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# Complex Systems and Complexity Measurement on Programs

**A One-Day Tutorial With Sarah A. Sheard**

**Thursday, 10 May 2010, 8:00 a.m – 4:30 p.m.**

**Location: CNM Workforce Training Center, 5600 Eagle Rock Ave., NE, Albuquerque, NM 87113**

## ABSTRACT

Many systems engineers have come across complex systems science only recently and only through popular books such as Gleick's *Chaos* or Waldrop's *Complexity*. Both sciences seek to explain phenomena seen across scientific disciplines in a general manner. How could such discoveries, which have ballooned with ubiquitous computing power, be applied within systems engineering? ***This tutorial shows how the fields of chaos, fractals, networks, self-organization, complex adaptive systems and the dynamics of complex systems can be applied to a variety of systems engineering situations and roles.*** A new module at the end of the day discusses ***complexity measurement for systems acquisition and development programs***, based on the author's Ph.D. dissertation work.

Topics include:

### Introduction

- Paradoxes in System Development
- The Complexity Quagmire
- Order-Chaos Spectrum

### Introduction to Chaos Theory

- Fractals
- Principles of Chaos

### Concepts from Complexity Science

- Edge of Chaos, Critical Point
- Power Laws
- Complex Adaptive Systems
- Fitness Landscape
- Self-Organization and Emergence
- Ashby's Law

### Attributes of Complex Systems

- Systems of Systems
- Islands of Order
- Complexity Profile and Scale
- Cooperation and Competition

### Networks

- Small World Networks
- Scale Free Networks and Power Laws
- Hubs
- Neural Networks and The Brain

### Dynamics of Complex Systems

- Phase Transitions
- Growth and Change
- Evolution of Complex Organisms

### Engineering and Managing Complex Systems

- Specific Tips for Adapting Systems Engineering for Complex systems
- Design, Risk Management, Genetic Algorithms, etc.

### Systems Engineering Complexity Measurement

- Measurement of processes and programs
- Systems engineering leading indicators
- Varieties of complexity and application for complex adaptive systems
- Measurement predictive of program outcomes

## THE PRESENTER

**Sarah Sheard** has over 20 years of experience in systems engineering, process improvement, and curriculum development and implementation. Ms. Sheard is defending her doctoral dissertation at Stevens Institute of Technology in March 2012. Her topic is on measurements of complexity that help predict improved outcomes on systems engineering programs.

As the Principal at Third Millennium Systems, Ms. Sheard teaches courses ranging from basic systems engineering to advances for the future, including systems engineering processes and application of the sciences of complex systems to systems engineering. She consults with private companies and government agencies regarding processes for systems engineering, systems engineering curriculum, managing complexity, and systems-of-systems. Ms. Sheard also teaches at George Washington University and University of Maryland Baltimore County.

Previously, Ms. Sheard led the systems engineering effort at the Systems and Software Consortium, engineered both air traffic control and systems engineering processes at Loral and IBM Federal Systems (now Lockheed Martin), and engineered satellites at Hughes Aircraft Company (now Boeing). Several of her papers are used in universities around the world, the most famous ones being Twelve Systems Engineering Roles, the Frameworks Quagmire and Principles of Complex Systems for Systems Engineering. Two of her papers received INCOSE symposium “Best Paper” awards. Ms. Sheard has given keynote speeches on three continents.

An INCOSE Fellow since 2006 and the 2002 INCOSE Founder’s Award recipient, Ms Sheard has published over 30 INCOSE papers, led the Communications committee and the Measurement technical committee, and currently leads the Complex Systems working group. She has also served as program chair and director of the Washington Metropolitan Area chapter and is an INCOSE Certified Systems Engineering Professional (CSEP).



## MEETING DETAILS

**Location:** CNM Workforce Training Center, 5600 Eagle Rock Ave., NE, Albuquerque, NM 87113, (505)-224-5200, URL: “<http://www.cnm.edu/campus/wtc/>”.

**Package:** The tutorial cost includes notes. Acknowledgement of payment receipt will be by email.

**Payment:** Please submit the attached registration form and \$200 (member), \$250 (non-member) or \$0 (student) as indicated on the form. See the Enchantment Chapter website and click on the link to the Tutorial page for opportunity to pay with PayPal. [www.incose.org/enchantment](http://www.incose.org/enchantment)

# **TUTORIAL ENROLLMENT FORM (Remit with Payment)**

## ***"Complex Systems and Complexity Measurement on Programs"***

Thursday, May 10, 2012

**Albuquerque, NM**

**→ PLEASE COMPLETE AND RETURN BY FRIDAY, MAY 4**

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Questions? Please contact Ann Hodges at [alhodge@sandia.gov](mailto:alhodge@sandia.gov) or Woody Weed at [jwweed@sandia.gov](mailto:jwweed@sandia.gov).