Training Summit Presentation Abstracts

Huntsville Society of Reliability Engineers — U.S. Space & Rocket Center — RAM XV Training Summit

Educator Training Facility, Huntsville, AL **Nov. 1st & 2nd 2023**

Day Time	Room	Ses #	Presenter	Title	Abstract
Day #1 Ses# 1 Time: 0930 - 1030	A	A1a	Alden Moreton	Leveraging IIoT Techniques for Real-Time Systems Integration	This presentation explores industry leading streaming and industrial internet of things (IIoT) techniques for use in real-time systems. A large emphasis will be put on how organizations can integrate previously disparate sensor pipelines into a single system with sub-second latency. Benefits of pipeline integration include reduction in hardware duplication as well as opportunity for statistical model advancements. Our examples for this will be from the perspective of an aviation implementation and will include prognostic health monitoring (PHM), computer vision, and decision automation as possible use cases. We will begin by outlining the significance of IIoT in our industry, highlighting the ability to collect and analyze data from a multitude of connected devices in real-time. Next, we will delve into the key components and architectural considerations of a robust streaming data infrastructure tailored for IIoT systems monitoring. Topics covered will include data ingestion, processing, and visualization techniques. Finally, we will explore how systems like these may be securely deployed to the edge. The goal of the presentation is to inform listeners on the possibilities streaming pipeline integrations create for developers, as well as how they may be implemented.
		A1b	Zeb Freeman	Enhancing Reliability Engineering through Advanced Visualizations and User Interfaces	This presentation explores the transformative role of advanced 3D visualization models and user interfaces in driving digital innovation within the military domain, particularly in the context of reliability engineering. By leveraging live streaming data, modeling and simulation techniques, and predictive maintenance strategies, these technologies offer tremendous potential to enhance operational readiness and optimize maintenance processes in military systems. This session will go into the practical applications of visualization, user interfaces, and data-driven methodologies, and how they are integrated within the Future Vertical Lift (FVL) program. Through real-world examples and case studies, attendees will gain insights into how these aspects can drive reliability and effectiveness in military operations.
	B	B1a	Rachel Boydston	H-1 Modeling & Simulation	This session will detail modeling & simulation engineering projects that have recently been conducted on the H-1 aircraft program and maintenance facilities. The brief is intended to demonstrate how modeling and simulation tools are being used to solve practical, real-world problems being experienced throughout the H-1 community. These typical reliability engineering processes and tools are being applied and utilized in the field today in order to provide tangible benefits to the warfighter. The benefits are realized in the form of better maintenance practices and scheduling, more accurate availability and readiness predictions in order to prepare for operations, and determination of root causes of deficiencies. While this brief focuses on DoD applications, the processes and tools used are applicable to other industries.
		B1b	Tate Fleming	The Effects of M-out-of-N Systems on Reliability Metrics	For many System of Systems (SoS) – especially military defense systems – the reliability of its required systems is often the driving factor of the SoS's availability. System redundancy is an effective technique for increasing SoS availability. Redundancy can also be used when multiple of a system are required for the overall SoS to be operational. Systems with this application of redundancy are commonly known as M-out-of-N systems. The following study observes the effects that variations to M-out-of-N systems have on SoS reliability metrics. A modified SoS Analysis Toolset (SoSAT) is used to model and simulate a hypothetical SoS with different M-out-of-N system requirements. Statistical techniques are used to reduce resource consumption and determine the highest impacting factors to the model's reliability results.
Day 1 Ses#2 1045 - 1215	A	A2	Dr. Favssal Safie	Reliability Engineering the Link to Safety and Risk assessment	The tutorial starts with a detailed discussion of reliability engineering followed by a brief overview of PRA and safety engineering. This includes definitions and tools and techniques that are commonly used by government and industry. The main intend of the tutorial is to show the differences and the links between reliability and safety, and reliability and Probabilistic Risk Assessment (PRA). The tutorial also discusses a case study that show how reliability, safety, and PRA work together in a complimentary manner to support critical program decisions. The material in this tutorial is based on over 30 years of extensive industry and Government experience in reliability engineering, safety, and risk assessment.
	B	B2a	Keith Zook	Bridging the Gap Between MBSE and RAM Using Parametric Diagrams	Many of today's complex weapon systems are represented as models using Model Based Systems Engineering (MBSE) tools and methodologies. Several MBSE languages and frameworks exist for this purpose, including the System Modeling Language (SysML) and the Unified Architecture Framework (UAF). Much of the focus of a system model is on its required behavior – what the system does, and its structure – system components and interfaces. Several SysML and UAF diagram types are dedicated to the graphical representation and illustration of a system's required behavior and structure. Non-functional constraints of the system, however, simply cannot be modeled as behavior or structure. These non-functional constraints include physical properties such as size, weight, color, natural and induced environmental conditions, safety, and security. These physical properties, represented in SysML as Value Properties, and in UAF as Measurements, are 'owned' by the system, or its subordinate components. Reliability and availability constraints can also be modeled in this manner and, subsequently, form the basis for performing comprehensive calculations directly within the system model using equation parameters that are directly linked to the system's properties. This presentation explains in detail how to represent RAM-type system properties within a system model and perform supporting calculations, within the central model repository, using SysML/UAF Parametric Diagrams.
		B2b	Connor Green	Using Big Data Analytics Approaches to Analyze Aviation and Missile RAM Data	As the amount of data that engineers and analysts need to evaluate increases, the use of Artificial Intelligence (AI) and Machine Learning (ML) techniques become more critical. Dimensionality reduction techniques, cluster analysis, application of neural nets and transformers, and Natural Language Processing (NLP) can all be used to find patterns and relationships within large data sets. The domain of Reliability, Availability, and Maintainability (RAM) for aircraft and missiles provides an ideal application for these big data methods. For aviation data, looking at relationships and patterns within and between maintenance events and on-board flight sensor data for the UH-60 M aircraft can provide added value for maintenance and logistics managers. Using the ML-derived relationships between sensor data and subsequent maintenance events can reveal potential channels that function as indicators of upcoming non-scheduled maintenance events. For missile system data, looking at relationships and patterns within and between component testing data, flight testing data, field data, and surveillance inspections and testing data for the HELLFIRE missile helps support the Stockpile Reliability Program (SRP). Our presentation will explain in detail how we are using data science tools and techniques to provide value to RAM stakeholders through the innovative analysis of aviation and missile big data sets.
Day #1 Ses#3 Time: 1315 - 1415	A	A3	Richard Meshell	The Past, Present, and Future of Probabilistic Risk Assessment	Probabilistic Risk Assessment (PRA) serves as a cornerstone for understanding and managing complex risks across a wide array of industries. Delving into PRA's genesis in weapons development and nuclear safety helps gain valuable insights that pave the way for its contemporary application across diverse sectors. This rich history and broad-based utilization aid in constructing a robust framework for the evolution of the methodology. As we approach a new era defined by emerging technologies—small modular reactors, advancements in artificial intelligence, or the establishment of lunar bases—our comprehension of PRA's past and present equips us to effectively navigate the future of risk assessment and management.
	B	B3	Nathan Rigoni	Demystifying Large Language Models: How do we use them in reliability?	The recent developments of OpenAI and Google in the realm of pretrained models has no only made a technological leap forward din AI but has become a viral sensation through the use of DALL-E, VALL-E, and chatGPT. Being able to converse with AI in order to generate data or perform tasks such as search is currently revolutionizing the engineering industry. For reliability there are many areas that this technology can be applied that advance the readiness of fleets and inform the maintainer of the optimal way to maintain aircraft. The generalize understanding of operational data in these AI assistance will change the way we do business and revolutionize the way the warfighter operates. This presentation will break down the common Large Language models and talk about potential use cases in reliability and condition based maintenance."

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Day #1 Ses#4 Time: 1430 - 1600	A	A4	Ann Marie Neufelder (Mission Ready Software)	**First Half of Mod 11 Integrating HW and SW Predictions**	This is a 2-part session on Integrating Software and Hardware Reliability Predictions. The session will discuss how to identify the portion of total system failures that are likely to be due to software versus hardware. The relative portion of total failures due to software is then used to derive a system objective that is feasible in consideration of the growing size of software in today's mission critical systems. Next the methods for combining software and hardware predictions will be covered. These include simple methods such as reliability block diagrams as well as more complex methods such as the mission model, operational profile model, use case model and Markov model. Then the methods for allocating the system reliability to individual software components is covered. These methods include two top-down methods and one bottom-up method. All the methods are recommended by the IEEE 1633 Recommended Practices for Software Reliability.
	B	B4a	Ernesto Primera (University of Delaware)	**Equipment Reliability Analysis Process and Validation Methods through AI (ChatGPT) - Case Study**	Rotating equipment plays a pivotal role in various industrial sectors, impacting the global economy significantly. Ensuring the reliability of such equipment is paramount to maintaining the efficiency, productivity, and competitiveness of industries worldwide. This research dives deep into the reliability analysis of rotating equipment, from pumps, turbines and compressors to blowers and beyond. By employing Time-To-Failure data from a 15-year study on a specific model of rotating equipment, we present a comprehensive understanding of failure patterns. Descriptive statistics illustrate the variability in failure times and the differing lifespans of components such as bearings and mechanical seals. However, the traditional reliability analysis methods may present uncertainties. This paper introduces an innovative approach to bridge these gaps: the utilization of Artificial Intelligence, particularly ChatGPT, to validate the research findings. This integration not only emphasizes the significance of blending traditional reliability methods with modern AI-driven validation but also paves the way for more informed decision-making in the realm of rotating equipment management. Through this synergistic methodology, industries can achieve a more reliable, efficient, and sustainable operation, minimizing unexpected equipment failures and maximizing operational availability.
	B	B4b	Kristin Weger, Ph.D. (The University of Alabama in Huntsville)	**Cracking the Code of Failed Digital Transformations: Key Insights and How to Succeed**	Why organizations fail with their digital transformation. This presentation will focus on how organizations need to consider social systems, technical systems, and cultural change to succeed in a digital transformation. Particularly as these transformations are vital for competitiveness, yet many organizations need to catch up. Challenges include resistance to change, poor communication, and lack of leadership support. Organizational structures and siloed cultures impede integration. Inadequate infrastructure, legacy systems, data management, and IT resistance pose technical obstacles. Cultural barriers include a lack of innovation, digital literacy, and fear of job displacement. By addressing these factors and by taking the social and technical systems into account, engineering companies can achieve successful digital transformations, ensuring competitiveness in the industry. Yet, overcoming these challenges requires effective change management, improved communication, and leadership support. Bio: Kristin Weger is an Assistant Professor of Industrial Organizational Psychology in the Psychology Department at the University of Alabama in Huntsville. Her research focuses on organizational adoption, digital transformations, Industry 5.0, and leadership training. She received her PhD from Otto-Friedrich-University, Germany and worked for four years in the Industry as Consultant before arriving in Huntsville in 2017.
	B	B4c	Rachel Boydston (ASI Andromeda Systems Incorporated)	**Success Stories for Data Analytics and Visualization**	This session will detail various data analytics and visualization tactics used within the Naval Aviation Enterprise (NAE). The brief is intended to demonstrate how visualization tools and data analytics are being used to solve practical, real-world problems and streamline communication across the NAE logistics community. These typical reliability engineering processes and tools are being applied and utilized in the field today in order to provide tangible benefits to the warfighter. The benefits are realized in the form of better maintenance practices and scheduling, more accurate supply availability and predictions to prepare for operations, and determination of root causes of deficiencies. While this brief focuses on DoD applications, the processes and tools used are applicable to other industries.
Day #2 Session 5 Time: 0900 - 1030	A	A5	Ann Marie Neufelder (Mission Ready Software)	**Second Half of Mod 11 Integrating HW and SW Predictions**	Part 2 of 2, See A4 this is a two part session
	B	B5a	Quinn Slaugenhoupt (Bastion Technologies)	**The Last 10 Years in Spaceflight: Failures and Fixups**	This project is an overview and analysis of the past ten years (2013 – present) in global spaceflight, highlighting the orbital launches of countries, particularly the failures that occurred, the reasons they occurred, and a breakdown of the related statistics and background information. The analysis is conducted from a perspective of reliability and maintainability engineering and Probabilistic Risk Assessment (PRA) to formulate a quantifiable understanding of the data and how it is pertinent to Safety and Mission Assurance (SMA) in spaceflight. There is a breakdown by country or group, timelines, and number of launches. The failures over the years are categorized, all given a broad analysis of subsystem failures and details of events. A few failures are given a more in-depth analysis of root causes and failure modes determined by their unique or common nature. The data is retrieved from online, publicly available sources.
	B	B5b	Ernesto Primera (University of Delaware)	**Machine Learning Applied in Rotating Machinery for Anomalies Detection & RUL Estimation - Gearbox Case Study**	Rotating machinery stands as a fundamental cornerstone in numerous industries, orchestrating a myriad of critical operations. This study dives deep into the mechanical health of a specific rotating machinery, emphasizing its bearings and gears—components notorious for their susceptibility to high failure rates. Predominant anomalies, characterized by escalated vibrations, pointed towards operational challenges, foreseen to persist for the coming decade. The prime directive of this research pivots on the prognostication of the moment when these anomalies would breach accepted operational standards. By achieving this, the study endeavors to facilitate meticulous maintenance planning, ensuring optimal machinery lifespan and forestalling unplanned operational interruptions. Central to this study is the Prognostics and Health Monitoring (PHM) framework, weaving together a spectrum of stages, from data capture to informed decision-making. PHM's twofold aspects—diagnostics and prognostics—offer an exhaustive perspective, elucidating anomalies and ascertaining the Remaining Useful Life (RUL) of the machinery's vital components. One of the paramount challenges resonating through this exploration concerned the intricate dance of data acquisition and its ensuing management. The incorporation of wireless sensors, adept at capturing a frequency spectrum ranging from 0.5 Hz to 5,000 Hz, enabled a nuanced collection of vibration data across the machinery's bearings and gears. This rich data, chronicling a defined timeframe in 2021, underwent rigorous analysis, fortified by analytical methodologies such as neural network. Employing both descriptive and predictive analytics, the study converged on the Linear regression method as the most propitious avenue for vibration data analysis.

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Day #2 Session 6 Time: 1045 - 1215	A	A6a	Mike Olivier	Failure Review Board (FRB)	This training session will familiarize the audience with the need for and techniques used to conduct Failure Review Boards (FRBs). FRBs are used to formally investigate failures and develop evidence both for and against potential failure root cause(s). Failure root cause determination is the starting point for corrective action development and implementation. The FRB closes the failure investigation by verifying the efficacy of the corrective action.
Day #2 Session 6 Time: 1045 - 1215	A	A6b	Russ Alexander	Effect of R&M Parameters & Interactions on Op Av and O&S Costs	The presentation describes the methodology and results from using a fractional factorial experimental design to study the effect of R&M parameters, such as MTBx and MTTRx, and their interactions on certain response variables including Operations and Support (O&S) Costs and operational Availability (Ao). The LogSIM discrete event simulation at the U.S. Army Combat Capabilities Development Command-Aviation and Missile Center Logistics Laboratory was used to conduct the experiments using a 29-4IV fractional factorial design.
Day #2 Session 6 Time: 1045 - 1215	B	B6a	Samantha Rawlins (PhD Student)	Reliability Engineering as the Bridge Between Systems Engineering, Design Engineering and Integration and Test	Reliability engineering is a crucial discipline for product development; however, it is often overlooked by programs. This neglect has repeatedly resulted in avoidable cost and schedule overruns or even complete mission failures that could have been prevented. Several improvements to the development process have been proposed that prioritize reliability, such as Design for Reliability (DfR), Reliability-Based Design Optimization (RBDO), or Reliability-as-an-Independent Variable (RAIV); however, none have been thoroughly implemented in industry. The author proposes that the reason for this lack of adoption is due to a failure to demonstrate exactly how reliability should be utilized with the major programmatic disciplines of Systems Engineering, Design Engineering, and Integration and Test. This work presents a new framework, called Reliability-Driven Design and Test (ReDDT), that integrates reliability into each of the three disciplines and shows how reliability, and the associated uncertainties, can be used as a bridge to provide traceability and verification between the three. This process, while generic to all systems, is most useful for complex systems with a high consequence of failure. Consequently, this work is illustrated by following a generalized rocket engine design from system requirements to an initial engine test plan.
Day #2 Session 6 Time: 1045 - 1215	B	B6b	Derek Koehl (Grad Student)	Measuring Latent Trust Patterns in Large Language Models in the Context of Human-AI Teaming	Qualitative self-report methods such as think-aloud procedures and open-ended response questions can provide valuable data to human factors research. These measures come with analytic weaknesses, such as researcher bias, intra- and inter-rater reliability concerns, and time-consuming coding protocols. A possible solution exists in the latent semantic patterns that exist in machine learning large language models. These semantic patterns could be used to analyze qualitative responses. This exploratory research compared the statistical quality of automated sentence coding using large language models to the benchmarks of self-report and behavioral measures within the context of trust in automation research. The results indicated that three large language models show promise as tools for analyzing qualitative responses. The study also provides insight on minimum sample sizes for model creation and offers recommendations for further validating the robustness of large language models as research tools.
Day #2 Session 6 Time: 1045 - 1215	B	B6c	Andrew Atchley (Grad Student)	Definition of Reliability Across Disciplines	Recent studies have found that there are considerable deviations in the definition of reliability across disciplines. Few if any studies have examined how professionals in applied settings define reliability. We are conducting a survey among DoD professionals on LinkedIn to evaluate how reliability is conceptualized in the 'field.' In this survey, we are asking participants to define reliability, to explain what constitutes good and poor reliability, what measures they use to evaluate reliability, and what factors are most critical to assessing reliability. We also ask participants to select the most applicable definition among key reliability definitions highlighted in a previous review. This presentation will summarize literature findings, and results of the survey will be analyzed by the time of the presentation.
Day #2 Session 7 Time: 1315 - 1415	A	A7	Charles "Ronnie" Knight	Modeling and the Assurance Engineering Disciplines	This presentation surveys modeling in the rapidly developing digital engineering environment. Drawing on the experience of leading an effort to implement modeling capabilities in the Safety and Mission Assurance technical community at Marshall Space Flight Center, the presenter will discuss how models can be used to capture existing knowledge and create new knowledge. The foundation of engineering with digital models draws on an interesting connection between engineering and philosophy. The ramifications of that connection will be part of the discussion during the session.
Day #2 Session 7 Time: 1315 - 1415	B	B7a	Nicole Moore (Grad Student)	Stakeholder Elicitation for Autonomous Robotic Systems Design for Mission Critical Environments	The utilization of autonomous systems has witnessed an increasing trend, particularly with the advent of Industry 4.0, presenting new and complex challenges for comprehending stakeholder design preferences for robotic systems that promote acceptance and adoption. These preferences hold particular significance in mission-critical environments where reliability is paramount. Despite existing studies on user trust and the adoption of autonomous systems, there is a gap in the literature concerning the influence of predispositions and personal subjective values that affect individual design preferences for dependable robotic systems in mission-critical environments. To better understand these preferences structured interviews (N = 5) were conducted with several distinguished stakeholders. Responses revealed main preferences for themes regarding efficient quadrupedal autonomous robot designs, authoritative masculine voice communication, a preference for simulation training, and a heightened desire for increased interaction with autonomous robots. By focusing on design preferences, our study extends the existing literature on stakeholder adoption of autonomous robots and provides valuable insights into the impact of personal subjective values on stakeholder preferences, particularly in terms of reliability and engineering considerations.
Day #2 Session 7 Time: 1315 - 1415	B	B7b	Taylor Yeazitzis (Grad Student)	Affordability Culture in Organizations	Affordability has been a growing interest in organizations over the years. A relationship between reliability, maintainability, and affordability exists wherein reliability and maintainability of a system are related to affordability by way of cost of logistics support and infrastructure, cost of preventative maintenance, and cost of corrective maintenance. Though affordability is an ever-present issue within organizations, there is a lack of research surrounding affordability culture as an organizational subculture. The current study aims to close this research gap by identifying organizational aspects associated with affordability in which current organizational practices can be evaluated by organization members. To accomplish this goal, 346 participants from NASA, industry, and The University of Alabama in Huntsville were surveyed to understand the organizational aspects associated with affordability. Survey questions were grouped based on organizational components related to affordability, including the clarity of organizational goals, communication behaviors, working relationships, planning and scheduling behaviors, roles and responsibilities, processes, and budgetary aspects. Organization members were prompted regarding perceptions of these behaviors that can in turn impact the affordability of a project or program. Responses indicated that students tended to evaluate affordability in terms of budgets and funding, whereas NASA and industry respondents tended to evaluate affordability in terms of the organizational behaviors associated with affordability. Results from this study can be used to inform organizations of employee perceptions regarding current organizational behavior related to affordability.

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Day #2 Session 8 Time: 1430 - 1600	A	A8	Lisa Bates	**Defining & Developing a Digital Twin through creating synergies between Cyber, Software, Reliability & Safety**	Defining & Developing a Digital Twin through creating synergies between Cyber, Software, Reliability & Safety • This presentation will use a simple system of air pump to walk you through some practical answers to the following questions. • Defining the trade space for an affordable, efficient digital twin • How do you provide a real digital engineering end to end experience for the life cycle of a product from design to end of life to include training your people to work in that type of environment? • What do Machine Learning, Model Based Systems Engineering, Cyber, Software, Reliability and Safety functions have in common and how can we synergize them in a more automated way to build a practical affordable digital twin. • What does an Open Systems Dev*Ops low code to no code infrastructure for low cost development really look like? • Effective tools for knowledge sharing for all generations. Combining videos, wikis, sharepoints, teamwork cloud with search engine optimization techniques for your on premises intranet.
	B	B8a	Oluyinka Adedokun (Grad Student)	**Challenges in Developing Requirements for AI-based Systems: A Systems Engineering Perspective**	Artificial Intelligence has been referred to by many authors as the imitation of human intelligence by machines with the capability to think, learn, and make a decision with the ultimate goal of exceeding human intelligence. This has been demonstrated by many systems across various disciplines and industries by accomplishing various tasks and solving the most difficult and pressing problems. Its various applications in systems are referred to as AI-based systems. These systems are software-based systems that possess at least one component of AI, inclusive of the conventional software components. Simply put, it is the combination of conventional software and AI components. AI components (especially ML-based) usually consist of data, a machine learning model, and a framework; they are completely different from conventional software systems based on their data-driven nature, unpredictable behavior, and changing nature due to new data injection. Also, the requirement specification of conventional systems cannot be adopted for AI-based systems based on the varying input and output data-driven nature, techniques, and emergence of new requirements, hence the need to identify the challenges in developing requirements for AI-based systems. The current challenges for developing RE ranges from data requirements, requirement definitions, emergence of new requirements, NFR, roles of stakeholders etc which cut across the data, model, and systems axis of the RE processes. This presentation will focus on discussing these challenges in addition to highlighting a formal approach to address these challenges
		B8b	Luke Symasek (Undergrad Student)	**Individual Differences in the Acceptance and Adoption of Digital Technology**	Digital technology is increasing in its usefulness and potential to improve people's lives and the workflow of a business; however, technology is not always immediately accepted or adopted. Businesses often have a difficult time implementing a new digital technology because of a lack of acceptance from its employees, a lack of adoption from instructors can cause educational settings to lack the proper technological education, and medical institutions could be aided from mobile health applications if only people would use them. Because of the importance and potential usefulness of digital technology, it is important for organizations to understand what factors affect someone's likelihood of adopting and using a technology. One way in which research has examined the acceptance of technology is through individual differences (IDs) in the groups that the technology is targeting. The current presentation comes from a literature review examining studies researching IDs' influence on the acceptance of technology. Some of the IDs frequently examined in the research include personality traits, gender, social influence, socio-economic status, self-efficacy, trust, personality, and experience. Different circumstances will also affect how these IDs influence the acceptance of a technology. Banking applications, for example, rely on trust from the consumers using them, while educational institutions often need their teachers to have self-efficacy with using technology to effectively implement it. While IDs may affect acceptance differently in different circumstances, the findings from the literature review did allow for the creation of acceptance and adoption model by considering these various IDs.
		B8c	Yeraldy Bermudez (Undergrad Student)	**The Use of a Smart Factory Laboratory to Demonstrate Digital Manufacturing Capabilities in Ind & Sys Engr**	The adoption of the emerging technologies of the fourth industrial revolution, or Industry 4.0, is one of the most significant challenges facing today's manufacturing organizations. Successful applications of these technologies can accelerate a company's transition from traditional manufacturing to digital manufacturing. Digital manufacturing is the use of computer systems and digital technologies in manufacturing operations to improve productivity, quality, and reliability. These technologies include cyber-physical systems, automation and robotics, artificial intelligence and machine learning, digital twin and simulation, and additive manufacturing. The Industrial and Systems Engineering Department at the University of Alabama in Huntsville has established a Smart Factory laboratory to demonstrate the capabilities and challenges of Industry 4.0 cyber-physical systems. Over two semesters, a senior design team consisting of four students created standard work instructions to facilitate the efficient operation of the smart factory and developed various labs to facilitate its use in different classes. This presentation will introduce the smart factory, the standard work instructions created to facilitate its operation, and the development of one of the labs, which integrates the smart factory into our core simulation class.