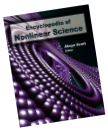
emerging

the newsletter of Plexus Institute

July/ August 2005

Adventures for the Intellectually Curious



The Encyclopedia of Nonlinear Science is densely packed with challenging ideas. With courage and humor, fearless reviewer Jeffrey Goldstein dials up his IQ and takes the plunge.

Click here or turn to Page 2.

Nature Speaks. Will Organizations Listen?

What do orangutans have to say about your manufacturing processes? What can a lotus reveal about marketing? Many corporations are listening. Gary Merrill and Michelle Merrill are serving as thoughtful translators.

Click here or turn to Page 6.

Lessons from the Deep

Dr. Ellen Prager will join us as a distinguished guest at the upcoming *On the Verge* conference. Take a peek into the beautiful, mysterious ocean world of this passionate advocate.

Click here or turn to Page 10.

Networks Across Disciplines

Complexity yields fascination in part because of the cross-application of its many insights. Few have practiced mastery of these applications with the depth of Dr. Larry Liebovitch.

Click here or turn to Page 16.

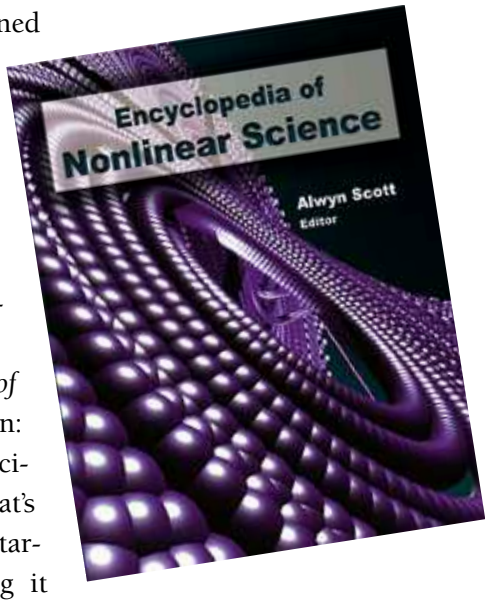
plus

Plexus Conferences! *On the Verge, Positive Deviance*
Meet our New Members • PlexusCalls • DC Area Fractal News

emerging: book review

Skyrmions, Anyone?

An ambitious new volume offers everything you never knew about skyrmions, solitons, and Toda Lattice. Just don't expect easy bedtime reading.



This very hefty, thousand page, double-columned encyclopedia covers such an abundance of mathematical and scientific material it should really be called *Every Known Nonlinear Equation that Could Possibly Ever Be Used in Mathematics and Science*! Indeed, its main strength lies exactly in this exhaustive, highly technical coverage of just about everything on nonlinearity that a mathematician and scientist would ever need.

This same feature also makes the *Encyclopedia of Nonlinear Science* (Ed. Alwyn Scott, NY and London: Routledge Taylor and Francis Group, 2005) a fascinating resource for the intellectually curious. That's why when I first received my copy, besides being startled by how surprisingly heavy it was (carrying it around the house can be used as a replacement for weight training), I spent two hours jumping from entry to entry. This was great fun but also a rather humbling experience as I came across many entries I not only found extremely difficult but hadn't even heard of! An example is "skyrmions" which I'll get to in a moment. By the way, the selection of entries was made by an international Board of Advisors who eventually got them down to 438. The contributors come from 30 different countries.

Professor Scott, the editor, has had an illustrious career at the University of Wisconsin, Los Alamos National Laboratory, the University of Arizona, and the Technical University of Denmark. Trained as a physicist and electrical engineer, he has conducted important research on, among many others, semi-conductors, superconductivity, and solitons. But it was on nonlinear dynamical systems theory (NDS), the parent of chaos theory, that Dr. Scott has focused dur-

ing the past twenty-five years. It was in this regard that Dr. Scott was chosen in 1981 as the founding director of the Center for Nonlinear Studies at Los Alamos, a center of intellectual ferment which went on to play a pivotal role in the burgeoning fields of chaos and later complexity theories. More recently, Dr. Scott has been actively involved in applying nonlinear dynamics to neuroscience and the blossoming field of consciousness studies.

In another of his publications, Dr. Scott (2005) points out that the term "nonlinear science" was used early on by the late physicist Joseph Ford in a letter to his colleagues where he was introducing his *Nonlinear Science Abstracts* (which later became the prestigious and authoritative forum for nonlinear studies in physics and mathematics, *Physica D: Nonlinear Phenomena*). According to Dr. Scott, the designation of "nonlinear science" as a particular field of study has applications across a great many specific domains. Yet study began taking place around 1970 when models in one field, e.g., population dynamics or planetary motion, were applied with insight to quite different fields, e.g., chemical dynamics and weather prediction. As a result of these cross-disciplinary efforts, research activities "began to be driven more by a general interest in nonlinear phenomena and less by specific applications."

"I recommend this book for the intellectually curious as long as they can handle being constantly humbled."

–Jeffrey Goldstein

As is evident in the *Encyclopedia of Nonlinear Science*, Dr. Scott and his colleagues have interpreted "nonlinear science" with a very wide-scope to mean any substantial work in mathematics and science where the use of nonlinear equations has been central. However, this broad definition of the field means that most entries will not be specifically relevant to any one person or group. There's no doubt that choosing the criteria by which entries are selected for a glossary or encyclopedia is an endeavor fraught with the risk of subjective bias or at least leanings in certain directions and not others. I ran into a much smaller version of this same problem in selecting the entries for my own "*A Nonlinear Dynamics and Complexity Glossary*" which I wrote for *Edgeware* (Zimmerman, Lindberg, and Plsek, 1998). Since Dr. Scott's background and leanings are more toward the nonlinear dynamical systems arena and less on complexity, this encyclopedia is definitely weak on complexity theory entries per se. Besides being few in number, the ones that do appear, for instance ones on cellular automata and artificial life, are for the most part rather skimpy.

Skyrmions, Solitons and Toda Lattice

As I mentioned above, *The Encyclopedia of Nonlinear Science* is chock-full of very technical, esoteric entries, although one can also find more accessible entries, many of which contain fascinating stories. For example, one of my

entry-hopping journeys through the book went as follows. I found an entry on "skyrmions" which grabbed my attention for two reasons. First, I had never heard of them and this intrigued me since I thought I was pretty well aware of most constructs in nonlinear science. Even if I didn't know them well at least I thought I would have heard of them. But this was not the case with skyrmions, as well as many others. Second, the suffix "-ion" suggested some sub-atomic particle which I am always eager to learn more about.

As it turned out, "skyrmions" were named after the physicist T. H. R. Skyrme who in 1961 had taken seriously the *nonlinear* terms in quantum field theory, and from a careful exploration of this nonlinearity, derived the existence of particle-like solutions to the field theory equations. Since that time, these "skyrmions" have been investigated in a great variety of ways, including topologically, and show behavior like solitons or energy conserving solitary waves. Then, following the "see also" suggestions at the end of this entry, I moved to the several entries on solitons (remember: Dr. Scott is a well-known expert on solitons) where I came across a fascinating account on the discovery of solitons. It seems that in 1834, a Scottish engineer, John Scott Russell was studying canal boats for the sake of figuring out how to best convert from horse power to steam and noticed a very strange phenomena. When the boat stopped suddenly, the water in the channel which had been put into motion by the boat did not stop but instead "accumulated around the prow of the vessel in a state of violent agitation...rolled forward with great velocity, assuming the form of a large solitary elevation, a rounded, smooth and well-defined heap of water, which continued its course along with the channel without change of form or diminution of speed". Russell followed the wave on horseback which kept its form until eventually traveling out to sea. He then went back to his office and wrote his observations and thus began the study of solitons. Indeed, that terrible force of nature that unfortunately none of us now will ever forget, the tsunami, is thought to be a type of soliton. Consequently the more light that is shed on tsunamis by nonlinear dynamics, hopefully, the greater will be our ability to predict these terrible events.

Following another of the "see also" entries at the end of the entry on types of solitons, I jumped to the one on "Toda Lattice," another supposedly nonlinear construct about which I never heard. It turns out that a Toda Lattice is technical in the extreme having to do with a host of recondite mathematical equations and constructs from mathematical physics including Lax representations, "Loop algebras," and "affine Lie algebras." Although not a few Nobel prizes in physics have involved the use of Lie algebras in regard to symmetries for the purpose of unifying elementary forces, I gather that for most of us complexity afficionados they will remain just curiosities.

The many entries like Toda Lattices though, lead to the big question: to whom should this encyclopedia be recommended? Because of its extremely technical nature, I'm not sure many people without a strong science background would find it helpful to have *The Encyclopedia of Nonlinear Science* on

their personal library shelves. Yet, I definitely would suggest it as a reference book for colleges, universities, and other research libraries in health care institutions and businesses. Having it there would provide a valuable resource for students and researchers as to which kinds of mathematical approaches might be relevant to the problems and research agendas on which they are working.

I also recommend the book for the intellectually curious as long as they can handle being constantly humbled. From my experience, I can reassure you that even if you can't get through a whole article, you can at least get a general idea about all sorts of interesting creatures in the nonlinear zoo. ■

By: Jeffrey Goldstein, PhD, Professor at the Adelphi University School of Business Garden City, NY

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Lessons from the Lilies

When Gary Merrill and Michelle Merrill look to biological systems, they find not only beauty, but insight. They're transforming those lessons into strategies for organizational change.

The lovely lotus flower, traditionally a symbol of purity, rises from muddy water in a dark, murky environment. It maintains its pristine beauty because of its structure, Gary Merrill explains, and it offers economic as well as spiritual inspiration.

"If you look very closely, it has the structure of very tiny sharp pin points, very closely packed together," he says. "So water droplets actually sit on top of the points, then roll away carrying any dirt with them, and the flower stays clean despite growing in a muddy habitat."

Recognition of that sharp prickly surface led an organization in Germany to design paint that has the same self-cleaning surface.

Plants like the water lily and the lotus have a surface texture that beads water and keeps them clean, even in muddy habitats.

"One of the ways to change our industrial story is through the lessons that can be learned by simulating biological systems," Mr. Merrill observes. "It refers to the idea that our biological systems show us the direction forward."

"We do a lot of simulations that actually illustrate what we know about biological systems, things that show

self-organization and how that works to create systems," Dr. Michele Merrill elaborates. "We invite people to explore, looking through the eyes of another species, to see evolutionary strategies, what adaptations have been made, and how these could apply to human design challenges and problems within human systems." It's an approach that has given birth to surprising realizations in unexpected places.

From Biological Systems to Organizational Systems

Gary Merrill, who is an organization and executive development consultant, has a masters degree in community and clinical psychology from the San Jose State University, and his niece, Michelle Merrill, who has a doctorate in biological anthropology and anatomy from Duke University, combine their creativity at Emergent Systems, in Santa Cruz, CA. Emergent Systems is devoted to sustainable changes in human activities through ecological understanding. Their workshop *Sim-Bio-Sys: Life as a Business Partner*, guides learners through such concepts as biodiversity, food webs, evolutionary strategies and biological networks, and elucidates the lessons they hold for human organizations, business and industry. Dr. Merrill has studied orangutans in the Sumatran rainforest, and has taught evolutionary biology, social networks and communications and she has a special interest in how creatures develop intelligence and innovation.

The orangutans that use tools most often belong to the most sociable orangutan population studied, in Suaq Balimbing on Sumatra.

"It is important to take complex notions from the emerging understanding of the biological and natural world and make them simple enough to be understood by non-scientists in the business world," Gary Merrill says. "The more we learn from each other, the more adaptive we are. When I work with organizations, I find we are too silo-ed—one department doesn't know what the other is doing, even when there is a common project or design. Organizations have become

overspecialized. We need to increase social networking, and natural systems can help illustrate that."

The Evolution of Learning

Michelle Merrill has studied the evolution of learning and the origins of technology and culture. She has found, for instance, when an innovation of tool use has diffused within a primate group, individuals in that group have a survival advantage. She has also found that the more technologically or culturally complex a primate group is, the more sociable its members are. But the benefits of cooperative relationships don't apply only to primates.

"We can look to other species, and we find symbiotic relationships, integrated ecosystems and social networking. Adaptation isn't just about competition. Cooperation is natural, and it is a huge component of how creatures adapt to their environments," she says. "Mutually beneficial relationships between species are how ecosystems function and survive."

Their goal is to change the way people think about the environment. It's not enough to avoid doing harm, or to try to make products less damaging. Examining nature, they say, offers inspiration for designs and products that are intrinsically more sustainable. They take some of their inspiration from the pioneering work of Janine Benyus, the author of Biomimicry, who describes biologists as translators of nature's design notes.

"Velcro is based on the burrs of a certain weed. Airplane design was inspired by attempting to mimic the natural flight of bats and birds. Swimsuits for racers have been designed with textures that copy shark skin."

Copying nature is not a new idea in industry. Mr. Merrill notes that the structure of Velcro is based on the burrs of a certain weed. Airplane design was inspired by attempting to mimic the natural flight of bats and birds. Dr. Merrill says commercially designed swimsuits for racers have been designed with textures that copy shark skin, because researchers discovered that particular texture reduces drag as the swimmer moves forward in the water. But greater understanding can produce more sophisticated adaptations.

An Urgent Challenge

"When you think about how any living organism makes whatever it makes, it has to do it at body temperature and in or adjacent to its body," Dr. Merrill observes. "So there can't be toxic components or byproducts. The way living organisms create things chemically—without raising temperatures, and nontoxically, that's what makes systems more sustainable."

Many industrial manufacturing processes depend on extreme temperatures, high pressures, and toxic components. If we look at how plants, animals

and other organisms build, she says, we can achieve some desired goals using less energy and producing less waste. These concepts have proven useful in agricultural innovation, information technology, construction materials and architecture, Gary Merrill says, and they have been profound in the manufacture of fabrics and dyes. For instance, he says, one Swiss textile company was close to closing because of its toxic waste production created by the commercial dye used in the manufacture of its products. Using materials that were chosen for their low toxicity, it was able to make a better product with materials that are environmentally friendly and waste that can be usefully composted. Fabrics manufactured with these non-toxic dyes are now being installed on a new Airbus.

We take our resources for granted, and have not yet seriously addressed energy conservation, Gary Merrill and Michelle Merrill agree. But both are optimistic that humans have the capacity to meet new challenges, and one of their satisfactions with their work comes when they see evidence of a changed frame of reference.

"When you look at an ecosystem, all that energy is coming free from the sun, and with energy that's free you can get a rainforest.

"We talk about what we can learn from natural systems," Dr. Merrill says. "When you look at an ecosystem, all that energy is coming free from the sun, and with energy that's free you can get a rainforest. The industrial revolution has been based on fossil fuel—petroleum and coal—energy that has been stored for a very long time. We are running out of those stockpiles. And as they diminish—it may take a couple of centuries, it may be only a couple of decades—we're going to have to start using current income that comes from the sun, and we'll have to decide how to capture that. "

Both believe the usually forgotten stakeholders can be engaged in a search for solutions. That means not just the designers, managers and shareholders in for-profit corporations, but the people who build, produce, and consume products and dispose of waste materials. In effect, everyone. A potent way of changing a frame of reference, they add, is serious play. All mammalian species play, in one way or another, and Emergent Systems instruction sessions and workshops in natural systems are put together with play in mind. And what, exactly is play? Some creatures have simpler rules than humans make, and lots of researchers and scholars have tried to define play and pin down its characteristics. "Whatever it is," Gary Merrill observes, "we all know it when we see it."

By: Prucia Buscell, Plexus Institute

Deep Learning

Author, teacher and activist Ellen Prager has an urgent message about one of the most beautiful and misunderstood places on Earth: The ocean.

Dr. Ellen Prager's fascination with the mystery and majesty of the ocean has led her on a journey of exploration from the bottom of the sea to the classroom to the airwaves and to the solitary task of putting her knowledge and passion in writing.

"We are connected to the ocean, we rely on it, and it helps us live on the planet," she says. Her message is straightforward and her mission enormous: she hopes to help people grasp the urgent need to understand, preserve and protect our ocean.

When she was a student at Wesleyan University, she took a semester off to study marine science in St. Croix, and got a dream job of working as a diver for

Off the island of Fiji, Dr. Prager encounters this rush hour traffic on her way to work.

an underwater research laboratory. "Teams of scientists lived undersea, and I was their underwater 'gofer'," she recalls. "It was great. Not only did I really hone my diving skills, but I learned about marine science and had the opportunity to network with scientists."

Dr. Prager was already a skilled diver. As a teenager life-guard and swimming instructor, she was captivated when someone brought scuba equipment to the pool. Her parents told her she could take lessons as long as she paid for them. She did, was soon a certified scuba diver, and diving has been invaluable to her career as a marine scientist. Dr. Prager earned a master's degree from the University of Miami's Rosenstiel School of Marine and Atmospheric Science, where she later served as an assistant dean and is now an adjunct professor, and earned her doctorate from Louisiana State University in 1992. She has participated in research expeditions to such exotic places as the Galapagos Islands, Papua New Guinea, the Caribbean, the Bahamas, and the deep waters of the Florida Reef tract.

> "We really don't know what a shark spends its day doing."
>
> –Dr. Ellen Prager

An Unexplored World

With her book, *The Oceans*, which includes a forward written by famous ocean explorer Sylvia Earle, Dr. Prager combines her talents as researcher, explorer, student, teacher and advocate to share a love for the sea and its nearly unfathomable importance to all life. While the ocean covers nearly three quarters of the earth, only five percent of it has been explored. "There is a lot down there we have never even seen, let alone understood, "she observes." Even for the creatures we see, we see them for such short periods of time we know little of their behavior. For example, we really don't know what a shark spends its days doing."

Scientists are discovering new organisms, and new things about known creatures. Surprisingly, they are finding more and more marine creatures that can produce light, a phenomenon ancient mariners considered magical or hallucinatory. Bioluminescence, the production of cold light through biological processes, is not totally understood, she notes in her book, but it has some interesting and ingenious uses. It may have the dual function of frightening potential predators and luring prey. The squid, Dr. Prager says, is a wonderfully complex example. It not only produces light, it can control the color and intensity of its light. And it can produce light that exactly matches the levels of light in the environment, an exceptional asset for camouflage.

Have you ever wondered why so many fish have light underbellies, silver sides and dark coloration on top? Divers know. "If you are in the ocean and you look up, the sky is very bright, so anything with a bright underbelly is hard to see. If you look into the water from above the surface, anything with a dark top is hard to see," she says. "That coloration pattern is extremely common for

creatures that live in the top portion of the water where light is an issue. It's so simple and so brilliant."

Vanishing Resources

Dr. Prager is especially impressed with the tuna. As she explains in her book, humans have tried to replicate its perfect hydrodynamic shape in submarines and torpedoes. Researchers have found migrating tuna can swim more than 6,200 miles from Norway to the Bahamas in 50 days, suggesting a circulatory system and muscle structure beyond the dreams of human athletes.

"It makes you think differently about eating tuna," she observes. "In the long run, there will be some species of fish we cannot continue to commercially hunt, and tuna is probably one of them unless we can find a good way to farm them. We haven't been able to do that yet, because they are very big (some weigh more than 1,400 pounds) and they need to swim constantly and over long distances."

Scientists wondered why the Maine lobster population was burgeoning. It turned out the cod that used to eat the juvenile lobsters have nearly disappeared.

Sea bass and swordfish have also been over-fished, and the population of cod has collapsed in some areas. Dr. Prager tries to limit her seafood consumption to fish such as tilapia that can be caught or farmed in an ecologically friendly way.

The Aquarius station. Dr. Prager arrives for work.

"Do we really think that as human populations grow, and we want to eat more and more fish, that we will be able to hunt more fish?" she asks. "If we use hunting land populations as an analogy, the answer is no. Are there any wild populations we hunt commercially on land? No."

Dr. Prager reports in her book that within the US alone, more than 80 percent of the 191 commercial fish stocks are fully exploited or overfished. Fishing, by itself, isn't harmful. The problem is environmentally destructive methods, and fishing in numbers the ocean can't sustain.

Changes in the marine environment often bring unexpected results. For example, Dr. Prager says scientists wondered why the Maine lobster population was burgeoning. It turned out the cod that used to eat the juvenile lobsters have nearly disappeared. "The question is what is the next step?" Dr. Prager asks. "What will lobsters prey upon, and can they sustain a huge population? The really important question is how has human activity altered the ecosystems in the ocean, and what will happen in the future?"

What we put in the water is as important as what we take out. In addition to polluted water runoff, substances from the atmosphere, global warming and ozone depletion, are causing change. We are now seeing an increase in harmful algae blooms and the invasion of non-native species in our oceans, and while the reasons are complex, human activities surely play a role.

Dr. Ellen Prager in the moon pool of the aquarius undersea research station, 1998

"We have dramatically altered the ocean's web of life, and a once bountiful sea has turned to troubled waters," Dr. Prager writes.

Many questions of resilience and natural and man-made influences remain unanswered. Take coral reefs, the massive and growing framework of undersea rock that is home to an exceptionally diverse and beautiful community of marine creatures. Reefs

change over time, with the impact of environmental pressures. "But the concern now is that they are becoming less resilient because of the impact of humans—climate change, pollution, over-fishing, excess nutrients, sediments—combined with natural stresses and the question becomes can coral reefs adapt over time and if not, what will happen?"

The condition of coral reefs, which is one indicator of ocean health, varies around the world. Severe degradation has occurred where dynamite and bleach have been used to capture fish. Dr. Prager notes more research is needed to better understand how reefs change, grow and die over time. But the consequences of destruction can be stunning. Coral reefs have a role in tsunamis, and damaged reefs may have exacerbated the death and devastation that struck Southeast Asia last Christmas. "Coral reefs influence wave dynamics in several ways," Dr. Prager explains. "The reefs can cause waves to break further offshore, and it's when they break that they dissipate their energy. Where a healthy coral reef exists, wave energy might have been partially dissipated before the surge of water reached the shore. Further, the mangroves that served as a buffer to inland areas and helped the shoreline from eroding, also had been cut down in many areas."

Coral reefs have a role in tsunamis, and damaged reefs may have exacerbated the death and devastation that struck Southeast Asia last Christmas.

People around the world need to protect coastal environments from degradation and harmful development.

"Most people understand now that you can't dump garbage and untreated sewage into the ocean—although there are island nations and undeveloped countries that are still doing that—but now, even now, when it rains many of our municipal facilities if they are facing overload, release treated and untreated sewage into the ocean," she says. "Storm water runoff is one of the biggest pollution issues today. All the pollution on our land, from roads, parking lots, fertilized lawns, runs into the ocean. We have moved away from many of the problems associated with point source discharges, but now we have a more difficult problem to control, non-point source pollution. It's hard to get people to understand that they shouldn't dump oil in their driveways or use too much fertilizer on their lawns."

The National Oceanic and Atmospheric Administration budget was recently slated for cuts by the House on the order of $149 million, despite urgent need for ocean research and improved management, which impacts human health and water supplies, climate, medicine and global and regional economies.

"It seems we are going backwards instead of forward, and the general public doesn't understand that their political representatives are not investing in our own planet," she says. "It's just shameful, the lack of money we are spending on our own planet. We spent $17 billion a year just for human space flight.

And yet each year, we're spending only $600 million for ocean science, technology and education. I support space exploration, but the magnitude of the difference, between what we are spending on space and the preservation, understanding and protection of our own ocean, is truly unbelievable."

Climate change can alter the amount of water cycled into the air, land and sea, and many scientists have predicted dangerously diminishing supplies of clean drinking water.

"We will see more and more fresh water from seawater as desalinization plants develop with improved technology," Dr. Prager says. "There are large desalinization plants around the world now, and the process is becoming less expensive. Big ships have desalinization on board now. But one issue is, what will we do with the concentrated brine that is produced? If you dump it into the ocean, what will that do? "

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Spreading the Word

Dr. Prager believes scientists haven't effectively communicated the relevance of the ocean to our every day lives and our very survival. *The Oceans* helps correct that. Its fact-filled pages are a wonderful primer on the sea, from its ancient origins to the present day to its uncertain future. Dr. Prager conveys her extensive knowledge with graceful, lively description and genuine awe. Jean Michel Cousteau calls her book a "must have". Dr. Prager has written for scientific journals and poplar publications. Her earlier books include *Furious Earth: The Science* and *Nature of Earthquakes, Volcanoes and Tsunamis*, and a series of children's books, written with the National Geographic Society, *Sand, Volcano* and *Earthquake*. She has explained marine science as a guest on several network TV shows, and appeared in Discovery Channel productions. In addition, she helped write the 2004 report of the U.S. Commission on Ocean policy, available at http://www.oceancommission.gov.

Her book for 8 to 12 year olds, *Adventure on Dolphin Island,* is due this summer. She hopes the mix of real science and an entertaining story will foster children's love and respect for the ocean.

Dr. Prager's scholarship is continually evolving, and she is endlessly intrigued by marine creatures and their extraordinary survival strategies. Personal favorites, she says, are pteropods, or "sea butterflies" that use a sticky net of mucus to collect food particles from the water. "The human analogy," she says, chuckling as she savors the image, "would be a person who blows a huge bubble gum bubble in a room full of insects and then slurps it all in." ■

By:Prucia Buscell, Plexus Institute

The Networked Universe

From fluid dynamics in astronomy, to the human eye, to disease control and beyond, one scientist is finding important commonalities in a universe of networks.

Larry Liebovitch has the sort of intellectual inclinations that demand challenge and experimentation. Astronomy was challenging, but astronomers can't move stars and planets around and they can't examine them at close range. So he turned his attention to a subject that is infinitely smaller but still imbued with compelling universal interest: the human eye.

"My special area in astronomy was fluid dynamics. I had studied how the stars and hydrogen gas moved in galaxies, and I was looking for jobs where my knowledge of fluids would be useful," he recalls. "I connected with a group studying fluids in the eye. I studied how fluids in the center of the eye wind up in the cornea, and how the cornea moves sodium and potassium. That creates an osmotic flow of water to keep the cornea dry and transparent.

"I wound up in one lab, then another, and then I began doing mathematical measurements of water movements through corneas. Those movements are driven by the movement of ions like sodium and potassium and chloride, and they are similar to what happens in other parts of the body, such as the kidney."

Dr. Larry Liebovitch

Dr. Lebovitch studied how sodium, potassium and chloride ions move through proteins called ion channels in the cell membranes, and he realized he was seeing fractals. That new vision would lead him to new discoveries and a new direction in scholarship.

Dr. Liebovitch earned a bachelor's degree in physics at City College of New

York, a doctorate in astronomy from Harvard. He was a Postdoctoral Fellow at Mt. Sinai School of Medicine in New York, and then served as assistant professor at the College of Physicians and Surgeons of Columbia University.

When he saw fractals in cells in his laboratory, he recalls, he immediately bought himself a new copy of the book by Benoit Mandelbrot, the famous inventor of fractal geometry. Mandelbrot had described the coast of England as a fractal, because on closer and closer examination, he kept seeing the same kind of irregularities. Fractal structures self-replicate across different scales. The structure of tree branches, for instance, is fractal because the successively smaller branches at the top of tree successfully replicate the patterns of larger low branches.

"I realized I could apply Mandelbrot's mathematical ideas to study ion channels, and then I began applying them to more complex ideas in biology," Dr. Liebovitch says. "Others heard about what I was doing, and they would come to me about other problems they had in biology, usually about systems that had separate pieces. They asked help analyzing questions related to a number of things, things like breathing, for instance."

People always looked at the brain in terms of anatomy. Scott's Kelso's central theme was to look at the brain in terms of dynamical *patterns*.

For several years, Dr. Liebovitch has used complex systems, including fractals, chaos, and neural networks to study molecular, cellular, physiological and psychological systems.

"I specialize in systems that have a lot of pieces that interact with each other," he explains. Dr. Liebovitch is now the interim director of the Center for Complex Systems and Brain Sciences at Florida Atlantic University, where he also has appointments in the Departments of Psychology and Biomedical Science and the Center for Molecular Biology and Biotechnology. At the moment he is working on three projects that involve networks.

One is an investigation of how genes regulate other genes, and how that network of interactions manifests itself in the changes that happen when people have heart disease. He is doing that study in conjunction with former students and colleagues at FAU and the University of Miami. Another project is a study with people at the US Naval Laboratory and others on how diseases such as measles spread from one geographic area to another, and how population densities in urban, suburban and rural settings influence the spread.

In addition, he is working with a group of researchers in Syracuse who are investigating the properties of a single celled organism. "This cell has two cilia, or oars, that it can't swim without, " he says. "They are trying to reverse engineer this little bug. They can set up measurements and try to understand when light comes in, what are the biochemical pathways that change. We want to understand all the ways this little thing works."

Connections to Scott Kelso

At FAU, Dr. Lebovitch just finished working on the Center's courses for next spring. He is trying to craft closer cooperation among scholars and researchers in medical science, psychology, and engineering, and get the Center to interact more fully with people at other research institutions who are investigating things related to how the brain works.

The Center celebrates its 20th anniversary this year. It was founded in 1985 by neuroscientist Dr. J.A. Scott Kelso, whose background originally was in sports and physiology, motor control and motor coordination. Dr. Kelso was influenced by the ideas of Dr. Hermann Haken, who had profound insights about self-organization in complex systems. Dr. Kelso realized those ideas could be applied to biological systems. He began the Center with the idea of gathering a group of scientists who could work together using sophisticated concepts in physics, engineering, math, biology and psychology to look at self-organizing systems. "People had looked at the brain in terms of anatomy, in terms of electrical signals," Dr. Lebovitch observes, "and Scott's central theme was to look at the brain in terms of dynamical patterns." That was a major contribution, he says, because it emphasized the concept that the dynamics of a system, in the brain or anything else, is something that can be studied and that it is vital to understanding how a system works.

Dr. Liebovitch and colleagues have come up with unexpected findings in their study of the timing of heart attacks: The pattern was fractal.

The Center's accomplishments have been innovative and substantial. "We helped train a generation of scientists who are comfortable with biology and math, and who can link the two together," Dr. Liebovitch says. "We hope that as they filter through the scientific community they will set new approaches to many areas. The idea is to gather people who not only work in teams with their separate skills, but people who have multiple skills themselves, which in itself brings a new way of looking at the world."

Surprising Applications

The concept of dynamical patterns has already had important ramifications in several areas of research into complex systems. Dr. Liebovitch and colleagues in collaboration with Dr. Mark Wood at the Medical College of Virginia have come up with unexpected findings in their study of the timing of heart attacks. They looked at a group of patients with heart disease who had implanted defibrillators, which are tiny computers placed under their skin in their chest with wires snaked to their hearts. When the heart began to beat in an unhealthy way, the normal rhythm could be restored by a shock to the heart. With two years of data, they analyzed the time between the episodes of irregu-

larity that triggered the shocks. The length of time between the triggers might be minutes or months, but surprisingly, the pattern was fractal—that is, as events became more frequent, the times between them became increasingly and successively shorter.

"We are doing a follow up study to see if we can use that information in a different way to monitor the success of therapies," he explains. "We don't have a definitive answer yet. But what is important is that you don't have an average time between events. The single most used statistic in science is the mean, and fractals don't have a mean value. There is no average for time between these events just as there is no average for the size of the branches of a tree. With the tree, you can only ask how many new branches there will be in smaller and smaller sizes, which is described by the fractal dimension. The fractal dimension has deep importance for how we handle all kinds of data."

The single most used statistic in science is the mean, and fractals don't have a mean value. There is no average for time between these events just as there is no average for the size of the branches of a tree.

Income is a good example of data where the real distribution is fractal and an arithmetic average is misleading: Averaging the income of Bill Gates and a sales clerk doesn't produce a meaningful figure. An economist using the fractal dimension, Dr. Liebovitch says, could ask different questions, going down the income scale by factors of 10, and identifying in each group how many people have each income and how fast the income rate is changing. Dr. Liebovitch says there is even research to suggest that people's emotions, tracked over time, have fractal properties. In one experiment, research subjects watched a video and were asked to record their feelings with a stylus on a digitizing pad, where the top represented happy, and the bottom sad. When subjects are asked to rate their feelings numerically, say from 1 to 5, dynamic qualities are eliminated. When they used the stylus on the pad, the up and down movements were fractal.

Dr. Liebovitch discovered another mathematical surprise during a study of e-mail viruses.

The Internet has grown so big that it is basically more biological than electronic, he observes. "It's like a living thing put together from different pieces," he says. "People don't even have a map of what it is out there, and there are studies, called Internet tomography to find out."

One way of probing the structure of the Internet, he says, was to look at arrival times of Internet viruses at an Internet Provider node in the UK.

"We thought these viruses were coming from different computers, so we did not think they would come together. In fact, we found a fractal correlation in arrival times," Dr. Liebovitch says. He and colleagues created a mathematical model of the structure of the Internet, and the pattern of e-mail virus arrival

times showed a correlation between the fractal structure of the Internet and the fractal timing of arrival of messages along its pathways.

He found that project engaging, he says, "because you had to sit down with a blank piece of paper and figure out what the model was going to be. It's a lot harder and more fun than having a complicated model and adding bells and whistles at the end."

A Shift in Thinking

Despite the enjoyment he derives from applying his own skill and creativity to difficult and esoteric challenges, Dr. Liebovitch believes the most exciting expectation for complexity science is not specific research results, but changes in attitudes. "We have to deal with many complicated systems, and it may take a multidisciplinary approach to do it," he says. "In biology, we have torn things apart and tried to study the dead parts. Using the methods of complexity we have to understand interactions. And we have to study things in their working environment, and we have to understand context. That's the philosophical background."

In biology, we have torn things apart and tried to study the dead parts. Using the methods of complexity we have to understand interactions. And we have to study things in their working environment, and we have to understand context.

The National Institutes of Health Roadmap, which is designed to look at complicated medical systems from a multidisciplinary view, is one example of the philosophical change at work. The new approach involves evaluation of the social, psychological, environmental and economic context in which a medical condition arises and is treated. That will lead to new understandings. But perhaps, Dr. Liebovitch suggests, the biggest success for complexity would be if people begin to understand it so well that it no longer needs to be viewed as a separate entity.

"People say there are no good examples of artificial intelligence any more, because as soon as some example works, it becomes part of the engineering culture and doesn't count as AI any more," he says by way of example. "Artificial neural nets are connected to phone systems, menus move you to somewhere else, it's all become so common place it doesn't seem like first line science any more. Once complexity becomes really well understood, it won't seem so unusual any more." ■

By: Prucia Buscell, Plexus Institute

Meet our New Members

A new group of fascinating and talented people has joined our journey. Take a moment to meet them!

Anne Wilson

I started my career in emergency room nursing. After two years with the Peace Corps in Ecuador I shifted attention to global health where I have remained. More than at any other time in history we have the resources in our hands to address some of the most intractable health issues on the planet. Complexity offers a set of creative tools that can move us forward both in building effective alliances and articulating a vision that mobilizes diverse communities to action. I am currently focusing on human capacity building issues and how to reframe the work environment to more closely align with 21st century demands – how to sustain productivity and avoid burnout. I also teach meditation and yoga and spend as much time in wilderness as possible. I was attracted to Plexus because it seems to be a magnet for creative people. A respected colleague suggested Plexus as a good place to find innovative thinkers who are also able to keep a sense of humor.

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Dale Guenter

I'm a bit obsessed with finding explanations for how things work, and it's not really limited to any one particular thing. I tended to pull apart all sorts of appliances and toys and things when I was a kid, always had to know what was going on inside. Science was the most obvious direction entering university, but history was a very close second. Religion and social systems and organizations have all been playgrounds at different times. Now, I ski and hike with my partner, fly airplanes and gliders, work as a family physician, walk my dog, administrate and teach and do research.

When a dear friend of mine who had been introduced to complexity a few years back started forwarding things my way, I had a sense of finding "home". My major professional focus is prevention and care of HIV disease, a human malfunction that I dread, but also love dearly for what it has to teach us about biology, immunology, social systems, ethics, human behaviour, activism, equality, empathy, spirituality and death. Few phenomena have changed our lives as much. With my first introductions to complexity, I thought, "hey, this is the framework for what I have been working on."

My introduction to Plexus Institute was at the HIV conference it hosted in 2004...a really mind-opening experience. I came away again feeling like there was room here for me to stretch, and that once and for all I didn't have to feel remorse that I couldn't quite find the right pigeon hole to make a nest in. But I also came away feeling like Complexity Science was a bit of an umbrella for a whole lot of things I had warmed to previously, like medical anthropology, abundance leadership, creative tension and mysticism. There were also a number of things I was not as familiar with, like chaos, deviance, patterns and waves and emergence.

I've decided to think of "Complexity Sciences", in the plural. It just helps me to work less hard to peg a tight definition. Complexity Sciences, then, give me a family of principles around which to rethink some of my most cherished questions: how do organizations work best for those who are in them; how can therapeutic relationships be most helpful; how can HIV disease be prevented, or cured? These newfound principles have already had an impact, largely in the way I function in my professional organization. I spend a lot more time looking for patterns that already exist, looking for ways to "tune" these patterns, sitting in the background and waiting to see what happens. The same has happened in my therapeutic relationships with patients. Next, I'm eager to get a social medicine research project designed on complexity principles.

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Henry Senko & Marilyn Herasymowych

We have spent the last five years developing techniques and ideas that we think will work well for people to think and act in ways that is pays attention to the complexity that people in organizations face. For example, we tried to use Peter Senge's concept and technique of doing systems thinking with no success. We then thought about systems thinking using the principles of complex adaptive systems and were able to develop a unique approach to

systems thinking that works extremely well in dealing with complexity and complex and intractable problems. We have written guides for each of the concepts and techniques that we have discovered and modified to use the principles of complex adaptive systems including action learning, reflexive practice and strategic practice. This guides work on the principle that, as humans, we work in conversation, and the recognition of patterns developed from these conversations. Our guides act as devices to help generate conversation and recognize different patterns in the situation.

We develop these courses and Guides in concert with a number of client organizations that let us test the concept, technique and approach for ability for people to use them in real time, ability to produce desired results as well as emergent properties, and ability to produce sustainable ways of thinking and acting within complex situations and difficulties.

Currently we are delivering a *Leadership Through Learning Program* based on these concepts and techniques and our unique approach to these to many clients, including the school system in Texas. We are also developing online support materials for all of our courses and guides to support others to be able to use this work in their own situations, either as facilitators or consultants or leaders. The Leadership Through Learning Program has also become accredited towards a BSc and MSc, and we are in the process of becoming the *MHA Institute,* offering courses, programs, and supporting people world-wide to use these ideas based in useful techniques and concepts that are also modified to fit the principles of complex adaptive systems.

Both of us are science oriented and became interested in Complexity Theory when we read Mitchell Waldrop's book *Complexity*. We learned about action learning in 1996 and noticed that it was one of the most effective techniques that we seen, and started to make connections to the principles of Complexity Theory, and more specifically complex adaptive systems. This led us to consider using a different approach for systems thinking using action learning as the process and our approach to systems thinking as the way in which to think about complexity. We had so much success with our approach to systems thinking, which was based in the principles of complex adaptive systems that it drove us to explore more in the field, and we haven't stopped yet.

Someone sent us an e-mail and since we were already reading and applying principles of complex adaptive systems it was easy to want to become a Plexus member. There was no other organization that we knew of that was focused on Complexity, so we joined and have received a lot of information that has been really useful to us.

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Page Morahan

I'm a microbiologist turned leadership and career developer for scientists and faculty — particularly those in academic medicine and dentistry. I have a particular interest in advancing women and minorities (www.drexelmed.edu/elam) and counteracting our exploitation of the world through working with wonderful faculty in developing countries to enhance their medical education and leadership expertise (www.faimer.org).

After two decades of microbiology research and chairmanship of a medical school microbiology department, I became fascinated with: (1) how we can teach medical students more effectively, and (2) how faculty members develop and change. So...I moved into curriculum change and into leadership development, which led me into studying change systems, which led me to strengths-based, high engagement, inclusive change processes. In this journey of almost two decades, I've explored future search methodology, appreciative inquiry, appreciative leadership, positive deviance, communities of practice, small group dynamics, continuous quality improvement, along with a whole host of smaller methods. (I was the first medical school faculty member to use flip charts to make everything visible to everyone in the room in a small meeting!) My current approach is to embed these methods and philosophies in our leadership programs, and show participants that they can use them in most any setting, be it improving teaching by increased engagement of students; to leading their groups of faculty, students and staff; to full scale organizational change brought on by curriculum change.

Complex adaptive systems interest me because of their centrality to much of our personal and organizational world - where we only have the "illusion of control." I like to view the world and our organizations as a holistic dynamic interplay between three arenas: *Seeing* (leadership/vision), *Doing* (management/implementation), and *Being* (appreciative leadership, emotional intelligence, complex adaptive systems, etc.)

I thank my colleague, Stewart Mennin, for prompting me to join Plexus. I had kept up with much of the area from other avenues, and am glad to be involved in an organization focused on complexity.

And in my spare time, I live in a 100+ year old barn converted to an art studio in the 1920's and create paper art, primarily photographs and greeting cards. I will have my first show at our co-op art and craft gallery, Orchard Artworks in October! (www.orchardartworks.org and www.bahvartwalk.org).

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Roberto Saco

I'm always multi-tasking due to a diversity of interests. My day job for a couple of decades has been in the financial services industry where I focused on quality management and strategic planning. And I was truly, madly, deeply involved in the US National Quality Program for many, many years. I'm also doing graduate work on change management at Templeton College (Oxford) and at the HEC Graduate School of Business (Paris). My work revolves around the notion of the "Good Company" and approaches like Positive Deviance and Appreciative Inquiry to bring out the best in organizations.

I turned to complexity through early work in process management and systems thinking. These are all ways of living with and within change...first you start with linear processes, then add feedback loops, and then the feedback becomes feedforward, and then you have unintended consequences and you enter the realm of complexity. I became interested in complexity in the early 1990's, attended the multidisciplinary Santa Fe Institute conference in 1995 where Stuart Kaufmann, Brian Arthur and others blew us all away with fantastic insights, and recently became interested in the topic again through my study at Templeton where Richard Pascale is an Associate Fellow.

I've known about Plexus for a while...two or three years maybe. The Positive Deviance (PD) workshop in Boston was the immediate motivation to become a member. I think Plexus approaches complexity mostly through the Health Sciences (just like PD), which is not my field of expertise...but I'm inclined to look at things through various lenses and am attracted to metaphor and analogy for a better understanding. And besides Plexus is accepting enough of positive deviants!!

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Announcing the Fall Meetings of

The DC Plexus Fractal

Please feel free to pass this invitation along to any in your network who would like to join us!

Thursday, September 8

Foray into the Whole Brain:
An Adventure at the Creative Edges of Consciousness

with Win Wenger, Ph.D., Founder and Director of Project Renaissance www.win-wenger.com

This is a session sponsored by one of our "sister" organizations, The Capitol Creativity Network. Plexus members are welcome and there is a fee of $10 at the door.

In this session, we will explore an aspect of the roles of the conscious and beyond-conscious minds in creativity and understanding. Encounter hands-on both a very ancient and brand new method, invented just this year. "Sidebands" is a phenomenon everyone involved with creativity needs to know about. You will be introduced to an easy way to access more of the natural creative wellspring that already exists within you. Come experience this unique method, created by Dr. Wenger, using your brain in real time. Win Wenger, Ph.D., is a pioneer in the fields of creative method, accelerated learning, and brain and mind development. An educational psychologist, physicist and inventor, Dr. Wenger is renowned for his research and training programs around the world, and is the author of 48 published books. His most well known work on improving intelligence, The Einstein Factor, is co-authored with Richard Poe and his latest CD series release, The Genius Code, co- designed with Paul Scheele, is becoming equally as popular for helping to access and use the astounding brain potential we have waiting to be tapped. His work appears frequently in Success Magazine and countless other publications. He founded Project

Renaissance, a unique non-profit organization dedicated to increasing individuals' potential and accelerating the dawning of a new Renaissance. Through this organization, he is in the process of establishing Renaissance University with the same focus. Every year Win organizes a conference that attracts people from around the world, followed by a week of certification training in his original techniques.

Thursday, October 6

The Power and Promise of Social Network Analysis

With David Intracaso, Ph.D. Evaluation Officer, Agency for Healthcare Research & Quality, US Public Health Service, Department of Health and Human Services

Social network analysis [SNA] is the mapping and measuring of relationships and flows between people, groups, organizations, animals, computers or other information/knowledge processing entities. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of human relationships. David will share how he has been using network analysis methodologies in his AHRQ evaluation work. Beyond using Social Network Analysis for 4-5 projects at AHRQ, David is contributing to the "New Directions For Evaluation" monograph re: SNA, doing a piece for a fall FedTech Magazine and sharing ideas about SNA with other Federal agencies.

Thursday, November 3

Economics in a World of Emerging Economies

With Marsha McGraw Olive, Senior Knowledge and Learning Officer for the ECA Region, World Bank

Marsha has twenty years of experience managing economic and institutional development programs at the World Bank, UN Food and Agriculture Organization and a private foundation. She has extensive regional field experience in Africa and Europe and Central Asia with experience in country program management, institutional development and political economy of reform. She was previously Senior Vice President of the Eurasia Foundation, Washington, DC where she directed a decentralized grant-making program in the former Soviet Union

Thursday, December 1

Leveraging Knowledge Management for Strategic Change

With Tojo Thatchenkery, Ph.D., Associate Professor, Organizational Development and Knowledge Management, George Mason School of Public Policy, http://policy.gmu.edu/faculty/thatchenkery/

Tojo is the author of a new book, *Appreciative Sharing for Knowledge: Leveraging Knowledge Management for Strategic Change*. You have heard them all: Second generation KM, the new knowledge management, knowledge garden, knowledge harvesting, communities of practice, narrative management, knowledge sharing, storytelling, knowledge ecology, data mining, and groupware. The list is endless, yet you wonder what knowledge management is anyway? Haven't I been doing this all along? Do I really need this? Isn't knowledge management kind of an oxymoron in a nonlinear world? Come participate in a conversation with one of the most creative thinkers in the field!

Meeting Details:

- DC Plexus Fractal Meetings will be held this fall in the Social Room at: Van Ness East/ 2939 Van Ness Street / NW DC 20008

- Join us at 6:30pm for networking (bring your own snack) .. The program will start at 7pm.

- Take the Red Line to Van Ness/UDC Station, go to Van Ness St and walk 2 blocks East to the Van Ness East building. The nice folks at the desk will direct you to the Social Room, where we meet.

- FREE Parking (park in a visitor space and register your car at the desk where they will 'valet park' it) ■

Emerging Conferences

Plexus Conferences inspire and challenge as they connect a community of like-minded learners. Haven't experienced one yet? Now is a perfect opportunity!

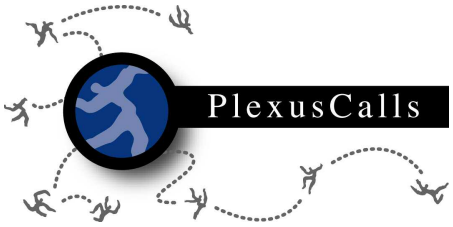
On the Verge: *Changing Lives, Organizations and Minds—Complexity Science in a Changing World*

September 11-13, 2005 at the Delray Beach Marriott, Delray Beach, Florida.

In nature, a verge is where different ecosystems intersect, a place where abundant diversity and interactions yield the energy for evolutionary potential and change. The session in Florida will bring together original thinkers and practitioners in diverse fields whose ideas can plant the seeds of positive transformations. Visit the website for this exciting event, sponsored by Plexus Institute, The Florida Atlantic University Center for Complex Systems and Brain Sciences, and the Florida Medical Association, and learn about the programs and presentations. Join the session, and you will meet such creative scientists and scholars as Larry Liebovitch, Ellen Prager, and Gary Merrill and Michelle Merrill. Register today!

From the Insure Out: *Uncovering Solutions to Intractable Problems through Positive Deviance*

November 3-4 , 2005 at the Metro-Central YMCA, Toronto, Canada. Sponsored by Plexus Institute and Leading Edge Seminars, with a special pre-conference *Introduction to Complexity Science: Implications for Organizations, Communities and Leadership*, November 2, 2005. Visit the conference website and register to learn about this provocative and innovative new approach to social and behavioral change, and hear from the people who have used it to address some very difficult social issues. ■



PlexusCalls Summer-Fall 2005

Bringing People Together in Conversation

If you would like to listen to these provocative conversations:

- Dial (641) 594-7500
- Enter the access code 85392, followed by "#"

PlexusCalls are scheduled for Fridays from 1 PM to 2 PM Eastern Time. Please check www.PlexusInstitute.org for further details, additions or changes to the schedule.

September 30:
An Exploration of Nonlinear Science.

Guests will include Dr. Alwyn Scott, Emeritus Professor at the Department of Mathematics at the University of Arizona and Dr. Jeffrey Goldstein, professor of management marketing and decision sciences at the Hagedorn Hall of Enterprise at Adelphi University. Dr. Scott has devoted his professional life to the study of nonlinear dynamics, both theoretically and in a wide variety of physical, chemical. Biological and neural systems. In 1979 he became founding editor of *Physica D: Nonlinear Phenomena* and from 1981to 1985 he was Founding Director of the Center for Nonlinear Studies at the Los Alamos National Laboratory. At the University of Arizona, Dr. Scott is a member of the

Neuroscience Program and the Program in Applied Mathematics. He has written extensively on mathematics and emergent systems. His latest work is the Encyclopedia of Nonlinear Science, a collection of scientific essays on topics than range from chaos to turbulence. This extensive reference for all aspects of nonlinear science is designed for undergraduate and graduate students as well as researchers and established scientists. Dr. Goldstein has researched and written extensively on business and management and complexity science.

October 28
Relationship-Centered Patient Care

Guests will include Dr. Anthony Suchman, senior consultant in Relationship Center Health Care, Rochester, NY, Dr. Penny Williamson, an internationally recognized facilitator, educator and coach, and Dr. Cathy Risdon, professor of medicine at McMaster University in Ontario, Canada. Dr. Suchman is board chair of the American Academy on Physician and Patient (AAPP) a society devoted to research, education and professional standards in patient-doctor communication. Its goal is to improve the practice of medicine by helping clinicians, patients and learners relate more effectively. Dr. Williamson received her doctorate from the Johns Hopkins University School of Hygiene and Public Health and is a part time associate professor of medicine at the Johns Hopkins University School of Medicine. She is also a senior facilitator an advisor for the Fetzer Institute Courage to Teach Program, and holds faculty positions in the AAPP and the Foundation for Medical Excellence. Dr. Risdon is the first holder of the David Braley-Nancy Gordon Endowed Chair in Family Medicine at McMaster and her mandate is to develop innovations in education, clinical service and research relating to the doctor-patient relationship and interdisciplinary team relationships.

Recent PlexusCalls Included:

Life, Death and Health Insurance *(July 15)*

Guests were Rushika Fernandopulle and Susan Starr Sered, co-authors of *Uninsured in America: Life and Death in the Land of Opportunity*. Dr. Fernandopulle was the first executive director of the Harvard Interfaculty Program for Health Systems Improvement and is a founder of Renaissance Health, a primary care practice in Boston designed to use innovative techniques to enable patients to maximize their own well being. He is also a clinician at Massachusetts General Hospital, a member of the Harvard Medical School Faculty, and a member of Plexus Institute. Susan Starr Sered is research director of the Religion, Health and Healing Initiative at Harvard's Center for the Study of World Religions. She is a medical anthropologist and the author of several books and articles. More than 45 million Americans lack health

insurance. Drs. Fernandopulle and Sered began research to find out exactly what that means to individuals, families, communities and society at large. Their research uncovers the often-unacknowledged cost of untreated injury and illness. The stories of the uninsured men and women they interviewed present a disturbing picture of the way ill health cascades through other areas of life. The authors also present a compelling argument that the insurance consequences of one divorce, one pink slip or one serious illness could push most ordinary Americans into a permanent caste of those fated to become and remain sick. They believe America faces the danger of an emerging caste of people whose lack of access to medical care leaves them permanently disadvantaged and often physically identifiable by obesity and bad teeth.

New and Old Strategies for Sustainability: Life as a Business Partner *(August 19)*

Guests were Gary Merrill, a principal in the human systems development firm Emergent Systems, and his niece Michelle Merrill, PhD, who develops and presents experiential exercises and "eco-literacy" curricula for Emergent Systems. They were joined by Tom Mandel of Social Computing Strategy and Leadership, in Silver Spring, MD. Tom Mandel is also a writer and poet. Gary Merrill is an organizational development specialist with more than 20 years experience as a management consultant and group facilitator, educator and organizational leaders. Dr. Michelle Merrill has taught and lectured on evolutionary biology, anthropology and sustainability. She is an expert in primates and has studied orangutans in the Sumatran rainforests. Gary Merrill and Michelle Merrill believe that understanding the evolutionary strategies and ecological processes taking place in the living systems around us can help create the basis for a new but time tested approach to the design of organizations and consumer products. In simulating biological systems, they explore how the "facts of life' are providing energy and ideas for a revolution in industry and organizations. ■