Vol. 11, Issue 5: October – November 2013

NEWSLETTER

2002, 2004-12 2003

2008, 2012 President's Award for Most Outstanding Chapter

October Speaker Meeting: "Disaster Resilience: Using Systems Engineering to Effect Change in Practice at the Community Level"

By Rebecca S. Zukowski, Ph.D.

PARTICULARS:
WHEN: Tuesday, October 8, 2013, 5:30 p.m. to 7:45 p.m.
HOST SITE: Aerospace Corporation in El Segundo
COST: Free to members; $10.00 for non-members attending at locations offering refreshments
Registration Required
Remote sites and virtual attendance for individual participants will be available; see the INCOSE-LA website for details.
MEETING AGENDA:
5:30 – 6:15 p.m. Registration, networking, refreshments
6:15 – 6:30 p.m. Welcome and announcements
6:30 – 7:45 p.m. Presentation, followed by Q&A
Refreshments will be provided at the host site.

BIOGRAPHY

Dr. Rebecca Zukowski is the Associate Academic Dean and Chairperson of the Division of Nursing at Mount Aloysius College. She has been a nurse for over 30 years and has worked in a variety of settings, including the military, academia, and health care systems. Prior to joining Mount Aloysius College, Dr.

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The Art of Invention: One Tech Professor's Hunt for the Wellspring of Creativity

By Van Jensen and Rich McKay

Nancy Nersessian is driven by a simple question that doesn't have a simple answer: "Where does creativity come from?"

As a Regents professor of cognitive science at Georgia Tech, she conducts groundbreaking research into the art of innovation—how scientists and inventors actually think. Her work bridges the philosophy of creativity and the hard science of math and physics, and it has revealed the process of innovation to be far different from what has long been hailed as sacrosanct.

Nersessian has been fascinated by math and science since childhood when, as a four-year-old, she would eavesdrop on her older sister's sessions with a math tutor. Later, she was the lone female physics major in her class at Boston University and at the same time helped program the Apollo 11 computers for the moon landing. In 2011 she was the inaugural recipient of the Patrick Suppes Prize in Philosophy of Science from the American Philosophical Society. Oh, and she's an accomplished opera singer, too.

So in her studies on the culture and source of creativity, she draws upon plenty of personal experience. And Georgia Tech is a fitting setting for her topic of inquiry: The Institute's faculty, alumni, and students always have generated inventions that have saved lives and changed the way people live, and the Tech campus is home to world-renowned researchers, startup

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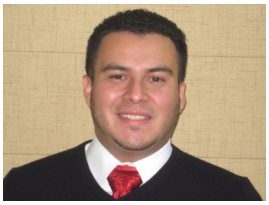
Inside This Edition

Human-System Interaction, Interfaces, and Integration – A New Frontier

By Jorg Largent

The August speaker meeting featured Mr. Douglas Orellana, a System Architecting and Engineering doctorate student at the University of Southern California. Mr. Orellana's presentation centered on his research of model-based systems engineering (MBSE) and its use throughout the life cycle of a system, with a focus on the human-machine interface (HMI) through system modeling and simulations. His premise was that as systems continue to grow in scale and complexity, human-machine interactions and the human-machine interface itself combine to become a crucial consideration in overall system design. In complex systems, humans are increasingly a part of the system as opposed to being just users of the system. The human mental model, work instructions, and procedures are key attributes that a systems architect needs to analyze in order to ensure the success of the overall human-machine system. MBSE techniques potentially offer new ways for systems architects and engineers to conceptualize and analyze HMI requirements and use the findings to define the requirements for the design.



After an introduction, Mr. Orellana broke down his presentation into discussions of

- human capabilities, limitations, and challenges,
- human-system interaction, interfaces, and integration (HSI3) analysis challenges,
- model-driven systems engineering (MDSE – often used interchangeably with "MBSE"),
- current HSI3 analysis using MDSE, and
- extending MDSE for HSI3 for full lifecycle coverage.

The increasing scale and complexity of systems have made it difficult to ensure that systems conform to human capabilities and limitations. There is a need to develop new systems architecting and engineering methods, processes, and tools (MPTs). These tools would be used to analyze emergent behavior, identify hidden interactions, and obtain tacit knowledge of HSI3. Model-driven systems engineering offers potential new ways for systems architects and engineers to analyze HSI3 and the consequent influences on the design of a system.

Mr. Orellana addressed the question of why humans are so important to the system. He answered that humans are no longer just system operators but "system agents" within the system. The cognitive abilities of humans are increasingly important to, and an integral part of, system functionality. Human adaptability, in particular, should be considered as a part of the architecting of a system. A question was asked about "human adaptability" in the rising consideration of resilience as a part of system design. Answered Mr. Orellana: "Adaptability is part of resilience; is about half of what the definition of what resilience

(See August Speaker Meeting, continued on page 5)

Exceptional Leadership Practices for Building Innovative and Adaptive Environments

Dr. Suzette S. Johnson was the featured speaker at the September speaker meeting. Dr. Johnson, who works for Northrop Grumman Information Systems near Baltimore, Maryland, is a systems engineer, certified Project Management Professional, and a Certified Scrum Coach. She has an interest in and passion for promoting and implementing agile engineering principles. Her interest and passion span the spectrum from small teams to large-scale systems environments. Dr. Johnson received a Doctorate of Management at the University of Maryland with a dissertation focused on leadership styles and agile practices.

Dr. Johnson opened her presentation by asking: "Why are we interested in leadership?" and "What do we know about leadership?"

She commented on the amount of data available: searches of the Web for "innovative leadership" came up with millions of hits and over 90,000 books on leadership on Amazon.

Dr. Johnson offered a definition: "Leadership is about making a difference about whatever it is that you are passionate." Part of the challenge that faces contemporary leaders is that what got us here won't get us there. She commented on the contrasting leadership differences between the industrial age (repeatable and predictable) and the knowledge age (inspect and adapt): the motivator in the industrial age was money for more work, but in the post-industrial knowledge age the motivators are a sense purpose and contribution—a shift away from a task-oriented work place. She commented that she was looking at leadership styles and came out with leadership procedures.

Dr. Johnson then discussed "10 Principles for Building Innovative and Adaptive Environments":

1. Delight our customers – passion for the customers and mission we serve
2. Create self-organizing teams – it's a team sport
3. Focus on client-driven iterations – our work … our results, our work … our results
4. Frequent delivery of value – build credibility
5. Provide transparency and an open culture – build on a foundation of trust
6. Continuous improvement
7. Interactive communication and collaboration – the power of exchanging ideas
8. Innovation is everyone's job
9. Foster a culture of innovation
10. Be a productivity expediter – build high-performance teams

Dr. Johnson then described "It Was Great Coming to Work When…" by quoting Pollyanna Pixton: "Create a workplace where people want to be, where people are valued and are full

(See September Speaker Meeting, continued on page 6)

Presentations to the Chapter from the International Symposium

By Jorg Largent

Chapter past-President John Silvas, President Eric Belle, Mr. Joshua Sparber, and Dr. Padman Nagenthiram of the INCOSE Ways and Means Committee were four of the many Chapter members who attended the International Symposium (aka IS13). They shared their experiences and observations with the Chapter membership at the July speaker meeting.

Mr. Silvas spoke on several topics, including student divisions and Chapter leader training. Mr. Belle reported on INCOSE Strategy, the information technology infrastructure plans, and the Mentor Challenge. Dr. Nagenthiram discussed systems thinking, tech operations, the systems engineering tool vendor challenge, and future directions. Mr. Sparber provided a report from the Wednesday plenary.

According to Mr. Silvas's report, there are nine universities that have a student division. INCOSE is invested in strengthening the profession, and the student divisions are an integral part of that strengthening. Sustaining the student divisions continues to be the primary concern. Mr. Silvas noted that a primary element of student division success is dedicated stakeholder efforts. An action step from the symposium is to implement ideas from the symposium by work with our ambassadors to the University of Southern California and Loyola Marymount University.

Mr. Silvas reported on INCOSE's efforts to transition the website to a more capable site by taking advantage of advances in information technology. The purpose of this transition is to make the website of greater value to INCOSE members. Strengthening the effectiveness and value of the Chapters is part of the plan, which includes a "Chapter Wiki." INCOSE is building this new website to replace INCOSE Connect with special consideration of the chapters. INCOSE's position is that local chapters are essential in supporting local members and achieving INCOSE's goals and objectives. Far more than local administrative groups, chapters are performing units that organize a multitude of professional and social programs, conduct membership recruitment and retention drives, support technical activities striving to advance the state and art of systems engineering, and market INCOSE as the international authoritative body on systems engineering.

An important portion of the Keys to Effective Chapters program is processes and best practices to facilitate the operational portions of chapter administration, and allow more time to the actual education and promotion of systems engineering.

Mr. Belle reported on INCOSE's "SE Vision 2020," which had been released in 2007. As a part of the progress since 2007, a core team was established in 2012 to develop the initial issue for evolving the systems engineering vision. The work has expanded to provide a systems engineering vision for the 2025 time frame, a vision which is intended to inspire and guide the direction of systems engineering (not just an extrapolation) to:

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Chapter Strategic Planning Meeting

Date: Saturday, October 19, 2013
Time: 9:00 a.m. – 3:00 p.m.
Where: Building S Café, Northrop Grumman Corporation
2100 Marine Drive, Redondo Beach
Free for members; lunch and snacks will be provided
Look for details in a Reflector Notice or online at
http://www.incose-la.org

The Board of Directors of INCOSE-LA will be conducting a quarterly strategic planning meeting on October 19, 2013, and would like to invite the members of the Chapter to attend. The meeting will be an opportunity to learn about the plans being considered and implemented by the Board, as well as to provide the Board with some highly valued inputs. The Board wants the INCOSE-LA Chapter to be responsive to, and of value to, the members of the Chapter, and inputs from the members are keenly appreciated. This is also an excellent opportunity to hear about the variety of volunteer positions available in the chapter, for members who may have an interest in volunteering for an event, a chapter office, or chapter products or processes.

The agenda is in its final stages of development. Topics addressed in past meetings include Student Division plans, planning for Mini-Conferences, and review of potential topics and speakers for future speaker meetings and tutorials.

Members who have a topic that they would like to be discussed in the meeting should send the topic to the Chapter President, Eric Belle, at ***eric.belle@incose.org***.

RSVP: Please indicate your attendance using the INCOSE-LA website at ***http://www.incose-la.org***.

You are invited to the INCOSE-LA Chapter Holiday Party
Tentative Date:
December 7, 2013
3:00 p.m. to 7:00 p.m.

Great people ✵ Fine food ✵ Lots of Fun
White Elephant Gift Exchange

An INCOSE-LA Tradition!

Look for more details in the next edition of the *Newsletter*, in a Reflector Notice, and on the INCOSE-LA web page

(October Speaker Meeting, continued from page 1)

Zukowski was a Senior Research Associate for the National Center for Disaster Medicine and Public Health. During her tenure at the National Center, she worked closely with the U.S. military and the Uniformed Services University of the Health Sciences to evaluate and advise on curriculum for disaster preparedness and response. Her assignments included travel to post-earthquake Haiti and other Caribbean nations to evaluate the effectiveness of humanitarian assistance missions.

Dr. Zukowski is a veteran of the United States Navy, where she served as a nurse corps officer. She received her Ph.D. from Indiana University of Pennsylvania; her dissertation was titled "A Quantitative Study Identifying Adaptive Capacity and Its Impact on Response and Recovery in Communities Affected by Major Disaster." She holds a Bachelor of Science from Carlow College in Pittsburgh, Penn., with a dual major in Nursing and English. Her Master of Science in Nursing is from Marquette University in Milwaukee, Wis., with a specialty focus as an adult practitioner/teacher. Her research interests include community resilience to disasters, core competencies for medical disaster response, and health care access for vulnerable populations.

ABSTRACT

Our nation and others continue to experience disasters and public health emergencies due to wildfires, pandemics, hurricanes, floods, terrorist attacks, and other catastrophic events that result in loss of life, damage to property, and consumption of resources that significantly affect our economy. History informs of the devastation and loss of life that occur when disasters strike communities. According to FEMA, national preparedness requires the building of disaster resilient communities by supporting and strengthening the institutions, assets, and networks that are already at work within the community. However, resilience to disaster remains a very complex phenomenon difficult to conceptualize and operationalize. Although national-level frameworks and training exist to support communities in the development of disaster readiness capabilities, there has been a lack of research to validate the relationship between capability development and improved response and recovery outcomes. To address this, Dr. Zukowski will review a conceptual framework for establishing disaster resilient communities and will discuss findings from her recent research study involving over 300 communities impacted by disaster. In addition to providing an overview of the presenter's research, application to the role of systems engineering in effecting changes in practice at the community, organization, and policy level will be discussed.

RSVP

Register online by October 4, 2013.

If you are uncertain about whether you will attend, DO make a reservation and indicate that you're uncertain. Register online at www.incose-la.org. Click on the link for this speaker meeting in the "Upcoming Events" section on the homepage, where you will find the link for Registration.

We request that all reservations be made online. This helps facilitate registration and planning for our host and remote sites. Visitors at JPL and Boeing must register by the deadline to obtain visitor clearance from site security, which requires registrants to provide their email address, name, title, company, phone number, and membership and citizenship information, and to identify at which site they will be attending.

(August Speaker Meeting, continued from page 2)

is; if they [the humans who are part of the system] have a wealth of knowledge of the system then they can adapt faster…."

These positive abilities are tempered by limitations and challenges. As the defining medium, HSI3 design becomes a challenging problem because of the need to address human cognitive limitations (Mr. Orellana also used the term "cognitive overload") as well as human versatility. One of the challenges to HSI3 is human error, which Mr. Orellana attributed to:

- inadequate training of the human and about his or her role and how it fits in the larger context of the system,
- a lack of a full understanding of inner workings of the system, and
- the improper execution of the human element due to many factors (overwork, boredom, stress, mood, etc.).

The evening concluded with a wide range of questions from the appreciative audience. Those interested in more detail can view Mr. Orellana's presentation in the Chapter's 2013 Speaker Meeting folder on our INCOSE Connect site.

Mr. Orellana is continuing in his research, and is planning on presenting a paper at the Conference on Systems Engineering Research in 2014.

Conference on Systems Engineering Research Coming to Los Angeles, March 2014

CSER, the annual Conference on Systems Engineering Research, is the premier conference at which systems engineering researchers and practitioners convene and collaborate on the latest breakthroughs and ideas in our field. CSER 2014, to be held in Redondo Beach, is sure to be one of the most informative systems conferences of the year.

At CSER 2013, researchers from around the world presented papers addressing societal challenges and next-generation systems for meeting them. Papers addressed topics from evolutionary systems to smart grid and infrastructure, workforce training and even defense and aerospace. Offerings at the 2013 conference at the Georgia Institute of Technology were deep and comprehensive, featuring thirteen topics focused on systems engineering core concepts and eight topics associated with model-based systems engineering as a theme. CSER 2013 addressed outreach for the profession and the future of the discipline with five topical areas in systems engineering education and training and nine groups of presentations on next-generation systems engineering. Two other domains were shared at CSER 2013: multi-disciplinary approaches and needs with six groups of presentations, and systems engineering applications with fifteen groups of presentations.

INCOSE-LA has a very unique opportunity as we provide conference management and overall administration to next year's gathering.

In 2011, Chapter members like you helped to make the CSER 2011 a conference that is still referenced today as an example to follow. We ask for your support and involvement in our conference. CSER 2014 will be a unique venue to exhibit your individual talents and your company's products, and services. We have several levels of flexible sponsorship and exhibitor package opportunities. Companies, corporations, organizations, and individuals interested in furthering engineering research and collaboration in systems engineering: get involved in CSER 2014! Together we will make this the best CSER ever. For more information please call Roz at 310-336-1805 or Terry at 949-910-1128, or email at the addresses below.

The Los Angeles Chapter, continuing its role as conference facilitator, is at work preparing for CSER 2014. The conference management committee, headed by Terry Rector (terry.rector@incose.org) and Roz Lewis (rosalind.lewis@aero.org), is seeking volunteers, exhibitors, and sponsors. Much as it "takes a village to raise a child," it "takes a Chapter to host a conference."

Are you interested in joining this august group in the facilitation of CSER 2014? Please contact Terry Rector at terry.rector@incose.org.

(September Speaker Meeting, continued from page 2)

contributors to forming and supporting the direction of the organization." Dr. Johnson concluded with the question: "What Does This Mean to Me?" Her answer:

- Create environments that emphasize collaboration, creativity, team empowerment, trust, and organizational learning.
- Give people the time to collaborate and innovate (as at FedEx and Google).
- Train managers in the practices that work best in adaptive environments.
- When transitioning to more adaptive practices, communicate and demonstrate the principles to which the organization plans to adhere.
- Address team needs and impediments and communicate back.
- Practice active listening.
- Establish cross-functional teams to help deal with complexity and problem solving.

The ten principles precipitated some observations from the audience. There was some uncertainty with respect to how a leader might guard against an employee spending so much effort in delighting the customer that the customer does not get the desired product. Part of the challenge for a modern organization seemed to be innovation and the consequent need for the creation of an environment that would foster and facilitate innovation, but without an understanding of how innovation occurred in the older work environments. The discussion of "continuous improvement" resonated with veterans of continuous improvement programs and LEAN facilitators. The examples of product improvement (masking tape, the Swiffer floor sweeper) and the methodology behind the cited improvements has a lot in common with LEAN. Some in the audience were uncertain how to transition from innovating and expediting to actually delivering a product to the customer. In some respects, the presentation seemed to more a discussion of the in-vogue attributes of an organization than a discussion of how to lead.

Dr. Johnson's informative and thought-provoking speech was followed by questions and answers from her appreciative audience. The slides used for the presentation are available on the Chapter's Connect site.

Stay Connected

Get the latest on INCOSE-LA happenings in the Reflector e-mails
If you wish to be placed on our e-mail distribution, contact Susan Ruth at susan.c.ruth@aero.org

12th Annual Conference on
SYSTEMS ENGINEERING RESEARCH

Engineered Resilient Systems: Challenges and Opportunities in the 21st Century

March 21–22, 2014, Redondo Beach, CA

www.incose-la.org/cser2014

TOPICS

We invite original research papers addressing the conception, design and architecting, development, modeling and simulating, production, operation and support of systems; the definition of metrics of performance, and improvement methods; the assessment and mitigation of risks; the definition of critical success factors, and best practices. The refereed research papers at the conference will be complemented with invited talks. Abstracts are invited in broad areas to include:

- Autonomous Resiliency Research and Applications
- Model Based Systems Engineering
- Value-based, Lean, Agile Systems Engineering
- Cybersecurity and System Security Engineering
- Social Networks and Graph Theory
- Early Stage Design Concepts and Economic Value of "ilities"
- Uncertainty and Complexity Management in Complex Systems
- Systems Architecting and Tradespace Analysis
- Cognitive Engineering and Human-Systems Integration
- Big Data and Analytics
- Cyber-Physical-Social Systems
- Systems/Critical Thinking

GENERAL INFORMATION

For information about registration, hotel, location, financial support and other subjects, see the CSER 2014 website at www.incose-la.org/cser2014

The University of Southern California in collaboration with the Stevens Institute of Technology presents the 12th Annual Conference on Systems Engineering Research.

The primary conference objective is to provide practitioners and researchers in academia, industry, and government a common platform to present, discuss, and influence systems engineering research with the intent to enhance systems engineering practice and education. Papers are solicited pertaining to research in all these topic areas.

Organized by the University of Southern California (USC) in collaboration with the Stevens Institute of Technology, managed by the Los Angeles Chapter of the International Council on Systems Engineering (INCOSE), and additionally co-sponsored by others.

Conference Honorary Chair
George Friedman (USC)

Conference General Co-Chairs:
Azad M. Madni (USC)
Barry Boehm (USC)

Technical Program Co-Chairs:
Marilee Wheaton (The Aerospace Corporation)
Michael Sievers (JPL)

Conference Management Co-Chairs:
Terry Rector (Irvine Sensors Corporation)
Rosalind Lewis (The Aerospace Corporation)

MILESTONES

We have received over 150 abstracts and will be sending out preliminary acceptance notification soon.

Draft Paper Submission	**Nov. 15, 2013**
Final Notification to Authors	**Dec. 13, 2013**
Submission of Final Paper	**Jan. 10, 2014**

(July Speaker Meeting, continued from page 3)

- Identify systems engineering capabilities to support future challenges and needs
- Align systems engineering planning in research and development of curriculum, standards, methods, and tools
- Promote funding for systems engineering research and organizational investment
- Broaden the base of practitioners across industry domains and motivate others to pursue systems engineering:
  - Students
  - Related disciplines
  - Non-traditional stakeholders (e.g. small to medium-size enterprises)

Supplementing Mr. Silvas's presentation, Mr. Belle also discussed the new IT Service Portfolio, an integral part of INCOSE's strategic vision and efforts to be of increasing value to the profession and the members.

Mr. Belle concluded his portion of the evening's presentation with a report on the Mentor Challenge. The Mentor Challenge was something new this year at the symposium and gave veterans an opportunity to help first-time attendees and new members navigate the many presentations, forums, panel discussions, and working groups at the symposium. An article on the Mentor Challenge is available in the September edition of INCOSE Insight (volume 16, issue 3, https://connect.incose.org/INSIGHT%20Library/Forms/AllItems.aspx).

Dr. Nagenthiram opened his portion of the evening's presentation with additional discussion of the "SE Vision 2025 Status and Way Forward." The INCOSE Board of Directors is planning on a rollout at the 2014 International Workshop and is proposing a two-hour plenary presentation. The presentation was envisioned to include detailed discussions within relevant working groups, supported by a new core team.

Dr. Nagenthiram continued with a report on the systems thinking discussions at the symposium. Systems thinking is an increasingly important part of the vision for INCOSE and was a part of the academic program at IS13. The application of systems thinking to systems engineering is gaining momentum in the United States. In 2010, the INCOSE systems engineering Competency Framework included a set of systems thinking competencies; in doing so it acknowledged the need for systems thinking within systems engineering, especially as a way of dealing with increasing complexity. Systems thinking is still taught by only few academic institutions. Systems science, systems thinking, and systems engineering all contribute to an integrated systems approach. It was noted that there was a whole day track on Systems Thinking at the INCOSE-LA Mini Conference in March 2013.

Dr. Nagenthiram's report on Technical Operations included the note that four tutorials are available on INCOSE Connect:

- SE Fundamentals
- SE Handbook
- Leadership Skills
- Requirements (New)

Mr. Sparber concluded with a report from the symposium's Wednesday morning plenary, "Systems Engineering in Energy and Power." The plenary speaker, Ms. Dianne Anderson, opened her presentation with a vision of the challenges in the future: massive population growth and a dramatic increase in gross domestic product and energy consumption in countries such as China and India. Ms. Anderson then discussed her understanding of the history of power consumption and its implications. Historically, global energy markets have been dominated by single fuels. First was wood, which was replaced in its primary role by coal, which, in turn, was followed by oil. Each of the historical sources has had successively greater carbon content per unit energy: coal more than wood, oil more than coal. In the latter half of the twentieth century, nuclear energy, and later renewable sources, began to eat into oil's grip. The United States and other countries have begun to extract natural gas from shale as an energy source that may be a bridge to cleaner and safer alternatives. Even though natural gas is cleaner burning than wood, coal, or petroleum, its extraction through underground fractionation techniques breeds troublesome byproducts.

Ms. Anderson continued her discussion of history, noting that in the past fuels have had long, stable tenures. However, inequalities in their global distribution and impacts of their burning resulted in global conflicts, catastrophic environmental and health impacts, and societal divisions.

Currently, the existing established infrastructures and their governing regulations are out of date and often run up against a wall of unintended consequences in development that prevent progress. For example, the oil industry has a stable infrastructure but is governed by regulations that are over 100 years old. Fledging industries, on the other hand, have many standards, but few regulations are in force.

Re-coordinating this assortment of infrastructures and developing them into systems that are sufficiently useful, non-wasteful, and productive calls for the skills, abilities, and experience possessed by current and future systems engineers.

Ms. Anderson proposed some approaches. Lifetime studies and degradation can be used to examine outlines of energy system growth. Failures of technologies may be a good place to uncover improved methods for planning. Another approach might involve four phases: inductive logic to find greater laws, deductive reasoning based on those discovered laws, building virtual worlds to check against other possible histories, and use of "big data" to fathom trends previously not observed.

The latter two principles may be applied in the coming years. At the power company, switching between energy sources takes place on the nanosecond level. Coordination between types of power, through interfaces, will be vital in the coming years. A "Hollywood Model" of system design was brought up: this analogy has the executive as the producer that combines standards with policy, the manager as the director that builds a collaborative team, and engineers as the actors that complete the play. Developing countries may need to take new paths to create necessary energy sources, ones that will allow them to leapfrog ahead. These countries have shown marked willingness to adapt to new power types.

The slides from this speaker meeting are available on the Chapter's Connect site.

(Wellspring of Creativity, continued from page 1)

incubators, and invention competitions that foster the next generation of innovators.

The *Alumni Magazine* picked Nersessian's brain about the limits of the scientific method, the intersection of physics and philosophy, the future of creativity, and more.

How did you become interested in this area of study?

I loved math from the moment I encountered it. I really didn't like science labs in school, especially biology labs. Anyone who was paired with me in science lab was unfortunate and often in danger since I was quite clumsy. I was always theoretically oriented. I won third place in the Boston Science Fair for my project, which was a mathematical analysis of hyperbolic and elliptical functions.

[In college] my physics professors were just interested in teaching the formulas. I was asking, "What does it all mean?" But they didn't encourage me to pursue this question. In my junior year, I accidentally signed up for a class with Milic Capek, a professor of philosophy and brother of the Czech science fiction writer Karel Capek. His class was on the philosophy of space and time, and I was hooked. It was then that I started to understand what Einstein's theory of relativity told us about nature. I wanted to find out, "Where did these theories come from? What's the process?"

I wanted to look at ordinary scientists and engineers doing frontier research and how they think. How do they solve problems and compare that to the struggles of the great scientists and thinkers like [Michael] Faraday, [James Clerk] Maxwell, and Einstein? How did they solve their problems?

A different perspective of "step 0" of the systems engineering process

How do you go about researching that?

The best advice I ever received came when I started grad school, from my mentor, Howard Stein, now an emeritus professor at the University of Chicago. He said: "Don't just read what philosophers say about science, read the scientists themselves." As a physics student, it had never occurred to me that it was possible to read the writings of the people who had created the theories in the textbooks.

What I began to find wasn't just mathematical problems, but their letters and diaries, notebooks filled with sketches and drawings. They made lots of analogies. They ran lots of thought experiments. I was surprised when I first encountered the numerous sketches in Faraday's diary, the analogical models in Maxwell's writings, and Einstein's use of thought experiments. These didn't fit the view of "the scientific method" I'd been indoctrinated with, and yet I was convinced that they were key to understanding how scientists think creatively. However, you can't talk to dead scientists, so I also began studying scientists and engineers in their research labs.

How does their process differ from the perceived view of the scientific method?

What we're taught often is that you make a hypothesis, deduce a result, and then test it empirically. But that's not what they did. They went through a different process. I call it model-based reasoning. It's the engine of creativity. It's what drove people to their solutions.

How does model-based reasoning aid creativity?

A model is an integrated representation that provides an interpretation of the phenomena under investigation. Models are selective (you can't model everything) and are constructed to exemplify what are considered to be the important features of phenomena, and so a good model focuses the mind on the cognitively relevant features and enables manipulation of these.

The processes of building models integrate constraints from a variety of resources so that, over many iterations, genuinely novel behaviors or structures can emerge. And models can be represented in different formats which enable different kinds of manipulations and support different kinds of inferential processes. Transforming models from one format to another can lead to novel insights (e.g., language affords logical inferences, diagrams enable perceptual inferences).

What's an example of this?

In constructing the electromagnetic field equations, Maxwell built a series of conceptual models that incrementally merged what was known experimentally about electricity and magnetism with constraints from fluid mechanics and machine mechanics to create imaginary models that enabled him to tap into the representational power of the mathematics of continuum mechanics—something he and others at Cambridge had been working on for years before he took on the electromagnetism problem. The other thing he did was to make diagrams of the models that facilitated thinking about the complex interrelations of electricity and magnetism through perceptual inferences and mental simulations.

You hold appointments in the College of Computing, the College of Architecture, and the Ivan Allen College of Liberal Arts. Why are you such a proponent of interdisciplinary research?

This merging of constraints from various sources is part of what makes interdisciplinary research a source of creativity. For instance, the biomedical engineering researchers my research group has studied often build physical simulation models that merge constraints from biology and engineering—they can't experiment on the phenomena directly, so they build physical models that capture what they consider to be relevant aspects, manipulate these hybrid bio-engineered models, and again novel behaviors and structures can emerge. Something new is created in the course of representing these (usually in math).

The systems biologists we've studied build computational models to produce simulations that integrate data from a vast range of literature, creating a synthesis that exists nowhere else, and building and running the simulations through numerous iterations often leads to novel behaviors that provide insight into system-level phenomena about which little is currently understood.

Do people have a predisposition to being creative? How can an institution like Georgia Tech foster creativity?

That's a driving question. There are a lot of smart, creative people who never produce anything. And there are many people who might not think that they are all that creative, but they do

(See Wellspring of Creativity, continued on page 10)

(Wellspring of Creativity, continued from page 9)

produce. There's a persistence factor in this. They keep working a problem, looking at it from different angles. They struggle. Now, if we can understand that cognitive and neural activity, what happens there, that would be something. And I think we can get there. But without that we can still figure out what the characteristics are that promote creative thinking and foster them.

Do you have any ideas of what those characteristics might be?

A major one is cognitive flexibility—the ability to see something from different perspectives. One way to foster this is to provide opportunities for students to engage a problem from multiple points of view. Also, I think philosophy is great training for any scientist. It teaches you how to formulate problems. It teaches you how to think—how to understand things conceptually. We shouldn't be restricted to just looking at formulas. Music also fosters creativity more broadly. Einstein played the violin.

What I tell my Ph.D. students is that they need to have real intellectual problems driving their research and feel a passion for the research that will sustain them through the hard work, failures, and difficulties that they will inevitably encounter along the way. This points to the significant role of emotion in creativity. It's what cognitive scientists call "hot cognition." The moments of insight come with elation; things going well can be exciting; impasses produce despair. To stick with it requires resilience in the face of impasse. Resilience is something that can be fostered in the learning environments designed to promote creativity and innovation.

Where do you think creativity comes from?

The short answer is: from a lot of hard work. I like Einstein's paraphrase of the old adage: "Genius is 1 percent talent (inspiration) and 99 percent hard work (perspiration)." Some people focus on creativity as an act—the "Aha!" moments of insight. But this leaves out all the prior thinking that went into preparing the mind for that moment. Others focus on creativity as an attribute or characteristic—there are psychological tests to measure the creative predisposition of an individual.

I focus on creativity as a process and, specifically, as a problem-driven process. Thinking of it as a process enables us to see how it takes place within a cognitive-social-cultural nexus that can facilitate or impede it. Importantly, as educators, it also enables us to think of ways in which we can design learning environments that cultivate and facilitate ways of thinking and working that promote creativity and innovation.

How does artistic creativity relate to scientific creativity?

I see them as lying on a continuum. Creative thinking across the arts, humanities, sciences, and engineering makes use of various forms of model-based reasoning: analogies, visualizations, thought experiments. The problems and resources for solving them are contextual in the arts as for science and engineering. There is support for this from countless accounts by writers, artists and musicians that detail their struggles to solve problems in trying to create something novel. In the final telling, these struggles are often omitted or underplayed.

What's an example of that?

There's the myth that Jack Kerouac wrote *On the Road* in one continuous stream of "spontaneous writing." However, that myth leaves out the fact that he struggled for years and across many drafts both with how to tell that story and how to perfect the art of "spontaneous writing." Renaissance artists struggled with the problem of perspective, twentieth-century musicians with tonality. I think even performing artists go through problem-solving processes. As an opera singer, my struggles were not only with problems of technique and vocal production but also with how to portray the character I was singing—finding the experiential and imaginative resources that would tell the story of that character.

What is the future of creativity in science and engineering?

The area that's exploding with creative research is the interface of computation, biology, and engineering. Computational power and sophisticated algorithms are enabling us to begin to understand complex biological systems and to design synthetic organisms. New technologies are enabling us to merge biological and engineered materials (including in the human brain). Bio-computing is opening the possibility of reprograming or repairing biological processes. Biologically inspired design is creating novel products. These developments—if we consider the ethical implications—have the potential to transform human life in positive directions.

When I was a student, everyone pointed me in the direction of physics. As much as I love that subject, when science and engineering students ask me where the action is—where they have the possibility to be most creative—I send them in the bio-computing-engineering direction.

The Board of Directors wishes to welcome the following new members to the Los Angeles Chapter of INCOSE.		
Note: The information listed below is from the member directory and is based upon your initial membership application. If the information is not correct or complete, then please access the member directory (at www.incose.org) to update your information.		
Name	**Title**	**Company or Organization**
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Timothy J Crowley	Engineer	
Ju Y Oh	Test Engineer	Western Digital
Johathan (Jon) D Plotner		
Melissa (Missy) Wallace		
William (Bill) Parks	Chief Engineer	AeroVironment, Inc.
Amanda J Foo		LMCO
Adam C Grenberg		
Christopher J Trainor	Systems Engineer	Moog Inc
Dr. Saeideh Fallah Fini	Assistant Professor	California State Polytechnic University
Kareem Rashad	System Engineer	Honeywell Aerospace
Stuart (Stu) A Swalgen	Manager; Reliability, System Safety, & Specialty Engineering	Aerojet Rocketdyne

CHECK OUT THE WORKING GROUP OF INTEREST TO YOU! MEET COLLEAGUES WITH SIMILAR INTERESTS!

International Workshop 2014

January 25 to 28, 2014
To be held in the Los Angeles area
Details available from INCOSE in late October

IT'S LOCAL!

2013 Board of Directors

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INCOSE-LA Chapter NEWSLETTER

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Forwarding Service Requested

The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems. INCOSE's mission is to share, promote, and advance the best of systems engineering from across the globe for the benefit of humanity and the planet.
The Los Angeles Chapter meets several times per year for speaker meetings and, in addition, sponsors tutorials, mini-conferences and other activities of interest to those in systems engineering or related fields.

UPCOMING EVENTS

For more details on Chapter-sponsored events and registration, go to http://www.incose-la.org

October Speaker Meeting
"Disaster Resilience: Using Systems Engineering to Effect Change in Practice at the Community Level
Speaker: Dr. Becky Zukowski, Ph.D., R.N., Associate Academic Dean, Division of Nursing, Mount Aloysius College
Date: Tuesday, October 8, 2013
Time: 5:30 p.m. – 7:45 p.m.
Where: Aerospace Corporation in El Segundo
Cost: Free for members; $10.00 for non-members at host site
See article on page 1

November Speaker Meeting
"INCOSE Working Group Update"
Speakers: Representatives of various Working Groups
Date: Tuesday, November 12, 2013
Time: 5:30 p.m. – 7:45 p.m.
Where: details in work
Cost: Free for members; $10.00 for non-members

Strategic Planning Meeting
Date: Saturday, October 19, 2013
Time: 9:00 a.m. – 3:00 p.m.
Where: Building S Café, Northrop Grumman Corporation
2100 Marine Drive, Redondo Beach
See article on page 3

November Networking Event
Date: Wednesday, November 20, 2013
Time: 5:30 p.m. – 7:30 p.m.
Where: West 4th and Jane
Address: 1432 4th Street, Suite A, Santa Monica, 90401
Phone: 310-395-6765

INCOSE-LA Holiday Party
Date: December 2013
Where: Details in work

CHAPTER OFFICER ELECTIONS IN DECEMBER!

The 2014 Conference on Systems Engineering Research (CSER)
March 20 – 22, 2014
Crowne Plaza Hotel, Redondo Beach
See pages 6 and 7