The Enchanted View
⊕ Thinking about Systems ⊕
2019 Q2

Coming Soon →→→ An Early Stage R&D Working Group

Heidi Hahn
Chapter President

An INCOSE Early Stage Research and Development Working Group (ESR&D WG) is in the works and your Enchantment Chapter board members are in the thick of it! Ann Hodges and I teamed with Nick Lombardo of Pacific Northwest National Laboratory (PNNL) and Mitchell Kerman of Idaho National Laboratory to host an information session at the 2019 International Workshop. Response was overwhelmingly positive, with over 40 people expressing interest. And, although we had thought that most of the interest would come from national laboratories and other Federally Funded Research and Development Centers, a wide spectrum of organizations, including academia and industry, were represented.

Interested? See sidebar for more information and contact Ann Hodges (alhodge@sandia.gov) or me (Hahn@lanl.gov) and we'll get you on the WG information list.

From the ESR&D WG draft charter:

The purpose of the Systems Engineering in Early Stage Research and Development (ESR&D) Working Group (WG) is to provide an open forum for the application, development, and dissemination of systems engineering principles, best practices, and solutions relating to issues of high importance to national and international laboratories, federally funded research and development centers, university affiliated research centers, and public and private science and technology (S&T) and research and development (R&D) organizations.

ESR&D is one of the most crucial phases in the design process. It both blends and blurs the lines between science and engineering, and it requires a disciplined approach in order to effectively manage scope, cost, and complexity of the final design. Furthermore, many leaders, program managers, and scientists are unwilling to involve systems engineers and just do not recognize the value of systems engineering as applied to ESR&D.

The WG will provide and support opportunities to exchange knowledge and systems engineering information and solutions within the scope of the WG, both within INCOSE and with external organizations sharing similar interests and goals.

We Win the Gold
...but would have liked the platinum

Your INCOSE Enchantment Chapter just learned that it has won the ***Gold Circle Award*** for its accomplishments in 2018. The award will be presented at this summer's International Symposium in Orlando, Florida. Come join us at the ceremony! The Circle Awards are a way of sharing best practices, encouraging activity and recognizing excellence at the chapter level. It takes a lot to merit the highest awards (gold and platinum), and, over the years, our Enchantment Chapter has done exceptionally well, earning eight gold and three platinum awards! Kudos to you all!

Quantum Tic Tac Toe ~ QT³
## our student chapter takes the (quantum) leap...

by Eric Smith, UTEP

A game for the very small? For the very brave? Quantum Tic-Tac-Toe is a quantum mechanical generalization of the classic game. Students in the UTEP Systems Engineering SE 5343 Requirements Engineering graduate class played Quantum Tic-Tac-Toe in a live simulation – *the first such life-size* **QT³** *game play in the world!*

In life-size **QT³**, students move as life-size game pieces, similar to live, life-size plays of classical games such as chess. Students were provided the opportunity to gain course credit by first learning the rules of Quantum Tic-Tac-Toe, and then running several games, with opposing teams. The key academic requirements were:

- Game play action by the whole class, as a system, must accurately follow the rules of Quantum Tic-Tac Toe.

- Individual student players must each, individually, understand and demonstrate accurate understanding of the rules of Quantum Tic-Tac-Toe.

The rules of Quantum Tic-Tac-Toe embody quantum phenomena of *Superposition, Entanglement*, and *Collapse* (see sidebar). The game play thus challenges the students to not only implement logical rules, but also to learn the strangely intuitive realities of the quantum world.

This game play was successfully accomplished in the fall of 2018. Although pictures of the game play were taken, it is felt that video capture of the game play, display of the rules, and posting to YouTube, along with a dissemination campaign, will allow classes throughout the Americas and the world to become encouraged to learn the quantum rules of **QT³**, and to enjoy the benefits of life-size social play using this important science and engineering paradigm.
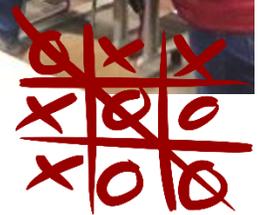
The Rules of Quantum Tic-Tac-Toe, by Allan Goff

Quantum Tic-Tac-Toe is played on the same board as Classical Tic-Tac-Toe. It consists of a 3×3 grid of squares, labeled "1" through "9" (left to right and top to bottom). The game starts with an empty board.

There are two players, X and O. They take turns marking their moves, with X going first. As in Classical Tic-Tac-Toe, player X marks his moves with "X"s and player O marks her moves with "O"s. However, in Quantum Tic-Tac-Toe, each player must place marks in two different squares. The marks are subscripted with the number of the current move, so all of X's moves are subscripted with odd numbers, and all of O's moves are subscripted with even numbers. The moves in Quantum Tic-Tac-Toe are mixed state moves – half in one square, half in another. One only finds out, later in the game, in which square each move actually is.

Mixed state moves can share squares, becoming entangled. There is no limit on the number of mixed state moves that can be in a square. However, at some point, these entanglements will always become circular, and then a new type of move is required – the collapse. Collapses are how the quantum moves are converted to classical moves. Half of each pair of the involved mixed state moves are eliminated. The one that is left is the classical move, there can be only one per square, and further quantum moves into such collapsed squares are forbidden…

For more, see: http://www.cel.edu/Quantum/Tic-Tac-Toe/

Play is our brain's favorite way of learning. – Diane Ackerman

If quantum mechanics hasn't profoundly shocked you, you haven't understood it yet. – Neils Bohr

Not for Women Only

by Heidi Hahn,
Los Alamos National Laboratory

March was Women's History Month, so there was a trove of interesting and inspiring articles. Here are just a few:

National Women's History Month Reminds Us We Can All Be Champions For Change by Naz Beheshti:
https://www.forbes.com/sites/nazbeheshti/2019/03/04/national-womens-history-month-reminds-us-we-can-all-be-champions-for-change/#632f3f8844d0

Women's History Month: Legacies & Life Stories:
http://www.legacy.com/news/explore-history/article/womens-history-month-legacies-life-stories

Women's History Month: Sharing Our Stories:
https://www.youtube.com/watch?v=6bUFr4F0URA

There was also a great *60 Minutes* program about the dearth of women in computer science and what some people are trying to do about it https://www.cbsnews.com/news/closing-the-gender-gap-in-the-tech-industry-60-minutes/ (spoiler alert – it's all about early STEM engagement, done in very creative ways). As the American Association of University Women (AAUW) note in their landmark literature review *Solving the Equation, The Variables for Women's Success in Engineering and Computing* (available for download at: https://www.aauw.org/research/solving-the-equation/) there are parallels between the two fields when it comes to shortages of women both in the classroom and in the workforce. If you watch the 60 Minutes segment and are inspired to try to do something similar for engineering, contact the Empowering Women as Leaders in Systems Engineering (EWLSE) group at ewlse@incose.org and let's talk!

Re-Imprinting

by Bob Pierson,
ATA, newsletter editor
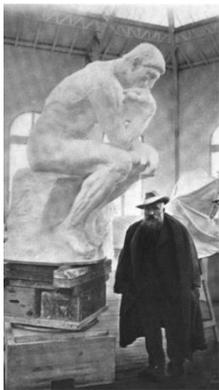
I've come to deeply value the work Eric Smith has done to expose our hidden biases as systems engineers. (You might recognize Eric's name as UTEP professor, Enchantment Board member, and author of articles in this issue about our student chapter's activities.) Eric's research reminds me that, when I set up a trade study between options, I will often imprint my own biases into the trade. If I'm not careful, the seemingly "fair" trade becomes a foregone conclusion.

I first came across the idea of "re-imprinting" in graduate school. An ancient text may convey an important new idea to a future generation. But, it also transmits baggage – hidden contexts that slip in and come along for the ride. That context re-imprints on future readers, propagating hidden assumptions from generation to generation.

Why would I bring this up? Well, first, as the new editor of this newsletter, I need to acknowledge that the prior editor, Rick Dove, has set an extraordinarily high bar. I'll do my best to live up to his example, but you'll be getting my biases now, instead of his. For example, I'll admit right now that my eyes must not be as good as his, so you'll be getting bigger font and a bit more white space. This is a known bias.

But I also bring my unknown biases to this task… and to my systems engineering. One way to expose these biases is to get other points of view. Rick Dove and Heidi Hahn, as past president and president, have worked to diversify our chapter's board with the goal of diversifying systems engineering itself. The problems that face us today require views from all angles in order to reveal when we've stubbornly insisted on approaching from only one side.

One example from the newsletter: The prior header had a close-up of the "The Thinker" sculpture by Rodin. That's an immediately recognizable way to get across the idea of "Thinking about Systems." In fact, if you search for images of "thinkers" as I did, you'll see plenty of Rodin sculpture images. But I also found a few images that made me pause (see this page). Why was my image of a "thinker" a hulking male? What message does that image re-imprint endlessly into my own thoughts and actions?

So I'm taking Rodin's sculpture off the masthead for a while. The new image, although a bit abstract, shows a thinker with a real dilemma – there's a system in front of him that he needs to understand, and a model of that system in his head. How do they relate? That is our challenge – how to use our human brilliance for pattern-finding without falling victim to it. How do we work in ways that do not insist on re-imprinting our old patterns of thought onto the new worlds we encounter?

When Do Human Studies Become Research?

Changes to Federal Law Affect (Some) Systems Engineering Research

by Heidi Hahn,
Los Alamos National Laboratory
Institutional Review Board Chair

Do you work in Human-Systems Integration (HSI) or Human Factors (HF)? If so, listen up! Changes to 45 Code of Federal Regulations (CFR) Part 46, which is the regulation governing the protection of human subjects in research, took effect on January 21, 2019. The revised CFR expands the list of activities deemed <u>not</u> to be research to include: scholarly and journalistic work that focuses directly on the specific individuals about whom the information is collected; public health surveillance activities conducted, supported, requested, ordered, required, or authorized by a public health authority; criminal justice investigations; and authorized operational activities in support of intelligence, homeland security, defense, or other national defense missions.

The last item is a big deal for those of us who work in the Intelligence Community (IC), as we have long argued that intelligence activities do not meet the federal definition of research (a systematic investigation, including research, development, testing, and evaluation, designed to develop or contribute generalizable knowledge) because they are (a) not shared outside the IC and (b) usually not applicable to other situations (not generalizable).

There are also changes to the exemption categories in the CFR. Notably, the exemption related to surveys, interviews, educational tests, and observation of public behavior was expanded to include the collection of sensitive and identifiable data. The exemption related to secondary research was expanded to allow prospective data review; maintenance of identifiers for public health information, if all study data is protected health information; and research conducted by, or on behalf of, a Federal department/agency or using government-generated or –collected information that was obtained for non-research purposes and to allow secondary use of identifiable data obtained under "broad consent." Broad consent is a new concept introduced in the revised CFR – it refers to seeking prospective consent to unspecified future research. Finally, the CFR creates a new exemption for "benign behavioral intervention"—which is defined as "one that is brief in duration, harmless, not physically invasive, painless, not embarrassing or offensive, and not likely to have a lasting adverse impact"—with an adult subject. Excluded from this exemption is research involving deception, physiological data collection, or the collection of sensitive or identifiable data.

While the liberalization of the exemption categories is potentially freeing, its effect on those of us whose funding comes from the federal government will be negligible because the CFR requires that an Institutional Review Board (IRB), not the Principal Investigator, make the exemption determination. It is possible to use an expedited review process for these determinations. Check with your local IRB to see what's available at your site.

There are a few additional changes of which HSI/HF researchers should be aware. The revised CFR removes the requirement to conduct continuing review for certain minimal risk studies and for studies that have completed study interventions and are only analyzing study data. This is another area where you should check with your local IRB. At Los Alamos, we have developed criteria for determining when continuing review will be required.

In addition, the revised CFR creates a requirement for US-based institutions engaged in cooperative research to use a single IRB for that portion of the work that takes place in the US. This requirement will go into effect later this year and I am anticipating major problems for both DoD and DOE/NNSA Labs where there is a requirement that the site IRB or the central federal agency IRB serve as the IRB of record when agency or site employees or their data are used as human subjects in research. Stay tuned for more on this in future newsletters.

The broader one's understanding of the human experience, the better design we will have. – Steve Jobs

What You Missed...

Recent Chapter Meetings

by Ann Hodges,
Sandia National Labs

❖ **JANUARY 2019**: **Brian Selvy**, CEO, CTO, and Co-founder of Nymbysys LLC, gave a presentation on *Risk and Opportunity Management in an MBSE with SysML Environment*. Today's SysML tools and platforms typically do not offer an intuitive and effective means for capturing and modeling risks and opportunities. While it may be easy to modify existing elements to provide a static identification of risk and opportunity attributes within any given model, much more thought and care needs to be employed to generate a methodology that includes analysis of the time-phased, evolving aspects of R/O management. Only then can the attribute data related to potential risks and opportunities be analyzed sufficiently to make technical and programmatic decisions, and a full model-based system-level understanding of a project is incomplete without it. This presentation discussed the problem of ignoring risks and opportunities in a complete MBSE employment and described a set of custom SysML extensions and a methodology that meets typical project needs. A few examples for how to create static and dynamic model elements for identifying, analyzing, and predicting the probabilistic impact of these potential events were presented, as well as means of tailoring the rigor and scope of a model-based risk & opportunity program to the needs of an organization based on project size, complexity, and stakeholder demands.

❖ **FEBRUARY 2019**: *Winter Social*. See below!

❖ **MARCH 2019**: **Dr. Don Gelosh**, Chair of the INCOSE Competency Working Group, gave a presentation on the much-anticipated new ***INCOSE Systems Engineering Competency Framework*** which was released in July 2018. He discussed how individuals and organizations can use a practical evidence-based approach with the new framework to enhance their systems engineering expertise. The framework consists of 36 competencies across five groups: Core, Technical, Management, Professional, and Integrating. In addition to a description and explanation of why it is important, each competency includes a set of evidence-based indicators of knowledge and experience for five levels of competence: Awareness, Supervised Practitioner, Practitioner, Lead Practitioner and Expert. Dr. Gelosh explained how individuals and organizations can use these evidence-based indicators to help identify and acquire the necessary knowledge, skills, abilities, behaviors and experiences at the appropriate levels of proficiency to enhance their own Systems Engineering effectiveness across their careers and the workforce.

Rick Dove, past-president of the Chapter, shows off his new habitat in the wildlands just north of Phoenix, AZ.

Winter Social @ The Gruet Winery

by Mary Compton,
Sandia National Labs

On February 8, 2019 thirty of your fellow chapter members and friends gathered at the Enchantment Chapter Winter Social for wine, good food, and the opportunity to connect with their Systems Engineering Community of Practice. The social was held at the Gruet Winery Tasting Room located in the Albuquerque. Unfortunately, we have no people pictures to share here. We were all mesmerized by the wine served, engaged in lively conversations, and going back for seconds and thirds of the appetizer buffet. We hope to see you at our Chapter's Summer Social! Stay tuned for upcoming details.

Penicillin cures, but wine makes people happy.
– Alexander Fleming (Nobel Prize for discovering penicillin)

Coming Up Next

Next Chapter Meetings / Events

by Ann Hodges,
Sandia National Labs

Third Annual Socorro System Summit: April 5-6
SEP Exam: April 4, 4:00-6:00pm
Very Large Array Tour: April 4, 11:15am-2:15pm
At New Mexico Tech, Socorro, NM, near Albuquerque
Details: Library tab at www.incose.org/enchantment

❖ **APRIL 5-6, 2019: Socorro Systems Summit**: Keynote Speaker: Kerry Lunney, INCOSE President Elect. Summit cost is $100. April 4 NRAO Very Large Array tour and SEP exam are free. Workshops focus on collaborative definition of the problem space, not the solution. More details and registration can be found here.

❖ **APRIL 10, 2019**: *Strategies for Complex Systems Development: Program Management and Systems Engineering*. The disciplines of Program Management and Systems Engineering are inherently intertwined. To develop and deliver complex systems, all three sides of the "iron triangle" (cost, schedule, and performance) must be known, traded, and evolved in consideration of the others. When there is tension and confusion over the roles of PMs vs. SEs, programs suffer from deadline overruns and failures. This presentation will introduce the fundamentals of system program management. Every systems engineer must understand key P3M fundamentals in order to critically evaluate and, when necessary, credibly challenge

Chapter Meetings are open to all and unless otherwise indicated are held from 4:45 - 6:00 p.m. on the second Wednesday of each month at the Albuquerque offices of Applied Technology Associates (ATA), 1300 Britt St, SE, Albuquerque, NM 87123. (505) 767-1200

management on potentially unrealistic expectations related to project cost, schedule, scope, and risk. This presentation will discuss strategic issues and scenarios that cannot be fully predicted such as unplanned rework, perceived versus actual progress, and misalignments between work breakdown structures, organizations, and product architectures.

Bio: Dr. Tina P. Srivastava serves on INCOSE's Board of Directors as Secretary. She is co-chair of the PM-SE Integration Working Group and is one of the authors and editors of the book *Integrating Program Management and Systems Engineering*. She is an entrepreneur and has held senior engineering leadership and technical management roles across the aerospace, cyber security, and commercial sectors. She is a lecturer at MIT in aerodynamics, complex systems, technology roadmapping and selection, and aviation. Dr. Srivastava is also an FAA certified pilot.

❖ **MAY 8, 2019**: *Systems of Systems (SoS) Managerial and Operational Affinity.* Two key characteristics of systems of systems are operational and managerial independence. But what do these terms really mean, and what am I supposed to do about it? This presentation is a dialogue about assessing the operational relationships between the constituent systems within a system of systems, and the managerial relationships between the organizations that own them. For each of the relationship types, or affinity options, a framework for tangible, actionable guidance is offered.

Bio: Dr. Mike Yokell is a Lockheed Martin Fellow and Deputy Director, Systems Engineering. He is the US representative to International Standards setting bodies for Systems and Software Engineering and is the project editor for two new international standards on Systems of Systems Engineering. Mike is certified as an expert systems engineering professional (ESEP) by the International Council on Systems Engineering (INCOSE). He holds multiple US and European Patents for Model Based Systems Engineering (MBSE) and large scale immersive virtual reality.

❖ **JUNE 12, 2019**: - *Enterprise Data Management for System of Systems.* This presentation is about a model-based approach to data design and management for a remote sensing ground station which is being developed as a system of systems. It is also about the evolution of an enterprise data management approach for that same "system."

A cardinal principle in systems theory is that all parties that have a stake in a system should be represented in its management. – Malcom Knowles

Coming Up Next (continued)

Bio: Barbara Mills is a Principal Staff Member at Sandia National Labs in the remote sensing ground station area. Her focus in this group has been data design/management as well as system architecture. Her prior position, as technical lead of an OPIR Data Standards group, set the stage for the current data design work. Barbara received her masters of science in electrical engineering (MSEE) from the University of California, Berkeley and her BSEE from the Ohio State University. Her experience at SNL has been varied (hardware design, embedded software design, signal processing, data and system design) but all applied to various sensing systems. In every case some kind of model was created; it is puzzling that complex systems are still created without them.

IMSE Day at UTEP

by Eric Smith,
UTEP

On April 11th, the Industrial, Manufacturing & Systems Engineering (IMSE) Department at the University of Texas at El Paso (UTEP) will hold its **11th annual "IMSE Day"** (newly renamed from "SE Day") to reflect the integrated nature of the three research fields of the department. The organizational effort is being provided by the student members of the **Student Division of the Enchantment Chapter of INCOSE** and by the members of the Institute of Industrial & Systems Engineers (IISE) student chapter. The preliminary agenda includes speakers from IBM, Fort Bliss, Army Research Labs, and Arizona State University.

This 2019 conference is coincident with the 105th year of operation of the previously-named State School of Mines and Metallurgy, now the University of Texas at El Paso (UTEP), which has this year been designated by the Carnegie Classification of Institutions of Higher Education as an **R1: Research 1: Doctoral University with Highest Research Activity.**
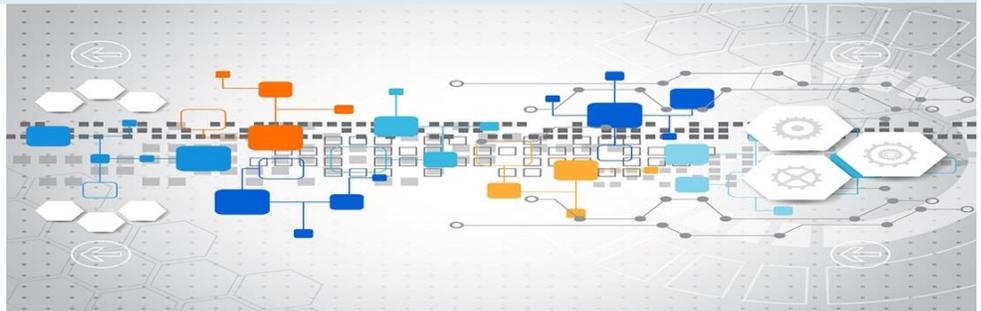
The impetus for this conference is to increase awareness of the wonders of engineering, and to promote the study and application of systems engineering, industrial engineering and manufacturing engineering in shaping the world of the future. The theme for this year is Testing and Enabling Robotic and Autonomous Platforms. All are welcome to attend this free event, starting at 8am, at the UTEP El Paso Natural Gas Conference Center.

Other Upcoming INCOSE Events

◎ **APRIL 3-5, 2019: CSER 2019 - Conference on Systems Engineering Research**, Washington, DC, United States, www.CSER.info

◎ **APRIL 29 – MAY 1, 2019: SETE 2019 - Systems Engineering Test & Evaluation Conference**, Canberra, Australia, https://www.sete2019.com.au/

◎ **MAY 1-2, 2019: 5th Annual Systems Engineering in Healthcare Conference**, Minneapolis, MN, https://www.eventbrite.com/e/2019-systems-engineering-in-healthcare-conference-tickets-52309821083

◎ **MAY 19-23, 2019: 14th Annual System of Systems Engineering Conference**, Anchorage, AK, http://sosengineering.org/2019/

◎ **JULY 20-25, 2019: INCOSE IS 2019 – International Symposium,** Orlando FL USA, http://www.incose.org/symp2019

29th Annual INCOSE international symposium
Orlando, FL, USA
July 20 - 25, 2019

INCOSE is seeking an Assistant Director of Early Career Professionals. The position reports to the INCOSE Secretary and was created to help us focus on our members who are new to SE. If you know a good candidate or would like to know more, please contact ms.kaylamarshall@gmail.com.

Meet Your New President-Elect!

In February, the board of directors was pleased to ratify the nomination of Robin Reynolds to President-Elect of the INCOSE Enchantment chapter. Robin will act as vice president this year and take the post of president in 2020. If you recall, the President-Elect position was vacant at the end of last year, and in that situation, the bylaws call for the president to nominate and the board to ratify a suitable candidate. We are glad Robin has joined the board and agreed to serve. Here is her brief bio. – ed.

Robin Reynolds (505-844-8839, rmreyno@sandia.gov) has been with Sandia National Labs since 2004 and was educated at UNM and Johns Hopkins University. Her early career at SNL was focused on the synthesis and characterization of materials and leveraged degrees in Chemistry (B.S.) and Nanoscience & Microsystems Engineering (M.S.). Robin holds Project Management Professional (PMP) and Lean Six Sigma Green Belt certifications and is a certified Scrum Master. In her career at SNL, she has held various positions and has developed an interest in how interdisciplinary approaches can be effectively applied within complex systems to achieve technical goals. As a Systems Engineer, she is currently working to develop, manage, and deploy nuclear weapon lifecycle requirements through the Realize Product Sub System (RPSS), a dynamic system which incorporates modern systems engineering approaches throughout the NW lifecycle.

New Members:

We've had a bumper crop of new chapter members so far this year! Please welcome the following new members and student members to our Enchantment Chapter!

Rubi Almaguer	Stoneridge Electronics
Hillary Amstrong	Sandia National Laboratories
Jacqueline Arreola	The Aerospace Corp. *(student)*
Penny Bencomo	CACI International
Aylin Camacho	UTEP *(student)*
Rachel Chang	Sandia National Laboratories
Abdiel Fierro	UTEP *(student)*
David Fraire	Stoneridge Electronics
America C Fritz	Sandia National Laboratories
Jennifer Griffy	CACI International
Laini Hamilton	Sandia National Laboratories
Erick Hijar	Stoneridge Electronics
Robert Hoover	CACI International
Jared Quintana	Booz Allen Hamilton
Lauren Ratliff	Sandia National Labs
James Robeson	CACI International
Jeffrey Shanks	Strategic Management Solutions
Kevin Shannon	CACI International
Meghan Van Den Avyle	Sandia National Labs
Charles Villamarin	Sandia National Laboratories
Oscar Wall	Stoneridge Electronics
Tracey Wolfert	CACI International

Enchantment now has 139 members. That includes 115 regular members and 24 student members.

INCOSE has ~17,000 members in 70 countries worldwide.

Found Object Puzzler: *What am I? Can you correctly identify what I do? And how old I am? Send your best guess to bob.pierson@atacorp.com. The correct answer (and perhaps the best wrong guess) will appear in the next newsletter.*

INCOSE Enchantment Chapter Board and Committee Leads

Board of Directors

President	**Heidi Hahn**	hahn@lanl.gov
President Elect	**Robin Reynolds**	rmreyno@sandia.gov
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Director	**Anthony Matta**	armatta@sandia.gov
Director	**Eric Smith**	esmith2@UTEP.edu

Committees

Outreach	**Robin Reynolds**	rmreyno@sandia.gov
Prof. Development	**Ann Hodges**	alhodge@sandia.gov
Collab. Engagement	**Phil Bennett**	pcbenne@sandia.gov
Operations	**Bob Pierson**	bob.pierson@atacorp.com