Systems Engineering Education and Training Programs
Weber State University, University of Utah
January 2020

The purpose of this document is to outline the need for systems engineering education and training programs in Utah. Over the past year, Utah companies such as L3, Northrop Grumman, Sarcos Robotics, Stadler Rail, Hill Air Force Base, Lockheed-Martin, Moog, Boeing, Borsight, Stryker, Kihomac and other companies have expressed concern about the shortage of systems engineers in the state of Utah. Collectively, companies across the state have identified hundreds of high paying job openings that require training and experience in systems engineering.

Systems engineering is a specialized type of engineering that is more and more common among companies today. Just like electrical, mechanical and civil engineering, systems engineering plays a critical role for these companies. They have identified that specific courses, certifications and training on systems engineering would help fill their job demand in that area.

In the fall of 2019, the Governor's Office of Economic Development convened a meeting with several Utah companies, the Utah System of Higher Education, and deans from the following universities; Utah State University, Weber State University and the University of Utah. During this meeting, the institutions had the opportunity to share with the companies the engineering programs they already have in place. The companies also had the opportunity to share their recommendations for integrating systems engineering into those programs. Following that meeting, the three universities submitted a proposal as to how they could better meet the needs of industry. Representatives from those companies then reviewed the proposals and recommended the both Weber State University and the University of Utah would best meet their needs.

The proposed plan would be between the two institutions, Weber State University and the University of Utah, to increase access to distance based instruction for current systems engineering certificates, expand curriculum to include additional technical elective courses to train working professionals, create an area of emphasis for systems engineering for undergraduate students and provide concurrent enrollment systems engineering pathways. Through these combined efforts, Utah will be able to better meet the needs for this critical skillset among companies in Utah.

The proposals from the University of Utah as well as Weber State University are attached. A high level budget is below:

Institution	One Time	Ongoing
Weber State University	$22,000	$200,000
University of Utah	$170,000	$400,000
Total	**$192,000**	**$600,000**

Expanding Systems Engineering Education and Training in Utah

University of Utah, College of Engineering
Prepared by: Andrew Merryweather, PhD – Associate Professor, Mechanical Engineering
Last Updated: January 24, 2020

1 Application Overview

The University of Utah College of Engineering proposes a strategic plan to address the *critical need for systems engineering education and training* identified by major Utah employers in the technical sector. We plan to expand systems engineering education and training in three areas: 1) **Increase access** to distance-based instruction and training to our systems engineering certificate program, 2) **Expand curriculum** to include additional technical elective courses to train working professionals in systems engineering and systems management, and 3) **Create an emphasis area** in systems engineering for undergraduate students to compliment current bachelor's degree programs in the College of Engineering. To satisfy the urgent need to provide a rigorous and exceptional training program for systems engineering in the state, we will build upon our existing Graduate Certificate Program in Systems Engineering, established in 2008. An abbreviated outline of our plan follows:

I. The College of Engineering has had a Graduate Certificate Program in Systems Engineering in Mechanical Engineering for nearly 12 years and has graduated 85 students.
   a. Now we propose to expand systems engineering to the rest of the College of Engineering and increase access to distance learners and working professionals using evening, summer and intensive training courses (week-long and hybrid formats).
   b. We will do so by making the existing graduate certificate program work for the other departments in the college and design curriculum to meet the specific needs of each of the engineering disciplines in the college.

II. We will develop an undergraduate certificate program within the College of Engineering in systems engineering to compliment current bachelor's degree programs across the college.

III. We will embed systems engineering into many courses throughout the college, starting with capstone and design courses, introducing systems engineering approaches and tools.
   a. The results will be all College of Engineering graduates having some background and education in systems engineering thinking, and many students having a focus (certificate or emphasis) in systems engineering.

The budget needed to do execute our plan is $400,000 in ongoing support to grow and sustain the program to the desired level and $170,000 in onetime support. A description of the plan to accomplish our vision and a detailed version of the budget are found in Sections *4 Proposed Plan* and *5 Budget* of this document.

The remainder of this application is organized into 4 Sections: *Need for Systems Engineering Program Support, Current Systems Engineering Certificate Program and Undergraduate Emphasis Areas in Mechanical Engineering, Proposed Plan, and 5 Budget.* Upon completing our plan, we will achieve an optimal format for delivering the urgently needed education and training in systems engineering necessary to maintain Utah's thriving economy.

2 Need for Systems Engineering Program Support

We have entered a different era, where a system's complexity requires a far broader range of expertise than was typical previously. Professionals are coming to systems engineering earlier in their careers without the benefit of

years of experience as discipline or component specialists. To mitigate the effects of reduced experience it is imperative that appropriate tools be used (example of a systems engineering tool is found in Attachment I), and that appropriate training in applying the tools be provided. While "overdependence on tools at the expense of talent or training" may be a common pitfall, tools can, nevertheless, enhance and standardize systems engineering efforts. Without standardization the subjective nature of many systems analyses is typically at the highest level, directly influencing or creating the conclusion. Some of the techniques available to the systems engineer put the subjective assessments at the lowest level of the analysis, where the conclusion is likely to be less affected by subjectivity.

The *primary objective* of the Graduate Certificate in Systems Engineering at the University of Utah is to provide working engineers with the skills to design and manage complex mechanical and organizational systems. The current program provides participants with an understanding of the fundamentals of systems engineering and the ability to develop, analyze, and model systems of all kinds. Participants learn to develop both general system performance requirements and quantitative system metrics for the management and evaluation of systems.

Currently, undergraduate programs are siloed, meaning they focus on specific skills traditionally expected in their disciplines (e.g., Chemical Engineering, Electrical Engineering, and Mechanical Engineering). With added complexity and the overwhelming presence of complex integrations among engineering disciplines, additional cross-training and systems level thinking approaches are needed to strengthen engineers graduating from these traditional, focused programs. Our proposal will unify the departments across the college and modify our existing Graduate Certificate Program in Systems Engineering to serve all departments in the college.

Feedback from industrial partners suggests that by leveraging our existing certificate program and expanding it to include more departments within the college, we can meet the growing need for systems engineers in Utah. Further investment in undergraduate and graduate training programs will continue to fuel the growth of Utah's economy and fill the clear need for specialized training in systems engineering in our state and beyond.

3 Current Systems Engineering Certificate Program and Undergraduate Emphasis Areas in Mechanical Engineering

We have been offering graduate classes in a distance-learning format for nearly 12 years (partnership between Orbital ATK, now Northrop-Grumman and UU) and have graduated 85 students. In this program, on-campus classes are recorded and uploaded to a learning management system (CANVAS) the same-day for viewing by off-campus students. These students receive the same high-quality instruction as the face-to-face students, albeit without the benefit of real-time interaction.

The current Systems Engineering Certificate program is open to all matriculated, upper-division College of Engineering students or any student who has a bachelor's degree from a recognized engineering program or an allied science. To obtain the certificate the student must complete 15 credit hours of approved course work, plus a project. The course work is made up of 9 hours of core courses, and 6 hours of electives. The Systems Engineering Certificate options are based on existing UU courses. The 3 core courses provide engineers with a basic understanding of systems engineering and the ability to develop, analyze, and model systems of all kinds.

These core classes are:

Fundamentals of Systems Engineering
This course provides an overview of the art and science of systems engineering, and an introduction to the systems approach and methodological framework for creation and reengineering of large-scale systems and processes at technology readiness levels 1 through 6. Topics covered include the systems approach, understanding and defining customer (stakeholder) problems, eliciting and defining stakeholder requirements, defining stakeholder-driven value systems, developing alternative system concepts, modeling and analysis of

alternatives and associated risks. There will be a focus on multi attribute utility theory to provide guidance for integrated engineering approaches, and design uncertainty as part of the architecture tradespace. The student will develop an understanding of the larger context in which requirements for a system are developed, and learn about trade-offs between developing mission needs or market opportunities first (versus assessing available technology first). Techniques for translating needs and priorities into an operational concept and then into specific functional and performance requirements will be presented. The student will develop an understanding of risk management techniques.

Requirements Engineering and Management

This course provides the principles, practices, knowledge, and skills to organize and distribute requirements, and develop derived requirements, which together form the starting point for engineering of complex hardware / software systems. The student will assess and improve the usefulness of requirements, including such aspects as correctness, completeness, consistency, measurability, testability, and clarity of documentation. There will be a strong focus on developing a master verification plan (MVP), assigning verification types, determining requirements validation, and developing the compliance matrix. This course will provide the student with the theoretical and practical aspects of discovering, analyzing, modeling, validating, testing and writing requirements for systems of all kinds. The student will learn how interface control and how ICs are created and managed through the life of a program. The course will examine the processes and methods to identify, control, audit, and track the evolution of system characteristics throughout the system life cycle, and the student will be able to create and maintain a configuration and requirements management plan and procedures. Case studies involving different types of program / engineering systems and requirements engineering methods and techniques will be used.

Systems Engineering Capstone and Project: Systems Engineering and Integration

This course provides the student with an understanding of the context and framework for carrying out a systems-engineering project and the system-level responsibilities of a systems engineer, through hands-on activity. Topics covered include systems design and development, system test and evaluation, system reliability, system maintainability, human factors and system design, system producibility and supportability, balancing life-cycle cost, schedule, suitability and performance, risk management, and systems engineering project management and control. Types of systems considered will range from small-scale to large-scale and from primarily technical to primarily social-political. Students will carry out projects and assignments both individually and as teams, with a final project accounting for up to 40% of the course grade.

Five program specific option areas that have been identified to include technical electives are:

1. Systems Engineering Management
2. Product Engineering Design
3. Manufacturing and Process Systems
4. Design Systems Optimization
5. Transportation Operations

These five option areas will allow students to apply the understanding of systems engineering learned in the core courses to their specific background or area of interest. Assessment mechanisms include student course evaluations, student exit interviews, industry feedback and student placement. In addition, graduates of the certificate program are contacted one year after certificate completion (or graduation, in the case of students who receive the certificate as part of an M.S. degree) to provide feedback on the relevance of the certificate curriculum and make suggestions for course modifications, new course material, and new courses. The Systems Engineering Certificate Program Advisory Committee meets at least once per year to review and assess the program for continuous improvement.

3.1 Industrial and Systems Engineering Emphasis

For undergraduates interested in focusing a portion of their technical education in a specific subdiscipline, individual departments create emphases in more specific areas of study. For example, in Mechanical Engineering there are 13 areas of emphasis:

1. Aerospace Engineering	2. Biomechanics
3. Design & Manufacturing	4. Dynamics & Control
5. Ergonomics & Safety	6. Fluid Mechanics
7. Mechatronics	8. Micro/Nanoscale Engineering
9. Modeling	10. Robotics & Control
11. Solid Mechanics	12. Thermal Science & Energy Engineering
13. Industrial Engineering (*New 2019)	

Courses which could be offered to support a Systems Engineering emphasis include:

1. Systems Modeling & Simulation (including Queueing Systems)
2. Engineering-Oriented Optimization (Non-linear & Linear Programming)
3. Lean Manufacturing and Services
4. Quality Engineering (with Statistical Quality Control)
5. Material-Handling Systems
6. Production & Inventory Control
7. Decision Analysis
8. Regression Modeling and Forecasting

Existing courses have been identified that would be applicable to a Systems Engineering emphasis. These are presented in Attachment II of this document and can be expanded to cover all necessary specialty training across departments within the college.

4 PROPOSED PLAN

The University of Utah College of Engineering maintains a strong working relationship with industry in Utah to offer graduate degrees and coursework, including our Systems Engineering Certificate program designed and created in partnership with Orbital ATK in 2008. This type of training program specifically targets Utah professionals seeking advanced training and education (see Attachment III for examples of jobs needing systems engineering training).

We expect enrollments to continue to increase as the current program enrollment has almost doubled in the last 2 years, and it is only servicing Northrop-Grumman. The plan to 1) increase access to education and training, 2) expand curriculum, and 3) create a flagship training program at the University of Utah emphasizing systems engineering for Utah's industries is outlined below.

4.1 INCREASES ACCESS TO DISTANCE BASED INSTRUCTION AND TRAINING IN OUR EXISTING SYSTEMS ENGINEERING CERTIFICATE PROGRAM

Additional personnel are required to offer courses and provide training to more participants. We anticipate needing to hire an additional faculty with expertise and experience in Systems Engineering to direct and expanded program. The expanded program will need support to do the following:

1. Hire a Systems Engineering program director ($150,000)
    a. Act as program director and liaison across departments within the college and university
    b. Engage industry to make sure curriculum offered meets expectation/need

c. Identify projects for Capstone – multi-disciplinary course with systems project
d. Promote systems engineering program across the state and region
e. Manage course offerings, short course rigor and instructors
f. Design a program at the college level to service all departments

2. Administration Support ($60,000)
    a. Support the program director and take care of all other admin duties and coordination across the college (e.g., schedule and oversee online course development, course recordings and distributions, testing procedures off-site, enrollment, certificates, adjunct hires and TAs)
3. Hire adjunct Faculty to offer courses outside the core, but that are tailored for industry rather than research (6 courses x $10k-instructor, $5K TA/Course x 6 courses = $90,000)
4. Support for faculty summer salary – 1-week intensive format (4 courses/summer x $10k = $40,000)

4.2 EXPAND CURRICULUM TO INCLUDE ADDITIONAL TECHNICAL ELECTIVE COURSES TO TRAIN WORKING PROFESSIONALS IN SYSTEMS ENGINEERING AND SYSTEMS MANAGEMENT

1. Appoint faculty/lecturer to develop and teach night and summer courses
    a. Teach and develop core classes and electives (5 classes/year)
    b. Support for distance-based curriculum development and management
    c. Develop fully online certificate program capable of open entry and exit outside regular semester schedule (2-3 core classes and select elective classes) ($20k/course x 3 = $60,000)
        1. Core classes will be developed first, followed by select electives in subsequent years
    d. Develop the core classes and select elective classes as hybrid intensive courses (e.g., 40 hr + group project and pre/post homework ($20k/course x 3 = $60,000)
        1. Core classes (could be offered as continuing education in addition to credit towards the certificate and degree requirements)
        2. Select elective courses will transition to this format as needed in subsequent years
    e. Support to digitize teaching materials and assist with media and online content development
2. Support to equip a classroom in COE to facilitate online, concurrent and distance learning, including hybrid offerings ($50,000)

4.3 CREATES AN EMPHASIS AREA IN SYSTEMS ENGINEERING FOR UNDERGRADUATE STUDENTS

1. Systems Engineering Capstone Project Support
    a. Support undergraduate *interdisciplinary* capstone projects/year ($15k/project x4 = $60,000)
    b. Coordinate systems engineering projects across departments at the college level.
2. Develop modules in systems engineering topics for current design and project classes across the College of Engineering.
    a. Work with faculty to embed content related to systems engineering in design project classes
    b. A responsibility of the proposed new faculty hires in systems engineering

The proposed plan enables the University of Utah to be a flagship for developing and providing systems engineering education and training to both industry and academia in Utah and beyond. The additional support requested in this proposal will go towards significantly enhancing current efforts to maintain rigor and the highest quality training possible to meet the demands of today's sophisticated and complex systems engineers. These efforts compliment our current programs and build upon our past experience and successes.

5 BUDGET

A summary of the requested support outlined in the Program Plan is provided along with a timeline for implementation (Table 1). Of the funds requested, $170,000 is requested to prepare infrastructure and course materials for online formatting for the enlarged program. Continual funding of $400,000 is required to sustain and grow the program to the expected level.

Table 1- Program Plan Budget and Timeline

Project Plan Item	Funds Requested	Timeline T_0+24 months *0-6 mnth* | *7-12 mnth* | *12-18 mnth* | *18-24 mnth*
3.1 Increase Access to Distance Based Instruction		
3.1.1 - Systems Engineering Program Director	$ 150,000	
3.1.2 - Administrator support	$ 60,000	
3.1.3 - Adjunct Faculty and Teaching Assistants	$ 90,000	
3.1.4 - Summer Salary Support - Current Faculty	$ 40,000	
3.2 Expand Curriculum		
3.2.1 - Appoint Systems Engineering Faculty 3.2.1c.-e. - Support for course development*	$ 120,000	
3.2.2 - Classroom updates for online and hybrid*	$ 50,000	
3.3 Crease Emphasis for Undergraduate Programs		
3.3.1 - Systems Engineering Capstone Projects	$ 60,000	
Total One Time Funds Requested*	$ 170,000	
Total On Going Funds Requested	$ 400,000	

6 SUMMARY

Given the recent interest in "holistic" approaches to science and engineering for our society and environment, systems engineering is increasingly important. The proposed plan helps meet the University and College's mandate to provide a meaningful resource to the State's inhabitants and businesses as well as, perhaps, increase enrollment within the college (Utah residents interested in systems engineering would not need to leave the state to be educated).

Systems Engineering demand greatly outstrips supply. There is a significant opportunity to offer a Systems Engineering certificate program for all departments within the College of Engineering at the University of Utah. This program is designed to offer online education, through distance-based learning for working professionals in addition to offering new pathways for study for existing degree programs.

In summary, the plan outlined in this proposal increases the ability for the University of Utah to offer a robust program in systems engineering to address the urgent need for professional education and training to support Utah's economy. This is accomplished by growing our existing program through the development of curriculum and delivery formats to accommodate working professionals who benefit from flexible schedules and distance-based education while working. The program contains fundamental core materials and electives allowing participants more intensive and focused training for specific industries/markets. An investment in this program is an investment in Utah and Utah's growing technology driven economy.

7 ATTACHMENT I: EXAMPLE SOFTWARE TOOL TO TEACH SYSTEMS ENGINEERING

Description of Cameo by No Magic software of Dassault Systems/CATIA:

> Cameo Systems Modeler ™ is an industry leading cross-platform collaborative Model-Based Systems Engineering (MBSE) environment, which provides smart, robust, and intuitive tools to define, track, and visualize all aspects of systems in the most standard-compliant SysML models and diagrams. The environment enables systems engineers to:
>
> - Run engineering analysis for design decisions evaluation and requirements verification
> - Continuously check model consistency
> - Track design progress with metrics

Source: https://www.nomagic.com/products/cameo-systems-modeler

The figure below shows the SE software environment with author-provided red circles to highlight areas of ME interest in the Cameo engineering environment.

Figure source (without highlighting): https://www.nomagic.com/mbse/overview/technical-overview.html

8 ATTACHMENT II: EXAMPLES OF EXISTING COURSES TO SUPPORT SYSTEMS ENGINEERING EMPHASIS

Systems Engineering Management
ME EN 5000 Engineering Law and Contracts (3)
ME EN 6030 Reliability Engineering (3)
ME EN 6040 Quality Assurance Engineering (3)
ME EN 6960 Project Management in a Technical Environment (3)
ME EN 7010 Computer-Aided Engineering (3)
BIOEN 6060 Scientific Presentation (1)
BIOEN 6061 Scientific Presentation II (1)
CVEEN 6260 Applied Probability and Statistics (3)
CVEEN 6820 Project Scheduling (3)
CVEEN 6830 Project Management and Contract Administration (3)
CVEEN 6850 Engineering Law (3)
ECON 6360 Industrial Organization (3)
FINAN 5270 Business Risk Management (3)
FINAN 6020 Financial Management (1.5 to 3)
FINAN 6025 Managerial Economics (1.5)
FINAN 7090 Industrial Organization I (3)
FINAN 7091 Industrial Organization II (3)
MGT 6040 Data Analysis and Decision Making I (1.5)
MGT 6041 Data Analysis and Decision Making II (1.5)
MGT 6060 Production and Operations Management I (1.5)
MGT 6061 Production and Operations Management II (1.5)
MGT 6160 Operations Management (2.8)
MGT 6420 Quality Management I (1.5 to 3)
MGT 6421 Quality Management II (1.5 to 3)
MGT 6630 Operations Planning and Control (1.5 to 3)
MGT 6660 Project Management (1.5 to 3)
MGT 6710 Strategy & Technology (1.5 to 3)
MGT 7590 Multivariate Statistics for Management (1 to 4) MET E 5690 Process Engineering Statistics (2)
URBPL 5370 System Dynamics and Environmental Policy (3)
URBPL 5871 Complexity and Systems Thinking

Product Engineering Design
ME EN 6030 Reliability Engineering (3)
ME EN 6040 Quality Assurance Engineering (3) ME EN 6100 Ergonomics (3)
ME EN 6120 Human Factors in Engineering Design (3)
ME EN 6130 Design Implications for Human-Machine Systems (3)
BIOEN 6060 Scientific Presentation (1)
BIOEN 6061 Scientific Presentation II (1)
CVEEN 6850 Engineering Law (3)
MGT 6420 Quality Management I (1.5 to 3)
MGT 6421 Quality Management II (1.5 to 3)

Manufacturing and Process Systems Design
ME EN 6010 Principles of Manufacturing Processes (3)
ME EN 6030 Reliability Engineering (3)
ME EN 6040 Quality Assurance Engineering (3)
ME EN 7010 Computer-Aided Engineering (3)

BIOEN 6060 Scientific Presentation (1)
BIOEN 6061 Scientific Presentation II (1)
CH EN 6303 Environmental Applications of Chemical Engineering (3)
CH EN 6960 Green Engineering (3)
CVEEN 6530 Quantitative Methods in Transportation Operation (3)
CVEEN 6660 System Dynamics and Environmental Policy (3)
CVEEN 6661 Complexity and Systems Thinking
CVEEN 6830 Project Management and Contract Administration (3)
CVEEN 6850 Engineering Law (3)
ECON 6360 Industrial Organization (3)
MGT 6060 Production and Operations Management I (1.5)
MGT 6061 Production and Operations Management II (1.5)
MGT 6160 Operations Management (2.8)
MGT 6420 Quality Management I (1.5 to 3)
MGT 6421 Quality Management II (1.5 to 3)
MGT 6630 Operations Planning and Control (1.5 to 3)
MGT 6660 Project Management (1.5 to 3)

Systems Optimization
ME EN 6030 Reliability Engineering (3)
ME EN 6040 Quality Assurance Engineering (3)
ME EN 6200 Advanced Modeling and Control (3) ME EN 6210 State Space Methods (3)
ME EN 6810 Thermal System Design (3)
ME EN 7000 Optimal Design (3)
ME EN 7010 Computer-Aided Engineering (3)
ME EN 7200 Nonlinear Controls (3)
ME EN 7210 Optimal Controls (3)
ME EN 7220 Advanced Control Design (3)
BIOEN 6060 Scientific Presentation (1)
BIOEN 6061 Scientific Presentation II (1)
ECE 5510 Random Processes (3)
ECE 5520 Digital Communication Systems (3)
ECE 6530 Digital Signal Processing (3)
ECE 5570 Control of Electric Motors (3) EGE 6235 Wireless Communications (3)
ECE 6530 Digital Signal Processing (3)
ECE 6551 Survey of Optimization Techniques (3)
ECE 6570 Adaptive Control (3)
MGT 6040 Data Analysis and Decision Making I (1.5)
MGT 6041 Data Analysis and Decision Making II (1.5)
MGT 7590 Multivariate Statistics for Management (1 to 4)
MET E 5690 Process Engineering Statistics (2)

Transportation Operations
ME EN 5000 Engineering Law and Contracts (3)
ME EN 6030 Reliability Engineering (3)
ME EN 6040 Quality Assurance Engineering (3)
ME EN 6960 Project Management in a Technical Environment (3)
CH EN 6960 Green Engineering (3)
CVEEN 6530 Quantitative Methods in Transportation Operation (3)
CVEEN 6260 Applied Probability and Statistics (3)
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CVEEN 6820 Project Scheduling (3)

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System Engineer

Stadler Rail Group is a system supplier for customer-specific rail vehicles with manufacturing and service locations in Switzerland and around the world. We are a leading manufacturer of regional and suburban trains, trams, and rack-and-pinion rail vehicles and systems.

Stadler has multiple contracts to deliver passenger rail vehicles to customers in the United States and Canada. To help fulfill this demand, we are looking to fill the following position in our NEW Salt Lake City facility.

What we offer

> We provide an interesting and challenging position in an international, success-oriented company with national and international career opportunities. Extensive training, competitive salary, vacation time, 401K program are some of the great benefits Stadler offers.

As a **System Engineer,** you will be a viable member of a team focused on creating highly efficient design plans for building state-of-the-art passenger trains. If you have experience in any of the following systems this is the career for you:

> Doors, Pneumatics, Brake, Interior or Exterior (System Integration), Electric and Lighting, Passenger Information, Positive Train Control or Seating Systems, HVAC.

Key Activities

- Create concepts, specifications and technical documentations
- Coordinate with procurement and production to ensure quality and functionality of the project system
- Follow scheduling, budgetary goals and guidelines
- Support Procurement, Production, Commissioning and Type Testing departments
- Collaborate with suppliers and Certification Authorities in an international environment
- Interpret and incorporate local and federal as well as customer requirements into system design
- Integrate the system design into the vehicle
- Ensure compliance to customer requirements, considering applicable standards, laws and national requirements
- Take ownership of the design, documentation and function of sub-systems
- Responsible for performing FAI's for the designed systems, if necessary

Qualifications

- Bachelor's degree in Engineering (mechanical or electrical)
- System specialist supported with proof of experience in systems engineering and integration in a complex environment
- 3 - 5 years of relevant experience in railway, defense, aerospace or equal

- Structured to manage integration of multiple projects, conduct testing and prepare all deliverables associated within the system
- Excellent communication and writing skills
- Excellent problem-solving abilities with strong teamwork skills
- Business fluent in English (German preferred)

Stadler US is an Equal Opportunity Employer

Stadler US is committed to creating a diverse environment and is proud to be an equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, gender, gender identity or expression, sexual orientation, national origin, genetics, age, disability status, veteran status, or any other characteristic protected by Federal, State, or Local laws.

STADLER

Physical Integration Engineer

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As a **Physical Integration Engineer,** you will be a viable member of a team focused on creating highly efficient design plans for building state-of-the-art passenger trains.

Key Activities

- Create concept, design, details, drawings and documents of mechanical assemblies
- Coordinate with procurement and production to ensure quality and functionality of the physical integrations
- Follow scheduling, budgetary goals and guidelines
- Support Procurement, Production, Commissioning and Type Testing departments
- Collaborate with suppliers and Certification Authorities in an international environment
- Interpret and incorporate local and federal as well as customer requirements into the assemblies
- Integrate the assemblies into the vehicle
- Ensure compliance to customer requirements, considering applicable standards, laws and national requirements
- Responsible for performing FAI's for the designed systems, if necessary

Qualifications

- Bachelor's degree in Engineering (mechanical)
- 3 - 5 years of relevant experience in railway, defense, aerospace or equal advantageous
- Excellent communication and writing skills
- Excellent problem-solving abilities with strong teamwork skills
- Business fluent in English (German preferred)

Stadler US is an Equal Opportunity Employer

Stadler US is committed to creating a diverse environment and is proud to be an equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, gender, gender identity or expression, sexual orientation, national origin, genetics, age, disability status, veteran status, or any other characteristic protected by Federal, State, or Local laws.

Job Title: Systems Engineer

Summary

This position is responsible for the technical planning, system design, requirements management, system integration, verification and validation, engineering cost and risk management, and supportability analyses for communication systems. Analyses are performed at all system levels including concept, design, fabrication, test, installation, operation, maintenance and disposal. Ensures the logical and systematic conversion of customer or product requirements into total systems solutions that adhere to technical, schedule, and cost constraints. Collaborates with customers, hardware and/or software engineers in the planning, design, development, and deployment of communications systems and products.

Qualifications

- An ABET (EAC/CAC) accredited Bachelor's of Science degree in an Engineering discipline is strongly preferred, or equivalent technical education and experience
- Required experience in product development (preferably in military application environment) is dependent on position level
- Proficient understanding of engineering architecture and design concepts along with basic understanding of the engineering practices and procedures required to develop, test and deploy systems
- Presentation and communication skills (verbal/written/visual)
- Problem solving skills and the ability to meet critical deadlines
- Effective coordination of project(s) and efforts of technical support personnel
- Ability to productively contribute work, ideas and collaboration as part of a team
- Good leadership skills, with the ability to guide and provide technical direction/vision for a given project
- Ability to obtain a DoD Security Clearance
- Experience with Word, Excel, PowerPoint, MS Project, DOORS, Rhapsody, Cameo, UML, SysML or similar tools and languages
- Ability, willingness to travel when required to support customer installation, demonstrations and general field support

Responsibilities

- Plans and conducts technical projects or portions of projects
- Employs best practices, tools and techniques and applies processes and methodologies selected to design and develop new products or modify existing products
- Involved in the capture and/or management of customer and derived requirements, decomposition and assignment of requirements to appropriate functional areas of responsibility, insuring traceability from a verification test matrix back to original customer and system level derived requirements
- Develops technical specifications, interface control documents, test plans and procedures, analyzes configuration and processing solutions, and tests conformance to specifications
- Recommends new or improved design solutions and processes; reviews literature, patents and current industry practices of relevance to assigned project
- Ensures technical performance, quality, and adherence to schedule
- Identifies and manages program risks
- Participates in design reviews
- May coordinate the efforts of technical support personnel and may mentor and/or provide work leadership

Systems Engineer Specialist

The Systems Engineer Specialist is responsible for robot systems engineering work product development for all assigned projects. This includes but is not limited to user stories, use cases, system requirements and system architecture. This role will also mentor the software engineering disciplines in ensuring that software requirements and software architecture is developed from the system work products.

Role/Responsibilities:

- Develop features and user stories for robotic applications.
- Utilize use cases to develop system requirements.
- Document the system requirements and assign them to functional domains.
- Support the Sarcos Chief architect and the Vice President Engineered Systems in the development of robot system architectures.
- Allocate the system requirements to the elements of the architecture and define interfaces.
- Validate the System Architecture.
- Ensure that all work products are entered in the PLM system and that horizontal and vertical traceability is ensured.
- Function as an evangelist to mentor, teach and foster systems engineering practices within the organization.
- Support the software (firmware and cloud) teams in deriving software requirements and software architecture.
- Design, develop, and deploy verification tools including HILs, and other test systems to test functional requirements for various products.
- Utilize the Sarcos exoskeleton prototype to facilitate required tests.
- Support the selection and design of testers & new test equipment.
- Design and develop test infrastructure software such as Plant Models, Loss Models, Closed Loop Control Algorithms etc. to safely auto-test ECUs and systems.
- Interface with cross functional engineering, and manufacturing teams to ensure requirements are specified and implemented correctly.
- Participates in continuous improvement efforts, researches, recommends and initiates implementation of enhancements to products, processes and programs.
- Generate and maintain all necessary validation engineering documentation and data to ensure traceability and compliance to applicable standards (e.g. ISO/TS 16949, ISO/IEC TR 15504, ISO 26262).

Competencies

- Working knowledge in planned and structured approaches
- Working knowledge of problem-solving techniques
- Innately possesses accountability, fearless risk-taking, and measurable achievement
- Working knowledge of configuration management, and project monitoring and control techniques
- Able to work in a dynamic, fast paced team environment
- Ability to multitask and prioritize.
- Strong analytical and interpersonal skills.
- Persuasive oral/written communication abilities.
- Flexible and adaptable (willing to work on other technical problems as needed).
- Insatiable curiosity for science, technology and understanding of how things work.

Qualifications:

- Bachelor's / Master's degree in engineering or demonstrated equivalent skills Matlab/Simulink, dSpace, Labview, model-based development tools.

- Familiarity with robotic systems
- Experience in developing object-based software for embedded products

Work Environment and Physical Demands:

- Advanced knowledge of MS Office package
- Expert in using system engineering tools
- Work is performed Monday through Friday with occasional overtime and weekend requirements.
- Safety awareness is absolutely essential at all times while in the work area.
- Must be able to stand and sit for extended times.

Our Pledge to Each Other

Our most important value is to work as a team. How we treat each other is critical to our success. As a result, you are making the following pledge to the Company and your colleagues.

I will do my best to:

- Treat everyone on our team, regardless of seniority or role, the way they want to be treated
- Trust my colleagues and believe that they have the best of intentions
- Proactively communicate in a candid manner, with sufficient information to allow my colleagues to achieve their objectives
- Be open minded and receptive to review, constructive feedback, and collaboration
- Act with integrity by doing what is right for the company, my customers, my colleagues and myself
- Demonstrate a positive can-do attitude coupled with the drive and determination to win, while holding myself accountable for both my success and the success of the company
- Never criticize, disparage or malign colleagues behind their backs or in front of others
- Not tolerate anyone in the company doing anything inconsistent with any of the above

When I fail to act consistently with my pledge, I will expect my colleagues to respectfully and privately address it with me.

- May provide technical consultation to internal organizations and/or customers
- May evaluate vendor capabilities to provide required products or services

Systems Engineer – Level 2

Sarcos' Systems Engineers participate in the design of complex systems that integrate hardware and software with a responsibility to define product, safety and reliability requirements, productivity improvement, cost reduction, and drive customer satisfaction. This position requires demonstrated expertise in system reliability and safety engineering, along with in-depth knowledge of electro-mechanical systems, machine design specific to complex industrial applications, preferably robotics. Experience in electronics, mechanisms, systems requirements/ design, component design, assembly design, and robot design/ integration are necessary skills. The successful candidate will also have strong analytical skills, and FMEA/FMECA expertise.

Role/Responsibilities:

- Participate in the development, and evaluation of human operated, electro-mechanical systems that involve hardware, software and firmware elements in a concurrent development process.
- Develop or participate in the development of system and subsystems requirements and specifications.
- Manage the assigned design elements and assemblies with emphasis on system and subsystems functionality, performance, reliability, availability, maintainability, serviceability, safety and total product cost.
- Perform Failure Modes Effect (FMEA) and Criticality Analysis (FMECA).
- Develop system reliability test plans (including HALT, HASS) and procedures.
- Perform system and subsystems functional and safety analysis.
- Develop and implement operational redundancy and fail-safe system design approaches.
- Develop protocols and write reports documenting product reliability and safety verification, validation and certification as required.
- Conduct analysis of root causes of failures and develop strategies to cope with failures.
- Participate in and/or coordinate design reviews with cross-functional teams, leading efforts related to System Engineering, with emphasis on reliability and safety engineering.
- Participate in the development of subsystem interfaces documents (*i.e.*, develop ICDs)

Competencies

- Ability to align thoughts, actions and results to the Sarcos Pledge of:
- Ability to multitask and prioritize.
- Innately possesses accountability, fearless risk-taking, and measurable achievement.
- Strong analytical and interpersonal skills.
- Able to work independently, with minimal supervision.
- Demonstrated creative and innovative solutions and problem-solving skills;
- Persuasive oral/written communication abilities.
- Flexible and adaptable (willing to work on other technical problems as needed).
- Insatiable curiosity for science, technology and understanding of how things work.

Qualifications:

- BS degree in Engineering from an accredited college/university with a minimum of 5 years relevant system engineering experience with emphasis on reliability and safety engineering.
- Expertise in common reliability analysis and management techniques (*e.g.*, Failure Modes and Effects Analysis, Failure Modes, Effects and Criticality analysis, Fault Tree Analysis, Reliability Centered Maintenance Planning, Hazards Analysis, and Fail-safe design).
- Experience in requirements management and traceability.
- Experience with concurrent design and engineering processes (*e.g.*, DFA, DFM).
- Experience working with cross-disciplinary engineering teams.

- Experience conducting DOEs is a plus.
- Experience in robot design and integration is a plus.
- Experience with requirements flow-down, technical readiness and manufacturing readiness levels.
- Ability to direct complex technical development projects, build relationships, lead cross-functional teams, and build consensus among development team members.
- Demonstrated ability of product planning with a focus on reliability, maintainability, and safety.

Work Environment and Physical Demands:

- Work is performed Monday through Friday with ability to work overtime and weekends.
- Safety awareness is absolutely essential at all times while in the work area.
- Must be able to stand and sit for extended times.

Our Pledge to Each Other

Our most important value is to work as a team. How we treat each other is critical to our success. As a result, you are making the following pledge to the Company and your colleagues.
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- Proactively communicate in a candid manner, with sufficient information to allow my colleagues to achieve their objectives
- Be open minded and receptive to review, constructive feedback, and collaboration
- Never criticize, disparage or malign our colleagues behind their backs or in front of others
- Not tolerate anyone in the Company doing anything inconsistent with any of the above

When I fail to act consistently with my pledge, I will expect my colleagues to respectfully and privately address it with me.

Proof of right to lawfully work in the United States required. This position is not eligible for VISA sponsorship. Sarcos is committed to creating a diverse environment and is proud to be an Equal Opportunity Employer, Females, Minority, Veterans, Disabled, Sexual Orientation, Gender Identity, Religion, National Origin.

Weber State University Engineering, Applied Science & Technology
Systems Engineering Proposal Brief 2020

Partnership

Weber State University (WSU), through the College of Engineering, Applied Science & Technology (EAST) and the Computer Science, Electrical Engineering, Mechanical Engineering, Manufacturing & Systems Engineering, and Physics Programs will work with and accommodate the needs of industry partners on the Wasatch Front, utilizing INCOSE, DoD standards, to provide Systems Engineering education.

The location of Weber State in Ogden, Layton, and Farmington creates a unique opportunity to provide education convenient to the aerospace and manufacturing community of Northern Utah. Currently, for example, HAFB employs more WSU graduates in engineering than from any other school in the nation; and our location allows us to teach specialized programs on base. As a teaching university, WSU has proven itself an excellent return on investment both in terms of student dollars and state and corporate investment. Small classes, instruction by full-time faculty, hands-on and project-based learning means our students should be able to hit the ground running, so to speak, both technically and socially.

- Weber State University—Dean David Ferro and systems engineering faculty David Wetzel, Nicole Batty, and Dustin Birch of College of Engineering, Applied Science & Technology
- L3/Harris, Northrup-Grumman, Hill Air Force Base (HAFB), Lockheed-Martin, Moog, Boeing, Borsight, Stadler, Sarcos, Stryker, Kihomac, Barnes Group, Williams International, and numerous others
- Industry advisors assembled by Ben Hart and Kimberlee Carlile for GOED meeting: Brian Mcquivey, Misty Porter-Belch, Tyson Kelly, Randal Sylvester, Jon Liddle, Stephen Guine, Willaim VanJones, Megan Ware, Teresa Schlegel
- Advisors for this proposal include Paul White, John Richards, Misty Porter-Belch, Angie Harbert, Rachel Geerlings, Ernest Kyed, Vince Johnston, John McCrea, Paul Nelson, John Metcalf, Ben Goldberg, Charles Precourt of Wasatch INCOSE and Dave Hansen, Jay Fiebig, Jeff Kwok, Jim Vanfleet, Norm LeClair of the HAFB, Department of Defense. Some of these individuals sit on our systems engineering industry advisory board. See Appendix B.

Board of Trustees Support—The Board of Trustees will send a separate message of support.
Presidential Support—The President will send a separate message of support.

Proposal

EAST shall provide a number of paths for systems engineering ‘thinking’ to address the various systems engineering requirements. Selected coursework is designed to prepare students for professional certification within INCOSE. We wish to work with our university partners at the University of Utah and Utah State to create pathways between our programs separate from those explicated here. We also believe there are opportunities to create stronger pathways with the high schools.

Table 1 – Systems Engineering Pathways and Outcomes Weber State University	
Pathway	**Level**
(Existing) BS in Systems Engineering (manufacturing emphasis) (ABET next year) - John Richards at Northrup-Grumman expressed appreciation for the manufacturing (including hands-on) emphasis of this BS for the manufacturing systems needs for his company and the Wasatch Front. - Existing courses focus on industry needs as detailed in response to Ben Hart's request for job listings. - Modify courses for both online and brick n' mortar delivery.	B.S.
Concurrent Enrollment in Systems Engineering - Working with the school systems and state to have existing Foundations of Systems Engineering count as concurrent enrollment class increasing likelihood of increased enrollment in systems engineering courses in college.	H.S.
BS-level Institutional Certificate in Systems Engineering - Utilizing existing and new courses in systems engineering to allow for an undergraduate certificate in systems engineering. - Courses: Foundations, Engineering Project Management, Analytics, Systems Dynamics & Architecture, Systems Requirements. - Certificate available to STEM majors. - Utilizing hybrid approach to instruction (brick n' mortar, online, combined) to accommodate student needs. - Existing Manufacturing Systems degree recipients automatically get Certificate.	B.S.
Systems Engineering Courses (for certificate) Counting as Electives for Other Majors - Working with Electrical and Computer Engineering, Computer Science, Mechanical Engineering, and Physics to have lower- and upper-division courses in systems engineering count towards those majors. - Those courses could then count towards undergraduate certificate - Utilizing hybrid approach to instruction (brick n' mortar, online, combined) to accommodate student needs.	B.S.
MS Certificate (15 credits) in Systems Engineering - Working with industry to create best certificate beyond BS level. - Utilize existing BS courses plus project and advanced assignments to get more bang for the buck – currently the approach we take for our EE, ECE and CS degrees. - Utilizing hybrid approach to instruction (brick n' mortar, online, combined) to accommodate student needs.	M.S.

MS Degree (30 credits) in Systems Engineering - Extending MS certificate to full MS degree - Project-oriented vs. Thesis - Utilizing hybrid approach to instruction (brick n' mortar, online, combined) to accommodate student needs. - Accelerated pathway for MS degree for those students with BS Certificate. - See Appendix A for support letter for this degree from HAFB.	M.S.
Outcomes	
- **G**ain **ABET accreditation for BS systems degree.** - Implement all Systems pathways. - Track number of enrollments, graduates, and work-based learning in each pathway.	

Table 2- Optimum Budget
Weber State University

Funding Need	**Budget**
Faculty – Program Coordinator **-** A faculty position to direct and coordinate BS, MS classes/programs. person would a. Hold a PhD in Systems Engineering as well as have 3+ years of industry experience. b. Work with industry and industry groups to focus curriculum development c. Liaison with secondary teachers, CTE coordinators, and concurrent enrollment coordinators to increase concurrent enrollment instruction in secondary schools d. Liaison with admissions, registrar, financial aid, and continuing education e. Work with industry partners to increase Work-Based Learning opportunities such as internships f. Oversee course design, curriculum development, analysis, and revision g. Arrange for professional development for instructors h. Manage admissions and scholarships i. Coordinate and oversee Academic Coach/Advisor j. Manage the budget k. Schedule courses l. Teach a minimum of six courses per year at the university to offset the increased demand for university-level instructors	$135,000 (ongoing)
Instructor – An instructor position *match* to teach systems engineering a. Hold a MS in Engineering as well as have 5+ years of industry experience in systems engineering. b. Teach a minimum of eight courses per year at the university to offset the increased demand for university-level instructors	$65,000 (ongoing)

***Course Design, Development, and Updating* – University educators will engage in preparing and maintaining the curriculum. For each course educators will** a. Design and develop course curriculum to be used by multiple instructors b. Engage in collaborative design to improve quality of materials c. Create instructional materials for online learning d. Develop assessments to identify mastery e. Incorporate structures to facilitate flexible progress f. Analyze effectiveness of material and student engagement g. Update existing courses to maintain topic relevance and educational quality h. Create online options	$20,000 (one-time)
Marketing includes Rack cards, cards, posters, and videos as promotion for events such as STEM Expo, high school and college career fairs and classes, majors fairs, college sessions, company visits, info sessions.	$2,000 (one-time)
Total One-time Funding	$22,000
Total On-Going Funding	$200,000

Curriculum

These ten courses are the core of the BS/MS degrees in Systems Engineering at Weber State. These courses (along with existing majors) include the software systems and standards required for industry.

Foundations of SE
The Foundations of Systems Engineering course is an introductory overview of the systems engineering perspective and is presented to set the conceptual and practical framework of the entire systems engineering graduate program. The course covers the foundational components of systems engineering, from the concept development stage through the process steps of engineering development. Several issues related to post-development and special topics areas are also presented.

Engineering Project Management & Risk Analysis

Engineering program management fundamentals, program planning and control strategies, risk assessment, work breakdown structures and costing options. This course is targeted to technical personnel and those who work with technical personnel on engineering projects. Successful engineering project management includes estimation and proactive risk identification and development of mitigation techniques. System uncertainty is reduced when project risks are identified, quantified, and mitigation strategies implemented. Tools, techniques, and methodologies used by successful project managers will be examined.

Analytics in Systems Engineering

This course will provide students with understanding of the fundamentals of using industrial data analytics techniques to transform from data-rich into decision-smart. It focuses on training students with the ability of formulating and solving real industrial problems with the appropriate modeling strategies and analytics principles for better decision making.

System Dynamics & Architecture

This course deals with understanding the higher-level behavior and issues that emerge from interaction between components in complex socio-technical systems. Illustrate the techniques of Model-Based Systems Engineering (MBSE) using an architecture model as the primary source material for Systems Engineering (SE) processes such as requirements analysis, high level and detailed design, performance and design trade studies, configuration management, specialty engineering, and others.

Systems Requirements Engineering

Introduction to the rigorous requirements process within systems engineering, including system requirements analysis elicitation, analysis, requirements decomposition, allocation, traceability, verification, and validation.

Engineering Optimization: Method/Application

This course will Introduce methods of optimization to engineering students, including linear programming, network flow algorithms, integer programming, interior point methods, quadratic programming, nonlinear programming, and heuristic methods. Numerous applications are presented in civil, environmental, electrical (control) engineering, and industrial engineering. The goal is to maintain a balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems

Design for Operational Feasibility

This course will introduce the application of engineering and management efforts to maximize the likelihood that the resulting system design will be operationally feasible, and perform as intended in an effective and efficient manner. The objective of the course is to present areas of design that are known to have a significant impact on the ultimate worth of a system and the customer need. Topics include: Design for reliability, maintainability, human factors, logistics, producibility, and affordability.

Systems Test and Evaluation

Test and evaluation of systems at both the component and systems levels to provide insights into how systems succeed or fail based on test methodologies. To gain a better understanding of what test & evaluation is and why its importance among government agencies and private industry has continued to increase over the last three decades. To understand the various roles test & evaluation can and should play in the business, programmatic and technical dimensions of each acquisition program.

System Logistics
Ensuring a System of Systems Approach

This course will introduce the subsequent sustaining maintenance & support of the system throughout its entire life cycle, including end of life/disposal. It will also include different DoD tailorable concepts to effectively manage and field product. Topics include: Reliability Growth, Initial Contractor Support (ICS), and Performance-Based Logistics (PBL).

Project / Independent Study

Typical examples are research and other courses where the objectives and activities are determined jointly by the instructor and the student. In most cases, the agreement on course activities and objectives is reached with the student and advisor or instructor before enrollment in the course.

Appendix A

AFSC/EN OL-Hill
5851 F Ave Bldg 849
Hill AFB, UT 84056-5713

Professor George Comber
Chair, Engineering Technology Department
1447 Edvalson St. Dept. 1802
Weber State University
Ogden, UT 84404-1802

Dr. Comber,

I am sending this letter to acknowledge that the proposed Weber State University (WSU) Masters of Science in Systems Engineering (MSSE) appears to align directly with enduring skills needed by various organizations at Hill Air Force Base (AFB) such as the Ogden Air Logistics Complex, 75th Air Base Wing, 748th Supply Chain Management Group, the Air Force Life Cycle Management Center, and the Air Force Nuclear Weapons Center.

The Air Force relies on its scientists and engineers to solve a wide variety of problems involving highly-technical equipment and systems, and to ensure effective sustainment (e.g., maintenance, repair, overhaul, modification, local manufacturing, supply chain management, life cycle logistics, etc.) of current and future weapon systems.

While Hill AFB is only one stakeholder in the Aerospace & Defense, Advanced Materials & Manufacturing, and Software & Information Technology sectors in Utah, it has over 2,600 science and engineering professionals who already have BS degrees. These civilian and military members are encouraged, (and tuition is typically funded), to pursue advanced degrees. The proposed Weber State University MSEE could be an attractive option for their professional development.

Although Hill AFB cannot endorse any particular degree program or academic institution, having an MSSE or similar degree program within commuting distance of Hill AFB would be of value in elevating the technical expertise of the civilian and military workforce. I appreciated the opportunity to participate along with other industry stakeholders in reviewing the proposed curriculum and believe it aligns with our strategic objectives. If you need further clarification of our workforce requirements and priorities, please contact our Engineering and Technical Resource Management Division Chief, James Vanfleet at (801) 777-3831 or james.vanfleet@us.af.mil.

JEFFREY D. KWOK, Colonel, USAF
Deputy Director, Engineering & Tech Management

Appendix B

MSE IC Contacts

IC Member	Company	email	note
Paul White	KIHOMAC	paul.white@kihomac.com	Senior Systems Engineer, CSEP
Vincent Johnston	L3T	Vincent.b.Johnston@l3t.com	Senior Systems Engineer, ESEP
John Metcalf	Northrup	John.Metcalf@ngc.com	
Derek Boddy	BAE	derek.boddy@baesystems.com	System Engineering Manager
Eric Falkenberg	Williams International	Eric.C.Falkenberg@gmail.com	Director of Operations for Ogden & Guaymas, Mexico
Mark Ripke	Boeing	mark.ripke@boeing.com	Chief Engineer
Kevin Johnson	Williams International	KJ7342@gmail.com	Manufacturing Systems Engineer / Business Intelligence
Jason VanArk	Williams International		Automation Manager
Guy Letendre	WSU		Economic Development Director