Safety as Pedagogy: Using Learning Management Systems to Imprint Essential Safety Concepts in Aviation Students

Michael F. Canders

***Abstract*—Safe operations are essential for organizational success, perhaps no more so than in aviation. A culture of safety can be a leading contributor to an aviation organization's success but developing such a culture and maintaining it can be very challenging. Collegiate aviation programs provide an exceptional opportunity to teach essential safety culture components to new aviators but a single safety course or two as part of the curriculum may not be enough. This paper presents a framework for using an established Learning Management Systems to present and reinforce key safety concepts to students as well as to support the construction and maintenance of a safety culture in the flying operations portion of a collegiate aviation program.**

***Index Terms*—Aviation safety, learning management system (LMS), safety management system (SMS), safety culture.**

I. Introduction

The global aviation industry is an essential element of the global economy. The safe and efficient transportation of people and goods by air enables transactional speeds that can drive economic stability and growth. Worldwide economic recovery is dependent upon reliable air transportation. As the current economic recovery continues in 2014, the largest aircraft manufacturer in the world, the Boeing Corporation, has forecast enormous demand for new aircraft to serve as airliners. As Fig. 1 indicates, the worldwide fleet of passenger and cargo aircraft is forecast to more than double in size by the year 2033 [1].

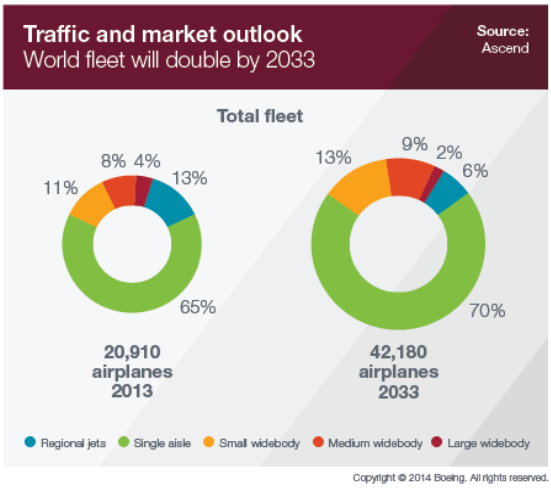

Fig 1. Forecast of global aircraft fleet 2013-2033.

All of these aircraft will require well trained and safe aircrew. A safe takeoff, flight en route, and landing, often under difficult weather conditions, are the basic ingredients for very large-scale air movements across the earth every day which are expected to grow between now and 2033. These flights are expected to be accomplished by human pilots aided by ever increasing technology that can enhance safe completion of these flights. Imprinting a safety mindset from the very beginning of their training will help these pilots assure safe operations as they progress from simple single engine training aircraft to the largest and most sophisticated jet aircraft in the world today. Economic forecasts indicate that there will be a lot of these pilots required in the coming years, particularly in light of the expected pilot shortage.

II. Pilot Shortage

The "pilot shortage" has been a much discussed topic among professional pilots. Over many years of airline industry turmoil, deeply exacerbated by 9/11/2001, pilots frequently found themselves subject to 'furlough", an airline industry term meaning loss of a job with the possibility of returning to the company with some seniority preservation. These tough times for the airlines may have discouraged those who previously may have sought a career as a commercial pilot. In 1991, the Federal Aviation Administration (FAA) issued 16,868 commercial pilot certificates [2] which is the typical precursor to a career as a commercial pilot. In 2011, the FAA issued only 8559, a reduction of 49% [2]. This means a much smaller pool of candidates for employment as airline pilots.

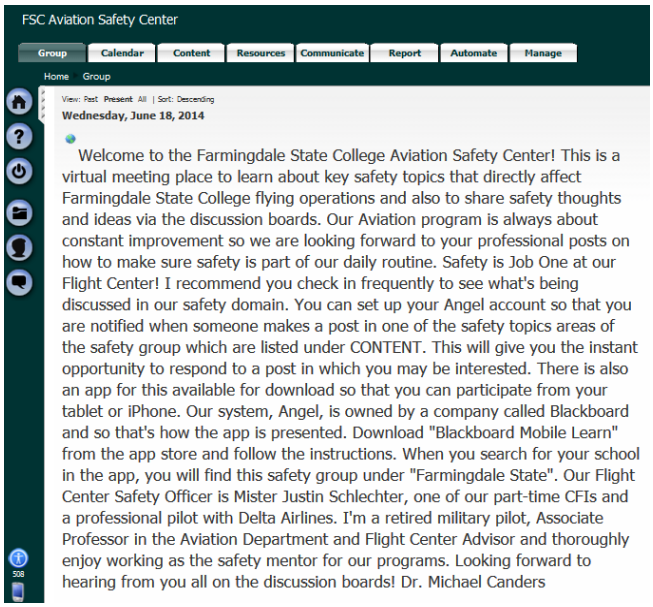

Fig. 2. Aviation safety center presented on LMS.

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Another significant pilot shortage factor is connected to the crash of Colgan Air Flight 3407 near Buffalo, NY in the winter of 2009. This accident was a catalyst for federal legislation which raised the bar for those seeking employment as new pilots in major US airline operations. 45 passengers, 2 pilots, two flight attendants and 1 person on the ground were killed in the fiery crash of this Bombardier Dash 8 turboprop aircraft that fell from the sky on February 12th [3]. The National Transportation Safety Board (NTSB) completed an accident investigation and published a report which included a number of safety issues such as pilot professionalism, fatigue, remedial training, and FAA oversight [3]. Intense lobbying by the victim's families to Congress forced the FAA to make significant changes to the hiring requirement for First Officers, which is considered the entry-level pilot position for the airlines. As of August 2013, First Officers are now required to have 1500 hours of flying experience and an Airline Transport Pilot certificate. This is a significant change from the previous regulations which required only a commercial pilot certificate (250 hour minimum) and instrument rating with new hires joining the airlines with typically less than 1000 hours of flying time [4].

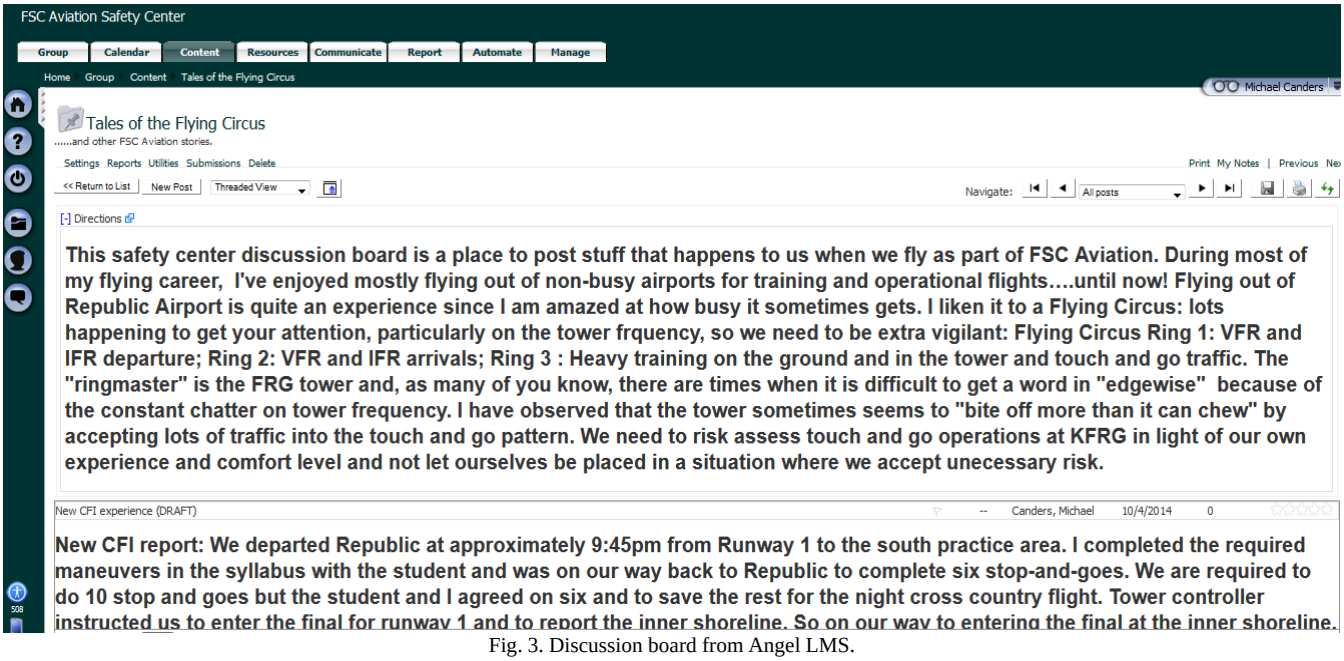

Fig. 3. Discussion board from Angel LMS.

Massive retirements from the current population of US airline pilots are expected to be a major contributor to the pilot shortage. Federal regulations require US pilots to retire at age 65 and because there was a significant amount of pilot hiring in the 1980s but much less in the past decade there is an expected large-scale exodus in the next few years [5].

Traditional sources of pilots are military aviation, general aviation and college aviation programs. Military aviation is not expected to be a reliable source for new airline pilots in the coming years. The U.S. Air Force for example predicts a shortfall of fighter pilots by 2017 [5]. General aviation as a source is also predicted to be unreliable as evidenced by the smaller number of private pilot and commercial certificates issued over the past 20 years [2]. College aviation programs may prove to be a very reliable source of new airline pilots since there are over 230 of these programs in the United States [6]. College programs are usually 2 year associates degree programs or 4 year bachelor's degree programs which combine actual flight training with general education and specialized aviation course study. Major US airlines show strong preference for pilots with four-year college degrees as 95% of new hires have this degree [6]. These aviation programs typically include safety courses over one or two semesters along with other aviation topics of interest such as aviation physiology, aerodynamics, and meteorology. The FAA recently began recognizing college programs that meet requirements specified in their Advisory Circular 61 – 139 by granting authorization to colleges to certify their graduates for reduced aeronautical experience [7]. Graduates of these programs are able to receive significant reductions from the new 1500 hour rule in place as federal law as of August 2013. Those graduates who successfully complete a four-year degree at a FAA approved college and meet all of the other flight requirements may be certified by that college to be hired by a major US airline with 1000 hours of aeronautical experience instead of 1500 [7]. Graduates of a two-year degree program can be certified to be hired with 1250 hours instead of 1500 [7]. These reductions can be a great advantage for both the aviation graduate and the airline because the expected vacancies in First Officer seats can be more quickly filled. Aviation colleges apply to the FAA for this authority and the FAA carefully reviews the flight training programs and the academic programs before granting the certification authority. Eight areas are specified by the government to be taught in a manner sufficient to justify reductions in aeronautical experience. These eight areas are: ground and flight training for certificates and ratings, aerodynamics and aircraft performance, aircraft systems, aviation human factors, air traffic control and airspace, aviation law and regulations, aviation weather, and aviation safety [7]. Aviation safety is listed last in the FAA guidance but it can be argued that is the most important part

of justifying the reduced experience.

III. Safety Education and Safety Culture

Safety training and education is integrated into flight training programs in varying degrees. The Federal Aviation Administration (FAA) requires certified flight instructors (CFIs) to include key safety concepts when instructing pilots. These required safety topics are described in the flight training regulations codified in Chapter 14 of the US Code of Federal Regulations (14 CFR) which are most commonly referred to as the Federal Aviation Regulations (FARs). Flight instructors are expected to constantly reinforce safety concepts during the course of ground and flight training.

The FAA has also developed safety specifications in the form of a framework presented for voluntary implementation by flying organizations. This framework is called the Safety Management System (SMS) [8]. The SMS calls for implementation of the safety system in four components: safety policy and objectives, safety risk management, safety assurance, safety promotion. These are considered to be four pillars of an effective safety system but safety promotion addresses the development of a safety culture. In the SMS framework, the FAA states that 'safety culture consists of psychological (how people think and feel), behavioral (how people in groups act and perform) and organizational or systematic (the programs, procedures, and organization of the enterprise) elements" [8]. They also add a few more dimensions to safety culture in the SMS manual by citing the work of organizational system safety theorist, James Reason, who stresses a *reporting culture*, a *just culture, and a learning culture*. Dr. Reason [9] defines a *reporting culture* as one in which the people in the organization who are in direct contact with hazards are willing to report those hazards. This reporting is required from the top management levels of the organization to the bottom. Reason [9] also promotes a *just culture* which connects directly to the reporting culture concept. The just culture promotes open reporting of hazards without fear of reprisal or ridicule. The cornerstone of this just culture is trust and respect in an environment in which people are encouraged and perhaps even rewarded for sharing essential safety information. Reason [9] is careful to add that there must be a very clear distinction between acceptable and unacceptable behavior as part of this reporting. A *learning culture* is one in which information, such as that gathered from reports from organizational actors, is used to learn about processes, methodologies or procedures which may prevent accidents or lessen their probability of happening.

In addition to the three components of safety culture cited by the FAA in the SMS framework and attributed to James Reason, there are two other useful components which Reason [9] describes: *informed culture, and flexible culture. Informed* culture refers to the collection, analysis, and dissemination of information about accidents or incidents or events which may have had the potential for same. *Flexible* culture describes an organization which can use information effectively to determine if changes needed to allow for continuous improvement to a safety system.

Safety culture may be the most difficult of the four FAA SMS pillars to develop and maintain but it may be the most important since strong safety culture typically equates directly to accident and incident prevention [10].

IV. Learning Management Systems

Learning management systems (LMS) provide a means to enhance instruction through use of an on-line framework for instructors to deposit content and students to access that content to further the learning process. One of the most powerful features of learning management systems is a discussion board option which allows students to post comments or responses to questions posed by an instructor. This allows for asynchronous interaction which will reinforce the topic of interest for students and the instructor. At Farmingdale State College the LMS provides a repository for every class that is taught at the College but is only mandated for those instructors who teach their course entirely on-line. Students are automatically enrolled in the LMS when they successfully register for class and the instructor provides access to the students once the semester begins. There is also a feature which allows for the creation of "Groups" and this LMS option is very similar to the layout of that built for the academic courses. A group was established for safety education and to build safety culture at Farmingdale and is called the "Aviation Safety Center". This group is proctored by a safety mentor and, more importantly, a safety champion who will choose the content to best stimulate safety promotion. The framework is presented in Fig. 2.

V. Safety Culture and LMS

Each of the components of Reason's safety culture [9] can be effectively promoted using a learning management system such as that presented in Fig. 2. The LMS presented is called "Angel" and it is licensed for use at Farmingdale State College by agreement with Blackboard Inc. All of the subsequent learning management system discussion in this paper will refer to Angel but it is expected that other learning management systems can be adopted for this use.

Tabs across the top of the Angel welcome page of this Aviation Safety Center group represent functional keys which are useful in safety culture development. These tabs are titled *Group, Calendar, Content, Resources, Communicate, Report, Automate, and Manage.* Each of the components of Reason's safety cultures [9] can be promoted using one or more of these tabs.

A reporting culture requires commitment by everyone in the organization to be willing to report information about hazards, accidents, incidents, or errors that they observe or commit [9]. It is important to establish a simple means to facilitate this reporting and to allow for provisions for attributed or anonymous reports. The learning management system provides a repository to put a safety reporting form online which allows the user the opportunity to provide a name and contact number or to report anonymously. This is easily done under the *content* tab and the LMS provides an easy way to collect the information.

The just culture assures that there will be no reprisal for reporting safety-related information in an atmosphere of trust and respect [9]. Some organizations have developed safety

reward programs and other recognition for those who are willing to share their experiences which may have resulted in an incident or an accident or to report on hazardous conditions and circumstances. The best beginning for the development of a just culture is to start at the top of the organization. Top leadership or management buy-in of safety culture development is absolutely essential to its success. An effective way to establish this is to get the top leader in the organization to write a letter and sign it affirming these key principles. The president of a college or university with a collegiate aviation program is typically the top official accountable for the safety of that program as well as all others. The letter from the college President should include affirmative statements about the importance of safety in aviation operations and maintenance for the organization and should highlight the key components of the just culture:

- safety reporting is an obligation shared by all
- there will be no reprisal or threat of reprisal for reporting
- reporting will allow for continuous improvement

This signed letter can be electronically imaged and then posted as the top item on the LMS as the first item viewers will read.

One of the most powerful uses of the LMS is in promoting the learning culture described by Reason. He explains that an organization that possesses a learning culture has the willingness and the confidence to draw the right information from its safety information system [9]. Reason discusses this at an organizational level but the learning management system can facilitate learning at an individual level through effective use of the discussion board feature. One of the options in the *content* section is to create a discussion board which allows readers to review content and then to post their comments thoughts or observations. This dialogue could be a very effective way for users to learn about key safety concepts. The discussion board provides an opportunity for users to "blog" but in a password-protected secure environment which is different from what bloggers would normally experience on the unprotected Internet. An example of this use is presented as figure 3 in which a topic of interest and concern is posted as a discussion board under the *content* tab. In this example, the very busy Farmingdale State College flying operations at Republic Airport, NY is described for consideration. The airport has a very heavy concentration of general aviation and corporate aviation and the air traffic control tower at the airport often gets overloaded with many aircraft departures and arrivals, sequenced in with a lot of touch and go traffic. Because the controllers in the tower are so busy, their communications with a large number of aircraft create a potential hazard and significant safety concern.

As Fig. 3 illustrates, the topic is introduced by providing a description of the potential safety hazard (“Tales of the Flying Circus”) and readers are encouraged to comment on the hazard and especially to share their experiences that they've had in this very busy airspace. The content and the posts represent current safety issues which tend to make the reading more interesting. Readers can learn from the experiences of others and can also add their own experiences and possible risk mitigation to further the learning culture on an individual basis. The post can also be used for trend analysis so that the learning culture can be developed on the organizational basis described by Reason. Changes may be made as a result of this organizational learning that comes from review of individual experiences.

The *informed culture* can also be promoted through the use of the learning management system. According to Reason, the informed culture is one in which those who manage and operate have the latest knowledge about the human, technical, organizational, and environmental factors that determine the system as a whole [9]. The *content* tab has a number of choices for the content manager to present important information to the users. There are folders, files to upload content, survey instruments, links to documents on the World Wide Web, and other useful tools to assure that the latest safety writings and documents are available to users. For example, the Farmingdale State College Aviation Safety Center contains the College Safety Management System (SMS) document which was developed and tailored under FAA guidelines and is available for download or review any time. The content section also includes other downloaded content and links to important and current FAA information.

The fifth component of Reason’s safety culture is the flexible culture which he attributes to organizations that are able to reconfigure themselves in the face of high tempo operations or certain kinds of danger [9]. Learning management systems are also capable of promoting this flexible culture. This flexibility is often manifested in safety risk management, one of the four pillars of the FAA Safety Management System [11]. Risk management means assessing hazards associated with a particular operation and then finding means to mitigate that risk if possible. There are a number of risk management tools which can be easily added to the content section of the learning management system to aid in the identification and mitigation of hazards. Consistently practiced risk management can increase the margin of safety in flying and maintenance operations.

Learning management systems typically have other features which assist in safety promotion. There is a *communications* feature which allows for e-mail messaging to all the group members at once. There is a *reports* feature which allows the group moderator to examine the frequency of use of the LMS group by individual group members. This is a good way to assess the acceptance of the learning management system as a component of the safety program. There are provisions to set up sections of the system restricted only to certain users which can encourage more frank discussions on safety issues and protect privacy. Finally there is an “app” which allows access to the system via a smart phone or a tablet which facilitates and encourages use on a much broader basis.

VI. Safety Champion(s)

Initial construction of the learning management system for aviation safety will probably be done by a”safety champion”. This person's passion for safety is the driver for building a robust and useful aviation safety LMS. Interesting content and lively discussion will be important to attract users to the site. One of the most potent attractions may be first-person accounts of errors which nearly resulted in an accident or accounts of observations that happen in daily operations that may impact safety. Compelling stories that are relatable to users of the site may encourage others to share stories and to begin conversations about aviation safety as a daily topic. The inaugural safety champion seeks to develop each user as a safety champion to promulgate a strong safety culture that

continuously improves and increases the number of champions.

VII. Conclusion

The global aviation industry is experiencing a new beginning of expected rapid growth which will require the preparation and training of a large number of new pilots. Safe pilots are the most important output of this preparation and training particularly in light of the reduced aeronautical experience allowed for graduates of approved college aviation programs. The pilot shortage and pressure on the airline business to fill pilot seats may naturally result in shortcuts in the training and preparation of pilots. Safety training and the development of pilots as safety champions in a culture which reinforces key safety elements should not be the place to cut corners. College aviation programs may have a unique opportunity to use already established learning management systems in use at their colleges or universities to build the requisite safety culture to protect their people and resources in their daily flying operations as well as to help develop the next generation of safe pilots. Colleges and universities who use learning management systems for safety promotion and to development safety culture may want to link their efforts to share best practices. Further development of technology-based accessible systems perhaps presented through smart phone or tablet-based applications (apps) is warranted to expand this safety pedagogy beyond collegiate aviation programs. Airlines, for example, may want to invest in smart phone or tablet technologies that will encourage their pilots to stay connected with key safety concepts that maintain a strong safety culture at their organization. Collegiate aviation students properly indoctrinated in a safety culture through learning management systems may provide the raw material from which airlines can build the future safety cultures necessary to assure safe global airline operations.

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