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Reimagining Freshman-Level Introduction to Aviation Course in a Dynamic Aviation Landscape

Shantanu Gupta, Ph.D., Bowling Green State University

Shantanu Gupta is an Assistant Professor at the Bowling Green State University in the School of Aviation within the College of Technology, Architecture, and Applied Engineering. Dr. Gupta earned a B.E in Mechanical Engineering from Visvesvaraya Technological University, India, a M.S in Aviation and Aerospace Management, a Graduate Certificate in Applied Statistics, and a Ph.D. in Technology from Purdue University, West Lafayette. His research interests include aviation data analytics, AI/ML applications in aviation, and aviation business, finance, sustainability, and education.

Dr. Jiansen Wang, University of Houston-Victoria

Dr. Jiansen Wang is a Assistant Professor in the Aviation Program at University of Houston-Victoria. He holds a Ph.D. in Technology and a Master of Science in Aviation and Aerospace Management from Purdue University. Jiansen completed his B.S. degree in Transportation Engineering from Civil Aviation University of China. Jiansen's research interest is using statistical analysis and sustainability to improve airport operations and sustainability.

Prof. Mary E. Johnson Ph.D., Purdue University at West Lafayette (PPI)

Mary E. Johnson is a Professor and Associate Head for Graduate Studies and Research in the School of Aviation and Transportation Technology (SATT) in the Purdue Polytechnic Institute at Purdue University in West Lafayette, Indiana. She earned her BS, MS and PhD in Industrial Engineering from University of Texas at Arlington

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INTRODUCTION

The traditional freshman-level introduction to aviation courses have focused primarily on aviation history and flight training, often catering exclusively to aspiring pilots. In 2025, full-fledged aviation programs offer a wide range of technical education to students, including flight and advanced air mobility, aeronautical engineering technology, aircraft maintenance, dispatch, airline management, airport management, and many other disciplines required to operate the national airspace system at a local, national, or international level. In the rapidly evolving aviation industry, a modified approach is needed in the freshman-level introduction course to fully prepare students for the diverse and complex opportunities now and in the near future. A modern redesign of an introduction to aviation course should provide an early exposure to a much broader range of topics highlighting the multidimensional nature of aviation today and in the future. This paper proposes a reimagined framework for a freshman-level aviation course that not only connects the history of aviation and principles of flight to traditional fields, but also exposes students to a wider spectrum of career paths and emerging trends in aviation.

In addition to historical milestones, the proposed course will introduce students to key sectors of the aviation industry such as airline operations, airport management, aircraft maintenance, aviation consultancies, and uncrewed aerial systems (UAS). The curriculum will emphasize on understanding the interconnectedness of these fields, illustrating how they contribute to the overall aviation ecosystem. Emerging technologies, including Advanced Air Mobility (AAM), Artificial Intelligence (AI) in aviation, and commercial space operations will be highlighted to expose students to the future demands of the transportation industry. The course should also offer insights into the regulatory, environmental, and technological challenges faced by the aviation industry, as well as the need and functioning of various aviation bodies such as the Federal Aviation Administration (FAA), European Union Aviation Safety Agency (EASA), Internation Civil Aviation Organization (ICAO), and special interest groups such as International Air Transport Association (IATA), Airlines for America (A4A), among many others. Students are expected to comprehend the variety of careers and gain exposure to job opportunities in the aviation industry.

The inclusion of these fields ensures that students gain a more holistic view of the aviation industry, and the interconnectedness of their intended career path in other areas of air transportation. This modernized curriculum will cater to a wider range of aviation interests, ensuring that graduates are equipped to enter diverse fields such as air traffic management, aviation consultancy, and emerging AAM sectors. The connections of the course objectives and outcomes to the program objectives and outcomes will be proposed as required by aviation program accrediting bodies of Accreditation Board for Engineering and Technology (ABET) Engineering Technology Accreditation Commission (ETAC) and Aviation Accreditation Board Internation (AABI). By researching and implementing this comprehensive framework, academic institutions can create a more inclusive and forward-thinking introduction to aviation course that aligns with the current and future needs of the aviation industry.

MOTIVATION: TRADITIONAL APPROACH AND EVOLUTION

Aviation education and training involves wide range of disciplines such as piloting, engineering, finance, laws, and among others. Traditional aviation-related education primarily focuses on pilots and aeronautical engineering. After the Airline Deregulation Act of 1978 [1], airlines started to develop more sophisticated routes, network plans, and revenue management techniques, and identified the need for talent in multiple fields [1]. Current institutions or programs with an aviation focus typically offer collegiate programs in professional flight, aviation maintenance, air traffic control, or aviation management. In these institutions or programs, freshmen level students are typically offered a gateway introductory course to welcome, transition, and expose newly admitted college-level students to the vast world of aviation. A course such as Introduction to Aviation is used by educators to highlight the overall functioning of the aviation industry.

However, most of such introductory courses are primarily focused on the history of the aviation; often dedicating little time on the other aspects of the aviation industry, especially the emerging technologies or future of aviation. Since such a course is offered at freshman level and is one of the first college-level courses taken by students, it usually allows students to ease into their major, stir interest and excitement about aviation, and understand the journey aviation has gone through to reach its current state. Overall, such an introductory course includes topics such as:

- **Early Aviation:** first mentions of aviation, Leonardo da Vinci's designs, development of the lighter-than-air (LTA) flying – hot air ballon, hydrogen ballon, seeking directional control, airships
- **Development of the Airplane and First Flight:** development of the heavier-than-air (HTA) flying, early researchers, experiments, and gliders, Wright brothers, first powered, controlled, and sustained flight
- **Role of Aviation in World War I:** patents, design innovation, production, pilot training, reconnaissance missions, aerial photography, aerial combat
- **Post War and Commercial Aviation:** Excess of airplane and pilots, barnstorming, development of Airmail, Air Mail Act of 1926, government involvement, and demand for regulation.
- **Regulators:** Morrow Report, the Air Commerce Act of 1926, the Civil Aeronautics Act of 1938, the Federal Aviation Act of 1958, and the Deregulation Act of 1978. Creation and development of Federal Aviation Administration (FAA), Department of Transportation (DOT), and National Transportation Safety Board (NTSB).
- **Department of Transportation (DOT), FAA, and NTSB:** history, organization, and duties and responsibilities
- **Types of flights:** commercial, private, mail/cargo, military, general aviation, and rotary.
- Some courses might also include information related to aircraft, aerodynamics, aviation bodies and organizations such as IATA and ICAO.

Table 1. Example of Textbooks and included Topics for Introductory Aviation Courses [2-6]

Title				
FAA Pilot's Handbook of Aeronautical Knowledge Chapter 1: Introduction to Flying [2]	*Air Transportation: A Management Perspective, 9th edition [3]*	*Fundamentals of Aviation Operations, 1st edition [4]*	*Fundamentals of International Aviation, 2nd edition [5]*	*Aviation History [6]*
Topics included				
History of Flight History of the FAA The Role of the FAA Aircraft Classifications and Ultralight Vehicles Pilot Certifications Selecting a Flight School The Student Pilot Becoming a Pilot Knowledge and Skill Tests	The Airline Industry: Trends, Challenges and Strategies Aviation: An Overview Historical Perspective Air Transportation: Regulators and Associations The General Aviation Industry The Airline Industry Economic Characteristics of the Airlines/ Airlines in Social Media Airline Pricing, Demand, and Output Determination Air Cargo Principles of Airline Scheduling Airline Labor Relations International Aviation	Theoretical Framework Authorities in Aviation Structure of Supply Structure of Demand Sustainability Of Aviation The Legal Framework of Airports Types Of Airports 8 Airport Economic Management Aeronautical Services at the Airport Airport Capacity Management Aircraft Operation Aircraft Economics Aircraft Supply And MRO Airline Management Airline Economics Airline Planning Airline Operations Into The Future	International Air Law Aircraft Airlines General Aviation Navigation Airports Security Environment Accidents Safety Remotely Piloted Aircraft	Early Aviation Wright Brothers Early Flight World War I Peacetime Aviation Golden Age World War II Cold War Space Age Aviation Modern Aerospace

Table 1 lists the titles and topics included in certain textbooks that are used by some of the introductory aviation courses instructors. The emerging technology sector in aviation is not included in many textbooks on the market. *While an introductory freshman course may focus on establishing the historical importance and journey of the industry, it is also crucial that such a*

course be designed to provide new students with adequate exposure to almost all elements of the aviation industry. Since introductory courses serve as a gateway to further understanding of the industry, it is important that topics included in this course are comprehensive so that students understand each major elements of aviation and potential career opportunities. Along with the historical perspective of the aviation industry, the course needs to also introduce topics such as aircraft, airlines, airports, manufacturing, maintenance, authorities and regulators, and emerging technologies such as AAM, UAS, and applications of AI in aviation.

THE NEED FOR A MODERNIZED CURRICULUM

As the aviation industry continues to grow and adapt to new challenges, it is imperative that educational programs also evolve to meet these demands. The new era of the aviation industry is facing many challenges such as environmental protection, noise control, fuel hedging issues, flight safety, terrorist attacks, airport and airspace congestions, shortage of air traffic controllers, pilots and mechanics, radio frequency congestions, and many others. The modern air transport industry has been one of the pioneers in adapting new technologies to solve practical problems. Industry-wide evolutions have been made to align with the dynamic changes in the aviation landscape. The industry needs talented individuals who understand the historical aspect of aviation, the elements and functioning of the aviation industry, and who are equipped with knowledge and skills to explore a board range of career paths such as airlines operations and management, airport operations and planning, aviation consultancies, air traffic control and navigation. While undergraduate students may take these advanced courses in junior, senior, or graduate level, *exposure* to these topics in the introductory level course may help stir interest, increase awareness, and potentially make the transition at higher academic level smoother.

ABET and ABBI accreditations consider meeting the industry standards and demand as part of their accreditation criteria. The ABET is a globally recognized quality assurance accreditation for programs in the areas of applied and natural science, computing, engineering, and engineering technology [7]. The envisions of ABET for students at accredited institutions and programs include educational experience meeting the global standard, enhanced employment opportunities, and supports entry to technical profession [8]. ABET review processes focus on faculty and staff self-assessment, continuous quality improvement process, and student learning outcomes [8]. Similarly, AABI is a specialized accrediting organization focuses on accrediting aviation professional programs at universities globally [9]. The purpose of ABBI is to 1) ensure the quality of the institution or program, 2) assist in the improvement of the institution or program, and 3) maintain relevance of education with the industry it serves [9]. The goals of AABI are to stimulate aviation program excellence and self-improvement; establish uniform minimum educational quality criteria [9].

With the emerging components in aviation fields, there may be a growing disconnect between aviation higher education and industry demands. With the shifting industry demands, it is important that aviation institutions and programs can provide education and training that meets the global standards, maintain relevance of education with the air transportation industry, and provide necessary skills in a wide range of aviation career-specific areas as well as emerging technologies. While it is important to realize that a freshman level introductory course cannot provide all the necessary skills and knowledge that directly apply to the industry, a well-designed course focused on providing relevant and adequate exposure to freshman students on topics such

as the elements of the aviation industry, operational and managerial aspects or airlines and airports, components and maintenance of aircraft, and emerging technologies will be valuable for students. Just like a degree or program curriculum is designed to meet the industry demands, a freshman-level Introduction to Aviation course may be designed to meet the demands of the sophomore, junior, and/or senior level courses.

DESIGNING A MODERN CURRICULUM FRAMEWORK

This paper proposes a restructuring of a freshman-level Introduction to Aviation course that may serve as a gateway course to expose undergraduate students to the overall aviation industry. The redesign aims to develop a well-rounded course that would not only highlight the historical aspect of aviation, but also introduce students to the major components of the aviation industry including the aircraft, airlines, airports, maintenance, and safety authorities and regulators. The course would also provide introduction to the emerging sectors in aviation such as UAM, space operations, and applications of AI in aviation.

Table 2 highlights the overall structure of the proposed Introduction to Aviation course. The core modules of proposed course include three major sections – Foundations of Aviation and Historical Aspect, The Aviation Industry, and the Emerging Sectors and Future of Aviation. The typical topics of an introductory aviation course such as history of aviation, principles of flight, airline and airport operations, maintenance, management, regulatory frameworks, environmental challenges, and general aviation are covered within the first two sections of the course. The topics in these two sections are commonly included in traditional introductory aviation courses. Some of the emerging technologies in aviation are provided in its own section to be used at instructors' discretion. The core topics provide students with necessary familiarization of different bodies of the industry to further their education and seek careers. The course also will introduce industry and regulatory bodies such as the FAA, DOT, NTSB, EASA, IATA, and ICAO. Introducing the history, organizational structure, and duties of these authorities and regulators will help students in understanding the role of these bodies and increase awareness of regulatory compliance.

The proposed course will include introductory knowledge of emerging technologies in aviation to familiarize students with the trending technologies and future directions of the aviation industry. The key components of the framework in emerging technologies include AAM, UAS, AI, and Analytics Methods. This framework aims to provide general knowledge about these technologies and their adoptions in the aviation industry. The learning process is to be kept at a fundamental level so that freshmen level college students can comprehend meanwhile gain some understanding on these technologies. Resources such as FAA Next Generation Air Transportation System (NextGen) [10], FAA Airport Cooperative Research Program (ACRP) [11], National Aeronautics and Space Administration (NASA) Advanced Air Mobility Session [12], and FAA Unmanned Aircraft Systems (UAS) [13] can be useful to instructors to implement such frameworks in the lecture.

Table 2. Overall structure of the proposed Introduction to Aviation course

Sections	Focus Areas	Topics included	
Foundations of Aviation and Historical Aspect	Overview of Aviation	An overall idea of the aviation industry	
	History of Aviation	Early mentions of aviation First Flight: powered, controlled, sustained Role of Aviation in WWI	Liberalization and Deregulation Development of Commercial Aviation
	Aircraft	Basics of Aerodynamics Forces: Lift, Drag, Thrust, and Gravity Aircraft Structure and Systems	Commercial, Military, General Aviation Passenger, Cargo Rotorcraft, Fixed-Wing, and Hybrid
The Aviation Industry	The Airline industry	Fundamental business models Legacy, Low Cost, Ultra Low-Cost Carriers	Networks and Route Planning Revenue and Costs
	Airports	Basics of Operations and Management	Layout and Functions Safety and Security; Air Traffic Control
	Aviation Maintenance	Importance of Maintenance, Entropy	Goals/Objectives of Maintenance Programs Aircraft Certifications
	Regulators and Organizations	Federal Aviation Administration (FAA) Department of Transportation (DOT) National Transportation Safety Board (NTSB)	European Union Aviation Safety Agency (EASA) International Air Transportation Association (IATA) International Civil Aviation Organization (ICAO)
	General Aviation (GA)	Definition of GA GA Market Users Importance of GA	
	Air Cargo	History of Air Cargo Characteristics of Air Cargo Types of Freight Carriers	The Market for Air Freight Service Factors Affecting Air Freight Rates
	International Aviation	International Air Law Formation of ICAO and IATA Chicago Convention on International Civil Aviation	The Bermuda Agreement of 1946 Globalization of Aviation
Emerging Sectors and the Future of Aviation	*Advanced Air Mobility (AAM)*	*AAM and Urban Air Mobility (UAM) concepts* *Electric Vertical Take-off and Landing (eVTOL) and Vertiports*	*Traditional and AAM aviation integration* *Challenges and Opportunities*
	Space Operations	*Commercial Space Flights*	*Space Traffic Management*
	Sustainability in Aviation	*Impact of Aviation*	*Sustainable fuels, green airports, electrification*
	Automation and AI	*AI in flight operations*	*Autonomous aircraft*

With the multilateral growth of the aviation industry and the evolution of the industry technologies, the potential career paths of aviation students have expanded in the past decades. While traditional aviation careers such as pilots, flight dispatchers, aircraft mechanics, and air traffic controllers remain in high demand, the breadth of career paths in aviation industry has increased. The physical expansion of airports to align with its increasing congestion and traffic flow requires airport management crew with knowledge and skills in construction management and project management. The developing of airline network and revenue management systems requires airlines to employ personnels with management skills such as finance, math, optimization, and advertising. Under the era of the data-driven world, more and more airlines are increasing their reservation of data analytics talents to develop strategies, innovate and stay competitive. With the rise of UAS, drone pilots also become a possible career path for aviation students with competitive compensation. The FAA and NASA envision the future of airports with advanced air mobility [12,14], promoting many possible career opportunities related to new technologies such as power-lift aircraft pilot and instructors, electrical-powered aircraft development, hydrogen aircraft development, and infrastructure development. Careers in aircraft manufacturers in this field are also expanded, such as aircraft engineering and industrial engineering. This course intends to place extra emphasis on introducing the multidisciplinary career paths that aviation students can choose.

Aviation sustainability is a trending topic that involves airlines, airports, regulators, and manufacturers. Related issues include but are not limited to airport sustainability [15], airport noise [16], sustainable aviation fuel [17]. The increasing needs of airlines and airports of sustainable operations enabled aviation students to expand their possible career choice at intersecting industry, such as engineering, business, finance, environmental studies, chemistry, biology, and many others.

Pedagogical Strategies: To effectively redesign the Introduction to Aviation course, incorporating various elements of the aviation industry, several pedagogical strategies can be employed. These strategies aim to enhance student engagement, foster critical thinking, and ensure that learners are well-equipped to navigate the complexities of the modern aviation landscape. For instance:

- Project-Based Learning (PBL) that allows students to engage in real-world aviation problems and projects, encouraging them to apply theoretical knowledge to practical situations. Freshman-level students may be exposed to short projects to prompt them to work in teams and cultivate teamwork spirit.
- Guest Lectures and Industry Partnerships to invite industry professionals as guest speakers that can provide students with insights into current trends and challenges in aviation. This strategy also provides opportunity to collaborate with industry professionals and provide students a peek into their future careers.
- Flipped Classroom Model to encourage students to engage with course materials outside of class, allowing for more interactive and discussion-based learning during class time.
- Case Studies and Problem-Based Learning to focus on recent developments in the aviation industry and stimulate critical thinking and problem-solving skills.
- In-Class Competition-style activities for students to conduct short research on predetermined topics and score points against other teams by asking and answering questions.

ANTICIPATED OUTCOMES, BENEFITS, AND CHALLENGES

This paper proposes a new framework to the introductory level courses to freshmen Aviation students. The new framework involves emerging technologies and broadened career paths to give students a comprehensive understanding of the current trends and shifting demands in the aviation industry. The overall anticipated outcome of the redesigned course is an early exposure to the breadth of the aviation industry. Specifically, the course aims to introduce students to the topics that they might study during their sophomore, junior, and/or senior years. For instance, if students take a junior level course in Air Transportation that includes the functioning of the airlines, then proposed course may introduce students to the different types of airlines, basic network structures, and fundamental business models. Similarly, if students take a senior level course in Airport Operations and Planning, then the proposed course may introduce students to basic airport operations, layouts, and functioning. In essence, just like an aviation degree or program is dedicated to preparing students to meet the post-graduation industry needs, an Introduction to Aviation course can be dedicated to preparing students to meet their pre-graduation collegiate education/course needs.

To ensure the effectiveness of the proposed course, this paper proposes the following metrics to assess student learning outcomes to comply with the ABET and ABBI accreditation requirements:

1. Describe professional attributes and requirements and planning applicable to aviation careers.
2. Be able to recognize different stakeholders and their responsibilities in the aviation industry such as airlines, airports, regulators, ICAO, and IATA etc.
3. Be able to describe principles of flight, common aircraft types, and fundamental forces of aircraft.
4. Understand the history, current status, and future trends of different sectors of the aviation business including passenger carriers, mixed carriers, air cargo, aerospace industry, general aviation and international carriers.
5. Understand the domestic and internation laws applicable to aviation; understand importance of regulatory compliance and certificates related to aviation operations.
6. Be able to describe the current application, future visions, and challenges of state-of-the-art technologies in aviation including AAM, AI, aviation sustainability, and space operations.

The proposed course structure is expected to benefit students with a wider range of topics discussed in the class. The increased exposure of emerging technologies and career paths may promote motivation and engagement of students who have certain interests in these areas. As the gateway course that aviation students take, a modern framework that incorporates these topics will better prepare students to explore fields. The framework provides students with a smoother transition to junior and senior level courses and eventually to their careers.

The new course structure is also expected to benefit the industry and the institution or program with better student learning outcome, more competent and proficient graduates, and potentially a higher employment rate of the graduates. With the proposed framework, potential

industry employers will expect students with a higher level of understanding of state-of-the-art technologies and a broader comprehension of the aviation industry. The framework also benefits these institutions by providing better alignment between the program outcome and the ABET and ABBI accreditation criteria. Challenges such as faculty readiness, institutional resistance, and resource limitations may be expected in aviation institutions or programs that intend to implement these instructional changes. Faculty readiness may involve the need for professional development, training in emerging technologies, or curriculum redesign support to effectively teach updated course content; whereas, institutions might resist change due to traditions, administrative constraints, or concerns over disrupting existing course structures. Additionally, resource limitations—such as insufficient funding, lack of access to modern technological tools, or limited instructional materials—may pose significant barriers to adopting and sustaining a modernized restructured course framework. Addressing these, and other challenges, may require strategic planning, institutional engagement, and potential investment in personnel, financial, and material resources. However, with intentional application, specific course instructors may be able to bring small, continuous, and progressive improvements within their classrooms when teaching introductory courses in aviation.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

As long as air transportation continues to adapt emerging technologies to solve its challenges, the industry will keep evolving and shifting its needs for talents. Aviation institutions and programs nowadays are at a turning point where shifts need to be made to better satisfy the industry's needs. This paper proposed a new framework of implementing the emerging technologies into an introductory level aviation course to better prepare students for further education and careers. Institutions and accrediting bodies may consider the proposed framework to better align with the industry needs and shifting.

Future research may consider using longitudinal studies to measure the effectiveness of the new curriculum. Similar frameworks can also be adapted to other entry-level courses in engineering or management fields. Case studies can be conducted in collaboration with industry partners for curriculum development. The concept of involving emerging technologies in aviation courses may in applied to more advanced aviation courses in the future. Future research may also consider incorporating emerging technologies into textbooks of such course.

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