GSAW 2016 Tutorial H:

Architecting Effective Ground System Automation

Length: Half day

Overview:

Ground systems must be developed and operate in today's complex, chaotic world. A question becomes how to plan for the future when the rate of change is faster than traditional acquisition cycles can achieve. One answer is to minimize time spent on trying to achieve impossible levels of automation. Thus, a guide that establishes the current level of automation achievable for various category of decision support activities allows effective development of ground systems with tailored automation.

This tutorial discusses the learning dynamic responsive decisioning system set of activities must include and the factors that inform the maximum level automation each activity can be achieved. Applying this insight, ground systems can effectively be developed to cope with the hyperturbulent context and leverage a dynamic responsive learning ground.

The choice of level of automation is guided by the need to exploit human strengths (e.g., complex decision making, flexibility) and compensate for human shortcomings (e.g., consistency / repetitive induced errors). The choice of levels reflects a human-centered automation design (i.e., automate in support of human operators and with good human-machine interaction) and the use of decision support and intelligence management theory (i.e., bounding sets of activities with considerations for decision types, intelligence pyramid categories, and implementation solutions).

As in most characteristics of an activity, the state is not a bimodal state but rather a scale from no automation (i.e., manual) to fully automated (i.e., no human interaction) for each activity performed. Each activity to be performed is assessed to evaluate what level of automation is the best return on investment for that activity.

In a stable predictable context, automation can achieve improved operational tempo, increases in repetition quality, and better uses of labor. In an unpredictable changing context, automation can reduce responsiveness to change, create inability to perform unexpected tasks, and limit access to complex cognitive power (i.e. experienced experts). Thus, to get the best return on investment, architecting needs to establish levels of automation for each activity the system performs.

Human operators can respond to anomalous behaviors and provide a work-around in unstructured problems, while automation of structured problems ensures overloading and other impacts are quickly addressed with known options. The use of full automation can be brittle to contextual changes and / or Black Swan Events. "Black Swan" refers to unexpected events or conditions often considered extreme outliers that play vastly larger roles than regular occurrences (e.g., rise of the Internet, 9/11). An example of human responsiveness to a black swan event was during 9/11. It was humans who grounded the planes – no preplanned automation could not have done this.

Challenges for human activities include coupled systems, information overload, and ever-quickening tempo. To realize a balance of automation benefits and detriments requires a tailored mix of automation levels across the enterprise's activities. A balance of level of automation works in a high operational tempo with complex interactions and makes Intellectual Capital assets more effective.

Instructors: Linda Vandergriff and Lee Harkless, The Aerospace Corporation

Biographies:

Dr. Vandergriff is a Senior Project Lead at The Aerospace Corporation. She holds Doctorate of Science in Engineering Management and Systems Engineering and serves as a Complex Venture Architect. With 39 years of experience in classical systems engineering, she has served as chief engineer on two major acquisitions and consultant on numerous electro-optics related acquisitions; develops and teaches classes on complex venture architecting and acquisition; and performs mission level behavioral modeling and satisficing studies. She served as a consultant on INCOSE's 2005 Complex Systems Engineering tutorial. In her 2005 dissertation "Unified Approach to Decision Support for Agile Knowledge-based Enterprises", she explored the application of complexity theory to the ever quickening pace of ground systems. She was a contributing editor for the 2009 In Search of Knowledge Management Pursuing Primary Principles Knowledge Management textbook. She also wrote sections of the 2007 Aerospace Corporation's Mission Assurance Guide and 1999 National Science Foundation's Photonics Curriculum. In her recent research, she is exploring the role of adaptive systems engineering and the application of OODA loop practices to cope at the edge of chaos. The presentations for this conference are synopsis of this research focused in the areas of automation, model based architecting, and complexity theory insights.

Mr. Lee J. Harkless has over 50 years of experience in System Engineering, with a specialty in Human-System Integration. His current work includes defining levels of automation and the use of expert systems concepts to automate various customer's ground systems. Prior to joining Aerospace, Mr. Harkless worked in Human-System Integration in a variety of industries including Northrop Space Systems (SBIRS Mission Data Processing &Technical Intelligence), Raytheon (automated air traffic control & air defense systems), Aerojet (DSP infrared satellite surveillance systems), and JPL (world-wide ground tracking & control systems for unmanned space flight operations). Mr. Harkless has a B.S. from the University of Southern California, Los Angeles (combined Industrial Engineering, Education & Psychology), and did post-graduate work in Psychology at California State University, Los Angeles with Human Factors Independent Study.

Description of Intended Students and Prerequisites:

- The tutorial begins with a discussion of what is automation and the levels of automation for ground systems so it should be a great introduction for people who are not experts in the subject. It applies a structured approach to automation for ground systems so it should also be of interest to those who have some experience in the field.
- The tutorial builds on Dr. Vandergriff's dissertation on Decision Support for Agile Enterprises, thus discusses decisioning for ground systems that need to quickly react to a hyperturbulent context with observe, orient, decide, and act (OODA) processes.
- The final section of the tutorial, identifies the key functions necessary to perform decisioning and maps the theoretical maximum level of automation possible. This ensures that ground system automation does not waste time or resources trying to realize unachievable levels of automation.

What can Attendees Expect to Learn:

- A standardized approach to the levels of automation that exists for ground systems
- What activities are performed in decisioning for ground systems and the factors that influence the selection of automation level
- Considerations for ensuring automation does not introduce new sources of error and system failure / brittleness