THE NEW AVIATION METEOROLOGY SPECIALIZATION IN THE GRADUATE AERONAUTICS PROGRAM AT EMBRY-RIDDLE

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1. INTRODUCTION

A new specialization has been added to Embry-Riddle Aeronautical University's (ERAU) Master of Science in Aeronautics (MSA) degree program. The specialization, Aviation Meteorology, adds a crucial domain to the existing MSA options in Air Traffic Management, Aviation/Aerospace Education Technology, Aviation/Aerospace Management, Aviation/Aerospace Operations, and Aviation/ Aerospace Safety Systems.

ERAU offers many different degrees within the field of aviation and related areas. Examples of undergraduate degrees include applied meteorology, air traffic management, aeronautical science, and aerospace engineering. The unique learning environment at ERAU offers students the opportunity to receive a world-class education and gain invaluable knowledge from experienced professionals in the field. For example, the air traffic management faculty has over 200 years of cumulative experience, as many professors are in a second career at ERAU after completion of a full career with the Federal Aviation Administration (FAA). In the aviation-related graduate degrees, this experienced faculty gives graduates a special edge for entrance into the industry. Seven master's degree programs in addition to the MSA are also offered at the Daytona Beach campus, including business administration, engineering physics, human factors and systems, and safety science. Out of the seven master's degree programs, the MSA makes up 23% of those enrolled based on fall 2007 statistics (ERAU, 2008). Starting in 2010, ERAU will begin offering doctoral degrees in Aviation and Engineering Physics.

This paper describes the aviation industry need for modernization, focusing on the area of aviation meteorology, outlines the requirements for completing the aviation meteorology specialization, provides an example from a test course offered last summer, and highlights two faculty research areas within the program.

2. INDUSTRY NEED

By 2025, U.S. air traffic is expected to double (FAA, 2008). The existing national airspace system (NAS) is not expected to keep up with the increased demand without drastic changes to the present system. To help cope with this significant increase, the Next Generation Air Transportation System (NextGen) program was created. NextGen is a multi-agency initiative to modernize the NAS drastically over the next 3-15 years. NextGen will provide both the need as well as the opportunity for MSA graduates with the aviation meteorology specialty, as we will discuss throughout this paper.

Weather affects every aspect of the NAS, from flight planning to critical air traffic control (ATC) decision making. Many times flights can take off and land at their destinations without a problem, but when aviation-impacting weather occurs, many issues arise. The FAA estimates that delays due to weather cost NAS users in excess of $4 billion annually, and make up 70% of delays nationwide (JPDO, 2009).

Significant "culture" changes must take place as the U.S. transitions from its present-day, overworked and antiquated NAS, to a network-enabled, "every airplane a node" type of operating environment in the NextGen era. For example, today's weather and ATC displays are largely separate, the weather predictions are deterministic, and a great deal of "mental integration" must go into decision-making at all levels of the NAS, from individual pilots and controllers, to the personnel at the Air Traffic Control System Command Center. There is presently no ability to assign a value of uncertainty to the forecast and thus assess quantitative risk to a flight operation from the weather. The transition from the present "Cope and Avoid" culture into an "Anticipate and Mitigate Risk" culture will require graduates who can be equally conversant and comfortable *across* multiple functional areas. The NextGen concepts of Weather/Air Traffic Management Integration, Weather Technology in the Cockpit, and Collaborative Decision-making will *require* it as the Federal Government, industry, and academia build the NextGen system over the next 15 years. It is areas such as these at which the new specialization is aimed.

Within the aviation meteorological arena, NextGen's Network Enabled Weather (NNEW) and Reduced Weather Impact (RWI) programs plan to reduce the number of delays due to weather significantly in the coming years. Key concepts within these programs include the four-dimensional weather data cube (Miner et al., 2009), which will provide a virtual source for all aviation weather data, combining public and private sources, but allowing each organization to have the weather information that suits its needs. Weather information from the cube

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will be integrated into Flight Management Systems and decision support tools to allow decision makers in the NAS to operate from a common operating picture with regards to the weather. So while professionals coming into this field will need a background in meteorology, they will also have been exposed to fields such as ATC, safety, business, operations, and human factors. All of these areas will be integral in putting this new transportation system together.

3. AVIATION METEOROLOGY SPECIALIZATION REQUIREMENTS

The interdisciplinary MSA program requires 36 credits for completion. The student must complete 12 credits of core courses. These include Research Methods and Statistics (required), and a choice of The Air Transportation System, Human Factors in the Aviation/Aerospace Industry, Aviation/Aerospace Communications/Control Systems, and Applied Aviation Safety Programs.

The aviation meteorology specialization requires 12 credits of coursework. All students, regardless of their undergraduate degree, are required to take Advanced Aviation Meteorology and Research Seminar in Aviation Meteorology. If a student has an undergraduate degree in meteorology/atmospheric sciences, he/she may take two elective classes applicable to the degree. For those students who do not have an undergraduate degree in meteorology/atmospheric sciences, an Advanced Meteorology survey course must be completed, along with one appropriate elective. Electives include relevant graduate courses in other programs as well as 400-level applied meteorology courses such as Environmental Security or Statistical Applications for Meteorological Data Analysis, which can be taken for graduate credit with permission of the professor. Additional examples of relevant electives may include Weather and Air Traffic Integration, Air Traffic Management Leadership and Critical Decision Making, Human and Organizational Factors in Technological Systems, Human Factors in Systems, Airline Optimization and Simulation Systems, or International Management and Aviation Policy. A choice of a six-credit thesis with two additional electives, or comprehensive exam with the addition of four more electives, completes the degree. Upon completion of the MSA with Aviation Meteorology specialization, a student can have as many as half (18) of the total required credits in aviation meteorological coursework and thesis research.

4. APPLICATION-EXAMPLE COURSE

In the 2009 summer term, an experimental course in Weather and Air Traffic Integration was offered as a means to introduce the students to the new specialization. The course familiarized the students with the concept of weather and air traffic integration as it currently exists, and what is being planned for the NextGen era.

The first portion of the class was lecture-based, and covered basics of aviation meteorology and ATC, in order to provide an even playing field for those students without a meteorology or ATC background. The second portion consisted of student-led seminars. Students were given topics on NextGen programs such as Automatic Dependent Surveillance – Broadcast (ADS-B), System Wide Information Management, National Airspace System Voice Switch, and the weather programs such as NNEW and RWI. In the seminar portion of the course, students were expected to read the relevant literature and present their findings to the class. They were also asked to engage the class with insightful discussion questions.

An example of one of these presentations is on the NAS Voice Switch. The connection from this NextGen project to Weather/ATM integration is as an enabling technology for easier transmission of information (including weather) to/from the flight deck. A background was given on the current system and the developments proposed in NextGen. The different possible solutions were also discussed. Figure 1 shows the differences between Voice Over Internet Protocol (VOIP) and Time Division Multiplex (TDM) switches, two of the proposed solutions.

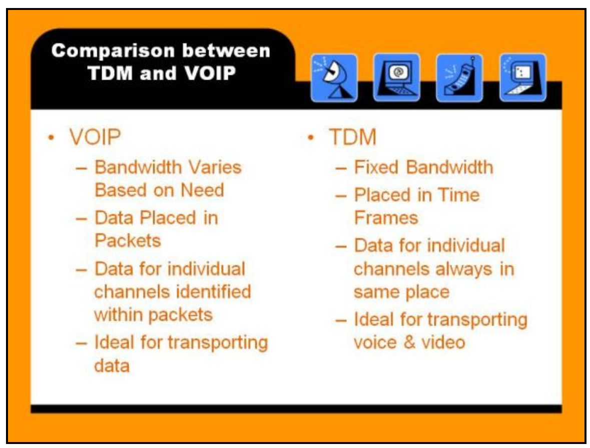

Figure 1. Student-led seminar slide on TDM/VOIP solutions.

Three discussion questions were then presented to the class:

1) From your personal experience or anecdotal evidence, have you ever had problems speaking/listening to ATC?

2) What do you expect the NVS program to improve (if anything)?

3) Do you think it is really possible to renovate the Voice Switch System in 10 years?

The summer class had a very diverse student background, which included three flight instructors with degrees in aeronautical science, one with a degree in engineering physics, and one with a degree in meteorology. The discussions were perceptive and showed good understanding of the topics along with the relative challenges and difficulties that might be faced in the future with NextGen. The course concluded with a field trip to the Jacksonville, FL Air Route Traffic Control Center. There, students met with Center Weather Service Unit meteorologists, discussed weather issues with personnel from the Traffic Management Unit, and sat with the controllers while they were controlling aircraft within a sector of KJAX Center airspace. The Weather and Air Traffic Integration seminar class was so successful that we are considering adding it to the required specialization courses, which will allow it to be taught in future semesters so that students can keep up with current NextGen programs and issues in this critical area.

5. CURRENT RESEARCH IN THE PROGRAM

Several research initiatives are underway within the new specialization, which will allow students to become familiar with the types of technological advancements being developed within the NextGen program. We will highlight two of them here: 1) Weather Technology In the Cockpit (WTIC); and 2) A weather and aviation data archive being developed to support NextGen operating environment simulations.

The first project is an FAA-sponsored WTIC research grant focusing on the education and training issues surrounding WTIC. Many developments have been made to the meteorological tools available to pilots, and many types of meteorological information such as NEXRAD data and current surface observations and forecasts are routinely sent up to the cockpit via data link. These products are displayed on multi-function displays, and more recently onto Electronic Flight Bag systems. These tools allow pilots to have weather information at their fingertips while flying, without the help of ATC or a Flight Service Station. However, while these WTIC systems have been put into place over the years, little work has been done to examine pilot education and training issues with regard to safe and efficient utilization of WTIC technologies. The issues become more complex when considering the differing needs of the general vs. commercial aviation communities.

The second project, described by Herbster et al. (2010a, b), involves the development and population of a weather and aviation data archive to be coupled with a cataloging and searchable database. This work is being done to support NextGen applications for simulations at the NASA Langley Research Center Air Traffic Operations Laboratory. This simulation capability will enable a variety of aviation and meteorological studies to test and evaluate the effectiveness of NextGen technologies such as ADS-B under different user-specified weather and air traffic scenarios.

6. CONCLUSIONS

The new Aviation Meteorology area of specialization in Embry-Riddle's MSA degree at Daytona Beach adds a critical component to this already diverse program. The cross disciplinary approach described here will allow graduates to apply multiple fields of knowledge to present and future problems affecting the NAS as it transitions to the NextGen environment over the next 15-20 years. The faculty plays two important roles in the program: first as valued mentors, bringing years of operational experience to the classroom; and second as accomplished researchers, performing cutting-edge studies in such important NextGen areas as WTIC and weather/air traffic integration. ERAU's partnerships with industry, government agencies, and other academic institutions, combined with world-class facilities such as its flight simulation laboratories, will allow graduates from this program to be at the forefront of NAS modernization and innovation. This program, along with the creation of doctoral programs in Aviation and Engineering Physics, will be instrumental in producing the next generation of operators, managers, and researchers in the aviation and aerospace industries.

7. REFRENCES

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