, (2) the intermediate stages are characterized by the extraction of rules alongside with the (re-) modelling of neural connections, the reorganization into different clusters and the onset of system-specific phase-shifts (heralded by over-productivity and fluctuations), (3) the final steady state shows coherent clusters and uniform patterns with large internal coupling strength and stability. The framework used allows for the spotting of system-

specific growth curves, facilitates reliable prognoses concerning the child's cognitive and linguistic future and serves as a vital toehold in the onset of efficient intervention programmes.

### **Temporal Scales and Order Parameters of Heart Rate Variability**

**Robert J. Porter,**

Directions for Mental Health, Clearwater, Florida,

**Susan Mirow,**

University of Utah School of Medicine

Nonlinear systems generate temporal structure at every level of biological organization, from the dynamics of molecular reactions in cells, to that of societies of brains. One commonly studied bio-temporal structure is heart rate variability. Heart rate variability is organized at many temporal levels, from the millisecond structures of spreading heart muscle excitation to the seconds or minutes of adaptation involved in CNS-mediated cardiac responses to changes in blood chemistry or posture. This short-term temporal structure of heart rate variability has been examined in a number of different ways, including spectral analysis, wavelet decomposition, and graphical analysis procedures. We will review some of these analyses, with special emphasis on ways that nonlinear biological processes generate temporal structure linked to possible cardiopulmonary system order parameters. We will also present new data showing how analysis of heart rate variability on the macro temporal scale (that is, minutes or hours) may reveal how nonlinear biological processes generate temporal structure tied to order parameters of the psychobiological system. Our analyses suggest that the temporal structure of biological processes such as heart rate variability may span a wide dynamic range and may provide, therefore, an ideal system for simultaneously observing order (and disorder) in biological processes across levels of organization. (Supported in part by Copperton Place and Cumming Foundation).

### **Applications of Difference Equations in Mathematical Biology**

**Michael A. Radin,**

Rochester Institute of Technology

We will examine several difference equations as epidemic models, grass growth models, and population models. In particular, we will discover how the long-term dynamics of the solutions depend on the relationship of the coefficients and not on the initial conditions. Also, time permitting, we will also examine how the delays of some of these equations affects the long-term behavior of the solutions.



## **Bios, Bios Data Analyzer and the Biotic Features of Galactic Evolution, DNA Sequences and Heart Rate Variation**

**Hector Sabelli,**

Chicago Center for Creative Development, Chicago, IL

**Arthur Sugerman,**

Chicago Center for Creative Development, Chicago, IL

**Lazar Kovacevic,**

Chicago Center for Creative Development, Chicago, IL

**Louis Kauffman,**

University of Illinois at Chicago

Our research program is developing a science of creative processes by (1) identifying the defining features of creative phenomena in empirical processes; (2) developing methods to measure them in time series; (3) formulating mathematical models; and (4) experimenting with these models to identify their essential features in order to generate strategies to promote creative human behavior. In this symposium, we shall describe new time series analyses that measure the defining features of creative processes: diversification, novelty, and nonrandom complexity. To reveal simple and complex patterns in creative processes, the Bios Data Analyzer constructs vectors of 1, 2,..., N consecutive terms of the time series as well as differences between consecutive terms, differences of differences, etc., up to the tenth difference, and computes statistical, dynamic and recurrence measures for each of these series. Changes in variance with embedding demonstrate diversification in biotic and stochastic series but not in stationary chaos. Plots of recurrence of isometric vectors as a function of vector duration differentiate order from creative organization. Consecutive isometry reveals causal or periodic order, and distinguishes chaos and bios from stochastic noise. Novelty and arrangement (nonrandom complexity) at high embeddings define creative phenomena generated by bios and stochastic noise. Embedding plots thus differentiate three types of aperiodic series: chaotic (low dimensional order and high dimensional randomness), stochastic (low dimensional randomness and high dimensional novelty and arrangement), and biotic (low dimensional order and high dimensional novelty and arrangement). Biotic features are evident in diverse processes: physical (galactic distribution between 100 and 400 megaparsecs, atmospheric temperature), biological (heart rate variation, respiration, some DNA base sequences), and economic (prices of some commodities, exchange rates, some economic indicators). Biotic patterns are generated by a number of nonlinear equations previously described and investigated as a model for deterministic diffusion. We regard bios as paradigmatic of creative processes and identify the process that generates it as a dialectic interaction of opposites and more specifically as bipolar feedback. Bios is defined as a deterministic process that generates episodic patterns, diversification, asymmetry, novelty, and nonrandom complexity. Bios is also characterized by irreversibility, lower entropy and greater continuity, asymmetry and sensitivity to initial conditions than chaos. Bios represents determined creation, stochastic noise random creation, and chaos "determined randomness." The demonstration of biotic features in fundamental structures supports the notion that bios and bipolar feedback may be major contributors to natural creative processes currently attributed to chaotic and stochastic processes. This indicates that creativity can be fostered by the interaction of opposites and diminished by oneness.

## **Marine Ecosystem Complexity: Scaling and Nonlinear Variability in Plankton Dynamics**

**Francois G. Schmitt,**

CNRS, Wimereux Marine Station, UMR ELICO,

**L. Seuront,**

CNRS, Wimereux Marine Station, UMR ELICO,

**S. Souissi,**

University of Lille 1, Wimereux Marine Station, UMR ELICO,

The question of scale is critical for marine ecosystem studies. Approaches that deny such a basic point have no way to perform a transfer of scales, in both downscaling and upscaling contexts. Contrary to terrestrial ecosystems, in the oceans the primary production is performed by unicellular organisms called phytoplankton. The population dynamics of numerous and diverse planktonic organisms consequently occur at small scales. From the recent emerging question of the transfer of scales one can mention the understanding of the microscale nature of plankton behaviour and dynamics, and the subsequent effects of microscale variability on large scale processes, such as global biogeochemical fluxes. We study here plankton variability as multiscale patterns, and consider their structure as an adaptation to their highly intermittent turbulent environment. We first specifically consider phytoplankton concentration data and compare it to passive scalar turbulence. Then we focus on the feeding behaviour of small planktonic crustacean using new cinematographic techniques allowing to record 2D and 3D trajectories in different experimental conditions. These datasets are analysed within the framework of multifractal anomalous diffusion. After characterising these patterns we develop individual-based models (IBMs) based on multi-agent systems and other artificial intelligence techniques. These simulations allowed to demonstrate how relatively simple behavioural rules may give rise to complex collective patterns. Finally the role of both experimental and numerical approaches in studying the complexity of plankton dynamics is discussed.

## **Dynamic Correlates of "Emotional Numbing"**

**David Schulberg**

Department of Psychology, The University of Montana

**Jennifer A. Waltz**

Department of Psychology, The University of Montana,

The symptoms and experiences of emotional avoidance, lack of emotional expressivity, or "emotional numbing" are central in descriptions of Post-traumatic Stress Disorder (PTSD). The current study builds on previous work on the statistical relationships between chaos, complexity, and information indices -- derived from near-instantaneous emotion ratings -- and measures of depression and anhedonia. It examines numbing in the context of momentary joystick ratings made by participants who were watching their partner in a videotaped discussion. Dynamic indices derived from these time series are related to measures of numbing both internal and external to the videotape rating procedure. The participants are approximately thirty female survivors of Child Sexual Abuse who participated in a study of couples relationships. The participants watched a split-screen image of their partner videotaped while self and partner were discussing a conflictual situation; they used a joystick to make ongoing ratings (ranging from negative to neutral to positive) of how they had been feeling during the taped session. The joystick procedure also allowed participants to report a lack of emotion or numbing. Complexity indices derived from the emotion ratings are related to measures of numbing from the joystick procedure and also correlated with more macroscopic self-report

measures of PTSD symptomatology in order to identify dynamic correlates of the experiences of emotional numbing, avoidance, or distancing.

**Is the Universe Winding Down, or Is It Just Us?  
A Philosophical and Mathematical Challenge to Entropy**  
**M. Spohn**  
Graduate School of International Studies, University of Denver

Entropy, the Second Law of Thermodynamics, points to the unfolding of time and events as being linear and irreversible. As far as we know, entropy will continue increasing, consistently and unidirectionally, until the universe is simply a uniform puddle of radiation. There are several potential challenges to its linearity and reversibility, however, from behavior of particles at the quantum level to human perception, by necessity the inventor of linearly-experienced time. Further, proof of the behavior of the law of entropy in physics is currently based on linear statistical probability. That is, while there is nothing in the basic laws of physics that suggests that a broken teacup cannot spontaneously reassemble and hop back up on a tabletop, the number of microscopic components making up the macroscopic system of the teacup make such a reassembly statistically unlikely. But this too is a mere linear reversal of a specific linear action. If one chooses to use analytical tools other than linear statistical probability, the rules change. This study challenges the notion of the linear and unidirectional process of entropy and, by extension, the linear and unidirectional experience of time.

**Universality And Scale Invariance: Organizing Principles That Transcend Disciplines**  
**H. Eugene Stanley**  
University Professor, Boston University

After a very short introduction to some of the more basic unanswered questions in the field of complex systems, we consider the problem of "rare events". At one time such rare events were considered "statistical outliers" because they did not conform to known probability distribution functions. Nowadays it is becoming widely appreciated that even extremely rare events may not be "outliers" but rather may conform to newly-uncovered empirical laws, such as the various power laws characterizing scale invariant phenomena. Further, these laws appear to be "universal" in the sense that they hold across a range of widely different phenomena, consistent with the intriguing possibility that these phenomena have some underlying features in common. We will illustrate this feature by discussing a few examples drawn from the social sciences, economics, and the physical sciences. For example, in economics, we have demonstrated a power law distribution of returns with exponent 3, outside the Levy-stable regime, which encompasses all economic fluctuations measured to date, including data taking place in times of market crashes. Another example concerns social networks, encompassing sexual networks. We especially focus on a number of topics in threat networks (Al Qaeda) and threatened networks (computer networks, and SARS-susceptible networks). We also discuss how interdisciplinary "social scientist/physical scientist" collaborations are beginning to gain theoretical insight and understanding of these new empirical laws using concepts drawn from both the social sciences and the physical sciences.



**Perception Studies of the Visual Complexity of Jackson Pollock's Dripped Fractals**

**Richard Taylor**  
Department of Physics, University of Oregon  
**Branka Spehar,**  
School of Psychology, University of New South Wales  
**Colin Clifford,**  
School of Psychology, Sydney University, Sydney, Australia  
**Ben Newell,**  
Department of Psychology, University College London, UK

Fractals have experienced considerable success in quantifying the complex structure exhibited by many natural patterns and have captured the imaginations of scientists and artists alike. Recently, we showed that the drip patterns of the American abstract painter Jackson Pollock are fractal. In this paper, we describe visual perception tests that investigate whether fractal images generated by mathematical, natural and human processes possess a common, fundamental aesthetic quality.

**Diversity, Compatibility and Sociability in EVS Modeling**  
**Irina Trofimova**  
Collective Intelligence Laboratory, McMaster University

Diversity, compatibility and sociability could be considered as global factors affecting the development of a system, as its interaction within the developmental stages defines the specific of these stages. Establishment of interactions between agents of a population on the basis of compatibility of their configurations is associated with a first order phase transition (in clustering behaviour), common in physical systems. Compatibility of interests in making a connection makes a phase transition from a population of small clusters to an all-unified population smooth. Absence of compatibility makes this transition sharp. Diversity of agents and an ensemble architecture of connections are beneficial for the survival of a natural system functioning in a changing environment, while unification is beneficial in stable conditions. Sociability is the major factor affecting clustering behaviour in a diverse population. Diversity and compatibility have ways to control sociability, and sociability has ways to control the diversity. Artificial holding of a connection instead of compatibility condition delays the phase transition in size of population and sociability conditions, but then makes the phase transition very sharp. Stickiness of agents decreases the possibility of a 1st order phase transition, but leads to a second order phase transition, common for biological systems.

**An Application of Network Dynamics to the Aggressive Recess Behaviors of Elementary School Boys**

**Keith Warren,**  
The Ohio State University College of Social Work, **Dawn Anderson-Butcher,**  
The Ohio State University College of Social Work, **Gheorghe Craciun,**  
The Ohio State University Department of Mathematics,

Most aggressive behaviors among elementary school boys occur during recess, however we have little understanding of the dynamics of the spread of aggressive behaviors. Watts derives a network model in which each individual undertakes an action depending on the percentage of the individuals with whom s/he is connected who have undertaken the action. We use this to model peer interaction driven by observational learning. Because the Watts model yields a distribution of numbers of actions per trial with a power law tail having a slope of  $-3/2$ , it is empirically testable. Aggressive behaviors

among boys were observed during the first and second halves of three successive recess periods on eighty-three school days. Log/log plots of number of behaviors and frequency of number for the two halves of the first recess period, that for first and second graders, and for the total of the second and third recess periods, those for the third and fourth and fifth and sixth graders, were constructed. All log/log plots showed power law tails having slopes within two standard errors of 3/2 (Slope = -1.58, SE = .18; Slope = -1.8, SE = .25; Slope = -1.3, SE = .17; Slope = -1.69; SE = .272). The power law tails imply the importance of keeping aggressive behaviors beneath the onset of the power law regime. The apparent applicability of the Watts network model suggests the possibility of exploiting network effects to block the spread of aggressive behaviors.

### **A Self-Reflexive, Holographic Nonlinear Dynamical Systems Process-Theory of Interactional Harmony and Discord**

**Ralph M. Waugh,**

School of Psychology, The Fielding Graduate Institute

Using systematic grounded theory methodology, analysis, and synthesis of text from 200+ peer-reviewed published, psychological secondary sources; this research focused upon what happens, moment-to-moment, during the unfolding of interactions in close, significant, well-established relationships. Results included a self-reflexive, holographic nonlinear dynamical systems process-theory of interactional harmony and discord. Initial conditions change instantaneously through interdependent intraindividual and dyadic state dynamic feedback processes. Multiple momentary iterations elicit continual self-organization of spontaneous emergences of co-constructed perceptions, expectations, cognitive-affective-psychophysiological processes, and dyadic system's behavioral trajectories.

### **The Chaotic Nature of Chaos Theory**

**Chad Webb,**

Department of Psychology, Pikeville College,

**Daniel Schnopp-Wyatt**

Psychology Department, Pikeville College,

From a qualitative standpoint, theories that led to a far-reaching paradigm shift had similar qualities. All had a causal barrier where understanding stopped and assumption began. This barrier served as the constant framework in which problems could be defined and later understood. The barrier served as a seed, a base, from which things were defined and understanding began. We suggest that this barrier is the edge of chaos. In science, as in theology, and in every other field of thought, an answer leads to more questions. Answers to individual questions effect the course of study as a whole. The pursuit of understanding is a self-referential feed-back phenomenon. The recursive pattern of previous paradigm shifts give indications of the future direction of chaos theory as it reshapes science. All major scientific advancements follow a pattern of chaotic turbulence giving rise to order before advancing into the next phase of chaotic disturbance. The question becomes the answer and the answers give rise to new questions. This is exemplified by the creation and elaboration of Newtonian physics, the central dogma of biology regarding DNA synthesis and reproduction, and the heliocentric theory of Copernicus. The chaotic nature of scientific endeavor resembles matter in a super-saturated solution. For structure to form the presence of a seed crystal or strange attractor - a causal barrier in the sciences - is

essential. We will present examples from the history of science and emphasize the evolution of chaos theory.

### **Solving Complex Problems Using Hierarchical Stacked Neural Networks Modeled on Cognitive Development**

**Myra Sturgeon White**

Department of Psychiatry, Harvard Medical School,

**Michael Lampion Commons,**

Department of Psychiatry, Harvard Medical School

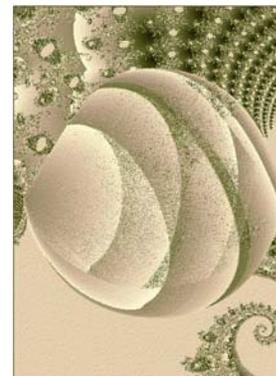
Neural networks have greatly improved our ability to model human behavior and solve complex problems. Their success lies in their ability to model neuronal function and organization within the brain. However, because we have not yet identified how combinations of neurons produce complicated behavioral sequences, neural networks are not able to fully mimic the brain's capacity to combine behaviors in novel ways to solve complex problems. As a result, they cannot solve complex problems that humans solve easily. Our work adds a new dimension by creating hierarchical stacked neural networks that model how humans acquire complex behavioral sequences. We present a blueprint for designing neural networks that incorporate Commons' Model of Hierarchical Complexity and thus, more closely parallel the behavioral learning process in humans with its capacities to flexibly solve and respond to complex problems. Commons' Model is based on research showing that cognitive development in humans proceeds through a series of ordered stages. Actions and tasks performed at increasingly higher stages are built on each preceding stage. Hierarchical stacked neural networks in our design parallel this process by being ordered in the same way as the developmental learning sequence outlined in Commons' model. The mathematical models used within each network in a stack are based on its developmental stage and not the logic of a task. Using our model, we have designed a system that directs incoming customers' calls to correct departments in a large organization based on customers' oral statements and responses to questions asked by the system.

### **Recurring Symbols and Patterns in Gift Exchange**

**George R. Williams**

Media Bureau, Federal Communication Commission,

A number of authors have suggested that gift exchange, distinct from ordinary monetary exchange or trade, promotes social bonding and coherence in a society. In this paper, we explore a number of symbols associated with gift exchange that recur across a number of cultures. The class of prominent symbols that recur suggest that gift exchange may be linked with fertility and rituals that link a community with the land.



**Investigating How a Wearable Computer Technology (Thinking Tags) Influences Opinion Dynamics**

**Susan Yoon**

University of Toronto,

**Eric Klopfer,**

Massachusetts Institute of Technology

**Earl Woodruff**

University of Toronto,

**Latika Nirula**

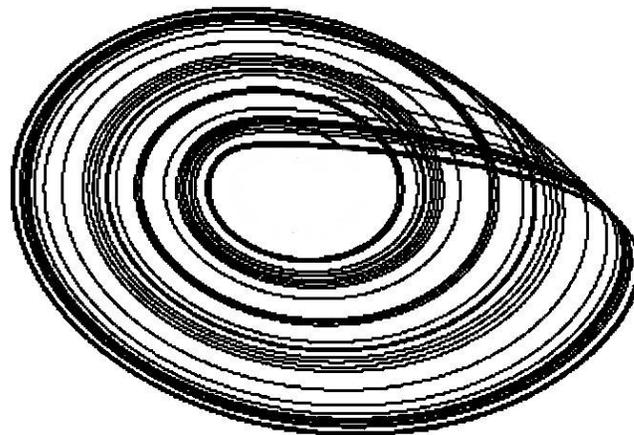
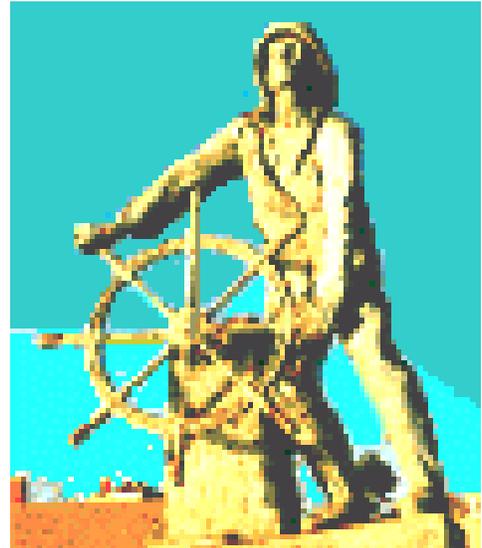
University of Toronto,

**Hal Scheintaub**

Governor Dummer Academy, Boston

Recent educational simulation and modeling tools have provided innovative opportunities for students and teachers to develop a complex systems understanding about how natural and social systems operate. In this interactive poster we report on a study aimed at investigating how the public display of first-person information mediates interactions between social and cognitive domains of learning. We specifically use a micro-computer technology developed at MIT called a "Thinking Tag" that communicates through infrared and can be programmed to represent various characteristics of the wearer. Our findings indicate that this technology has great potential as a tool for tracking the understanding that emerges as students learn about complex scientific issues. The feedback and

amplification of ideas reveal important decision-making processes (that normally remain hidden) in discursive classroom contexts. Participants in this session will be required to wear a "Thinking Tag", formulate an opinion on an issue based on the theme of this conference, and discuss their opinions with other participants.



**SOCIETY FOR CHAOS THEORY IN PSYCHOLOGY & LIFE SCIENCES**