A New Approach to Unmanned Systems Education and Training

Dr. Jerry LeMieux, President, Unmanned Vehicle University®

Commercialization of unmanned aircraft systems (UAS) has already occurred in many countries. New developments occur almost daily and the rate of change has outpaced the education system. A new university dedicated to unmanned air, ground, sea and space systems is making progress training the future leaders, engineers and entrepreneurs in this new career field. The current trends in UAS education are analyzed and a new approach to unmanned education is presented. The Appendix contains business opportunities, commercial applications and UAS degree courses and curriculums.

INTRODUCTION

Most people have heard about unmanned aircraft systems (UAS), commonly referred to as drones, being used in the military. There is a quiet emergence of a revolution in commercial applications for UAS on the scale of horse carriage to car or desktop computers to Internet. This revolution will soon lead to an explosion in economic growth and jobs in America. There are hundreds of commercial applications and business opportunities for UAS that will continue to stimulate entrepreneurship and innovation for many years. A sample list of commercial applications and business opportunities is included at Appendix 1.

We believe that the first step in preparing a UAS business case is to focus on an application and write your business case around it. The size of the market is a first step for your case, but you will have to drill further down to understand if a UAS can provide a service that is beneficial to your customer. By benefit we mean, does a UAS save time, save money or reduce risk to human life. In order to do this analysis, you must be familiar with your chosen industry problems and traditional methods for solving those problems. Once this analysis is complete, you will be ready to make a comparison of traditional to UAS methods for data capture.

Many have embraced the idea of commercialization of UAS but there is little knowledge about how to do accomplish this goal. Robotics technology is expected to impact a myriad of applications in agriculture and address farmers' constant struggle to keep costs down and productivity up.[1] Precision agriculture and public safety are the most promising commercial and civil markets. These two markets are thought to comprise approximately 90% of the known potential markets for UAS.[2] Commercialization of UAS has already occurred in many countries. More than 70 countries now own some type of UAS.[3] For now, let's focus on the commercial potential of the agricultural business as public safety is generally the realm of government agencies

AGRICULTURE

The reason to choose agriculture as a business area is obvious when you look at farming statistics. According to the Census of Agriculture[4] and the USDA research Service[5] there are 2.2 million farms in America comprising 922 million acres. The land area for the USA is approximately 2.3 billion acres which means approximately 40% of all land is used for farming. Net farm income statistics are shown in Figure 1. The large scale and scope of the agriculture business translates to a huge opportunity for a UAS

business. Realizing the size of the industry is a good start to focus on a UAS product or service. However, there is still a missing piece, "the sensor"

The words "precision agriculture" are getting to be common in the UAS community, but how many have said "I want to get into precision agriculture" without even knowing what precision agriculture is? One potential definition is "Measurement of complex parameters used for crop growth to make decisions on the precise application of chemicals to soil or plants. A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties. The soil scientist must capture soil data,

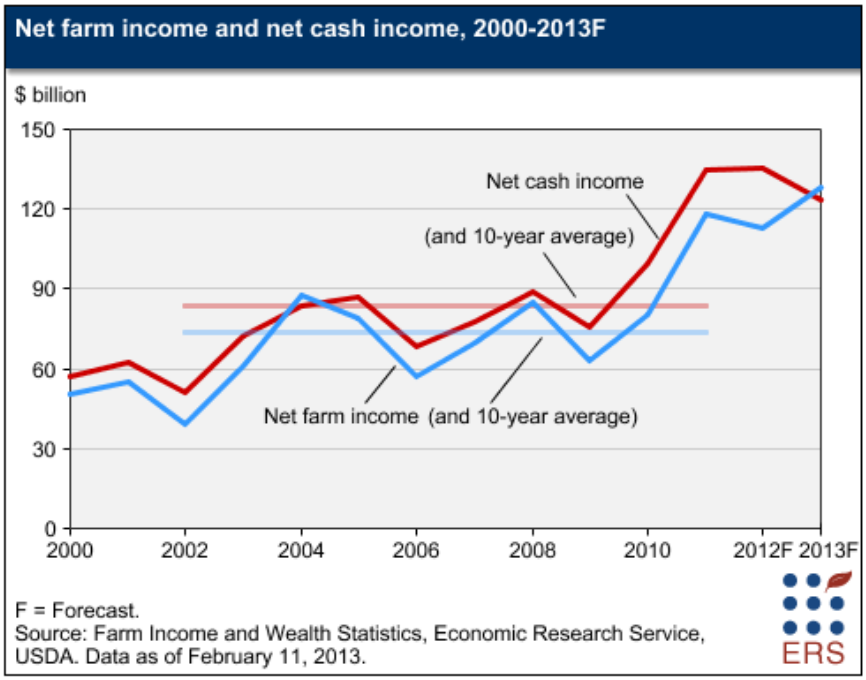

Figure 1 Annual Farm Income in the USA

analyze, interpret and make recommendations for decisions about use of fertilizer. A plant scientist is concerned with controlling and eliminating weeds, crop diseases and insect pests. Data is captured and analyzed to make decisions on herbicides, fungicides and insecticides. So how can precision agriculture help a farmer? If you want to pursue precision agriculture as a business area with a UAS, you must understand how the data is captured and the tools used to analyze the data. You must understand soil and plant science at a general level in order to write a business case that shows how time and/or money will be saved by using a UAS.

It is not likely that most farmers will attempt to purchase and operate their own UAS equipment, since most do not have the expertise to analyze and correctly interpret the data. They will do what they do best; grow crops in the most efficient manner possible while keeping operating expenses down to realize maximum profits. Some of the major expenses for crop protection are shown in Figure 2 which shows annual costs for fertilizer ($26 billion) and pesticides ($13 billion). The use of crop protection products adds $82 billion in increased yield. There is an entire market for crop protection which employs one million people and generates more than $33 billion in wages. So herein lies the major advantage of precision agriculture: employing a UAS adds a measurement dimension to more accurately scan large agricultural areas. Combined with proper data analysis, farmers will be able to detect problems, prevent future problems from occurring and make better decisions to increase profits.

Normally, farmers spread fertilizer on the entire farmland. If precision agriculture is used, a UAV could be equipped with an optical and near infrared sensor to make measurements that can be used to compute the Normalized Difference Vegetation Index (NDVI). There are relatively cheap, lightweight 3 band Near NIR-Blue-Green (NBG) vegetation stress cameras available on the market like the 12 megapixel XNite Cannon ELPH 300ND. Trouble spots for fertility can be identified and fertilizer can be discreetly applied where it is needed the most. Precise application of fertilizer on non-fertile areas will increase yields and decrease the use of fertilizer in areas not needed. This will result in a significant savings in fertilizer application. If for example the use of precision agriculture results in a 30% savings in fertilizer that would translate to approximately $8 billion dollars in savings.

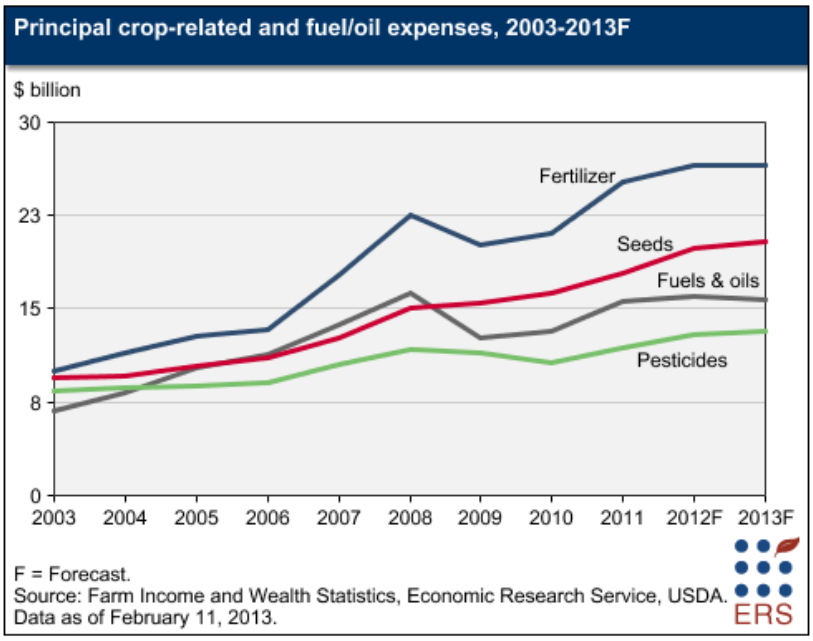

Figure 2 Annual Crop Expenses in the USA

Precision agriculture and many of the opportunities listed in Appendix 1 can be offered as services from private contractors. This is a huge emerging opportunity for entrepreneurs to set up their own shop and offer services that lead to a recommendation. An initial investment in equipment and data analysis tools will be required but will easily be recovered with monthly or yearly subscription services. The one area we have not discussed thus far is: How does one obtain an education about the vehicles and sensors? Unmanned Vehicle University ®, (UVU) has taken a new approach to unmanned systems education and training.

CURRENT UNMANNED SYSTEMS EDUCATION

There are a handful of schools that are offering undergraduate degrees in unmanned systems that are taking the military operational approach; train UAS sensor operators and pilots for operational jobs. If you examine the curriculums for these schools you will find some shocking news. The approach used is to take a normal degree program and substitute as little as 2 courses on UAS operations to create a minor in unmanned systems. For example, a BS in Aeronautics with a minor in unmanned systems. Some schools even require students to earn a commercial pilot certificate with instrument and multiengine ratings which adds significant cost to the degree.

UAS pilots make a good salary. According to Indeed.com the average UAS pilot makes $104,000. Many schools train students on a simulator and/or purchase a small UAS so students can get hands on experience as a UAS pilot/sensor operator. The problem is that students graduate with relative low flight times on the order of 50-100 hours and have to compete with ex-military UAS operators that have thousands of hours of experience. If you compare an ex Predator pilot with 2000 hours and years of training with a recent graduate with 70 hours of total flight time, who would you hire? In addition to low flight time, another major issue is that no FAA regulations exist for the licensing of American UAS pilots.

Transport Canada, Australia's Civil Aviation Safety (CASA) and the UK Civil Aviation Authority (CAA) all have regulations in place for UAS pilot certification. This adds a confusion factor for those that want to become UAS operators. Ask yourself the following questions: will I need a pilot's license; which certificate, private or commercial, will I need an instrument rating; will there be a minimum hour requirement; what type of FAA physical will be required, Class 2 or Class 3? The Air Line Pilots Association is pushing for UAS pilots to be licensed.[7] The FAA UAS Policy guidance document N8900.207 requires in certain instances that UAV pilots to have a pilot certificate, but in some cases they do not.[8] The bottom line is that schools are focused on pilot and sensor operator training for a career that has uncertain requirements. Students that spend four years earning a BS degree in aeronautics with a minor in unmanned systems with low flight time and no certification may be in for a disappointment in a highly competitive job market.

THE NEED FOR UNMANNED SYSTEMS TECHNICAL EDUCATION

Entering a new field of study begs many questions: What jobs are available and where does one gain the knowledge in the UAS profession? What are the topics a student needs to learn to prepare for this new career field? What jobs are available and more importantly and to the point, how much will it cost, how long will it take and where does one need to relocate? What if I don't want to spend four years in college and want to start a UAS business? How do I choose the right vehicle/sensor, what investment do I need to make and how do I obtain the training? In addition, what books should be used in a University based curriculum; what courses should I take if I want to learn how to build a small UAS? I already work in the UAS industry, what if I just want to learn about a specific topic like UAS autonomy or UAS propulsion?

Instead of focusing on operations as most schools do, a new school could focus on UAS engineering and program/project management. We need to provide a technical (not operations) education to the future leaders, engineers and entrepreneurs who will work at the thousands of companies starting up to meet strong demand. The heart and soul of an unmanned system is the sensor system and it is very important to understand system range, accuracy, resolution, precision, sensitivity, linearity, offset, hysteresis and response time. In addition, atmospheric and electromagnetic effects must be well understood so operations can be optimized and adverse effects can be minimized. It is very important for anyone in this industry to understand the theory and application of optical, near infrared (IR), thermal (mid-far-IR) multi-spectral, hyper-spectral, LIDAR, radar and sonar sensors. Unmanned systems engineers are needed to make the cost/performance trade studies to select the appropriate sensor and data processing for the business opportunity/application you have identified to prepare a business case for. From inspections and surveys to science and many more applications, sensor choice is critical for success.

Soon there will be thousands of new companies starting up to meet the demand for cheaper services. The FAA has predicted that there will be 10,000 UAS flying in the next 5 years but the recent AUVSI report indicates that sales for agriculture will exceed 100,000 vehicles per year. Program/project managers and systems engineers will need to develop customer requirements and create programs/projects to manage cost, schedule and technical performance much like the government acquisition process we use today.

Engineers will be needed to design, develop, integrate, test and sustain these vehicles. To build an unmanned system curriculum it is important to consider that both managers and engineers that design these vehicles and sensors, be exposed to aeronautical, electrical and mechanical engineering. Program and project managers and unmanned systems engineers should be exposed to multiple engineering disciplines to plan and mange new UAS programs. A mechatronics (i.e. mechanical and electrical) curriculum is a good example of how to integrate more than one branch of engineering. In fact you could call a degree in UAS engineering an aeromechatronics degree (aeronautical, electrical and mechanical engineering). UAS are very complex in terms of technology and a systems engineering approach is needed to ensure the vehicles are built efficiently and safely. A UAS engineering curriculum needs to include applied technology courses from different engineering disciplines, depending on the type of vehicle. The curriculum also needs to include systems engineering and project management courses. Graduates will then be able to obtain high paying jobs as program/project managers, systems engineers, flight test engineers and researchers.

UNMANNED SYSTEMS ENGINEERING

An unmanned system is not just a vehicle, it is a system composed of the air vehicle, communications, data links and control stations. Systems engineering applies to everything from a large unmanned system to computer hardware and software. It's a big-picture view that considers every aspect of a project, from costs and environmental impact, to time lines and life expectancy of equipment. An unmanned systems engineering curriculum should encompasses many disciplines so that engineers from diverse fields can better understand how to solve problems. An interdisciplinary degree program should cover modeling, simulation, design, architecture, integration, and testing of complex unmanned systems and processes. The degree program should supply students with underlying theoretical knowledge and practical experience applicable to unmanned systems. An unmanned systems engineering degree should provide expert knowledge so that graduates can apply for employment in engineering, design, development, integration and test of unmanned air, ground, sea and space systems.

Unmanned systems engineers will be critical to the positions of technical management and development of complex unmanned systems. These professionals will be responsible for planning, coordinating, and budgeting group efforts that translate operational needs into technology requirements. They use their skills to determine whether a system will meet cost, schedule, and performance goals. Unmanned systems engineers will perform a central role in realizing an unmanned systems success; they are in great demand by industry and government. Persons with a degree in unmanned systems engineering will enter the Unmanned Career field as systems engineers, researchers, flight test engineers, engineering program managers and project managers. Starting salaries estimated to be between $90,000 and $140,000. Figures are from Salary.com for a program manager or systems engineer.

A NEW APPROACH – EXTREME DIFFERENTIATION

Imagine starting a new University dedicated to commercial applications for all unmanned systems education and training. You would have to determine where to start, what qualifications the faculty would need, what tuition needs to be set, how to choose an insurance company, how to convince a state board of education you are legitimate, how you would get accreditation, what the curriculums and courses would be, what the mission and vision of the school should be, how to create content for the courses, what method should be used to teach and how you would recruit faculty and students.

Four Steps to Creating a New University Focused on Unmanned Systems Education and Training[9]

Step 1: Start from the Student's Perspective. The first step in creating an engineering curriculum should be to view it from the student's perspective. The course content needs to be interesting and directly applicable to the work that will be performed in a future job.

Step 2: Recruit World-Class, Subject Matter Expert Faculty. For each course topic, recruit world class experts with years of actual unmanned systems experience. Many think unmanned systems are new but they have actually been used since WWI. After all, the faculty is what makes one school standout over others. Minimum requirements should be a PhD in engineering and 25 years of experience. These people exist, but are difficult to find so use the social media (Linkedin.com is highly recommended) extensively in your recruiting efforts. Expand your recruiting to include instructors from other countries to find the best and the brightest.

Step 3: Keep Content Real, Worldly, Relevant, and Applicable. Course content needs to hold the students interest. Have the faculty develop lectures from the instructors experience, technical papers (with the latest discoveries) and online videos. Read extensively about new research and applications and continuously integrate these into course content. For student evaluations, design problems, use paper and design projects and add questions and take home exams. Improve student's technical writing skills by using a paper format that corresponds to an industry standard (e.g., IEEE). There are new developments in the unmanned systems industry almost every day and students should be encouraged to pick an interesting topic and publish their research, findings and ideas.

Step 4: Set a realistic business model and competitive pricing. Lastly is the pricing model. By having part-time instructors external from a brick and mortar campus teaching online, a significant cost savings can be realized. Keep the course costs affordable to be competitive. For a global pricing model, realize that incomes other countries, particularly in South America and India can be very low.

UNMANNED VEHICLE UNIVERSITY®

Unmanned Vehicle University® (UVU) is the only University in the world licensed to grant Doctorate and Master's Degrees in Unmanned Systems Engineering and offers a Certificate in UAS Project Management with all courses taught online. The University's concentration areas are unmanned air, ground, sea and space systems. Entrance requirements are a bachelor's degree in any topic and a calculus course. If students have not had calculus, a remedial course is available. The average faculty member at UVU has a PhD in engineering and 25-40 years of experience. The combined total experience of the subject matter experts is over 500 years. The schools UAV instructor pilots have combined experience of over 60,000 hours in Predator, Reaper, Global Hawk, Hermes, Heron, Aerostar and many small UAVs. UVU is located in the heart of downtown Phoenix at 1 East Washington St, 5th floor. The UVU website is at www.uxvuniversity.com, email is admissions@uxvuniversity.com, Phone number is 602-759-7372. Centrally located on the NE corner of Central Ave & Washington St. close to many civic, cultural and sporting venues. Attractions and destinations within walking distance of UVU. US Airways Center, Chase Field, Phoenix Convention Center, Arizona Science Center, The Herberger Theatre, Symphony Hall, Phoenix City Hall, Arizona State University, Orpheum Theatre, Phoenix Municipal Court, Arizona Biomedical Collaborative and University of Arizona College of Medicine

Degree programs at UVU take a systems engineering approach. Candidates are exposed to aeronautical, mechanical and electrical engineering as well as systems engineering and project management. The

systems engineering course includes preparation for the entry level International Council on Systems Engineering's Associate Systems Engineering Professional (ASEP) certification examination. INCOSE certification formally recognizes an individual's competency in the systems engineering process and is widely acknowledged as a significant accomplishment by practitioners in the field. The project management course includes preparation for the Certified Associate in Project Management (CAPM) certification by the Project Management Institute (PMI). PMI certification formally recognizes an individual's competency in the project management process and is widely acknowledged as a significant accomplishment by practitioners in the field. Master's Degree courses and curriculums are shown in Appendix 2. The university logo and seal are shown in Figure 3

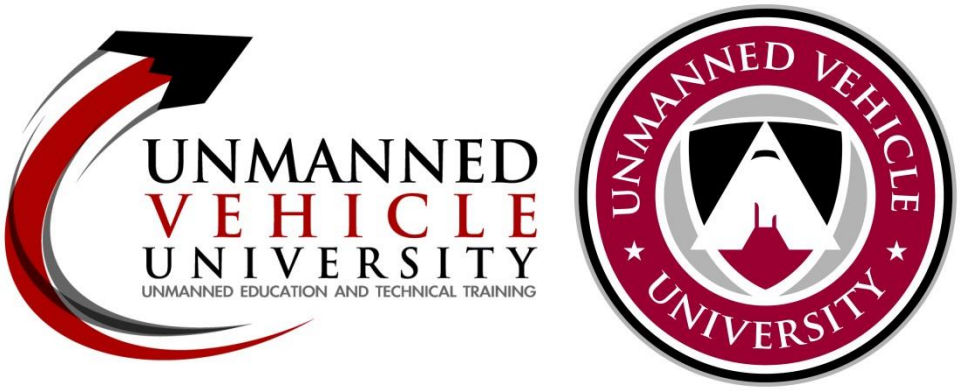

Figure 3 UVU Logo and Seal

Online learning—for students and for teachers—is one of the fastest growing trends in educational uses of technology. The Department of Education released a report[10] that analyzes 45 studies that compare traditional classroom instruction to online learning. The conclusion was that students participating in online learning performed modestly better than traditional face to face learning. All courses at UVU are taught online. When you login to the university website you will see a list of courses. When you click on a link, you enter the course and can view all course content. The top of the webpage has a syllabus and instructions about where to start. Your instructor will be proactive by contacting you on a weekly basis. All courses are conducted over a 12 weeks quarter. Each week, lectures, reading assignments, videos and technical papers are assigned for student preparation. Problem assignments are papers, design projects, problems and take home exams. The instructor normally posts an assignment on Monday with a due date of Sunday so students have the flexibility to complete the work when it is convenient.

Most people are able to learn online but it is a different way to learn. To succeed, you must be independent and able to set deadlines for your work. You work at your own pace; however, there are deadlines for the assignments. Instead of having an instructor lead you in a classroom, you will need to complete assignments on your own. You have the option to contact the instructor at any time with questions. To improve communications, UVU requires instructors to have a web conference at least once per week to go over the posted lectures and answer questions. For more challenging courses there is more than one web conference per week. Students can use their computer, iPad, iPhone or Android to view the conferences. This tool allows the student to clearly see the instructors computer desktop and hear his/her voice. Questions can be asked and answered in real time. The video presentations are excellent and even allow full motion video to be shared. We have trained students from around the world with this product.

Students receive a link in their email for the web-conference before the assigned date and time. Simply click on the link to be automatically logged in. All classes are recorded and available during the course for later viewing. A link to the video recording is sent after each live web-conference for students to review or allow students that

INTERNATIONAL JOURNAL ON UNMANNED SYSTEMS ENGINEERING

UVU publishes the International Journal of Unmanned Systems Engineering (IJUSEng), a refereed authoritative source of research in the field of unmanned systems engineering. The journal promotes the advancement of the applied science, technology and operation of unmanned systems through the dissemination of original research representing significant advances in the design, development, testing and operation of unmanned systems. IJUSEng is a platform for authors and researchers for communicating their latest findings, ideas and methods at the forefront of technology in unmanned systems engineering. The Editorial Board considers high quality original research articles, review articles, point-of-view articles, correspondence, technical notes and conference reports in the areas of aerial, ground, surface, underwater and space vehicle engineering. The scope is wide, covering research, design, development, operation, safety and reliability. A picture of the cover is shown in Figure 4, a list of topics is included at Appendix 3 and the Editorial Board is shown in Appendix 4. A complementary copy of the first edition can be downloaded at www.ijuseng.com

Figure 4 International Journal on Unmanned Systems Engineering (IJUSEng)

UNMANNED VEHICLE UNIVERSITY PRESS (UVU PRESS)

Unmanned Vehicle University® has recognized that there are few books published in the new career field of unmanned systems. UVU has established a publishing division called Unmanned Vehicle University Press. The first textbook published was Introduction to Unmanned Systems: Air, Ground, Sea and Space, Technologies and Commercial Applications and others are in the works. The cover is shown in Figure 5. UVU Press has already published unmanned systems courses on DVD and they are selling well on the

school website and at Amazon.com. A list of courses on DVD is shown at Appendix 5. To promote publication, UVU Press will publish for free, the first 50 approved textbooks on unmanned air, ground, sea and space systems. Authors will receive a royalty on every book that is published. To learn more visit the UVU Press website at www.uvupress.com.

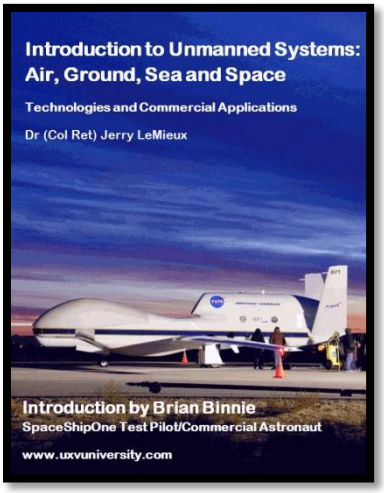

Figure 5 Introduction to Unmanned Systems Cover

1st WORLD CONGRESS ON UNMANNED SYSTEMS ENGINEERING

We cordially invite you to join us for the 2014 World Congress on Unmanned Systems Engineering in Oxford, United Kingdom. The Congress offers a chance to meet other Unmanned Systems researchers, scientists and business professionals in a relaxing atmosphere. Revered as one of the world's great academic institutions, the University of Oxford dominates the city skyline. A dense maze of historic honey stone colleges set around ivy-clad quadrangles in the heart of the city featuring some of England's finest architecture; together with excellent museums and a good range of restaurants that makes Oxford a highly rewarding Congress location. The 2014 WCUSEng offers four Engineering tracks: Air Systems, Ground Systems, Maritime Systems, and Space Technologies. The Congress aims to encapsulate a distinctive international flavor. Participants representing 30 to 40 different countries are expected in attendance. The Congress is sponsored by Unmanned Vehicle University® (www.uxvuniversity.com) and hosted by the International Journal of Unmanned Systems Engineering (IJUSEng). Authors instructions are contained at Appendix 6.

Figure 5 The University of Oxford

The benefits of attending the 2014 WCUSEng are:

- Researchers will be able to communicate their latest findings.
- The Congress offers various types of Abstract/Paper presentations: oral, E-presentations and poster presentations. E-presentations offer delegates remote presentation.
- Delegates may serve as Session Chairs for their respective sessions.
- Delegates may specify their preferred presentation day.
- Best Presentation Awards are determined by a vote of congress participants and recipients. Winners will receive a signed certificate from Unmanned Vehicle University®.
- An excellent opportunity to make business acquaintances.
- Accepted peer-reviewed Abstracts and Full Papers will be published online in the Proceedings of the 1st WCUSEng, hosted by UVU and the International Journal of Unmanned Systems Engineering.

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank all the faculty members and students at Unmanned Vehicle University®. They are all leaders and technologists venturing into the new career field of unmanned systems engineering. We are the "first and the best in unmanned systems engineering and training."

BIOGRAPHY

Doctor (Col Ret) Jerry LeMieux is the President of Unmanned Vehicle University®. He holds a PhD in engineering and has over 25 years of experience with research, development, technology transfer, integration and flight test and evaluation. Doctor LeMieux has over 20 years of course development and teaching experience at major Universities and Aviation Schools including; MIT, Boston University, University of Maryland, Embry Riddle Aeronautical University and Daniel Webster College. He has taught aeronautical, mechanical and electrical engineering and advanced mathematics courses at the undergraduate and graduate

levels. He has flown as a fighter/top gun pilot and Delta Air Lines pilot and has accumulated over 40 years and 10,000 hours of aviation experience. He has consulted on numerous airspace issues for the Federal Aviation Administration, Air Force, Army, Navy, NASA, DARPA and most major defense contractors. Doctor LeMieux is currently working with the FAA sponsored RTCA Special Committee 203 and 288 on legislative and airspace issues related to integrating unmanned air systems into US National Airspace. The FAA has invited him to speak on UAS integration into the NAS and has requested to use the UVU commercial applications list at Appendix 1. He is recognized as an authority on UAS and has recently been featured in the national media discussing the future of UAS on such programs as ABC Nightline and Fox News. He is the author of the first textbook on Unmanned Systems: Introduction to Unmanned Systems, Air, Ground, Sea and Space, Technologies and Commercial Applications. The introduction is written by Brian Binnie, test pilot for SpaceShipOne and second commercial astronaut. He is also Editor in Chief of the International Journal of Unmanned Systems Engineering the official Journal of Unmanned Vehicle University®. Recent interviews have been with ABC Nightline News, Fox News, Arizona Republic, Cronkite News, Cape Cod Times, Institute of Engineering and Technology (IET), Small UAS News, Experimental Aircraft Association, Washington Times, Flying Magazine, Las Vegas Review Journal, Big Beacon, Irish Times, Defense IQ and Flightglobal

APPENDIX 1

SAMPLE UAS COMMERCIAL APPLICATIONS

- Precision Agriculture
- Telecommunication
- High Altitude Imagery
- Maritime Surveillance
- Media and Traffic Monitoring
- Law Enforcement
- Natural disasters
- Real Estate Photography
- Meteorology
- Hurricane Monitoring
- Cryospheric Research
- Bridge Inspection
- Transmission Line Inspect
- HAZMAT Inspection
- Emergency Medical Supply
- Traffic Monitoring
- Aerial Surveying
- Damage Assessment
- Insurance Claim Appraisal
- Real Estate Marketing
- Concert Security
- Sports Video
- Runway Inspection
- Landmark Inspection
- Coffee Harvest Crop Disease
- Herd Tracking
- Cinematography
- Virtual Tours
- Hydrologic Modeling
- Geomorphic Model
- Flood Risk
- Entomology
- Forestry Inspection
- Fisheries Management
- Species Conservation
- Wildlife Inventory
- Mineral Exploration
- Remote Aerial Survey
- Forest Fire Surveillance
- Forest Fire Mapping
- Volcano Monitoring
- Remote Aerial Mapping
- Oil Spill Tracking
- Snow Pack Avalanche Monitoring
- Ice Pack Monitoring
- Poaching Patrol
- Insurance Claims
- Public Safety
- Firefighting
- Golf Resort Market
- Search and Rescue
- Bridge Inspection
- Meteorology
- Stadium Events
- Inspect Pipelines
- Power Restoration
- Newspaper Delivery
- Fire Prevention
- Crime Investigation
- Pipeline Inspection
- Traffic Monitoring
- Forestry
- Virtual Tours
- Inspect HAZMAT
- Motion Pictures
- Inspect Landmarks
- Aerial Photography
- Oil Spill Tracking
- Manage Fisheries
- Transmission Line Inspect
- Inspect Iceburgs
- Real Estate Marketing
- Crop Dusting
- Aerial Land Survey
- Volcano Monitoring
- Surveillance
- Predict Hurricane
- Predict Earthquake
- Disaster Relief
- Wildlife Research
- Archaeology
- Food Delivery
- Com Relay
- Crop Dusting
- Oil Rig Inspection
- Predict Earthquake
- Disaster Relief
- Wildlife Research
- Archaeology
- Food Delivery
- Com Relay
- Crop Dusting
- Oil Rig Inspection
- Monument Inspect
- Windmill Inspect
- Dam Inspection
- Nuclear Inspection

APPENIX 2

MASTERS DEGREE COURSES AND CURRICULUMS

Master's Degree in Unmanned Aircraft Systems Engineering
Job: UAS engineer, program manager, flight test engineer, analyst, researcher

UAV 601 Unmanned Aircraft System Fundamentals
MAT 701 Numerical Analysis
UAV 801 UAV Aerodynamics and Flight Stability
UAV 803 Unmanned Systems Autonomy
SYS 601 Fundamentals of Modern Systems Engineering
UAV 701 Optical, Infrared and Radar Sensors
SYS 701 Project Management of Complex Systems
UAV 702 Unmanned Aircraft Test and Evaluation

Master's Degree in Unmanned Ground Vehicle Systems Engineering
Job: Employment at Driverless Car Companies

UGV 602 Unmanned Ground System Fundamentals
MAT 701 Numerical Analysis
UXV 609 Introduction to Robotics
UGV 806 Advanced Motion Planning
SYS 601 Fundamentals of Modern Systems Engineering
UXV 701 Optical. Infrared and Radar Sensors
SYS 701 Project Management of Complex Systems
UGV 707 Autonomous Intelligent Control Systems
UXV 805 Human Robot Interaction

Master's Degree in Unmanned Underwater/Surface Vehicle Systems Engineering
Job: UUV/USV engineer, program manager, test engineer, analyst, researcher

Currently under development

Master's Degree in Unmanned Space Vehicle Systems Engineering
Job: Employment at Commercial Space Companies

USV 601 Spacecraft System Design, Performance and Development
MAT 701 Numerical Analysis
USV 603 Space Environment & Thermal Control
USV 606 Atmospheric Re-entry
USV 801 Orbital Mechanics
USV 605 Mission Design and Analysis
USV 703 Propulsion (includes rocket design)
USV 803 Spacecraft Structures, Mechanisms and Materials
USV 706 On-board Avionics (Power Supply, Data Handling, Computer, Software, TLM & TLC)
SYS 705 Space Project Management (including Product Assurance)

The Board of Directors at the

Unmanned Vehicle University

In recognition of scholarly attainments and distinguished service
and nomination of the Faculty of the University,
By virtue of the authority granted by the State of Arizona,
hereby confer upon

Student Name

the degree of

Doctor of Science in Unmanned Systems Engineering

With all honors, rights and privileges thereunto appertaining.
In witness whereof this Diploma is signed by the authorized officers
of the University and sealed with the corporate seal of the University.
Given in the Office of Unmanned Vehicle University
on the sixteenth day of May in the year two thousand thirteen.

Brian Binne
SpaceShipOne Test Pilot/Commercial Astronaut

Dr (Col Ret) Jerry LeMieux
Executive Director

APPENDIX 3

LIST OF TOPICS FOR THE INTERNATIONAL JOURNAL ON SYSTEMS ENGINEERING

Aerodynamics and aeroelasticity
Airships & aerostats
Autonomy and swarming
Economic impact
Electrical & electronic systems
Fire-fighting and disaster management
Flight control systems and avionics
Flight stability
Flight test & evaluation
Fluid mechanics
Human factors
Human-machine relationships
Law enforcement applications
Materials
Micro air vehicles
Micro-electro-mechanical systems
Modeling and simulation
Multi-vehicle systems
Navigation
Optical, acoustic and electromagnetic communications
Platform and payload integration
Robotics
Rotor craft design
Safety management systems
Satellite and spacecraft technologies
Socio-technical systems
Software engineering
Structural and mechanical design
Testing and performance
Unmanned systems control interfaces
Unmanned systems operator training
Visible, infra-red and radar sensors

APPENDIX 4

EDITORIAL TEAM FOR THE INTERNATIONAL JOURNAL ON SYSTEMS ENGINEERING

APPENDIX 5

LIST OF UVU PRESS UNMANNED COURSES

UAV Autonomy

UAV Aerodynamics

UAV Fundamentals

UAV Use in Agriculture (In Progress)

Small UAV Fundamentals

Small UAV Design and Construction with kit and Labs

Starting a UAV Business

Police UAV Applications

Driverless Car Design

UAV Flight Test and Evaluation (Future)

UAV Sensors (Future)

UAV Human Machine Interface Design (Future)

All courses can be purchased on the UVU website www.uxvuniversity.com or amazon.com. Signup for our newsletter on the website and receive a 10% discount on the courses on DVD.

APPENDIX 6

1st World CONGRESS ON UNMANNED SYSTEMS ENGINEERING
AUTHORS INSTRUCTIONS

Important Dates:

28th February 2014	Deadline for very early registration
31st May 2014	Deadline for Abstracts & Full Papers
31st May 2014	Deadline for early registration
After 31 May 20144	Late registration
30th June 2014	Upload final camera-ready Abstract or Full Paper
30th July to 1 Aug	Congress

AUTHORS' INSTRUCTIONS

Steps for Authors to submit their Abstract or Full Paper:

1. Review the Guidelines for Authors
2. Submit your Abstract or Full Paper
3. Receive notification of acceptance / rejection
4. Prepare your poster (Abstracts), presentation in PowerPoint (Full Papers), or narrated presentation (e-presenters).

Guidelines for Authors

The 2014 WCUSEng promotes the advancement of the applied science, technology and operation of unmanned systems through the dissemination of original research representing significant advances in autonomous vehicle systems. The Congress provides a forum for researchers, scientists and business professionals World-wide to present the latest innovations and future research directions in Unmanned Systems Engineering. The Congress Editorial Board will consider high quality Abstracts and Full Research Papers that present original research in the areas of air, ground, maritime and space systems engineering. The scope is wide, including themes such as: Aerodynamics & aero-elasticity, Airships & aerostats, Autonomy & swarming, Economic impact, Electrical & electronic systems, Electromagnetic communications, Fire-fighting & disaster management, Flight control systems & avionics, Flight stability, Flight test & evaluation, Fluid mechanics, Human factors, Law enforcement applications, Materials, Micro air vehicles, Micro-electro-mechanical systems, Modeling & simulation, Multi-vehicle systems, Navigation, Optical & acoustic communications, Platform & payload integration, Robotics, Rotor craft design, Safety management systems, Satellite & spacecraft technologies, Software engineering, Structural & mechanical design, Testing & performance, Unmanned systems control interfaces, Unmanned systems operator training, Visible & infra-red sensors, and Radar sensors.

WCUSEng adheres to the manuscript publication style for the International Journal of Unmanned Systems Engineering (IJUSEng).

Abstracts
Abstracts should not exceed one A4 page with one inch margins, and must be submitted as a Microsoft Word-compatible file. Text should be formatted using Times New Roman font at 11 points, 1.0 line space, and justified. Please download and use the template for Abstracts from this website. Your Abstract should be structured as follows:

- Abstract title
- Name and affiliation for all authors
- Email address and Company or Institution website for the corresponding author (this is optional)
- Introduction
- Main body of abstract
- Tables and figures in their correct position in the abstract (if applicable)
- Conclusion
- References

Acronyms and symbols should be defined in the text, if applicable.

Full Papers
Full papers should not exceed 10 A4 pages with one inch margins and must be submitted as a Microsoft Word-compatible file. Text should be formatted using Times New Roman font at 11 points, 1.5 line space, and justified. The abstract of the paper should be at 1.0 line space. Please download and use the template for Full Papers from this website. Your paper should be structured as follows:

- Paper title
- Name and affiliation for all authors
- Email address for the corresponding author and Company or Institution web addresses for all authors (this is optional)
- Abstract
- Keywords
- Introduction
- Main body of paper
- Tables and figures in their correct position in the paper (if applicable)
- Conclusion
- Acknowledgements (if applicable)
- References
- Notation (if applicable)
- Appendices (if applicable)

Acronyms and symbols should be defined in a Notation toward the end of the paper, if applicable.

Abstract or Full Paper Submission
Please submit your Abstract or Full Paper electronically via the Journal website: www.ijuseng.com. Authors should indicate the specific congress track for which the Abstract or Full Paper is being submitted. To ensure that your presentation appears in the congress proceedings, please submit the final version by 30th June 2014. For final versions and new submissions after this date, please contact us to make arrangements.

Notification of Acceptance
Notification of acceptance, or rejection, will be sent to authors by email within 10 days of receiving their Abstract or Full Paper. Acceptance will be classified as ‘Accepted’ or ‘Accepted subject to minor

revisions'. In the latter case, authors should attend to the peer-review comments put forward by the Congress Editorial Board and resubmit their Abstract or Full Paper within two weeks.

Abstract and Full Paper Presentations
Abstracts should be presented as a poster. Presenters must shadow their poster during the coffee break time in their assigned morning or afternoon poster session to discuss the research and answer any questions. Please consult the Poster Preparation guidelines.

Full papers should be presented using PowerPoint. Presenters are allocated 20 minutes to present their paper, followed by 5 minutes of questions and discussion. Please bring your presentation on a USB flash drive. Each presentation room will be equipped with a computer and data projector for PowerPoint presentations. Please consult the Presentation Preparation guidelines. For authors that cannot attend the Congress, please see the e-presentations guide.

Congress Proceedings
The Congress Proceedings for the 2014 World Congress on Unmanned Systems Engineering in Oxford (United Kingdom) will be published online in the International Journal of Unmanned Systems Engineering after the Congress. Participants receive the Congress Proceedings in a flash drive.

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