Acquiring and Implementing an Air Traffic Control Simulator in a Higher Education Aviation Program

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Professor Louis (Lou) Scala’s career in aviation began “back in the day” (1965) as a freshman at Aviation High School, in Long Island City, New York. At Aviation High School, he learned about the technology of aircraft and earned FAA Certification as an Airframe and Powerplant Mechanic. He continued his studies at the State University of New York Agricultural and Technical College (S.U.A.T.C.) in Farmingdale, New York, studying Aerospace Technology, following this by obtaining BS and MA degrees in Technical Education from New York University. Lou began his career as collegiate aviation educator at the Vaughn College of Aeronautics, as an aircraft maintenance technical instructor, and returned "home" to Farmingdale State College in 1982. During his tenure at FSC, Professor Lou, has taught many subjects related to aircraft and engine technology, the history of aviation, government regulations, airport planning, and airport operations. Of particular note, Professor Scala gained invaluable experience when he had the opportunity to shadow and be mentored by the FAA’s Eastern Region Airports Division Lead Airport Safety Certification Inspector, Mr. Vincent Cimino. Professor Scala is a Certified Member (C.M.) of the American Association of Airport Executives and has also earned Airport Certified Employee (ACE) credentials in Airport Operations. He is presently the faculty advisor of the FSC Chapter of the AAAE. Professor Scala is also an active member of the AAAE and Northeast Chapter of the AAAE, serving on their Academic Relations, Diversity, and Workforce Committees. Professor Lou has been instrumental in helping FSC students gain internships, scholarships to attend various AAAE and NECAAA conferences, and has helped many FSC alumni enter the industry as airport operations coordinators. Professor Scala is married to Annabelle, a young woman he met at S.U.A.T.C., in 1970, is the father of three grown daughters—Jennifer, Joanna, and Tina, and is the proud grandfather of Wylde, Sea, Evie and Luca.
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Background and intention

The higher education institution described in this paper is a state college located in the eastern United States. The college has an Aviation Department that resides within a school that has several technology and engineering programs. The Aviation Department has two degree programs accredited by the Aviation Accreditation Board International (AABI). These programs are a B.S. in Aeronautical Science – Professional Pilot, and a B.S. in Aviation Administration. The aviation administration program satisfies the criteria for what the AABI categorizes as an aviation management degree program. The graduates of the aviation administration program at the college in this paper are typically interested in being hired for various levels of management at airports and other aviation-based businesses located at or near airports. The intention of this paper is to describe the motivation and circumstances that led to initiating steps intended to improve both aviation degree programs at the college, which included the acquisition of the simulator. While the simulator described was available due in part to an unusual opportunity and good timing, the path describing its acquisition may prove useful to institutions planning on buying new simulators or other complex and expensive educational technologies. This paper shares the experiences and challenges met along the academic, technological, and financial paths of the project.

Motivation for improvement

The aviation faculty conducts semi-annual assessment activities on both of their degree programs. This includes the individual courses that make up these programs. The achievement levels of these courses are reviewed and analyzed. Student learning outcomes not meeting the desired minimum achievement levels are reviewed for possible reasons why they were not met, and what can be done to meet them by the next assessment cycle. Often it is determined that the solution for improvement is best applied within the course, but on occasion the assessment process finds that further support of student learning outcomes of one course can be improved by modifying prerequisite courses.

During the 2017 assessment cycle, the faculty discussed improving the level of technical knowledge their aviation administration students gained with relation to the airplane and the National Airspace System (NAS) it operates within. This improvement was directed at the Aviation Administration degree program. The courses within the program were found adequate in providing technical aspects and managerial concepts of airports. However, the faculty’s assessment led to an agreement that students may better appreciate technical and managerial airport concepts if they had a better understanding of the airplane itself and the airspace they navigate that surrounds airports. At the time of this discussion, the professional pilot students were not targeted since their curriculum already included extensive coverage of these concepts. It was decided that these ideas would be brought up at the next Aviation Industry Advisory Board meeting.
Opportunity

In summer 2017, an unusual opportunity presented itself in the possible auction of a high-fidelity air traffic control simulator that was housed in a recently closed college undergoing liquidation. The news of the auction came just after the faculty’s discussion on having aviation administration students take courses similar to the private pilot ground course, so they better understand aircraft and the environment they operate within (e.g. airports and airspace). One of the challenges in teaching flight related topics to students who don’t fly is they do not gain context in navigating airspace firsthand, often leaving the concepts abstract within one’s mind. Beckem and Watkins [3] describe how simulation allows learners to gain true knowledge transfer thanks to the hands-on aspect of this tool providing a contextual reality. The rational for acquiring such a simulator was quickly agreed upon in that it would aid in helping students better grasp challenging aviation concepts that they had no way of experiencing since they were not required to take flight lessons. Given the time-sensitive nature of the auction process, an aviation faculty member was assigned the responsibility to investigate the process of acquiring such a simulator, and also provide the administration with justification in how this technology would help meet program goals and learning outcomes of the aviation degree programs. This aviation faculty liaison would also maintain communications with the consulting company that was carrying out the liquidation process and sale of the simulator.

Justification/rationale

To help further justify introducing the ATC simulation lab to the program, the faculty looked for precedent of other aviation colleges offering similar courses. The idea to have administration students take ground school courses is not new. For example, as of 2019, 79.3% of 4-year AABI accredited Aviation Management programs listed on the AABI website had at least one required course in their curriculum that provided students with knowledge in topics related to flight [4]. A review of the course descriptions found these topics were similar to what their classmates in professional pilot programs would learn, which typically consist of an introduction to basic aerodynamics, propulsion, aircraft systems, flight instruments, airspace, etc. It was proposed that ATC simulation could enhance the topics of airspace and how air traffic moving through it has specific procedural and communication requirements. Additionally, as of 2019, 41.4% of 4-year AABI accredited Aviation Management programs listed on the AABI website had at least one required course in their curriculum that introduced students to the technical aspects of the National Airspace System (NAS) and how air traffic control (ATC) manages aircraft within the NAS [5]. These courses typically introduce aviation management students to the technical aspect of the structure of the NAS, and how ATC manages factors that affect its capacity, delays, and how the NAS will exist in the future. Graduates that go on to become pilots and air traffic controllers quickly learn to deal with the challenges of aircraft limitations, airway congestion, local and widespread winds, storm systems, and other factors affecting the NAS. However, these challenges also add to the complexity of issues that managers and administrators must consider when making decisions within their areas of responsibility. Since many college students in aviation management programs may graduate with no flying experience, the time it takes to gain the experience and wisdom needed to effectively consider all elements within the NAS on their ability to assess their decision making may take time to develop. Often, the ability for administration students to recognize the relationship between these issues in making decisions may occur only after they experience it first-hand once employed in the industry. The faculty felt
that if students can gain more real-world experience before they graduate, the better they will be equipped to start making effective decisions as they enter the workforce. The faculty felt well executed lessons utilizing a simulated interactive environment that could be provided by the ATC simulator would greatly enhance the topics described above. The faculty felt further justified in their rationale in moving forward with a proposal to the administration for approval in placing a bid on the simulator.

Advisory board input

Despite feeling confident with the reasoning in purchasing the ATC simulator based on the aspects described above, an additional educational consideration surfaced that had to be acknowledged. To what degree should the level of technical knowledge be raised within the aviation administration program? Would doing so significantly impact the level of student retention within the program? Are these technical topics truly relevant and beneficial to the educational outcomes for administration students? The faculty felt the issue was worth exploring with their Aviation Industry Advisory board.

The advisory board is made up of representatives that include leadership positions at airports, airlines, the Federal Aviation Administration (FAA), the Port Authority of New York and New Jersey (PANYNJ), which operates several airports in the NY/NJ metropolitan area, fixed base operators (FBOs), and training institutions such as Flight Safety International (FSI). The faculty asked the board to review the relevance of Aviation Administration degree courses for management of airports and aviation businesses. Additionally, the board was informed on the faculty’s plan to have two courses with outcomes that give students a better technical understanding of how the airplane works and its limitations. These courses would also give students a working knowledge of the NAS and how aircraft flowing through it are managed with the thought this may help graduates make better decisions in their future jobs.

The aviation faculty requested the advisory board to review both of the aviation degree programs while considering the faculty’s question of introducing more technical topics. The faculty also made the board aware that some AABI accredited colleges use their FAA approved private pilot ground school course to provide the technical understanding for their management students, while other colleges have courses that are similar to the ground school courses but are tailored to what they feel management students need to know. After considerable discussion it was agreed the intensity of a one semester ground school course without the flight training that complements the technical content might be unnecessarily complex. The faculty decided it would be better to modify a previously run course that would serve as an “administration version” that provides a solid foundation of what private pilots learn. The advisory board agreed and provided topic suggestions in alignment with what the faculty previously considered.

The faculty also utilized the advisory board’s expertise to review the proposed content of a new course that would integrate the use of simulation with traditional lecture to provide students with an enhanced technical understanding of how the NAS and ATC works. The intention was the same as the pilot foundation course, which is to help students make informed decisions in their future jobs. The faculty also proposed to the board the idea of requiring flight students to take this course. The majority of flight students graduating from the program would be dealing with ATC their entire professional flying career. The justification of this requirement was that flight playing the role of ATC would benefit from the “cross training” because they would also
continue to practice their aviation phraseology while talking on the radio to their classmates. The faculty proposed that flight students going through a course in ATC would have the opportunity to see what goes on behind the scenes by playing the role of a controller moving air traffic through the NAS. The advisory board agreed.

Administrative approval in acquiring the simulator

During the timeframe that faculty had initiated discussions on increasing the levels of technical content in the Aviation Administration degree program, the Aviation Department Chair met with the Dean of the engineering technology school to discuss how a recently closed college with a fully interactive ATC simulator that was under liquidation proceedings. The Dean was informed one of the aviation faculty members who had extensive experience operating the simulator had confirmed that purchasing the simulator separately from the property of the college being liquidated was a possibility. This faculty member was designated as the point of contact with the consulting company that was coordinating the liquidation of the college.

One challenge faced was the simulator would be purchased through an auction. Despite that no one else asked about its availability to purchase, the liquidation process required it be publicly posted for sale. Additionally, the college did not typically purchase items being auctioned, so this required some communication between administrators and the Chief Financial Officer to move forward. The next challenge was deciding on a price to offer. The liquidation company did not specify a minimum price. The simulator was originally purchased in 2005 under a grant for $1.8 million. The software simulation program was developed by Raytheon. The software was installed on 35 Dell desktop computers. This included 12 student work stations that made up the control tower positions, radar controller positions, and pseudo-pilot positions. Each workstation used two computers and displayed information over three monitors (4:3 ratio). Six computers served as “image generators” to handle the graphics, and were configured similar to gaming-class computers. The remaining computers served as two instructor stations, a “visual gateway” that exchanged information between the workstations and the visuals, a communication master that transmitted student voices and recorded them, and a computer handling airport lighting. The representation of the outside world was displayed in a tower cab mockup through six Samsung 63-inch plasma screen TVs. The computers, monitors, and TVs were housed within custom built furniture that represented a tower cab and radar stations. The pseudo-pilot stations had matching custom furniture as well.

After reviewing the inventory of software, hardware, peripherals, and furniture, it was determined that the primary value within the simulator was the ATC software licenses and the furniture that formed the mockup of the ATC tower cab, radar room, pseudo-pilot stations, and associated touch screen monitors. Given the age of the original computers (2005), the potential bid would be significantly lower than purchasing a brand-new system. To provide a better idea of worth for such software, an estimate was requested from a company that provides similar ATC simulation software and hardware configurations. That company provided a quote of $750,000 for a similar amount of student workstations and less visual fidelity. The cost to upgrade with identical visual fidelity could approach $1,000,000. The idea of possibly acquiring the simulator for a fraction of a new system became even more considerable.

Before making any bids, the next challenge would be finding enough space to create the ATC Simulation lab. A room was needed that could house the furniture of the tower cab, radar
stations, and pseudo pilot stations. Additional space would be needed to have desks and chairs for students to sit in during lectures, as well as simulation briefings and debriefings. Ideally there would also be additional space to grow the lab in the future. Added to the challenge was the shortage of campus space due to a student body that was growing annually. The search was conducted with the help of the school’s Dean, Aviation Department Chair, and aviation faculty liaison already familiar with the simulator. The dimensions of the lab component footprints were as follows:

- Tower cab: 14 ft. x 12 ft.
- Radar station: 12 ft. x 8 ft.
- Pilot stations: 25 ft. x 6 ft.

The length of the space for the pilot stations had some alternative arrangement options, but the plan for the 25 x 6 footprint was to keep these stations along a wall. Doing so would minimize intrusion into any potential central room area that could be used for lecture seating. The tower cab and radar station footprints did not have any flexibility without completely redesigning the furniture. The majority of the rooms under consideration had various drawbacks, ranging anywhere from “territorial” issues, odd room dimensions, distance from the aviation department, etc. The room that was ultimately identified as being suitable had several challenges, but now that a space was identified, the bid could now be submitted to the consolidation consultants. Since the college didn’t normally buy equipment being liquidated by auction, a meeting was held with the Dean, Aviation Department Chair, and aviation faculty liaison to discuss the formulation of a reasonable offer. This bid was initially based on an estimate of the equipment value and software on the drives. However, the final bid that was offered was based on a percentage of the quote that was recently provided for a new ATC simulator. The consolidation consultants accepted the bid.

Making it fit

The room that would ultimately house the ATC simulator had an open floor space measuring 35 ft. x 33 ft. Along one side of the room there were multiple storage rooms with individual door access. The open floor space was adequate to fit the three major components of the simulator, but it was apparent that it would become cramped when considering including a seating arrangement that would suit a lecture. Some of the space was consumed by two large tables belonging to different departments, one of them being firmly attached to the floor. Even if the decision was made to sacrifice seating comfort during aviation lectures, the room had to accommodate lecture seating for non-aviation classes given that campus real estate was hard to come by. The next challenge was the lack of air conditioning. The room was located in one of the older buildings on campus. This building had basement plumbing that radiated significant heat throughout the first floor. Whenever the forecasted temperatures exceeded 65°F, the room soared to over 80°F. These temperatures would likely rise with the addition of 30 or more computers, the associated monitors, and six large plasma displays operating. It was anticipated that student learning and computer stability would decline under these conditions. It was also determined that there was not enough electrical capacity for the required computers and air conditioning. It was becoming clear that in order for the project to move forward, approval would be needed for significant room modifications and electrical upgrades would have to be performed. The upgrades would require more departments to be involved, and the costs in addition to the actual simulator bid
would also need to be considered and approved. This led to communications between the aviation faculty and Chair, the school Dean, Provost, Director of IT, Physical Plant, Purchasing, and the CFO. The Dean and CFO emerged as strong supporters to move forward, and initiated a flow of communications between applicable departments that facilitated the advancement of the project.

The aviation faculty coordinated visits with IT and physical plant at the previous site of the simulator to determine the specific needs of the equipment and what would be worth transporting. Representatives of the original simulation developers and the custom furniture builders were also included in these visits. The details of how the selected room would be modified were established. First, the wall separating the open floor space and the storage rooms was removed, and the floor, walls, and ceilings were refinished. This added a 28 ft. x 12 ft. extension to the open floor space. This was followed by the electrical upgrades. Eventually the air conditioning was installed.

In addition to the winning bid price, additional costs for the simulator included the new computers to run the software, new headsets for the students to simulate communications, monitors for the work stations, and a yearly service contract to provide advanced simulation technical support. The infrastructure costs included the labor and materials to modify the room size, electrical upgrades, transport costs, and contractor costs to disassemble and reassemble the ATC Lab furniture. An estimated savings of $750,000 - $900,000 had occurred when compared to the purchase of a brand-new system.

Curriculum and course development

The faculty addressed the need for covering the technical aspect of the airplane and flight operations by instituting a General Aeronautics course. The course starts with an overview of the industry as a whole and the attributes of a professional. It then introduces basic aircraft components, aerodynamics, and flight characteristics. Finally, operations into and out of airports are discussed, and the basic concepts of the NAS described. This includes an overview of low and high-altitude airways, and how ATC guides aircraft into and out of airports on the airways in between. This course is basically a simplified private pilot course for administrative/management students that have no intention to fly for a career.

With this foundation developed, aviation administration students then take the aviation courses already established in the program, some of which include the topics of airport management, security, finance, planning and design, etc. During this time, their classmates in the Professional Pilot degree take their ground courses for flight. By the time students from both majors reach their junior year, they take the newly designed course that focuses specifically on ATC managing air traffic through the NAS. This Air Traffic Management course uses a traditional content delivery component, which includes lecture, videos, and required reading assignments. In addition, faculty take it beyond traditional delivery methods by using simulation to enhance the concepts of managing air traffic. The course starts by reacquainting aviation administration and professional pilot students with the foundation of their airport and airway knowledge while introducing how these topics relate to ATC concepts. The lessons begin to integrate their airport, aircraft, and airway knowledge with ATC procedures as they participate in simulated scenarios of flight and communication skills as they act as ATC. Students work together in applying concepts from readings and lectures, allowing them to experience the role of an air traffic
controller. The flexibility of simulation allows instructors to create unique scenarios that challenge students to work together and create solutions, evaluate the results, take what they’ve learned from experienced, and try again in the next scenario. The proposal would make the Air Traffic Management course a requirement for students in the Aviation Administration degree program and an elective for the students in the Aeronautical Science – Professional Pilot degree program. The faculty anticipated that the majority of flight students would enjoy taking such an elective due to the interactive nature of the course, and that it was heavily focused on flight concepts from an ATC point of view.

The aviation faculty determined the outcomes intended for this course met the pedagogical technique of experiential learning due to the hands-on nature of the lessons provided. The ATC simulator’s hands-on experiences would encourage to creatively experiment in different ways of applying the concepts they learn from lecture and reading when trying to find solutions. These lessons could be modified to include the replication of air traffic scenarios that parallel real-life situations. Previously the only way a student could experience such a scenario would be in the role of an intern observed when serving at an internship. However, this opportunity to see how textbook concepts apply on the job would partly depend on luck if an intern happened to be working the day of the scenario. The college defined applied learning as students acquiring knowledge and skill learned in the classroom and then apply it in a real-world environment. The faculty felt this course would support the college’s recently established Applied Learning Initiative, which mandated that every 4-year degree program provide an approved applied learning experience by the start of the fall 2019 semester.

With confirmation of the project advancing, the faculty moved forward in taking the documented course concepts into the course development and curriculum modification phase. The course was titled Air Traffic Management. The curriculum goal was to have all students in both aviation programs take the course. It was decided Air Traffic Management would be given to third-year students. The prerequisites for administration students would be the newly modified General Aeronautics course that provided aircraft, airport, and airspace basics, and Meteorology which would help them appreciate the nature of weather impacts. The prerequisites for professional pilot students would be the private pilot ground course and aviation weather course. In order to make Air Traffic Management a requirement, a curriculum change proposal (CCP) had to be submitted. The process involved an on-going back and forth between the Curriculum Committee, department Chair, and applicable faculty members over several weeks before the language of the goals and outcomes of Air Traffic Management were agreed upon. The Aeronautical Science Professional Pilot degree program required an added layer of approval since the curriculum also had to be approved by the Federal Aviation Administration (FAA). This approval required the Aviation Department Chair to work with the Federal Aviation Administration (FAA) in modifying their letter of agreement (LOA) to approve the inclusion of Air Traffic Management. This LOA recognizes the college’s curriculum in providing the education needed in order to grant the college’s graduates to be eligible for a Restricted Air Transport Pilot (R-ATP) certificate [6]. This allows them to be hired as a first officer in as little as 1,000 flight hours at age 21, compared to standard ATP applicants that must have a minimum 1,500 hours and be at least 23 years of age [7]. The faculty also mapped applicable student learning outcomes to the course as part of its formalized assessment process.
Soon after the Air Traffic Management course was approved by the college’s Curriculum Committee, the aviation faculty compared the course objectives and student learning outcomes of the Air Traffic Management course with the goals and requirements of the state mandated Applied Learning Graduation Requirements. For students to graduate, each degree program must provide a minimum of 10 hours of applied learning activity. Some programs use a combination of approved courses and approved co-curricular activities, such as internships or other community activities that provide hands-on learning. Beckhem and Walters [8] found that simulations can provide virtual internships that prepare students for future jobs. The aviation faculty proposed to the Applied Learning Review Board that the realism of the simulated ATC environment provided by the Air Traffic Management course would exceed the minimum of 10 hours of applied learning activity, thus not needing additional co-curricular activity. The Applied Learning Review Board examined the Air Traffic Management course objectives and student learning outcomes and agreed that it qualified as a Credit-Bearing (Full) Applied Learning course for the Aviation Administration degree program. This approval provided further evidence of the educational value in acquiring the simulator, even though it was not foreseen at the time it was decided to make the purchase.

Project success

The Air Traffic Management course started running in fall 2019, approximately 22 months after initial discussions on increasing the technical understanding of aircraft and NAS concepts for aviation administration students. The experience left several lessons learned of those involved. This paper speaks to some of those lessons from the vantage point of the lead faculty member that initially proposed the increase of technical knowledge, and was the liaison between the college and the liquidation consultant.

Framing the issue and the importance of institutional support

Most often when a change is proposed in any organization, there is a need to rely on others to help make the changes happen. Since those being asked to help make these changes may have to do more work or approve necessary funding, it is helpful to those involved to understand the relevance and benefits of the proposal. A simple change to a course may only involve faculty members that are writing the proposal and others that also teach the course. On the curriculum level, the department Chair also must be onboard, and committee members that approve or deny the changes must see the reasoning behind the request. If the proposed changes require significant funding, or changes to infrastructure, the scope of those that need to be onboard widens. Providing a clear and concise reason why the changes are being proposed and the potential benefits from the changes often increase the likelihood that the proposal will be approved, funding will be approved, and the employees asked to help will work hard to make it happen.

When the aviation faculty started investigating the feasibility of the project, they used the assessment process to help frame the issue to increase the likelihood of administrative support and approval. They wanted to ensure the administrators understood this was an investment in a serious legitimate educational tool and not view it as a video game, which Delgarno, Lee, and Carlson [9] found was common attitude that presents a barrier in gaining institutional support. Faculty discussions led to creation of goals and outcomes. These goals and outcomes were reviewed for relevance by the Aviation Advisory Board. Documentation of the faculty’s thoughts
and agreement by the board provided evidence that such changes were worth making. This clearly defined evidence led to support and approval on the institutional level moving forward. The authors of this paper felt this strategy contributed to receiving excellent institutional support on this project. In general, the school’s Dean, Provost, and college CFO demonstrated an open mind to the project. There were instances where apprehension on the administrative side surfaced, but the depth of knowledge the aviation liaison had in the benefits of using the technology as an educational tool, along with the backing of the Aviation Department Chair helped reassure the worthiness of the project.

Additional examples of framing the issue occurred with the IT department and Physical Plant. When the faculty liaison met the IT staff at the simulator site, an understandable apprehension may have initially occurred at the sight of 12-year-old outdated computers, plasma TVs and furniture being purchased with college funding. The liaison suspected this may be the case, but with his experience in previously using the simulator and an ability to describe how it functions, the IT staff recognized the value in the software licensing and the potential of the project. The value of the conversation also reassured the faculty liaison as the IT staff described the availability of new computers at the college. When the Physical Plant staff visited the site, there was concern in how the equipment would be transported without causing excessive damage. The faculty liaison was able to provide coordination with the vendor that built the furniture, who would be able to disassemble and reassemble the components for safe transport.

Leadership and communication

In the early stages of the project, the communication between those involved remained localized within the aviation department and the Dean of the school. Leadership involved the appointed faculty liaison. Even though this appointment was simply verbal, it was adequate since it was a communication between the liquidation consultant and the faculty liaison, and then the faculty liaison with the Aviation Department Chair and school Dean. However, once the project became a greater reality, several more departments became involved. As is the case of modern technology, the nature of communications often occurred through email. This required a careful tracking of communications and keeping prior messages organized. Ultimately, each department did their role very well, but there were times where an important task would arise and the appropriate person might later have been added to an already established email chain. This had potential to make it difficult to find out if a particular step was taken or who might be in charge of a next step. However, in the case of this college, the excellent institutional support made this a minimal issue thanks to everyone’s apparent willingness to work together. Despite this, any college or university considering such an endeavor might consider having an officially designated project manager or committee with representatives from each applicable department and a chair to communicate to all those involved in achieving their final goal. A primary reason why it didn’t happen in the case of the college described in this paper was the opportunity to purchase the simulator arose unexpectedly and with a very tight deadline. The fact that this purchase, installation, and program improvement was able to occur under unique and challenging circumstances a testament to the dedication of all involved.
References


