

The Development and Incorporation of Introductory Aerospace Curriculum into
Tennessee Secondary Education Systems

by
Jake Owens Garrette

A thesis presented to the Honors College of Middle Tennessee State University in partial
fulfillment of the requirements for graduation from the University Honors College

Fall 2018

The Development and Incorporation of Introductory Aerospace Curriculum into
Tennessee Secondary Education Systems

by
Jake Owens Garrette

APPROVED:

Dr. Andrea Georgiou
Advisor, Department of Aerospace

Dr. Wendy Beckman
Chair, Department of Aerospace

Dr. Wendy Beckman
Reader, Department of Aerospace

Dr. Philip E. Phillips
Associate Dean, University
Honors College

Acknowledgements

I would like to take the time to thank a variety of individuals and groups for their support of this project. I would like to thank the faculty, staff, and students of Community High School in Unionville, Tennessee for their amazing support, willingness to accommodate my lessons, and eagerness to learn.

I wish to acknowledge the Middle Tennessee State University Honors College and the Middle Tennessee State University Department of Aerospace for their unwavering dedication to students and their commitment to excellence. I have been blessed by receiving one of the finest educations from faculty that take a personal stake in my success as an aviator. I never wanted to attend any school other than Middle Tennessee State University, and I have never regretted my decision.

I would like to specifically thank Dr. Andrea Georgiou for her relentless pursuit of excellence and her amazing support of me during this whole process. She is the embodiment of how a professor should be: helpful, supportive, and wholeheartedly committed to the long-term success of her industry, her department, and her students.

Where would I be without the blessing of my family? They have stood by my career choice and have supported me every step of the way. I want to thank Mom, Dad, Grandma, Grayson, Keri Beth, Kyle, and my fiancé Lauren for their unwavering support whenever I need it the most.

This project is dedicated to every young and aspiring aviator who has dreamed of a life skyward. May the Lord bless your path in the way He has blessed mine.

“The heavens declare the glory of God, and the sky above proclaims his handiwork” (Psalm 19:1).

Abstract

This project discusses the commercial and general aviation industries and presents research demonstrating the importance of each. It then argues using modern research that the industries are greatly in need of pilots. The project then submits the solution in the form of basic introductory aerospace curriculum, titled *The World of Aerospace*, for secondary education systems in Tennessee. The methodology of the curriculum is discussed, followed by the curriculum itself in the appendices, along with reflections and revisions by the author after *The World of Aerospace*'s implementation in a Tennessee high school. While various facets of the industry are discussed and covered, the pilot sector will receive the most focus.

Table of Contents

Acknowledgements.....	iii
Abstract.....	iv
List of Figures.....	vii
Introduction.....	1
Importance of Modern Commercial Aviation.....	2
Importance of General Aviation.....	6
Decline of General Aviation.	7
Development of Curriculum	10
Purpose.....	11
Methodology	11
Discovery Flight.....	14

Conclusion.....	15
References.....	16
Appendices.....	20
Appendix A. <i>The World of Aerospace</i> Lesson Plans	A-1
Appendix B. <i>The World of Aerospace</i> Presentation Slides	B-1
Appendix C. <i>The World of Aerospace</i> Revised Lesson Plans.	C-1

List of Figures

Figure 1. Total current and forecasted passenger enplanements by United States domestic air carriers through Fiscal Year 2038..... 3

Figure 2. U.S. Domestic Carrier Fleet forecast, in number of aircraft, from 2007 to 20384

Figure 3. Worldwide forecast demand for new aviation maintenance technicians from 2018 to 2037, delineated by region5

Figure 4. Worldwide forecast demand for new pilots from 2018 to 2037, delineated by region6

Figure 5. New piston airplane deliveries in the United States from 1994 to 20168

The Development and Incorporation of Introductory Aerospace Curriculum into Tennessee Secondary Education Systems

The advent of the airplane has led to an explosion of technological and economic progress. The earth seems a much smaller place since heavier-than-air transport's debut. Air travel has connected the world by playing a monumental role in revolutionizing both shipping and human travel. In the United States alone, aviation's contribution is impressive. According to a 2014 economic impact publication released by the Federal Aviation Administration (FAA), civilian aviation contributed 5.4% of U.S. Gross Domestic Product in 2012. Such a contribution amounts to 11.8 million jobs and over \$1.5 trillion in total economic activity (2014). In comparison, the entire United States sports market in 2012 was only worth \$53.6 billion (Heitner, 2016). The impact that air travel has on the economy is staggering.

The same impact is also felt in the minds of those who work or wish to work in the field. Both to the trained and untrained eye, aviation can seem as though a miracle. How many faces have looked skyward imagining life as an aviator? Yet, how many of those who dream of becoming pilots actually pursue such a goal? The modern answer, unfortunately, is problematic and reflects a trend that must be reversed in order to provide a sustainable supply of aviators for both the present and the foreseeable future.

This project first discusses the necessity and importance of the aviation industry and argues that its vitality is necessary for economic progress in a developing world. It then explains the origins of industry workers and leaders in commercial aviation and presents theories related to the industry's shortage of skilled workers. The project

concludes by offering hypotheses and educational curriculum for reversing the downward trend of youth interest in aviation.

Importance of Modern Commercial Aviation

To stress that the industry of aviation constitutes an important contribution to trade, travel, and globalization would be a gross understatement. Air travel provides a myriad of benefits over traditional transport by sea, train, or land vehicle. Point-to-point navigation, negated effects of terrain, and (perhaps most importantly) the speed at which aircraft fly have played a monumental role in the modernization of society. Vaclav Smil writes, “The gas turbines that propel jet airplanes are fundamentally (that is, in energetic, physical sense) more important to the global economy than are any particular corporate modalities or international trade agreements” (2010, p. 18). He argues that without the global travel offered by aircraft, the world would face a loss of connectivity.

Smil’s hypothesis is supported by global and national aviation statistics. In 2018, the International Air Transport Association predicts worldwide passenger travel to exceed 4 billion people. In their new forecast, the organization expects the demand to nearly double to 7.8 billion passengers over the course of the next 20 years (2018). The United States, China, and India are the top three contributors to this global passenger traffic growth (O’Hare, 2018). In the United States, the Federal Aviation Administration expects passenger traffic to grow by 38 percent (2018), as represented in Figure 1 below.

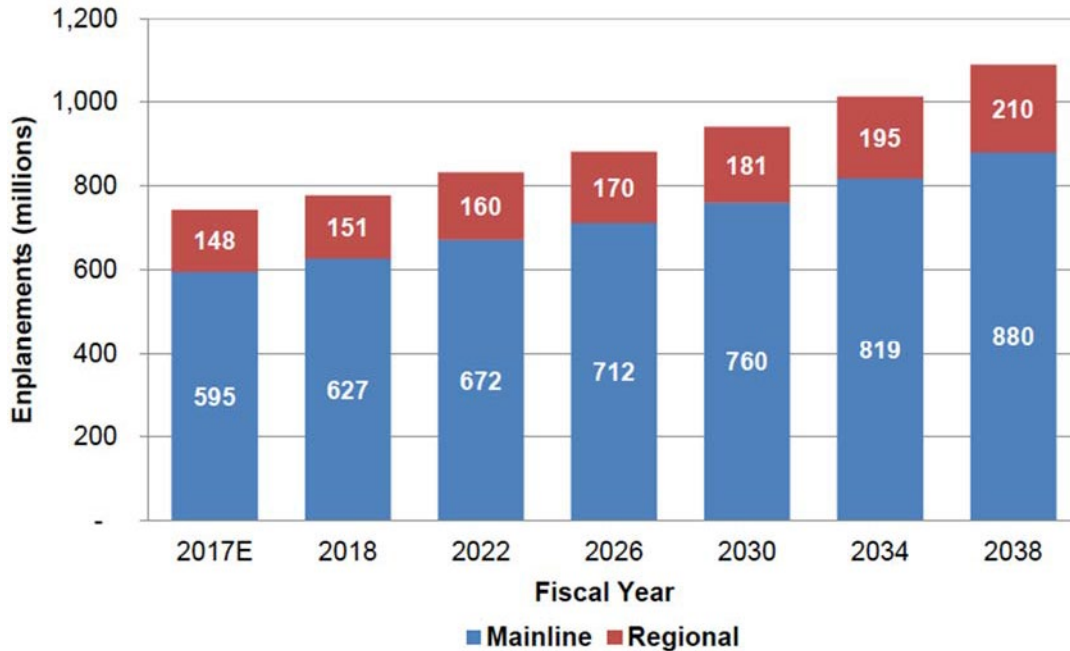


Figure 1. Total current and forecasted passenger enplanements by United States domestic air carriers through Fiscal Year 2038 (Schaufele, 2018).

Benefits of Global Air Passenger Traffic Growth

The aviation industry has provided a safe and efficient system of travel that has opened the doors for global progress and cultural interaction. With easy, affordable travel both across countries and continents, businesses and entrepreneurs are able to conduct meetings and transactions in distant locales. Previously remote, desolate locations can now be explored and settled with relative ease. Relief flights can deliver supplies, doctors, and other humanitarian aid to nature-ravaged or poverty-stricken areas worldwide. Families can connect across vast expanses like never before. There is a limitless list of the positive effects of global and domestic air travel.

Aircraft Demands

The continued growth of passenger travel will spur the necessity for an increase in flights far beyond the number that exists today. Foreign and domestic airlines are coming

to terms with this phenomenon and have risen to meet the growing demand. Worldwide, aircraft movements increased 3% in 2017 to 95.8 million (O’Hare, 2018). In the United States, the domestic airline fleet is growing in terms of passenger-carrying capability, due in large part to the accruiement by domestic regional airlines of larger “commuter” jets (Federal Aviation Administration, 2018, p. 3). In terms of numbers of aircraft, the FAA is projecting the number of aircraft in the U.S. commercial fleet to increase from 7,141 in 2017 to 8,290 in 2038 (2018, p. 29), as shown in Figure 2.

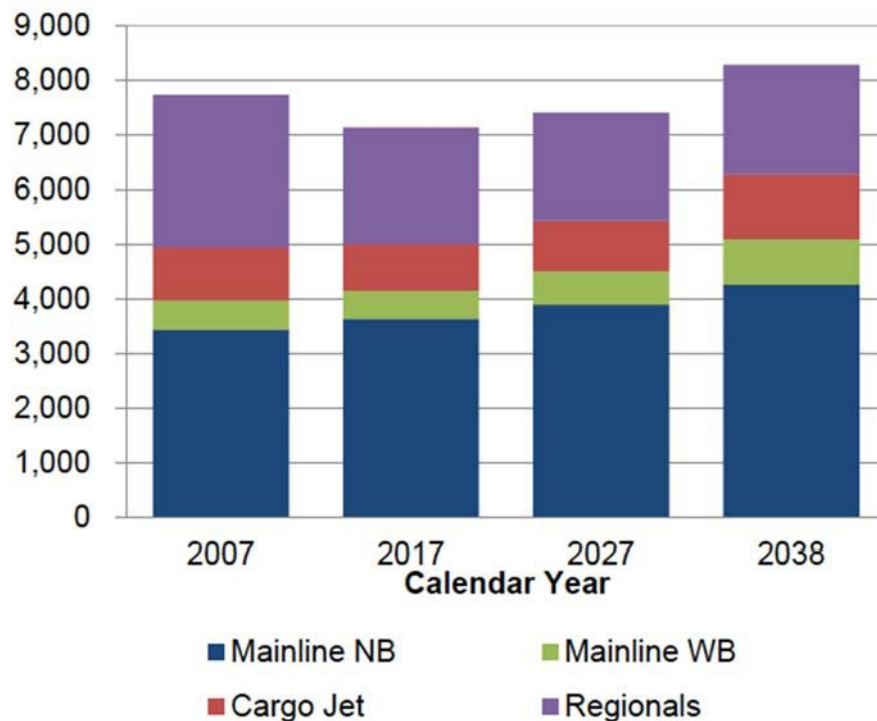


Figure 2. U.S. Domestic Carrier Fleet forecast, in number of aircraft, from 2007 to 2038 (Schaufele, 2018).

Personnel Demands

With a projected increase in flights comes an increase in the demand for personnel from every sector of aviation. More engineers are needed in order to design

and test new advancements in aviation technology. More dispatchers are needed to run operations centers. Figure 3 shows that the number of required maintenance personnel worldwide is forecast to increase by 754,000 technicians by the year 2037 (Boeing, 2018). This increase in aviation job demand is exceeded only by the global demand for pilots, represented in Figure 4. Boeing predicts a need for 790,000 new pilots globally by 2037 (2018).



Figure 3. Worldwide forecast demand for new aviation maintenance technicians from 2018 to 2037, delineated by region (Boeing, 2018).

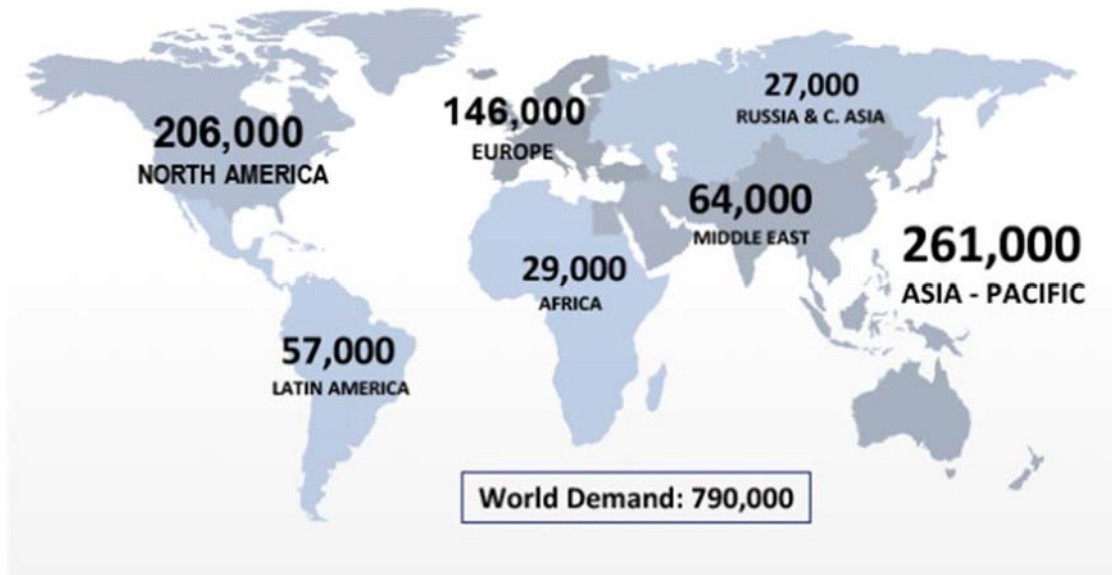


Figure 4. Worldwide forecast demand for new pilots from 2018 to 2037, delineated by region (Boeing, 2018).

Importance of General Aviation

The new national and global demands for increased air travel bring with them a strong demand for workers from every facet of aviation. The source for these highly skilled and qualified workers can only come from general aviation, the sector of the industry that does not utilize regularly scheduled air operations. Flight training, business flight operations, and pure pleasure and sport flying are all subsets of general aviation. According to Zimmerman (2013), the sector is known to be quite vibrant in the United States compared to other countries. Less restrictive airspace rules in the United States and an abundance of small, rural airports allow for a dynamic and open industry.

Both the infrastructure and the culture provide a strong foundation for aviation in general and private pilots in particular. Just unfold a sectional and look at how many airports there are in the US—and they’re not all in major cities either. Then consider the great service we get from Flight Service and air traffic control (heck,

even most FBOs) without paying user fees. There is probably no other place on Earth where you can take off with an iPad and a credit card and fly across the country—no flight plans, no government approval, and no radio required. That’s real freedom, and it’s to be appreciated. (Zimmerman, 2013 para. 2)

Nearly every pilot and mechanic will receive his or her initial training and will build experience in the general aviation sector. For example, an airline or corporate pilot will likely receive his or her initial flight training from a private flight instructor, flight school, or a university with an aeronautics program. He or she will then add successive ratings and certificates while continuing to build flight time. The next step for a professional pilot is usually become a flight instructor until his or her acquired flight time is sufficient to become hired at a regional airline or corporate position. This typical path to a career clearly demonstrates the importance and necessity of a vibrant general aviation sector.

Decline of General Aviation

There is a troubling opinion-based, as well as statistical consensus, running rampant throughout the industry of general aviation. Pilots, for whatever reason, seem to be disappearing. Whatever dreams men and women may seem to have of flying are either vanishing or are being pursued significantly less often than in decades past.

From 1973 to the present, the General Aviation Manufacturers Association (GAMA) keeps detailed records of airplane shipments, pilot certificates, and pilot ages. In 1981, the association counted 764,182 certificated pilots in the United States. By 2016, that number had dropped to 584,362, a 30.7% decrease. With a decrease in pilot certifications also comes a decline in airplane manufacturing. In 1981, the industry shipped over 9,457 aircraft. In 2016, the same industry shipped 1,525, a nearly 84%

decrease (2016). This decline is represented in Figure 5 below. General aviation is shrinking and has been for some time. According to data published by the Aerospace Industries Association, the entire aerospace and defense industry has remained stagnant over the last several years (2017).



Figure 5. New piston airplane deliveries in the United States from 1994 to 2016 (Zimmerman, 2017).

Not only are the number of airplanes and pilots shrinking, but the current pilots are becoming older. The average age of pilots has been steadily rising. According to GAMA, between 1981 and 2016, the average age of pilots, in years, has increased from 37.8 to 44.9 (1993-2016). Aviation faces a dearth of young aviators. As the aviation industry has grown, the demographics of the pilot base have continued to steadily trend in an aging direction. Has the airplane lost its luster with today's youth? Why is it that such a once-glamorous career has now fallen by the wayside in the minds of young adults? A

review of research has yielded several factors that may have influenced the decline of general aviation among today's younger generations.

Factors Influencing Decline

While aviation may very well be a rewarding and enriching experience, flying is normally associated with large expenses in maintenance and flight training. In fact, the cost of airplanes has skyrocketed. In 1981 just under 9,500 general aviation airplanes were shipped for a total factory billing of over \$7.8 billion in 2016 dollars. On average, an airplane in 1981, adjusted for inflation, cost about \$308,000. In 2016, over 1,500 aircraft were shipped with a factory billing of just under \$10.6 billion. That leaves an average cost of \$6.9 million per airplane shipped (GAMA, 2016). Airplanes have experienced a 95% increase in cost, a startling amount sure to shrink any industry. This increase in cost is passed on to the student pilot in the form of rising rental fees. In addition, supplies, the cost of aviation fuel, and testing fees (a single checkride, which is a practical test required to receive a new pilot rating or certificate, can cost over \$400 in the Murfreesboro area) can make pursuing a flying career quite difficult. As stated earlier, most pilots begin in general aviation, and the monetary struggles also continue upon the revelation of the knowledge that first-year pay at regional airlines (smaller airlines who hire pilots with less experience) is, according to the Bureau of Labor Statistics, around \$20,000 (2015). The good news is that pilot salaries are on the rise, with some regional airlines in 2017 paying their new pilots upwards of \$80,000 (Airline Pilots Association, 2017).

Another factor contributing to the decline of general aviation is a lack of exposure of aviation to students at a young age. According to Derek Rowe, a high school aviation

teacher at McGavock High School in Nashville, Tennessee and a national member of the Aircraft Owners and Pilots Association (AOPA) High School Steering Committee, aviation is only taught at 5 high schools in Tennessee. This greatly limits the opportunities in Tennessee for potential new aviation professionals

In conclusion, the pilot shortage that the industry is currently facing has its roots both from government regulation and a decline in the industry that feeds the transportation system (Beyer & Agnew, 2017).

Development of Curriculum

One solution to increase the size of the general aviation industry is an approach that introduces aviation to students at a young age. Surveys conducted at Saint Louis University indicated that the most popular reason students pursued a career in aviation was the sheer love of flying. In addition, data analysis of those surveys notes that many respondents stated that their obsession with flying began early in their lives (Steckel, Lercel, & Matsuo, 2010). AOPA itself has identified what it calls a “gap in aviation youth education that no other organization is filling” (AOPA High Schools, 2016, para. 1). Developing an inexpensive program that allows high schools across the state to implement a curriculum designed to foster enthusiasm for aviation is key to both the growth and the future of the industry. This curriculum must be engaging, easy to understand, insightful, and accessible to students from many different backgrounds. It must discuss all aspects of aviation, not just those related specifically to pilots. Reawakening the spirit of flying must begin in earnest, and it must start by bringing the joys of aviation to the generations that define the country’s future.

Purpose

The goal of this project was to develop introductory aerospace curriculum in order to provide an enriching, eye-opening experience for young students interested in aviation, taught over a half-semester period. The curriculum developed, titled *The World of Aerospace* was designed to provide students with no previous knowledge of aviation an introductory experience to flying and becoming a pilot. The curriculum was designed to expose students to the inner workings of the National Airspace System (NAS). In addition, the material discussed career options from all aspects of the industry, providing information about topics such as quality of life, salaries, and career advancement opportunities. After development, the curriculum was taught and tested in a local high school. At the conclusion of the class, an introductory flight will be given to participating students, funds permitting. Through this exposure to aviation at an early age, it is hopeful that students gain an understanding and appreciation of a vital American industry.

Methodology

The National High School Center at the American Institutes for Research published a 2012 curriculum effectiveness test for high schools (Fryer & Johnson, 2012, p. 5). The lesson plans for this project were built according to the standards set by the institute.

Subject Areas Included

The curriculum was developed to allow students to gain a basic ground knowledge of aviation. This allows students wishing to pursue a private pilot certificate outside of the course to be given a foundation for additional ground training and flight instruction. Therefore, most lesson plans in the curriculum were derived from the FAA's

Airman Certification Standards (ACS), a practical testing tool used by the agency's examiners to determine if a pilot meets the required criteria to receive a certificate (2017). The following topics have been derived from this tool to be included in the curriculum:

- Pilot qualifications.
- Weather information.
- Cross-country flight planning.
- National Airspace System.
- Aircraft performance and aerodynamics.
- Human factors, including decision-making, resource management, and risk assessment.
- Physiology in regards to aviation.

In addition to material included in the ACS, the following topics were also included:

- Career options across the industry, including air traffic control, flight dispatch, maintenance and mechanical work, unmanned systems, and administrative opportunities.
- Structure of airlines and airline industry.
- Information on local and collegiate training programs.
- Steps to continue flight training and its associated cost.

Standards for Each Lesson Plan

Each lesson was designed to adhere to select standards set by the National High School Center, modified as necessary. The following standards were used as a guide

during development and as a test to determine the effectiveness of the project. Below are the standards in bold, preceded by my commentary and modifications.

Curriculum and instruction are aligned to state and national standards that include college and career readiness. The curriculum was developed according to the ACS, allowing students graduating from the course to attain ground knowledge which will provide a significant knowledge advantage if further training is pursued.

Curriculum and courses are aligned vertically to ensure that students possess necessary prerequisite content knowledge for higher level coursework. Students graduating from the course will be prepared to further their education in aviation with a significant knowledge advantage. In addition, the course provides information on collegiate aviation programs and career options, allowing students to make a better-informed choice on their preferred areas of study.

Instruction strategies are compatible with high school organizational structures to address the needs of all students. The course has been designed to be taught in a high school classroom environment. Extra instructors and accommodations may be made as necessary.

Research-and evidence-based instructional strategies are incorporated across all classes for all students, including those with special instructional needs. Each lesson plan was constructed with material from approved, authoritative sources. Most technical subject topics find their roots from FAA publications such as the *Pilot's Handbook of Aeronautical Knowledge*. In addition, the course was designed to be taught by a certified flight instructor with considerable expertise on the subject matter at hand.

Curriculum and instruction are designed, modified, and adjusted for student learning strengths and needs. The lessons were developed in an easy-to-follow, simplified format. Efforts were made to avoid overloading students with an extreme amount of new information in too short a period.

Study skills are incorporated into instructional practices across all classes. Assigned reading is given to students periodically in an attempt to introduce students to concepts before lessons begin and to foster study habits useful for higher education.

Students are engaged in academic decision-making and planning processes. Students are able to provide informal input about the effectiveness of the course. Informal assessments will be given to objectively determine which areas are in need of improvement.

Instructional strategies and academic course offerings incorporate strategies for improving student engagement and developing communication skills, interpersonal skills, creativity, and innovation. Through the development and implementation of sound and engaging curriculum, it is hopeful that students will develop a love for aviation and begin to discover and prepare for opportunities to pursue their goals into college and beyond.

Discovery Flight

Airplanes from Middle Tennessee State University will be used later in the semester to provide students with a short introductory ride. This will be done in order to transition from the abstract concepts of the classroom to the experience of actual flight. Flight instructors will allow students to manipulate flight controls and will perform

various maneuvers. Each flight will last approximately 30 minutes. The discovery flight will be unofficial and entirely optional to students should they desire it.

Conclusion

The continued development of a high school aerospace curriculum will not only introduce students to a new challenging subject area but also will open collegiate and career opportunities in the world of aviation. There is a great need for new aviation professionals in the industry, and the seeds of growth must be planted at an early age. It is hopeful that through exposure to the inner workings of one of the country's most vital industries, students can gain a better appreciation and love for aviation in its many forms.

References

- Aerospace Industries Association [AIA]. (2017). *2017 facts and figures*. Retrieved from http://www.aia-aerospace.org/wp-content/uploads/2017/06/2017_AnnualReport_FF_Final_Web.pdf
- Airline pilots and commercial pilots. (2015). Retrieved September 29, 2017, from <https://www.bls.gov/ooh/transportation-and-material-moving/airline-and-commercial-pilots.htm>
- Airline Pilots Association. (2017, April). *Pay and benefits*. Retrieved from <https://clearedtodream.org/career-outlook/pay-and-benefits>
- AOPA High Schools. (2016, July 11). Retrieved September 29, 2017, from <https://youcanfly.aopa.org/high-school>
- Beyer & Agnew. (2017). *Pilot shortage: A current and future threat*. Arlington: Morten Beyer & Agnew. Retrieved from <https://www.mba.aero/the-pilot-shortage-a-current-and-future-threat-mba-insight-series/>
- Boeing. (2018). 2018 pilot outlook. Retrieved October 15, 2018, from <http://www.boeing.com/commercial/market/pilot-technician-outlook/2018-pilot-outlook/>
- Fryer, L. and Johnson A. (2012). *A coherent approach to high school improvement: a district and school self-assessment tool (p.5)*. National High School Center at the American Institutes for Research. Retrieved from <http://files.eric.ed.gov/fulltext/ED536814.pdf>

- General Aviation Manufacturers Association [GAMA]. (1993). *General aviation statistical data book and industry outlook*. Retrieved from https://gama.aero/wp-content/uploads/1993statisticaldatabook_pdf_498c2713d7.pdf
- General Aviation Manufacturers Association [GAMA]. (2016). *General aviation statistical data book and industry outlook*. Retrieved from https://gama.aero/wp-content/uploads/2016-GAMA-Databook_forWeb.pdf
- Heitner, D. (2016, March 28). *Sports industry to reach \$73.5 billion by 2019*. Retrieved September 29, 2017, from <https://www.forbes.com/sites/darrenheitner/2015/10/19/sports-industry-to-reach-73-5-billion-by-2019/#2567b65f1b4b>
- IATA. (2017, October 24). 2036 forecast reveals air passengers will nearly double to 7.8 Billion. Retrieved October 14, 2018, from <https://www.iata.org/pressroom/pr/Pages/2017-10-24-01.aspx>
- O'Hare, M. (2018, September 20). The world's busiest airport revealed. Retrieved October 14, 2018, from <https://www.cnn.com/travel/article/worlds-busiest-airports-2017/index.html>
- Philbin, A. (2018, January 17). Continued passenger traffic growth and robust air cargo demand in 2017. Retrieved October 14, 2018, from <https://www.icao.int/Newsroom/Pages/Continued-passenger-traffic-growth-and-robust-air-cargo-demand-in-2017.aspx>

Schaufele, R., Jr. (Ed.). (n.d.). *FAA aerospace forecast: Fiscal years 2018-2038*(United States, Federal Aviation Administration, Forecasts and Performance Analysis Division). Retrieved October 14, 2018, from https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2018-38_FAA_Aerospace_Forecast.pdf.

Smil, V.(2010). *Two prime movers of globalization. [electronic resource]: the history and impact of diesel engines and gas turbines*. Cambridge, Mass. : MIT Press, ©2010. Retrieved from <https://ezproxy.mtsu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat00263a&AN=mts.b3287534&site=eds-live&scope=site>

Steckel, R., Lercel, D., & Matsuo, H. (2010). Factors that influence an undergraduate student to choose a career in aviation, and enroll in the aviation science program at Parks College of Engineering, Aviation and Technology. *Collegiate Aviation Review*, 28(2), 69-83.

United States, Federal Aviation Administration. (2017). *Private pilot - airplane airman certification standards* (Change 1). Washington, D.C.: Flight Standards Service. Retrieved September 29, 2017, from https://www.faa.gov/training_testing/testing/acs/media/private_airplane_acs_6A.pdf

United States, Federal Aviation Administration. (2014, June). *The economic impact of civil aviation on the U.S. economy*. Retrieved September 28, 2017, from https://www.faa.gov/air_traffic/publications/media/2014-economic-impact-report.pdf

Zimmerman, J. (2016, February 27). 7 good things about general aviation. Retrieved October 14, 2018, from <https://airfactsjournal.com/2013/01/7-good-things-about-general-aviation/>

Appendix A: *The World of Aerospace* Lesson Plans

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **03/17/2018**

Lesson Title: **Introduction**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal	
<i>Students shall gain a basic understanding of different parts of an airplane while being introduced to the advantages and common myths of aviation.</i>	<i>What are the basic parts of an airplane? How do I decipher an airplane's instruments? Why should I consider flying? Are airplanes safe? What are some common myths about flying?</i>	
Lesson Objective(s)		
<i>Students will be well-versed in and able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Basic parts of an airplane</i> <i>2. Basic axes of an airplane</i> <i>3. Primary and secondary flight controls</i> <i>4. Cockpit instrument fundamentals</i> <i>5. Advantages of flying</i> <i>6. Disadvantages of flying</i> <i>7. Safety statistics</i> <i>8. Myths about aviation</i> 		
Terms and Definitions		
<i>Fuselage</i>	<i>Flap</i>	<i>Airspeed Indicator</i>
<i>Empennage</i>	<i>Trim Tab</i>	<i>Altimeter</i>
<i>Airframe</i>	<i>Propeller</i>	<i>Vertical Speed Indicator</i>
<i>Aileron</i>	<i>Landing Gear</i>	<i>Heading Indicator</i>
<i>Elevator</i>	<i>Composite Materials</i>	<i>Turn Coordinator</i>
<i>Rudder</i>	<i>Attitude Indicator</i>	<i>Inclinometer</i>
<i>Horizontal/Vertical Stabilizer</i>		
Assessment/Evaluation		
<i>Students shall demonstrate a thorough understanding of the components of an airplane and the basic principles of flying by active participation in group discussion and correctly answering the instructor's questions.</i>		
Instruction		
<i>Set/Motivator: Show video embedded in presentation slides (https://www.youtube.com/watch?v=sGw769X75u8). Discuss with students in a group setting why each individual is in the class.</i>		
Instructional Procedures/Learning Tasks:		

Structure of an Airplane

Fuselage

- Main body of airplane
- Accommodates crew, passengers, and cargo

Wing

- Main surfaces that produce lift
- Ailerons and flaps
- Can be high or low wing design

Empennage (Tail)

- Horizontal and vertical stabilizers, elevator, rudder, and trim tab
- A tail acts like an upside down wing.

Ailerons

- Near tips of the wing
- Control roll
- Decrease lift on one wing and increase lift on the other

Elevator

- Deflects up and down
- Controls the airplane's pitch

Rudder

- Controlled by pedals
- Control airplane's yaw and, to an extent, roll

Propeller

- Driven by engine (discuss engine)
- Produces thrust

Flaps

- Root of wing
- Slow airplane down and allow it to fly at slower airspeed

Trim Tab

- Usually only on elevator in small airplanes
- Relieves control pressure

3 Axes of an Airplane

Longitudinal, Lateral, and Directional

Cockpit Instruments

Attitude Indicator

- Gyroscope (spinning disk)
- Shows miniature airplane in front of artificial horizon

Airspeed Indicator

- Uses pitot tube and static port
- Shows nearly the speed of air flowing over the wings (some instrument and installation error)
- Variety of speeds important to pilots

Altimeter

- Uses static port (outside air pressure)
- Shows height above Mean Sea Level (MSL)

Vertical Speed Indicator

- Uses static port
- Shows rate of climb/descent
- Takes a second or two to settle into a rate.

Heading Indicator

- Gyroscopic
- Match up to heading shown by magnetic compass (works at all times, unlike compass)

Turn Coordinator

- Gyroscopic
- Shows rate of turn and if aircraft is coordinated (inclinometer)

Advantages

Speed

- Straight-line distance

Efficiency

- Large airplanes have incredible fuel mileage per passenger

Safety

- Airplanes are meticulously maintained.
- Airlines are unbelievably safe.

Questions for higher order thinking:

1. Why are engineers always pushing to make airplanes lighter?
2. Which instruments would be affected if the static port becomes blocked? What behavior will the altimeter exhibit?
3. During which phases of flight would flaps need to be used?
4. Why is trim necessary? What would happen to pilots if flight controls possessed no trim?
5. What is your greatest personal reservation to flying in an airplane? Why?

Closure: Aviation has captured the hearts and minds of people all over the world for many centuries. Understanding the principles of flying will help one to be able to gain a greater understanding and factual knowledge of aviation.

Material/Resources: *None*

Sources: *Chapter 3 – FAA-H-8083-25A Pilot’s Handbook of Aeronautical Knowledge*

Reflections/Future Modifications: *To be filled in after field test.*

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **04/02/2018**

Lesson Title: **Aerodynamics**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<i>Students shall develop a basic understanding of aerodynamics with respect to airplanes.</i>		<i>How does a plane fly? What is a stall, and why is it dangerous? Why are airplanes designed the way that they are?</i>
Lesson Objective(s)		
<i>Students will be able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Four forces of flight</i> <i>2. Ground effect</i> <i>3. Axes of an aircraft</i> <i>4. Stalls and spins</i> <i>5. Load Factor</i> 		
Terms and Definitions		
<i>Lift</i>	<i>Longitudinal Axis</i>	<i>Stall Speeds</i>
<i>Angle of Attack</i>	<i>Lateral Axis</i>	<i>Load Factor</i>
<i>Thrust</i>	<i>Vertical Axis</i>	<i>Maneuvering Speed (Va)</i>
<i>Parasite Drag</i>	<i>Critical Angle of Attack</i>	<i>Best Glide Speed (Vg)</i>
<i>Induced Drag</i>	<i>Stall</i>	
<i>Ground Effect</i>	<i>Spin</i>	
Assessment/Evaluation		
<i>75% of students shall demonstrate a basic understanding of aerodynamics by active participation in group discussion and correctly answering the instructor's questions.</i>		
Instruction		
<p><i>Set/Motivator: Have class blow over the top of sheets of paper, observing the effects. Use this to jump immediately into the discussion of lift.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Lift</p> <ul style="list-style-type: none"> Newton's Laws and Bernoulli's Principle Counteracts weight in straight and level flight Can be controlled by pilot <ul style="list-style-type: none"> Is a function of airspeed, wing design, air density, and angle of attack (lift equation) Angle of Attack <ul style="list-style-type: none"> Angle between chord line and relative wind Need to match weight (simplified) to maintain straight and level flight. Need excess to climb 		

Created by propeller

Propeller is basically a wing that makes lift in the forward direction.

Twisted because the tips are travelling faster than the roots

Lift in the forward direction

Allows aircraft to climb and move forward

Opposes Drag

Weight

Concentrated at CG

Tail balances weight in nose

Drag

Parasite

Pressure Drag

Interference Drag

Skin Friction Drag

Induced

Byproduct of lift

Wingtip Vortices (Show video <https://www.youtube.com/watch?v=aYkJhmw3TIo>)

Ground Effect

Destroys wingtip vortices within one wingspan of ground

Load Factor

Ratio of Lift to Weight

G-Loads and Speed Limits

Material/Resources: *None*

Sources: *PHAK Chapter 5*

Reflections/Future Modifications: *To be filled in after field test.*

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/10/2018**

Lesson Title: **Airport Operations**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal
<i>Students shall develop an understanding of operations pertaining to airports, including services, markings, lighting systems, and navigational equipment.</i>	<i>How do I as a pilot safely understand and am able to safely operate in an airport environment? What facilities and equipment are standard at airports nationwide?</i>
Lesson Objective(s)	
<p><i>Students will be well-versed and able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Airport, taxiway, and runway markings and signs</i> <i>2. Airport, taxiway, and runway lighting</i> <i>3. Navigation equipment and services present at airports</i> 	
Terms and Definitions	
<p><i>VOR</i> <i>Apron</i> <i>Rotating Beacon</i> <i>VASI/PAPI</i> <i>Traffic Pattern</i></p>	<p><i>Touchdown Zone</i> <i>FBO</i> <i>Tetrahedron</i> <i>Windssock</i> <i>Control Tower</i></p>
Assessment/Evaluation	
<i>Students shall demonstrate a thorough understanding of airport operations by active participation in the group activity and by correctly answering the instructor's questions.</i>	
Instruction	
<p>Instructional Procedures/Learning Tasks:</p> <p>Experiential Activity: "It's Called a WHAT?!"</p> <p>Students will be split into groups. Each group will be given one/several index cards with a definition on one side. A projection of an airport diagram with names redacted/removed will be displayed. Using the definition and diagram, students are to create a name of each airport fixture while matching the card to the appropriate fixture on the diagram. Once all cards have been placed, the instructor will correct the diagram with the class, taking care to correct the names of each airport fixture.</p>	

Closure: Most collisions happen on clear days near airports. Understanding how airports operate as well as what types of equipment they carry and services they provide is necessary to conducting safe flight operations.

Material/Resources: Index Cards

Reflections/Future Modifications: To be filled in after field test.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/09/2018**

Lesson Title: **Weather Theory**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal	
<i>Students shall develop an understanding of aviation weather principles, including basic meteorology, recognition of critical weather situations, and wind shear avoidance procedures.</i>	<i>How does weather work? To what degree does it affect those in aviation? How dangerous are certain types of weather? How can I predict what the weather will do?</i>	
Lesson Objective(s)		
<i>Students will be well-versed and able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Composition and structure of the atmosphere</i> <i>2. Coriolis force</i> <i>3. Barometers and atmospheric pressure</i> <i>4. High and low pressure systems</i> <i>5. Effects of altitude on humans</i> <i>6. Atmospheric stability</i> <i>7. Air masses</i> <i>8. Fronts and Thunderstorms</i> <i>9. Wind shear and wake turbulence</i> 		
Terms and Definitions		
<i>Atmosphere</i>	<i>Temperature Inversion</i>	<i>Cold Front</i>
<i>Coriolis Force</i>	<i>Dew Point</i>	<i>Squall Line</i>
<i>Mercurial Barometer</i>	<i>Cloud</i>	<i>Stationary Front</i>
<i>Aneroid Barometer</i>	<i>Precipitation</i>	<i>Occluded Front</i>
<i>Pressure</i>	<i>Air Mass</i>	<i>Thunderstorm</i>
<i>Convective Currents</i>	<i>Warm Front</i>	<i>Microburst</i>
Assessment/Evaluation		
<i>Students shall demonstrate a thorough understanding of aviation weather theory by active participation in group discussion and correctly answering the instructor's questions. Students will be given a review worksheet to complete in order to prepare for a scenario-based training activity in a future lesson.</i>		
Instruction		
<i>Set/Motivator: Discuss with students through a series of questions their current knowledge of weather and how it currently affects their activities/lifestyles.</i>		
Instructional Procedures/Learning Tasks:		

Atmosphere

Composition

78% Nitrogen

21% Oxygen

1% Other

Circulation

Uneven heating of the Earth's surface

Equator gets more heat than poles

Pressure

Molecules have weight and take up space

Pressure decreases as altitude increases

Coriolis force

Baseball thrown off merry-go-round

Measurement of atmosphere pressure

Mercurial barometer

Aneroid barometer

Altitude and atmospheric pressure

1 in. for every 1000 feet

Altitude and flight

Performance decreases as altitude increases

Altitude and the human body

Some people can become oxygen impaired as low as 5000 feet.

Lack of oxygen can kill you.

Wind and currents

Wind patterns

Northern Hemisphere – wind flows to the right/clockwise rotation.

Favorable winds can be found on northern side of a high-pressure system or the southern side of a low pressure system.

Convective currents

Small pockets of bumpy rising air

Effect of obstructions on wind

Objects on ground can cause wind gusts.

Leeward side of the mountain is turbulent.

Low-level wind shear

Passing storms and frontal systems

Microbursts can be up to 6,000 feet per minute.

Atmospheric stability

Inversion

Air acts as a lid.

Can cause poor visibility

Temperature increases as altitude increases.

Moisture and temperature

Amount of moisture is dependent on temperature.

Relative humidity

Amount of water vapor in the atmosphere

Temperature/Dew Point

Dew point = air can no longer hold moisture.

Closer = clouds

Saturation point

Air temperature can drop to reach saturation point.

Cold and warm air can mix.

Air cools at night.

Dew and frost

Moisture condenses and can freeze

Frost disrupts laminar flow

Fog

Cloud on the surface

Radiation – Clear nights, no wind, caused by ground releasing heat and cooling

Advection – Warm moist air over a cold surface, needs wind, common near coast

Upslope – Moist, stable air ascends mountain slope.

Steam fog – Cold, dry air moves over warm water.

Ice fog – water freezes into little tiny freezing clouds.

Clouds

Water vapor

Condensation Nuclei

Cooling

Activity: *Cloud in a Bottle*

Ceiling

Lowest layer reported as broken or overcast (5/8)

Visibility

Greatest distance a pilot can see with naked eye

Precipitation

Often accompanied by low ceilings and bad visibility.

Air masses

Large body of air

Take on source region

Fronts

Warm front

Poor visibility

Stable air

Stratiform clouds

Steady precipitation

Cold front

Good visibility

Unstable air

Cumuliform clouds

Showery precipitation

Wind shift

Frontal passage changes the wind.

Stationary front

Forces are equal

Occluded front

Cold front overtakes a warm front = mixed weather

Warm front overtakes a cold front = severe weather

Thunderstorms

Hazards

Mircobursts

Turbulence

Hail

Updrafts and downdrafts

Avoid by 20 nautical miles.

Squall line

Associated with cold front

Tornadoes

Can be hidden (rain-wrapped)

Turbulence

Extreme danger in thunderstorms

Icing

Thunderstorms can create supercooled water that freezes on impact.

Lightning

Cause havoc with avionics

Questions for higher order thinking:

1. What would be your plan if you checked the weather and noticed a cold front approaching? What would you expect the weather to be like as it arrives?
2. Are we able to fly over the top of thunderstorms in small airplanes? Why or why not?
3. Why are we not crushed by the atmosphere simply by standing in it?
4. Why do clouds form in even layers?
5. Why is a sudden change in wind direction near the ground so dangerous for airplanes?

Closure: Weather is one of the most vital pieces of information to which a pilot has access. As a result, an understanding of the underlying theory and principles behind weather allows pilots and dispatchers to predict, to a degree, its intensity and flyability.

Sources: Chapter 11 – FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge

Advisory Circular – AC 00-6A Aviation Weather

Reflections/Future Modifications: To be filled in after field test.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/10/2018**

Lesson Title: **Weather Services**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal										
<i>Students shall develop an understanding of aviation weather services, including sources of weather information, charts, forecasts, and enroute services.</i>	<i>How do I go about finding appropriate information on weather? How do I use this information to determine whether to fly or not?</i>										
Lesson Objective(s)											
<p><i>Students will be well-versed and able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Sources from which to obtain weather information.</i> <i>2. Information and advisories available regarding hazardous enroute weather.</i> <i>3. Decision-making skills, including the concept of “go/no go” decision and personal weather minimums.</i> 											
Terms and Definitions											
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>ForeFlight</i></td> <td style="width: 50%;"><i>SIGMET</i></td> </tr> <tr> <td><i>Flight Service</i></td> <td><i>Convective SIGMET</i></td> </tr> <tr> <td><i>HIWAS</i></td> <td></td> </tr> <tr> <td><i>Aviation Weather Center</i></td> <td></td> </tr> <tr> <td><i>AIRMET</i></td> <td></td> </tr> </table>		<i>ForeFlight</i>	<i>SIGMET</i>	<i>Flight Service</i>	<i>Convective SIGMET</i>	<i>HIWAS</i>		<i>Aviation Weather Center</i>		<i>AIRMET</i>	
<i>ForeFlight</i>	<i>SIGMET</i>										
<i>Flight Service</i>	<i>Convective SIGMET</i>										
<i>HIWAS</i>											
<i>Aviation Weather Center</i>											
<i>AIRMET</i>											
Assessment/Evaluation											
<p><i>Students shall demonstrate a thorough understanding of aviation weather services by active participation in group discussion and correctly answering the instructor’s questions. In addition, students will participate in an experiential weather planning scenario, during which at least 50% of students must safely complete the simulated mission.</i></p>											
Instruction											
<p><i>Set/Motivator: Show video embedded in presentation slides. Discuss with the class the importance of receiving reliable, up-to-date weather, not only for aviation but also for daily life.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Sources of Weather Information</p> <p style="padding-left: 20px;">ForeFlight Highly popular service used by general aviation pilots everywhere iPads have taken over the aviation world</p>											

Flight Service

1-800-WX-BRIEF

Most reliable and up-to-date source of weather; available airborne or on ground

Aviation Weather Center

Online weather service

Multitude of charts, graphs, and forecasts

METAR

Aviation Routine Weather Report

TAF

Terminal Aerodrome Forecast

Valid for 24 hours

Winds/Temps Aloft

Collected by weather balloon launched twice per day

Prognostic Charts

Used to predict movements of fronts

Doppler Radar

Works by the radar waves bouncing off precipitation (echoes)

Excellent tool for locating and tracking thunderstorms

Weather Advisories

AIRMETs

Warnings about moderate turbulence, icing, and when mountains are hidden by clouds (obscuration)

SIGMETs

Severe turbulence/icing, sandstorms, volcanic ash

Convective SIGMETs

Severe thunderstorms

MTSU aircraft are not allowed to fly in these

PIREP

Pilot report

Size of the airplane makes an enormous difference (“light” turbulence to a jet can be severe to small airplanes).

Activity: Experiential Weather Scenario

Closure: Weather is one of the most vital pieces of information to which a pilot has access. As a result, an understanding of the information and services available allows pilots and dispatchers to make accurate judgments when determining the safety of any flight.

Material/Resources: Included in Lesson Plan Packet

Sources: FAA-H-8083-25A Pilot’s Handbook of Aeronautical Knowledge

FAA-H-8083-3A Airplane Flying Handbook

Chapter 7 Section 1 – Aeronautical Information Manual

Advisory Circular – AC 00-45G Aviation Weather Services

Advisory Circular – AC 61-84B Role of Preflight Preparation

FAA-8083-9A – Aviation Instructor’s Handbook

Reflections/Future Modifications: *To be filled in after field test.*

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/18/2018**

Lesson Title: **Aviation Physiology**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal	
<i>Students will gain a basic understanding of factors affecting the human body during flight.</i>	<i>What medical effects does a pilot experience in flight? What are some health hazards to pilots? How can a pilot become disoriented?</i>	
Lesson Objective(s)		
<i>Students will be well-versed and able to recall the following topics with respect to aviation:</i> <ol style="list-style-type: none"> 1. <i>Load factor and G-loads</i> 2. <i>Hypoxia and its cause</i> 3. <i>Hyperventilation and its cause</i> 4. <i>Vestibular system and spatial disorientation</i> 5. <i>Visual illusions</i> 6. <i>Fatigue</i> 		
Terms and Definitions		
<i>Load factor G Hypoxia Hyperventilation</i>	<i>Vestibular System Inner Ear The Leans Motion Sickness</i>	<i>Fatigue Decompression Sickness</i>
Assessment/Evaluation		
<i>Students will demonstrate understanding of the concepts presented by participating in class discussion, with 75% of the students correctly answering the instructor's questions.</i>		
Instruction		
<p>Set/Motivator: <i>Show video embedded in provided presentation slides.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Load Factor Ratio of Lift/Weight Measured in "Gs" 1 G is what students are feeling right now.</p> <p>Hypoxia Lack of oxygen to the brain 4 Types Hypoxic Hypemic Stagnant Histotoxic</p>		

Symptoms

- Blue limbs
- Headache
- Impaired judgment and drowsiness
- Visual impairment
- Euphoria and lightheadedness
- Tingling in fingers and toes

Spatial Disorientation

Motion sickness is simply your brain receiving mixed signals from your senses.

The Leans

- Inner ear fluid in vestibular system can settle while in a turn.
- Forces you to feel as if you are turning while straight and level

Activity: Sensory Confusion: One student will be blindfolded and deafened and rendered spatially disoriented using a chair.

Fatigue

Dangerous due to the lack of recognition until it's too late. No amount of flight training in the world will prevent danger associated with fatigue.

Questions and/or activities for higher order thinking:

1. How does a jet fly so high if the air isn't breathable?
2. Why should a passenger on an airliner put his/her oxygen mask on first instead of their child's? (Show movie scene from Four Christmases)
3. Why does breathing into a bag help relieve hyperventilation?
4. Why do fighter pilots black out when exposed to excessive G-forces?
5. What should you do if you find yourself spatially disoriented?

Closure: The physiological effects of flight on a human body are profound and dangerous if misunderstood. Individuals involved in aviation should take great care in order to understand and recognize hazards associated with hypoxia, hyperventilation, and spatial disorientation.

Material/Resources:

Sources: Chapter 16 – FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge

Reflections/Future Modifications: To be filled in after field test.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **03/25/2018**

Lesson Title: **National Airspace**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<p><i>Students shall develop an understanding of the United States National Airspace System, including types, uses, and regulations of airspace, along with the concept of air traffic control.</i></p>		<p><i>How do planes avoid each other with no highways in the sky? How do so many airplanes get into the large airports safely? How much authority does air traffic control possess? How do pilots know which areas are off limits?</i></p>
Lesson Objective(s)		
<p><i>Students will be able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Categories of airspace</i> <i>2. Classes of airspace and their corresponding dimensions</i> <i>3. Special-use airspace</i> <i>4. Air traffic control purpose and function</i> <i>5. Airspace designations on sectional charts</i> 		
Terms and Definitions		
<i>Controlled Airspace</i>	<i>Class B Airspace</i>	<i>Prohibited Airspace</i>
<i>Uncontrolled Airspace</i>	<i>Class C Airspace</i>	<i>Temporary Flight Restriction</i>
<i>Class G Airspace</i>	<i>Military Operating Area</i>	<i>Air Defense Identification Zone</i>
<i>Class E Airspace</i>	<i>Warning Area</i>	<i>Air Traffic Control</i>
<i>Class D Airspace</i>	<i>Alert Area</i>	<i>Air Route Traffic Control Center</i>
<i>Class C Airspace</i>	<i>Restricted Airspace</i>	<i>Terminal Radar Approach Control</i>
Assessment/Evaluation		
<p><i>75% of students shall demonstrate a basic understanding of the national airspace system by active participation in group discussion and correctly answering the instructor's questions.</i></p>		
Instruction		
<p>Set/Motivator: <i>Show video of National Airspace System function.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>National Airspace System Network shared jointly by the FAA and military</p>		

Categories of Airspace

Controlled

Air traffic control exercises authority.

Different classes of airspace require different radio requirements and equipment.

Uncontrolled

Air traffic control has no authority.

Classes of Airspace

Class G

Only civilian uncontrolled airspace

Lightest weather minimums

Usually lowest airspace underneath all the others

Class E

Most low-level airspace in the U.S. is Class E.

Goes up to 18,000 ft. above sea level

Controlled, but don't need a radio if flying in visual conditions

Higher weather minimums than Class G

Class D

Controlled – usually surround smaller airports with control towers

Goes out 4 nm from airport

Must contact controller to enter airspace

Class C

Controlled – usually around airports with regularly-scheduled flights (Nashville)

Goes out 10 nm from airport

Must contact controller and be equipped with Mode C transponder (position and altitude equipment) to enter airspace.

Class B

Controlled – usually surround busiest airports in the country (Atlanta, Chicago, Memphis, etc.).

Airspace is tailor-designed to airport's needs.

Must have a Mode C transponder and clearance from controller (not just making contact) to enter airspace.

Student pilots are very restricted when operating in this airspace.

Class A

Controlled – VFR pilots not allowed in this airspace

High-level airspace. Starts at 18,000 feet

Must be on an IFR flight plan

Used for efficient travel of jets

Special Use Airspace (MCWRAP)

Military Operating Area

Controlled Firing Area

Not on sectional

Warning Area

Restricted Area

Not allowed in without permission from controlling agency

Alert Area

Prohibited Airspace
National Mall in Washington D.C.

Other Airspace

Temporary Flight Restriction
Popular after 9/11
Used to protect things such as large gatherings, political figures, and Disney World
Pilots are responsible for knowing where these are.

National Security Area
Air Defense Identification Zone
12 nm off of coast of U.S.
Will be intercepted if you cross this without permission

Air Traffic Control

Responsible for safe flow of traffic across U.S. and the world
U.S. air traffic controllers are federal employees.
Use radar and are slowly switching to GPS system.

Air Route Traffic Control Center
Terminal Radar Approach Control
Busiest section for controllers and regarded as most stressful

Questions for higher order thinking:

1. In which classes of airspace can you fly without using a radio?
2. If the speed restriction lifts after 10,000 ft. MSL, what do you think happens to the weather minimums?
3. Why does the FAA activate TFRs over open-air stadiums during game days?
4. What would happen to ATC's ability to locate an aircraft on radar if a mountain was between the aircraft and the radar scope?
5. What relatively new system do you think could eliminate this phenomenon?

Closure: The National Airspace System is complicated, but it is essential to the daily safe and efficient operation of a large amount of both civilian and military aircraft.

Material/Resources: *None*

Sources: *PHAK Chapter 15*

Reflections/Future Modifications: *To be filled in after field test.*

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/02/2018**

Lesson Title: **Aviation Qualifications**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal	
<i>Students will gain a basic understanding of the training required for each type of pilot certificate, dispatch certificate, and maintenance certificate by gaining a thorough knowledge of federal regulations pertaining to each.</i>	<i>How do I become a pilot? How long does it take? What if I want a career in aviation that does not involve flying an airplane?</i>	
Lesson Objective(s)		
<i>Students will be well-versed and able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Legal requirements and processes to obtain pilot certificates</i> <i>2. Legal requirements and processes to obtain maintenance certificates</i> <i>3. Legal requirements and processes to obtain dispatch certificates</i> <i>4. Legal requirements and processes to become an air traffic controller</i> 		
Terms and Definitions		
<i>Private Pilot Certificate</i>	<i>Flight Instructor</i>	<i>Airframe and Powerplant Ratings</i>
<i>Instrument Rating</i>	<i>Certificate</i>	<i>Aircraft Dispatcher Exam</i>
<i>Commercial Pilot Certificate</i>	<i>Airline Transport Pilot Certificate</i>	<i>Air Traffic Control Specialist</i>
<i>Multi-Engine Rating</i>	<i>Checkride</i>	
	<i>Mechanic's Certificate</i>	
Assessment/Evaluation		
<i>Students will demonstrate understanding of the concepts presented by participating in class discussion, with 75% of the students correctly answering the instructor's questions.</i>		
Instruction		
<p>Set/Motivator: <i>Show video embedded in provided presentation slides.</i></p> <p>Carousel (Word Bomb/Brainstorm): <i>4 large sticky notes/posters are placed around the classroom, labelled "Pilot," "Dispatcher," "Aircraft Mechanic," and "Air Traffic Controller." Students will walk around for 4-5 minutes at the beginning of the lesson, writing what they know about each career path.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <ol style="list-style-type: none"> I. Private Pilot Certificate <ol style="list-style-type: none"> a. Find an instructor and/or flight school and apply for a Student Pilot Certificate. b. Obtain a 1st, 2nd, or 3rd class medical certificate <ol style="list-style-type: none"> i. Private Certificate only requires 3rd Class. 		

- ii. MTSU requires 2nd Class.
 - c. Pre-solo flight training
 - i. Learning to take off and land
 - ii. Basic maneuvers
 - iii. Pre-solo Knowledge Test
 - d. Solo
 - i. Signed off by instructor
 - ii. Includes flights to other airports (cross-country flights)
 - e. Conclusion
 - i. Knowledge test
 - 1. Written exam
 - ii. Checkride
 - 1. Oral and practical exam
- II. Instrument Rating (Source – IFH)
 - a. Allows pilot to fly in bad weather
 - i. Every airline pilot has instrument rating.
 - b. Training can be done by instrument instructor.
 - c. Conclusion
 - i. Knowledge test
 - ii. Checkride
- III. Commercial Certificate (PHAK 1-18)
 - a. Allows pilot to fly for compensation or hire
 - b. Conclusion
 - i. Knowledge test
 - ii. Checkride
- IV. Multi-Engine Rating (Source: FAR 61)
 - a. Needed to operate aircraft with more than one engine
 - b. Conclusion
 - i. Checkride
- V. Airline Transport Certificate (PHAK 1-18)
 - a. Required to fly for an airline.
 - b. Must have 1,500 hours of flight experience
 - i. 1,000 if graduated from MTSU (Restricted ATP)
 - c. Conclusion
 - i. Knowledge Test
 - ii. Checkride
- VI. Flight Instructor Certificate (FAR 61)
 - a. Allows one to act as a Certified Flight Instructor
 - b. Conclusion
 - i. Two knowledge tests
 - ii. Checkride
 - iii. Certificate expires after 2 years.
- VII. Mechanic's License (Source – faa.gov)
 - a. Airframe and Powerplant Ratings
 - i. 30 months' experience working as an intern OR FAA Training Program
 - 1. MTSU is FAA-Approved Aviation Maintenance Technician School.

ii. Conclusion

- 1. Written exam**
- 2. Oral exam**
- 3. Practical exam**

VIII. Repairman's Certificate (Source – faa.gov)

- a. Need recommendation from repair station and 18 months' experience there.**

IX. Aircraft Dispatcher (Source – Sheffield School of Aeronautics)

- a. Must be 21 years old to take exam**
 - i. 23 to receive certificate**
- b. Conclusion**
 - i. Written exam**

X. Air Traffic Control Specialist (Source – faa.gov)

- a. Regulate traffic across U.S.**
- b. Must be under 30 to be hired**
- c. Work for federal government**
- d. Toughest requirements of all aviation**
- e. Must be willing to travel and relocate**
- f. MTSU Collegiate Training Initiative gives early training to those wanting to become controller.**

Questions and/or activities for higher order thinking:

1. What pilot certificates/ratings should you pursue if you are planning to fly locally for fun? What about for a career?
2. Can you become an aircraft mechanic with just a few month's training? Why or why not?
3. What is considered the most difficult aviation career for which to qualify?
4. What are the safety repercussions if mechanic training requirements were less strenuous? Air traffic controllers? Pilots?
5. Why do you think the FAA requires very strict age requirements for dispatchers? Air traffic controllers?

Closure: Pilots, mechanics, dispatchers, controllers, and many other occupations must all cooperate to ensure a safe aviation industry and national airspace system. As a result, there are strict regulations and procedures to follow to become qualified for any one of these positions. Talking to an instructor, mechanic, dispatcher, or controller yourself will greatly help reduce confusion and stress when you are getting ready to begin your aviation journey.

Material/Resources: *None*

Reflections/Future Modifications: *To be filled in after field test.*

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **02/11/2018**

Lesson Title: **Flight Planning**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<p><i>Students shall develop an understanding of flight planning procedures with regard to routes, wind correction, correction due to magnetic variation and deviation, dead reckoning, and flight by reference to landmarks.</i></p>		<p><i>How do I plan a flight to another airport? What counts as a cross-country flight? How do I correct for wind drift and magnetic errors? How do I know where I am without a GPS?</i></p>
Lesson Objective(s)		
<p><i>Students will be guided through a flight planning procedure step-by-step, allowing each individual to gain hands-on experience with the flight planning process.</i></p>		
Terms and Definitions		
<i>Visual Flight Rules</i>	<i>Dead Reckoning</i>	<i>Nautical Mile</i>
<i>Cross-Country Flight</i>	<i>Navlog</i>	<i>Cruising Altitude</i>
<i>Sectional</i>	<i>Wind Correction Angle</i>	<i>Groundspeed</i>
<i>E6B Flight Computer</i>	<i>Magnetic Variation</i>	
<i>Plotter</i>	<i>Magnetic Deviation</i>	
<i>Pilotage</i>	<i>Statute Mile</i>	
Assessment/Evaluation		
<p><i>At the completion of this lesson, 90% of students shall successfully complete a navigation log involving a flight to another airport.</i></p>		
Instruction		
<p>Set/Motivator: <i>None</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p><i>In this lesson, students will be led through an entire flight-planning process. Each student will receive the necessary equipment (included in the lesson packet) required in order to plan a short cross-country flight to a nearby airport. A step-by-step guide to flight planning is included in the lesson plan packet for instructor reference. Instructors unfamiliar with plotters and/or E6B flight computers should seek assistance prior to this lesson in order to complete the lesson objectives.</i></p>		

Questions for higher order thinking:

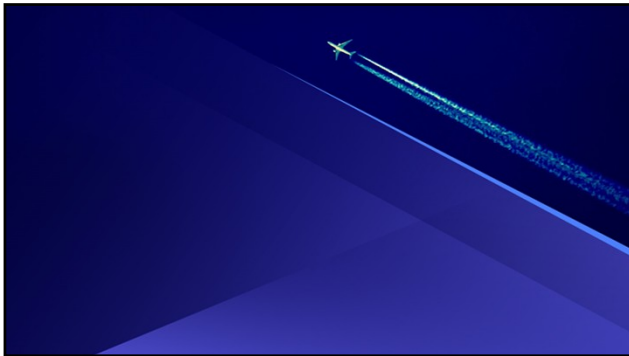
1. What was the most difficult and/or confusing aspect of the flight planning process?
2. Why would a pilot simply not point the airplane's nose in the direction of the airport and begin flying? What are some limitations that make this impractical?
3. What would you do if you are unable to identify a checkpoint? What if you become lost entirely?
4. How is groundspeed different from airspeed? Why does it matter?
5. (Challenge) Why would you not plan a flight from New York to London on a straight line as you would a shorter cross-country flight (hint: the flight paths follow a curve).

Closure: Flight planning is essential to the safe conduct of a flight. While flight planning appears complex and can involve several steps, it allows pilots and dispatchers to conduct efficient, accurate, and safe operations.

Reflections/Future Modifications:

Due to time constraints, this lesson plan was not utilized at the participating high school. This lesson was omitted due to a variety of its subject matter being covered previously and due to the instructor's assessment that flight planning is a far too complex process for one thirty-minute session. This lesson will need to be conducted over a minimum of two sessions.

Appendix B. *The World of Aerospace* Presentation Slides



The World of Aerospace

Course Presented by Jake Garrette, CFII.



Course Outline

- Course will be taught in college lecture format.
- You will be responsible for taking notes and digesting ideas outside of class.
- Class participation is **REQUIRED**. Ask questions, contribute to class discussions, and come well-prepared and ready to learn.
- There will be one comprehensive test at the end of the course, along with homework (mostly assigned reading) and quizzes.

Who Is Jake Garrette?



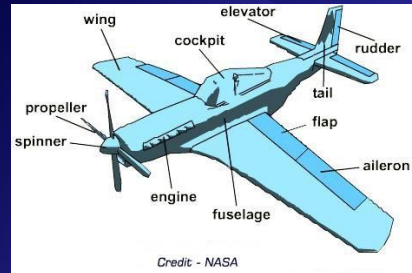
About Jake Garrette

- Originally from Centerville, TN.
- Moved to Shelbyville, TN at six years old.
- Graduated in 2015 as valedictorian of Community High School.
- Currently a senior aerospace major at Middle Tennessee State University.
- Commercial Multi-Engine pilot. Started flight training during senior year of high school.
- Certified Flight Instructor – Instrument

Aviation Work Experience

- Airport Operations Technician at Shelbyville Municipal Airport.
- Dispatcher at MTSU Flight Education Center.
- MTSU Flight Instructor.
- MTSU Stage Check Instructor.
- Tennessee Department of Transportation Flight Department.

Parts of an Airplane



The Plane You Will Fly: Diamond DA40



The Plane You Will Fly: Diamond DA40



The Plane You Will Fly: Diamond DA40



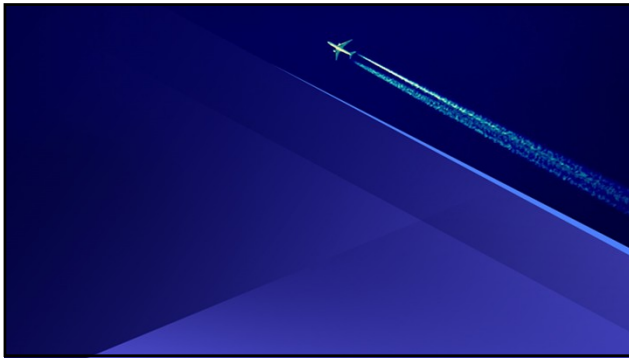
The Plane You Will Fly: Diamond DA40





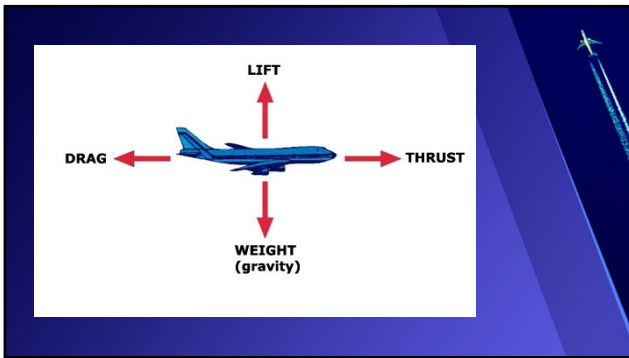
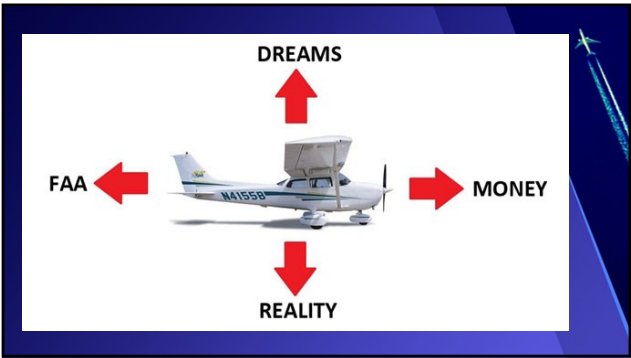
Why Airplanes?

- Straight-line distance
- Fuel Mileage
- Incredibly Safe



Aerodynamics

Course Presented by Jake Garrette, CFII.



Lift

- Force that overcomes weight
- Generated primarily by wings
- Lift can be produced due to several laws of nature.
- Functions of lift include airspeed, the density of the air, the amount of surface area the wing possesses, and angle of attack.

Drag

- Opposite direction of thrust
- Two Types
- Parasite
- Induced
- <https://www.youtube.com/watch?v=aWkIhmw3Tio>
- Wingtip vortices are very dangerous and can flip a small airplane.

Weight

- Opposite direction of lift
- Airplane must be balanced properly and must not exceed its max gross weight
- Wings can only generate so much lift.
- Most small airplanes are not designed to carry all passengers and full fuel without being extremely overweight.
- Center of gravity (CG) location is extremely important.

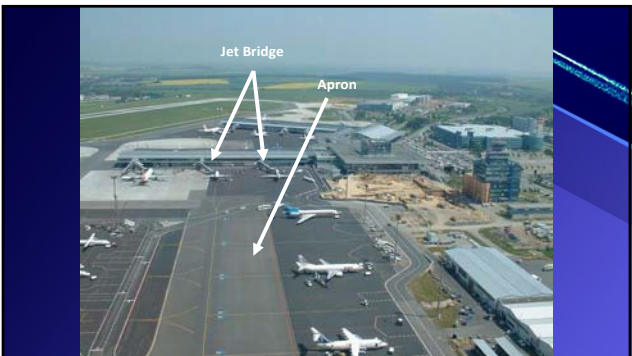
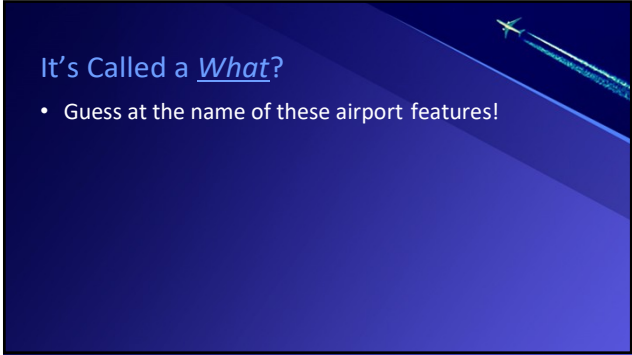
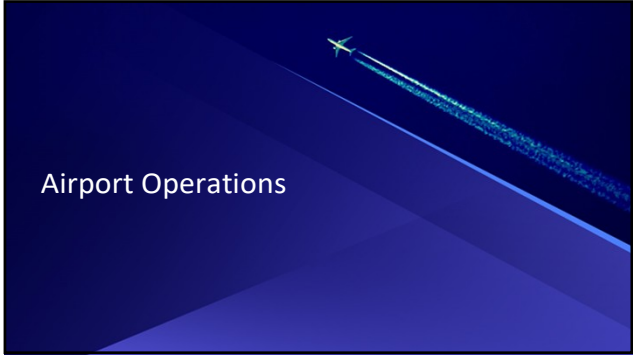
Thrust

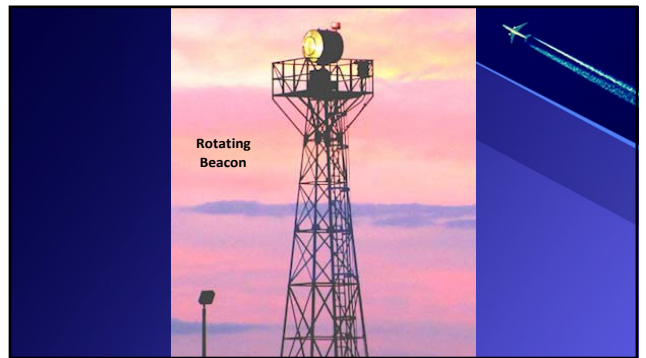
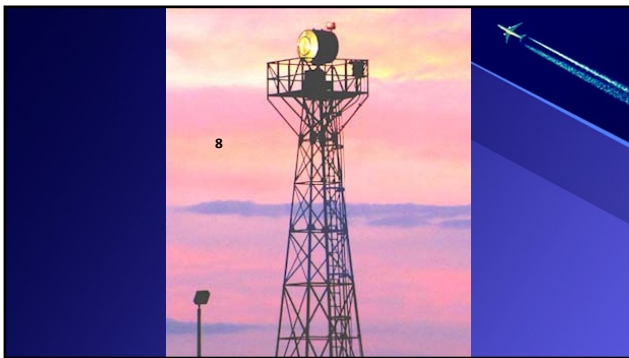
- Generated by propeller.
- Produces lift in the forward direction.
- Excess thrust helps you climb.

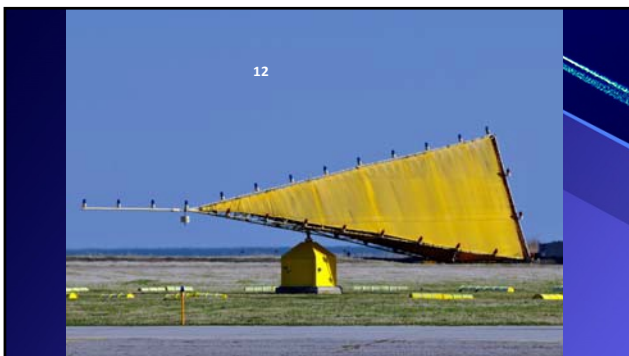


Load Factor (G-Loads)

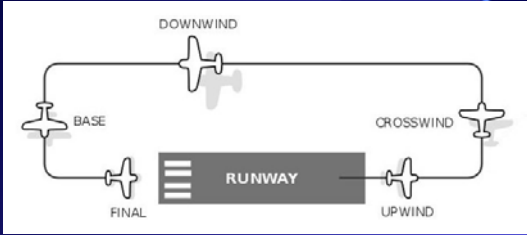
- Ratio of Lift/Weight
- Produce a lot of lift and you will increase positive load factor (Gs) and vice versa.
- Airplanes have load limits (called limit load factor) and can be damaged if the pilot exceeds these.
- <https://www.youtube.com/watch?v=HmikiomAkBc>

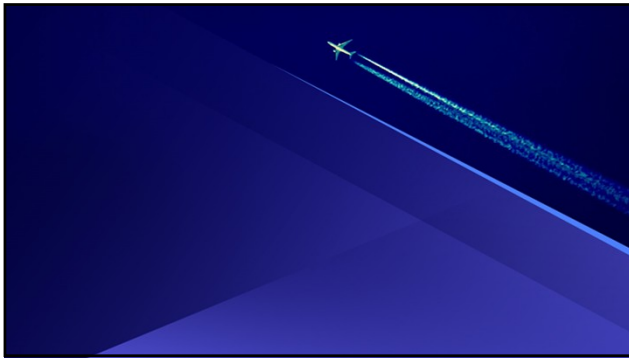






Traffic Patterns at Uncontrolled Airports





Weather Theory

Course Presented by Jake Garrette, CFII.

Atmosphere

- 78% Nitrogen
- 21% Oxygen
- 1% Other Gases
- Ratio stays same as you climb, but density of air decreases.

Source of Weather



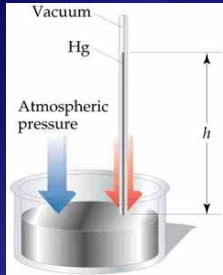
Pressure

- Air has mass, and therefore weight
- Large weight sitting on you.
- 14.7 lbs/in²
- 29.92 inches of Mercury.
- Source of wind.

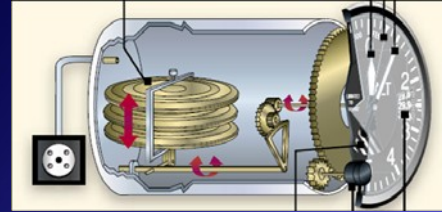
Coriolis Effect

- <https://www.youtube.com/watch?v=i2mec3vgeal>

Mercurial Barometer



Aneroid Barometer

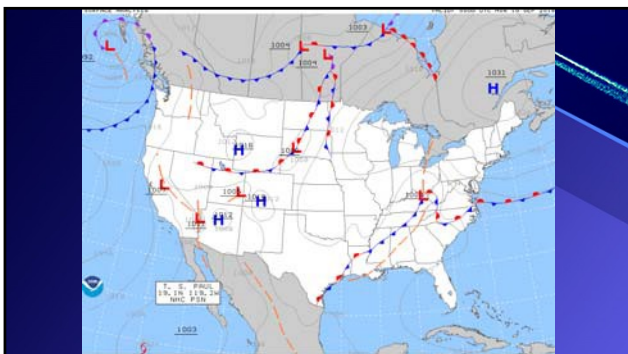


Oxygen

- Necessary for human life.
- Lack of oxygen is known as hypoxia
- Can occur as low as 5,000 ft.

Wind Flow

- High pressure systems flow clockwise (anticyclonic flow)
- Low pressure systems spin counterclockwise (cyclonic flow)
- When air is heated, it tends to rise.
- Sudden change in wind direction is known as wind shear.
- Caused by passing storms and frontal systems.



Stability

- Dependent upon moisture content (relative humidity).
- Relative humidity is dependent upon temperature.
- The more unstable the atmosphere, the more unevenly it cools.

Clouds and Dew

- Cloud development requires 3 things:
 - Moisture
 - Condensation Nuclei
 - Cooling
- Dew point plays a role in cloud height.
- Frozen dew (frost) can disrupt airflow over wings.

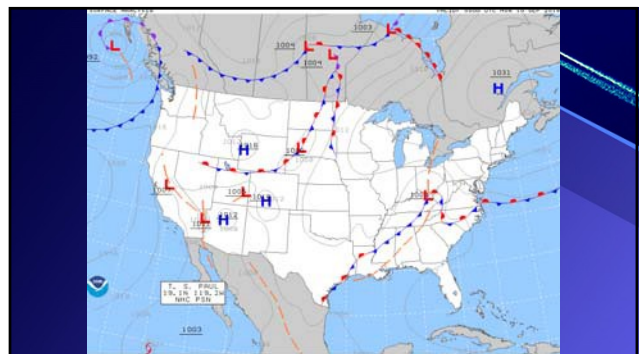


Air Mass

- Body of air with similar temperature and pressure properties
- Air masses tend to take on the properties of whatever terrain they are over.

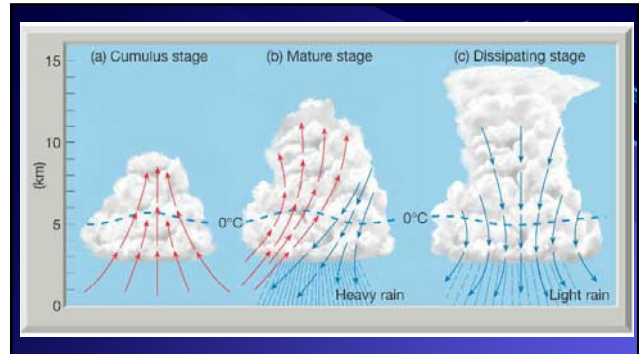
Front

- Boundary between two air masses
- Four types:
 - Warm
 - Cold
 - Stationary
 - Occluded



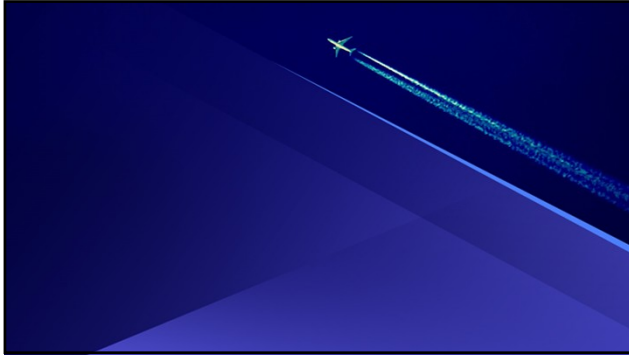
Thunderstorms

- Forms from cumulonimbus cloud
- Three stages:
 - Cumulus
 - Maturing
 - Dissipating



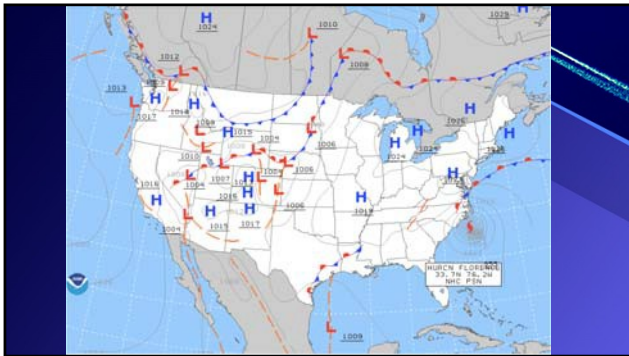
Dangers of Thunderstorms

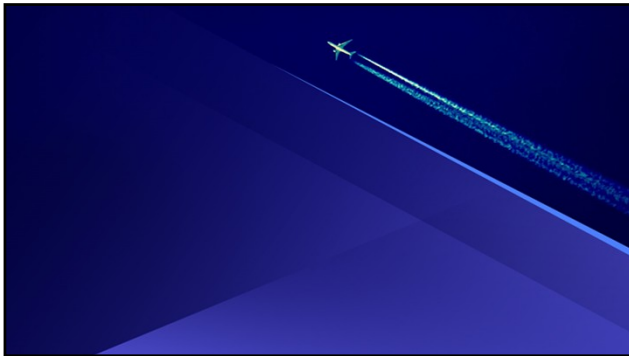
- Hail
- Turbulence
- Icing
- Updrafts and downdrafts
- Microbursts
- Lightning
- Tornadoes



Experiential Weather Activity

Course Presented by Jake Garrette, CFII.





Aviation Physiology

Course Presented by Jake Garrette, CFII.

G Loads on Body

- Ratio of Lift to Weight
- Can cause blackouts and redouts
- <https://www.youtube.com/watch?v=fpxsgDpX3uo>

Hypoxia

- 4 Types:
- Hypoxic
- Hypemic
- Stagnant
- Histotoxic

Symptoms of Hypoxia

- Blue limbs
- Headache
- Impaired judgement/drowsiness
- Tingling
- Visual impairment
- Euphoria
- Tingling in fingers/toes

Hypoxia Cont.

- <https://www.youtube.com/watch?v=kUfF2MTnqAw&t=434s>

Hyperventilation

- Too little carbon dioxide
- Very rapid breathing
- Symptoms similar to hypoxia

Spatial Disorientation

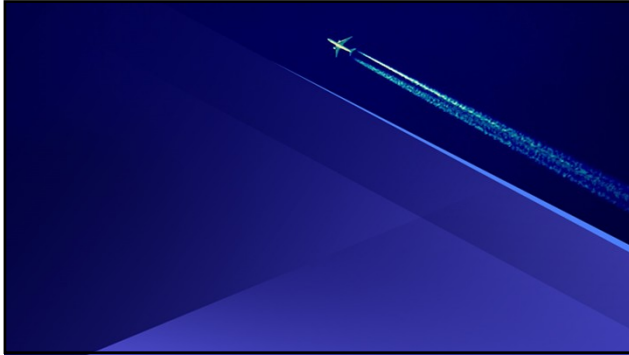
- Motion Sickness
 - Brain receiving mixed sensory signals
- Leans and Vestibular Illusions
 - Fluid in inner ear can disrupt your sense of balance and orientation.

Fatigue

- Dangerous due to difficult recognition
- Airline pilots have very strict federal rules to help mitigate fatigue.

IMSAFE Checklist

- Illness
- Medication
- Stress
- Alcohol
- Fatigue
- Eating

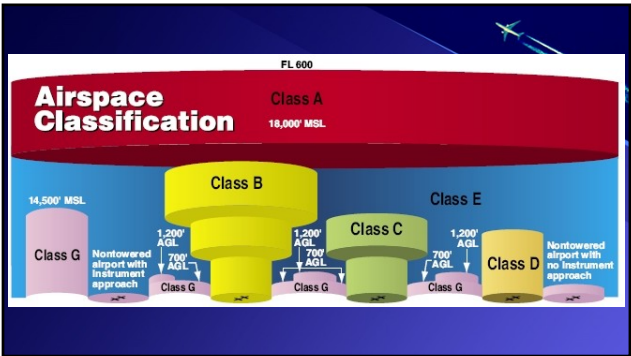


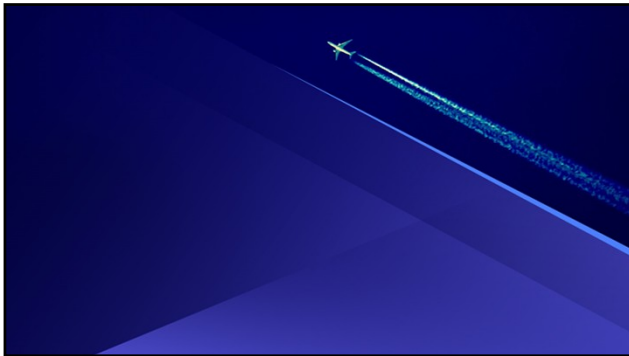
National Airspace System

Course Presented by Jake Garrette, CFII.

Sectional

- Aeronautical chart used by VFR pilots
- Contains topography, obstacle, airport, and airspace information.





The Next Step

Course Presented by Jake Garrette, CFII.

Private Pilot Certificate

- Medical certificate.
- Pre-solo flight training
- Solo
- Continued training in cross-country and maneuvers flight
- Knowledge test
- Checkride

Instrument Rating

- Rating for a private pilot
- Allows you to fly in bad weather.
- How airline pilots fly
- Knowledge test
- Checkride

Commercial Certificate

- Allows a pilot to be compensated (with restrictions)
- Training is spent building flight time and honing flying skills
- Knowledge test
- Checkride

Multi-Engine Rating

- Allows pilot to fly airplane with more than one engine
- No knowledge test
- Checkride

Airline Transport Certificate

- Required to fly for an airline
- Need 1,500 flight hours to apply for certificate
- 1,000 through MTSU
- Knowledge test
- Checkride

Flight Instructor Certificate

- Allows pilot to act as flight instructor
- Must be able to demonstrate flying skills at a very high level
- Two knowledge tests
- 8 hour checkride
- Instrument and multi-engine ratings can be added

Flight Instructor Certificate

- Allows pilot to act as flight instructor
- Must be able to demonstrate flying skills at a very high level
- Two knowledge tests
- 8 hour checkride
- Certificate expires after 2 years
- Instrument and multi-engine ratings can be added

Aircraft Maintenance Technician

- Certifies an individual to become an aircraft mechanic
- Need 30 months' intern experience or must graduate from an approved training program
- Written exam
- Oral exam
- Practical exam

Repairman's Certificate

- Allows a mechanic to specialize in a specific equipment group
- Need 18 months of experience at a repair station and a recommendation from it

Aircraft Dispatcher

- Plans and shares responsibility for commercial flights
- Must be 23 years of age
- Can take exam at 21 years of age
- Written exam

Air Traffic Control Specialist

- Regulate traffic across U.S.
- Must be hired under 30 years of age
- Employed by federal government
- Toughest medical and physical requirements in all of aviation
- Must be willing to travel and relocate
- MTSU CTI gives students early training

Other Options

- Airport Management
- Unmanned Aerial Systems
- Aerospace Technology

Appendix C. *The World of Aerospace* Revised Lesson Plans

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **08/20/2018**

Lesson Title: **Introduction**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<p><i>Students shall gain a basic understanding of different parts of an airplane while being introduced to the advantages and common myths of aviation.</i></p>		<p><i>What are the basic parts of an airplane? How do I decipher an airplane's instruments? Why should I consider flying? Are airplanes safe? What are some common myths about flying?</i></p>
Lesson Objective(s)		
<p><i>Students will be well-versed in and able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Basic parts of an airplane</i> <i>2. Basic axes of an airplane</i> <i>3. Primary and secondary flight controls</i> <i>4. Cockpit instrument fundamentals</i> <i>5. Advantages of flying</i> <i>6. Disadvantages of flying</i> <i>7. Safety statistics</i> <i>8. Myths about aviation</i> 		
Terms and Definitions		
<i>Fuselage</i>	<i>Flap</i>	<i>Airspeed Indicator</i>
<i>Empennage</i>	<i>Trim Tab</i>	<i>Altimeter</i>
<i>Airframe</i>	<i>Propeller</i>	<i>Vertical Speed Indicator</i>
<i>Aileron</i>	<i>Landing Gear</i>	<i>Heading Indicator</i>
<i>Elevator</i>	<i>Composite Materials</i>	<i>Turn Coordinator</i>
<i>Rudder</i>	<i>Attitude Indicator</i>	<i>Inclinometer</i>
<i>Horizontal/Vertical Stabilizer</i>		
Assessment/Evaluation		
<p><i>Students shall demonstrate a thorough understanding of the components of an airplane and the basic principles of flying by active participation in group discussion and correctly answering the instructor's questions.</i></p>		
Instruction		
<p><i>Set/Motivator: Show video embedded in presentation slides (https://www.youtube.com/watch?v=sGw769X75u8). Discuss with students in a group setting why each individual is in the class.</i></p>		
<p>Instructional Procedures/Learning Tasks:</p>		

Structure of an Airplane

Fuselage

- Main body of airplane
- Accommodates crew, passengers, and cargo

Wing

- Main surfaces that produce lift
- Ailerons and flaps
- Can be high or low wing design

Empennage (Tail)

- Horizontal and vertical stabilizers, elevator, rudder, and trim tab
- A tail acts like an upside down wing.

Ailerons

- Near tips of the wing
- Control roll
- Decrease lift on one wing and increase lift on the other

Elevator

- Deflects up and down
- Controls the airplane's pitch

Rudder

- Controlled by pedals
- Control airplane's yaw and, to an extent, roll

Propeller

- Driven by engine (discuss engine)
- Produces thrust

Flaps

- Root of wing
- Slow airplane down and allow it to fly at slower airspeed

Trim Tab

- Usually only on elevator in small airplanes
- Relieves control pressure

3 Axes of an Airplane

Longitudinal, Lateral, and Directional

Cockpit Instruments

Attitude Indicator

- Gyroscope (spinning disk)
- Shows miniature airplane in front of artificial horizon

Airspeed Indicator

- Uses pitot tube and static port
- Shows nearly the speed of air flowing over the wings (some instrument and installation error)
- Variety of speeds important to pilots

Altimeter

- Uses static port (outside air pressure)
- Shows height above Mean Sea Level (MSL)

Vertical Speed Indicator

- Uses static port

Shows rate of climb/descent
Takes a second or two to settle into a rate

Heading Indicator

Gyroscopic

Match up to heading shown by magnetic compass (works at all times, unlike compass)

Turn Coordinator

Gyroscopic

Shows rate of turn and if aircraft is coordinated (inclinometer)

Advantages

Speed

Straight-line distance

Efficiency

Large airplanes have incredible fuel mileage per passenger.

Safety

Airplanes are meticulously maintained.

Airlines are unbelievably safe.

Questions for higher order thinking:

1. Why are engineers always pushing to make airplanes lighter?
2. Which instruments would be affected if the static port becomes blocked?
What behavior will the altimeter exhibit?
3. During which phases of flight would flaps need to be used?
4. Why is trim necessary? What would happen to pilots if flight controls possessed no trim?
5. What is your greatest personal reservation to flying in an airplane? Why?

Closure: Aviation has captured the hearts and minds of people all over the world for many centuries. Understand the principles of flying will help one to be able to gain a greater understanding and factual knowledge of aviation.

Material/Resources: *Model airplane; Gyroscopic visual aid (bicycle tire)*

Sources: *Chapters 6 & 8 – FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge*

Reflections/Future Modifications:

08/15/2018

The initial lesson progressed smoothly. Of the nine students who registered for the class, three were female, which came as a mild surprise. The first day was spent with introductions, and the instructor asked each student individually his or her purpose for registering for the course. After introductions, the instructor followed the lesson plan, beginning with a course outline of what would be expected from the students. This was judged by the instructor as necessary and highlighted another benefit of the class; it was designed to be taught in a college style, *The World of Aerospace* provides students with exposure to education at the collegiate level.

The students were then instructed per the lesson plan, with the bulk of the class period spent explaining the location and function of items on a basic airplane's exterior and the four forces of flight. Students were participative and asked relevant questions. A proper balance must be struck between presenting concepts too simply and delving into topics too deeply for new aviation students to understand. Initially, this seems to be the biggest obstacle to overcome.

08/20/2018

The lesson was completed on this date. For future reference, the instructor should focus more effort on the advantages and disadvantages of flying. Short, thirty-minute sessions such as the ones being used during the initial field test have proven to be useful in conveying the information without overloading students. A material that should be added for this lesson is a visual gyroscopic aid such as a bicycle tire.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **08/30/2018**

Lesson Title: **Aerodynamics**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<i>Students shall develop a basic understanding of aerodynamics with respect to airplanes.</i>		<i>How does a plane fly? What is a stall, and why is it dangerous? Why are airplanes designed the way that they are?</i>
Lesson Objective(s)		
<i>Students will be able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Four forces of flight</i> <i>2. Ground effect</i> <i>3. Axes of an aircraft</i> <i>4. Stalls and spins</i> <i>5. Load Factor</i> 		
Terms and Definitions		
<i>Lift</i>	<i>Longitudinal Axis</i>	<i>Stall Speeds</i>
<i>Angle of Attack</i>	<i>Lateral Axis</i>	<i>Load Factor</i>
<i>Thrust</i>	<i>Vertical Axis</i>	<i>Maneuvering Speed (Va)</i>
<i>Parasite Drag</i>	<i>Critical Angle of Attack</i>	<i>Best Glide Speed (Vg)</i>
<i>Induced Drag</i>	<i>Stall</i>	
<i>Ground Effect</i>	<i>Spin</i>	
Assessment/Evaluation		
<i>75% of students shall demonstrate a basic understanding of aerodynamics by active participation in group discussion and correctly answering the instructor's questions.</i>		
Instruction		
<p><i>Set/Motivator: Have class blow over the top of sheets of paper, observing the effects. Use this to jump immediately into the discussion of lift.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Lift</p> <ul style="list-style-type: none"> Newton's Laws and Bernoulli's Principle Counteracts weight in straight and level flight Can be controlled by pilot <ul style="list-style-type: none"> Is a function of airspeed, wing design, air density, and angle of attack (lift equation) Angle of Attack <ul style="list-style-type: none"> Angle between chord line and relative wind Need to match weight (simplified) to maintain straight and level flight 		

Weight

Concentrated at CG
Tail balances weight in nose

Thrust

Created by propeller
Propeller is basically a wing that makes lift in the forward direction.
Twisted because the tips are travelling faster than the roots
Lift in the forward direction
Allows aircraft to climb and move forward
Opposes drag

Drag

Parasite
Pressure Drag
Interference Drag
Skin Friction Drag
Induced
Byproduct of lift
Wingtip Vortices (Show video <https://www.youtube.com/watch?v=aYkJhmw3Tio>)

Load Factor

Ratio of Lift to Weight
G-Loads and Speed Limits

Material/Resources: *Model airplane; blank printer paper or notebook paper*

Sources: *Chapter 5 - FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge*

Reflections/Future Modifications:

08/22/2018

Today was the first time the class discussed lift in detail, although the students did learn about the four forces in the previous introduction. The instructor was pleased with the transition between lessons. The topic of the forces of flight was covered in the previous lesson and provided a smooth flow into an explanation in this lesson on the basics of lift.

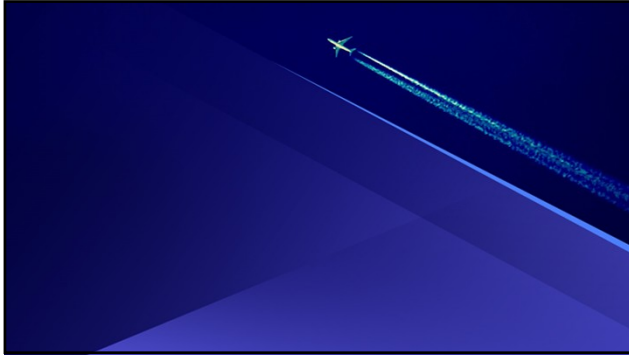
Students were told to blow over the top of the sheets of paper. The rising of the paper as each student blew air over it was a surprise to many. One student, however, understood the pressure effect immediately, which came as a pleasant surprise.

A glaring omission on the part of the instructor was the exclusion of an airfoil diagram in the slide presentations, a mistake that was corrected before class. The revised slide will be included with this revised curriculum.

08/24/2018

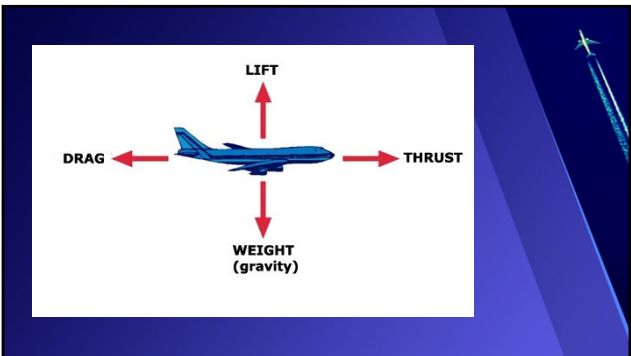
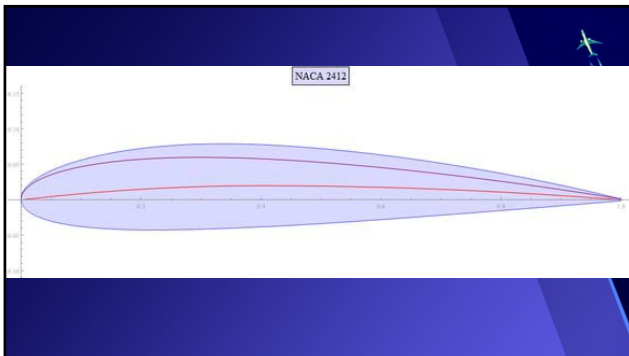
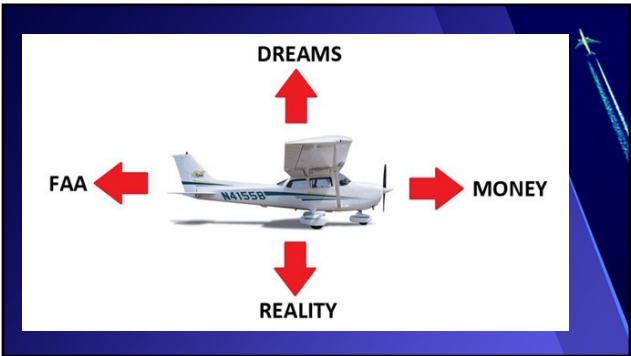
Due to an upcoming break, students were less attentive than usual. However, a few did give the instructor semblances of reasonable answers. It became readily apparent that aerodynamic principles were not an area of high interest for many in the class. The students did, however, seem to gain a basic understanding of terms such as angle of attack and stall.

Overall, the instructor was pleased with the basic aerodynamics incorporated into the lesson and found that most of the material, while complicated, was understandable for those with no previous background in aviation. The instructor will, however, shift the order of the forces discussed, as the lesson jarred when switching between forces that did not oppose one another.



Aerodynamics

Course Presented by Jake Garrette, CFII.



Lift

- Force that overcomes weight
- Generated primarily by wings
- Lift can be produced due to several laws of nature.
- Functions of lift include airspeed, the density of the air, the amount of surface area the wing possesses, and angle of attack.

Drag

- Opposite direction of thrust
- Two Types
- Parasite
- Induced
- <https://www.youtube.com/watch?v=gVUjhmw3Tlo>
- Wingtip vortices are very dangerous and can flip a small airplane.

Weight

- Opposite direction of lift
- Airplane must be balanced properly and must not exceed its max gross weight
- Wings can only generate so much lift.
- Most small airplanes are not designed to carry all passengers and full fuel without being extremely overweight.
- Center of gravity (CG) location is extremely important.

Thrust

- Generated by propeller.
- Produces lift in the forward direction.
- Excess thrust helps you climb.



Load Factor (G-Loads)

- Ratio of Lift/Weight
- Produce a lot of lift and you will increase positive load factor (Gs) and vice versa.
- Airplanes have load limits (called limit load factor) and can be damaged if the pilot exceeds these.
- <https://www.youtube.com/watch?v=HmikjomAkBc>

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/09/2018**

Lesson Title: **Airport Operations**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal
<i>Students shall develop an understanding of operations pertaining to airports, including services, markings, lighting systems, and navigational equipment.</i>	<i>How do I as a pilot safely understand and am able to safely operate in an airport environment? What facilities and equipment are standard at airports nationwide?</i>
Lesson Objective(s)	
<i>Students will be well-versed and able to recall the following:</i> <ol style="list-style-type: none"> 1. <i>Airport, taxiway, and runway markings and signs.</i> 2. <i>Airport, taxiway, and runway lighting</i> 3. <i>Navigation equipment and services present at airports.</i> 	
Terms and Definitions	
<i>VOR</i> <i>Apron</i> <i>Rotating Beacon</i> <i>VASI/PAPI</i> <i>Traffic Pattern</i>	<i>Touchdown Zone</i> <i>FBO</i> <i>Tetrahedron</i> <i>Windsock</i> <i>Control Tower</i>
Assessment/Evaluation	
<i>Students shall demonstrate a thorough understanding of airport operations by active participation in the group activity and by correctly answering the instructor’s questions.</i>	
Instruction	
<p>Instructional Procedures/Learning Tasks:</p> <p>Experiential Activity: “It’s Called a WHAT?!”</p> <p>Students will be split into groups. Each group will be given one/several index cards with a definition on one side. A projection of an airport diagram with names redacted/removed will be displayed. Using the definition and diagram, students are to create a name of each airport fixture while matching the card to the appropriate fixture on the diagram. Once all cards have been placed, the instructor will correct the diagram with the class, taking care to correct the names of each airport fixture.</p>	

Uncontrolled Airports

No ATC.

Pilots do not even need radio.

Safe traffic flow known as traffic pattern

Upwind, Downwind, Base, and Final legs.

Self-announce on radio.

Controlled Airports

Controlled by air traffic control

Need clearance to land

FBO

Fixed-base Operator

Provides services such as fuel, parking, hangars, flight training, catering, transportation, and pilot services.

Closure: Most collisions happen on clear days near airports. Understanding how airports operate as well as what types of equipment they carry and services they provide is necessary to conducting safe flight operations.

Material/Resources: *Index cards or notebook paper*

Sources: *Aeronautical Information Manual Section 4-3: Airport Operations*

Reflections/Future Modifications:

09/05/2018

Students participated in an experiential activity. The students were split into two teams of three each. A future modification that would yield more responses would be to have students split into pairs instead of groups of varying number. This would increase the number of (hopefully comical) responses, although it would involve more time.

The activity was unable to be completely finished on this day, with two airport features being left until the following class session. The instructor was pleased with the enthusiasm and responses of the students, who seemed to enjoy the activity. Ideally, a singular picture encompassing all airport features

would be displayed, but the instructor was unable to obtain a drawing/photograph that presented every feature in enough detail to properly identify. If one can be located, it should be used.

09/07/2018

The class began with the conclusion of the experiential activity. Students began asking the most pertinent, relevant questions of the course so far. Overall, while the activity was simple, it was an educational success.

It became apparent that additional information was needed after the activity's conclusion on safe operation in and around different types of airports. It was also noted that additional information on fixed-base operators (FBOs) was needed, as general confusion arose over their nature and purpose. The topics concerning operations in both controlled and uncontrolled airports and around FBOs were added to the revised lesson plan. These topics were taught in the traditional lecture format with positive results from students. Students also impressively demonstrated knowledge of aerodynamic principles from previous lessons.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/12/2018**

Lesson Title: **Weather Theory**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<p><i>Students shall develop an understanding of aviation weather principles, including basic meteorology, recognition of critical weather situations, and wind shear avoidance procedures.</i></p>		<p><i>How does weather work? To what degree does it affect those in aviation? How dangerous are certain types of weather? How can I predict what the weather will do?</i></p>
Lesson Objective(s)		
<p><i>Students will be well-versed and able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Composition and structure of the atmosphere</i> <i>2. Coriolis force.</i> <i>3. Barometers and atmospheric pressure</i> <i>4. High and low pressure systems</i> <i>5. Effects of altitude on humans</i> <i>6. Atmospheric stability</i> <i>7. Air masses</i> <i>8. Fronts and Thunderstorms</i> <i>9. Wind shear and wake turbulence</i> 		
Terms and Definitions		
<i>Atmosphere</i>	<i>Temperature Inversion</i>	<i>Cold Front</i>
<i>Coriolis Force</i>	<i>Dew Point</i>	<i>Squall Line</i>
<i>Mercurial Barometer</i>	<i>Cloud</i>	<i>Stationary Front</i>
<i>Aneroid Barometer</i>	<i>Precipitation</i>	<i>Occluded Front</i>
<i>Pressure</i>	<i>Air Mass</i>	<i>Thunderstorm</i>
<i>Convective Currents</i>	<i>Warm Front</i>	<i>Microburst</i>
Assessment/Evaluation		
<p><i>Students shall demonstrate a thorough understanding of aviation weather theory by active participation in group discussion and correctly answering the instructor's questions.</i></p>		
Instruction		
<p><i>Set/Motivator: Discuss with students through a series of questions their current knowledge of weather and how it currently affects their activities/lifestyles.</i></p> <p>Instructional Procedures/Learning Tasks:</p>		

Atmosphere

Composition

78% Nitrogen

21% Oxygen

1% Other

Circulation

Uneven heating of the Earth's surface

Equator gets more heat than poles

Pressure

Molecules have weight and take up space

Pressure decreases as altitude increases

Coriolis force

Baseball thrown off merry-go-round

Measurement of atmosphere pressure

Mercurial barometer

Aneroid barometer

Altitude and atmospheric pressure

1 in. for every 1000 feet

Altitude and flight

Performance decreases as altitude increases

Altitude and the human body

Some people can become oxygen impaired as low as 5000 feet.

Lack of oxygen can kill you.

Wind and currents

Wind patterns

Northern Hemisphere – wind flows to the right/clockwise rotation

Favorable winds can be found on the northern side of a high-pressure system or the southern side of a low pressure system.

Convective currents

Small pockets of bumpy rising air

Effect of obstructions on wind

Objects on ground can cause wind gusts.

Leeward side of the mountain is turbulent

Low-level wind shear

Passing storms and frontal systems

Microbursts can be up to 6,000 feet per minute.

Atmospheric stability

Inversion

Air acts as a lid.

Can cause poor visibility

Temperature increases as altitude increases.

Moisture and temperature

Amount of moisture is dependent on temperature.

Relative humidity

Amount of water vapor in the atmosphere

Temperature/Dew Point

Dew point = air can no longer hold moisture

Closer = clouds

Saturation point

Air temperature can drop to reach saturation point.

Cold and warm air can mix.

Air cools at night.

Clouds

Water vapor

Condensation Nuclei

Cooling

Dew and frost

Moisture condenses and can freeze.

Frost disrupts laminar flow.

Fog

Cloud on the surface

Radiation – Clear nights, no wind, caused by ground releasing heat and cooling

Advection – Warm moist air over a cold surface, needs wind, common near coast.

Upslope – Moist, stable air ascends mountain slope

Steam fog – Cold, dry air moves over warm water.

Ice fog – Water freezes into little tiny freezing clouds.

Ceiling

Lowest layer reported as broken or overcast (5/8)

Visibility

Greatest distance a pilot can see with naked eye

Precipitation

Often accompanied by low ceilings and bad visibility.

Air masses

Large body of air

Take on properties of source region

Fronts

Warm front

Poor visibility

Stable air

Stratiform clouds

Steady precipitation

Cold front

Good visibility

Unstable air

Cumuliform clouds

Showery precipitation

Wind shift

Frontal passage changes the wind.

Stationary front

Forces are equal

Occluded front

Thunderstorms

Hazards

Mircobursts

Turbulence

Hail

Updrafts and downdrafts

Avoid by 20 nautical miles.

Squall line

Associated with cold front

Tornadoes

Can be hidden (rain-wrapped)

Turbulence

Extreme danger in thunderstorms

Icing

Thunderstorms can create supercooled water that freezes on impact.

Lightning

Causes havoc with avionics

Questions for higher order thinking:

1. What would be your plan if you checked the weather and noticed a cold front approaching? What would you expect the weather to be like as it arrives?
2. Are we able to fly over the top of thunderstorms in small airplanes? Why or why not?
3. Why are we not crushed by the atmosphere simply by standing in it?
4. Why do clouds form in even layers?
5. Why is a sudden change in wind direction near the ground so dangerous for airplanes?

Closure: Weather is one of the most vital pieces of information to which a pilot has access. As a result, an understanding of the underlying theory and principles behind weather allows pilots and dispatchers to predict, to a degree, its intensity and flyability.

Material/Resources: *None*

Sources: *Chapter 11 – FAA-H-8083-25A Pilot’s Handbook of Aeronautical Knowledge*

Advisory Circular – AC 00-6A Aviation Weather

Reflections/Future Modifications:

09/10/2018

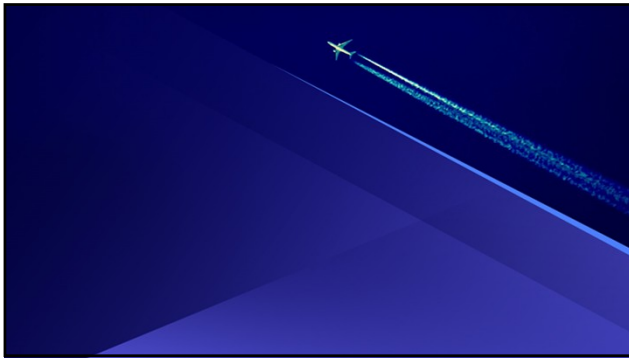
The class on this day was a bit of a challenge. As the course continued, this lesson was judged to be too complicated and needed to be scaled down. The presentation slides were slightly out of order and caused the lesson to be choppy. The presentation slides have been reworked and have been included with this revised lesson plan. In addition, the review worksheet was removed from the revised lesson plan, as time constraints will not allow a thorough lesson on aviation weather services.

While the class was engaged and attentive, the instructor felt as though concepts were not being properly built upon one another. Some blame may be placed due to the effort to force a massive amount of knowledge about a complex topic such as weather into two 30-minute class sessions. In reality, however, a more thorough review of the subject material by the instructor in the future will allow for a far smoother lesson.

09/12/2018

This day provided much more positive results than did the previous class session. The presentation was built to match the lesson plan and progressed very smoothly. The students struggled to understand most weather concepts for longer than a few minutes at a time, but certain topics (such as circulation in pressure systems) were seemingly drilled into their heads by the end of the period. However, the lesson did feel a bit rushed and should be taught with less tangents at a more efficient pace.

The experiment titled “Cloud in a Bottle” was a spectacular and resounding failure. During testing, the experiment worked perfectly. However, a cloud failed to appear during the class session. Infuriatingly, the cloud appeared no later than three minutes after the class was dismissed. This activity has been since removed from this lesson as a result.



Weather Theory

Course Presented by Jake Garrette, CFII.

Atmosphere

- 78% Nitrogen
- 21% Oxygen
- 1% Other Gases
- Ratio stays same as you climb, but density of air decreases.

Source of Weather



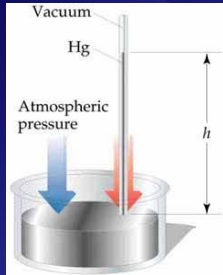
Pressure

- Air has mass, and therefore weight
- Large weight sitting on you.
- 14.7 lbs/in²
- 29.92 inches of Mercury.
- Source of wind.

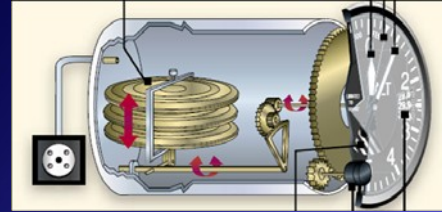
Coriolis Effect

- <https://www.youtube.com/watch?v=i2mec3vgeal>

Mercurial Barometer



Aneroid Barometer

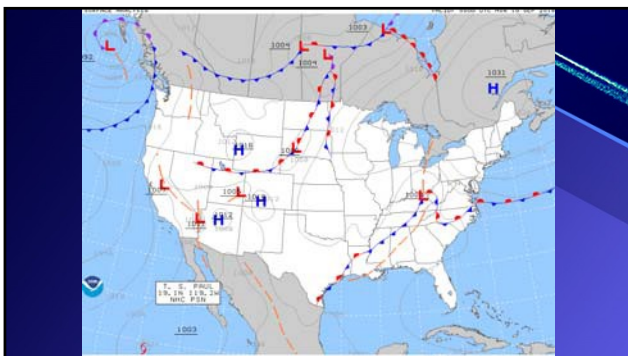


Oxygen

- Necessary for human life.
- Lack of oxygen is known as hypoxia
- Can occur as low as 5,000 ft.

Wind Flow

- High pressure systems flow clockwise (anticyclonic flow)
- Low pressure systems spin counterclockwise (cyclonic flow)
- When air is heated, it tends to rise.
- Sudden change in wind direction is known as wind shear.
- Caused by passing storms and frontal systems.



Stability

- Dependent upon moisture content (relative humidity).
- Relative humidity is dependent upon temperature.
- The more unstable the atmosphere, the more unevenly it cools.

Clouds and Dew

- Cloud development requires 3 things:
 - Moisture
 - Condensation Nuclei
 - Cooling
- Dew point plays a role in cloud height.
- Frozen dew (frost) can disrupt airflow over wings.

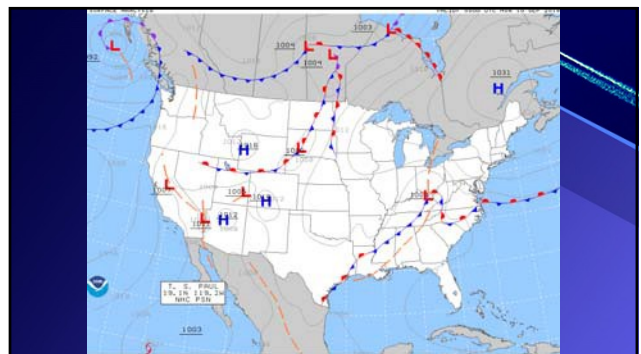


Air Mass

- Body of air with similar temperature and pressure properties
- Air masses tend to take on the properties of whatever terrain they are over.

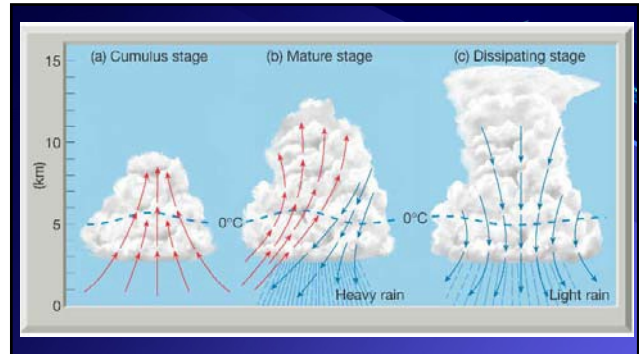
Front

- Boundary between two air masses
- Four types:
 - Warm
 - Cold
 - Stationary
 - Occluded



Thunderstorms

- Forms from cumulonimbus cloud
- Three stages:
 - Cumulus
 - Maturing
 - Dissipating



Dangers of Thunderstorms

- Hail
- Turbulence
- Icing
- Updrafts and downdrafts
- Microbursts
- Lightning
- Tornadoes

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/14/2018**

Lesson Title: **Weather Planning**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal
<i>Students shall develop an understanding of aviation weather services and aeronautical decision-making with regards to weather.</i>	<i>How do I go about finding appropriate information on weather? How do I use this information to determine whether to fly or not?</i>
Lesson Objective(s)	
<p><i>Students will be well-versed and able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Sources from which to obtain weather information</i> <i>2. Decision-making skills, including the concept of “go/no go” decision and personal weather minimums</i> 	
Terms and Definitions	
<i>ForeFlight Aviation Weather Center</i>	<i>Convective SIGMET</i>
Assessment/Evaluation	
<i>Students will participate in an experiential weather planning scenario, during which the students must safely complete the simulated mission.</i>	
Instruction	
<p><i>Set/Motivator: Discuss with the class the importance of receiving reliable, up-to-date weather, not only for aviation but also for daily life.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Sources of Weather Information</p> <ul style="list-style-type: none"> ForeFlight Highly popular service used by general aviation pilots everywhere. iPads have taken over the aviation world. Flight Service 1-800-WX-BRIEF Most reliable and up-to-date source of weather; available airborne or on ground. Aviation Weather Center Online weather service Multitude of charts, graphs, and forecasts 	

Prognostic Charts

Used to predict movements of fronts and pressure systems

Doppler Radar

Works by the radar waves bouncing off precipitation (echoes)

Excellent tool for locating and tracking thunderstorms

Activity: Experiential Weather Scenario – One student will be chosen to plan a simple flight between destinations chosen by the instructor. The student will then be blindfolded and placed in a rolling object to simulate an airplane (a swivel chair, for example). Other students in the class will take the roles of various forms of weather that will afflict the pilot along his or her route of flight. The instructor is encouraged to be creative in the ways weather is represented. For example, wind could be simulated by means of a leaf blower, rain by a spray bottle, or hail by ice dropped on the pilot. It is the instructor's responsibility to ensure proper safety for everyone involved and to take steps to ensure that no disruption to other students or classes is caused by the activity.

Closure: *Weather is one of the most vital pieces of information to which a pilot has access. As a result, an understanding of the information and services available allows pilots and dispatchers to make accurate judgments when determining the safety of any flight.*

Material/Resources: *Discretion of instructor*

Sources: *FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge*

FAA-H-8083-3A Airplane Flying Handbook

Chapter 7 Section 1 – Aeronautical Information Manual

Advisory Circular – AC 00-45G Aviation Weather Services

Advisory Circular – AC 61-84B Role of Preflight Preparation

FAA-8083-9A – Aviation Instructor's Handbook

Reflections/Future Modifications:

09/14/2018

The class was taught in one day, and the activity was judged to be a roaring success. Students were quick to volunteer and found the activity both amusing and educational.

Due to the complexity surrounding aviation weather services and time constraints, this lesson was heavily scaled down and simplified in terms of weather service information. It was deemed by the

instructor that a better educational experience could be achieved by full participation in the activity rather than continued lecture. In addition, an introduction to proper flight planning and aeronautical decision-making ability was deemed more informative and helpful and could be accomplished by way of the “Experiential Weather Scenario.” This activity is considered by the instructor to be a staple for this curriculum and clearly accomplishes the project’s goal of providing an eye-opening and enriching experience for young aviation students.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/17/2018**

Lesson Title: **Aviation Physiology**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<i>Students will gain a basic understanding of factors affecting the human body during flight.</i>		<i>What medical effects does a pilot experience in flight? What are some health hazards to pilots? How can a pilot become disoriented?</i>
Lesson Objective(s)		
<i>Students will be well-versed and able to recall the following topics with respect to aviation:</i>		
<ol style="list-style-type: none"> 1. <i>Load factor and G-loads</i> 2. <i>Hypoxia and its cause</i> 3. <i>Hyperventilation and its cause</i> 4. <i>Vestibular system and spatial disorientation</i> 5. <i>Visual illusions</i> 6. <i>Fatigue</i> 		
Terms and Definitions		
<i>Load factor</i>	<i>Vestibular System</i>	<i>Fatigue</i>
<i>G</i>	<i>Inner Ear</i>	<i>Decompression Sickness</i>
<i>Hypoxia</i>	<i>The Leans</i>	
<i>Hyperventilation</i>	<i>Motion Sickness</i>	
Assessment/Evaluation		
<i>Students will demonstrate understanding of the concepts presented by participating in class discussion, with 75% of the students correctly answering the instructor's questions.</i>		
Instruction		
<p>Set/Motivator: <i>Show video embedded in provided presentation slides.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>Load Factor Ratio of Lift/Weight Measured in "Gs" 1 G is what students are feeling right now.</p> <p>Hypoxia Lack of oxygen to the brain 4 Types Hypoxic Hypemic Stagnant Histotoxic</p>		

Symptoms

- Blue limbs
- Headache
- Impaired judgment and drowsiness
- Visual impairment
- Euphoria and lightheadedness
- Tingling in fingers and toes

Hyperventilation

Too little carbon dioxide

Symptoms

- Rapid breathing
- Other symptoms similar to hypoxia

Spatial Disorientation

Motion sickness is simply your brain receiving mixed signals from your senses.

The Leans

- Inner ear fluid in vestibular system can settle while in a turn.
- Forces you to feel as if you are turning while straight and level.

Activity: Sensory Confusion: One student will be blindfolded and deafened and rendered spatially disoriented using a chair.

Fatigue

Dangerous due to the lack of recognition until it's too late. No amount of flight training in the world will prevent danger associated with fatigue.

IMSAFE Checklist

Questions and/or activities for higher order thinking:

1. How does a jet fly so high if the air isn't breathable?
2. Why should a passenger on an airliner put his/her oxygen mask on first instead of their child's? (Show movie scene from *Four Christmases*)
3. Why does breathing into a bag help relieve hyperventilation?
4. Why do fighter pilots black out when exposed to excessive G-forces?
5. What should you do if you find yourself spatially disoriented?

Closure: The physiological effects of flight on a human body are profound and dangerous if misunderstood. Those involved in aviation should take great care in order to understand and recognize hazards associated with hypoxia, hyperventilation, and spatial disorientation.

Material/Resources: *Included in Lesson Plan Packet*

Sources: *Chapter 16 – FAA-H-8083-25A Pilot's Handbook of Aeronautical Knowledge*

Reflections/Future Modifications:

09/17/2018

This lesson was covered in a single class period with some difficulty. While the instructor considered the source material to be a bit dry, the students became engaged in the subject like never before. Topics observed among the students as the most interesting included the effects of load factor on the body and weightlessness. Students were sharing experiences of witnessing fighter jets at air shows, explaining concepts from undersea dives in which they had participated, and debating the causes of zero gravity in space. The instructor had to press ahead with the lesson several times in order to finish (and felt quite rushed in the process).

Several activities were left out due to time constraints and student discussion, but the instructor felt the lesson accomplished its objectives by introducing students to some common medical factors affecting aviators. In addition, the instructor was quite pleased with the amount of student participation in this lesson. Some credit may potentially be given to the “Experiential Weather Scenario” activity, where students were seen warming up both to the instructor and to each other.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/21/2018**

Lesson Title: **National Airspace**

Grade/Level: **9-12**

Curriculum Standards		Central Focus Question/Big Idea/Goal
<p><i>Students shall develop an understanding of the United States National Airspace System, including types, uses, and regulations of airspace, along with the concept of air traffic control.</i></p>		<p><i>How do planes avoid each other with no highways in the sky? How do so many airplanes get into the large airports safely? How much authority does air traffic control possess? How do pilots know which areas are off limits?</i></p>
Lesson Objective(s)		
<p><i>Students will be able to recall the following:</i></p> <ol style="list-style-type: none"> <i>1. Categories of airspace</i> <i>2. Classes of airspace and their corresponding dimensions</i> <i>3. Special-use airspace</i> <i>4. Air traffic control purpose and function</i> <i>5. Airspace designations on sectional charts</i> 		
Terms and Definitions		
<i>Controlled Airspace</i>	<i>Class B Airspace</i>	<i>Prohibited Airspace</i>
<i>Uncontrolled Airspace</i>	<i>Class C Airspace</i>	<i>Temporary Flight Restriction</i>
<i>Class G Airspace</i>	<i>Military Operating Area</i>	<i>Air Defense Identification Zone</i>
<i>Class E Airspace</i>	<i>Warning Area</i>	<i>Air Traffic Control</i>
<i>Class D Airspace</i>	<i>Alert Area</i>	<i>Air Route Traffic Control Center</i>
<i>Class C Airspace</i>	<i>Restricted Airspace</i>	<i>Terminal Radar Approach Control</i>
Assessment/Evaluation		
<p><i>75% of students shall demonstrate a basic understanding of the national airspace system by active participation in group discussion and correctly answering the instructor's questions.</i></p>		
Instruction		
<p>Set/Motivator: <i>Show video of National Airspace System function.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <p>National Airspace System Network shared jointly by the FAA and military</p>		

Categories of Airspace

Controlled

Air traffic control exercises authority.

Different classes of airspace require different radio requirements and equipment.

Uncontrolled

Air traffic control has no authority.

Classes of Airspace

Class G

Only civilian uncontrolled airspace

Lightest weather minimums.

Usually lowest airspace underneath all the others

Class E

Most low-level airspace in the U.S. is Class E.

Goes up to 18,000 ft. above sea level

Controlled, but don't need a radio if flying in visual conditions

Higher weather minimums than Class G

Class D

Controlled – usually surround smaller airports with control towers.

Goes out 4 nm from airport

Must contact controller to enter airspace.

Class C

Controlled – usually around airports with regularly-scheduled flights (Nashville)

Goes out 10 nm from airport

Must contact controller and be equipped with Mode C transponder (position and altitude equipment) to enter airspace

Class B

Controlled – usually surround busiest airports in the country (Atlanta, Chicago, Memphis, etc.).

Airspace is tailor-designed to airport's needs.

Must have a Mode C transponder and clearance from controller (not just making contact) to enter airspace.

Student pilots are very restricted when operating in this airspace.

Class A

Controlled – VFR pilots not allowed in this airspace

High-level airspace. Starts at 18,000 feet

Must be on an IFR flight plan

Used for efficient travel of jets

Special Use Airspace (MCWRAP)

Military Operating Area

Controlled Firing Area

Not on sectional chart

Warning Area

Restricted Area

Not allowed in without permission from controlling agency.

Alert Area

Prohibited Airspace

National Mall in Washington D.C.

Other Airspace

Temporary Flight Restriction

Popular after 9/11

Used to protect things such as large gatherings, political figures, and Disney World

Pilots are responsible for knowing where these are.

National Security Area

Air Defense Identification Zone

12 nm off of coast of U.S.

Will be intercepted if you cross this without permission

Air Traffic Control

Responsible for safe flow of traffic across U.S. and the world

U.S. air traffic controllers are federal employees.

Use radar and are slowly switching to GPS system.

Air Route Traffic Control Center

Terminal Radar Approach Control

Busiest section for controllers and regarded as most stressful

Note: This lesson can be taught most effectively in a community setting gathered around a aeronautical map. For example, students may elect to post a map (or an image of one) on a board and discuss distinguishing features located on it. A lesson in this format using a government-issued sectional chart will cover the topics in this lesson.

Questions for higher order thinking:

1. In which classes of airspace can you fly without using a radio?
2. If the speed restriction lifts after 10,000 ft. MSL, what do you think happens to the weather minimums?
3. Why does the FAA activate TFRs over open-air stadiums during game days?
4. What would happen to ATC's ability to locate an aircraft on radar if a mountain was between the aircraft and the radar scope?
5. What relatively new system do you think could eliminate this phenomenon?

Closure: The National Airspace System is complicated, but it is essential to the daily safe and efficient operation of a large amount of both civilian and military aircraft.

Material/Resources: *Included in Lesson Plan Packet*

Sources: *PHAK Chapter 15*

Reflections/Future Modifications:

09/21/2018

This day's lesson was a large success. The instructor has noted that the interest and curiosity of the students with regards to the curriculum has steadily increased. Students were asking relevant, insightful questions that demonstrated their interest in the subject being taught.

The instructor was quite pleased with the method in which this lesson was conducted. The communal atmosphere generated by the students gathering around and studying a map made for an intimate and involved educational experience. Students are shown to be highly responsive to instruction when given unique, hands-on lessons such as this one.

THE WORLD OF AEROSPACE

Name: **Jake Garrette**

Date Revised: **09/28/2018**

Lesson Title: **Aviation Qualifications**

Grade/Level: **9-12**

Curriculum Standards	Central Focus Question/Big Idea/Goal	
<i>Students will gain a basic understanding of the training required for each type of pilot certificate, dispatch certificate, and maintenance certificate by gaining a thorough knowledge of federal regulations pertaining to each.</i>	<i>How do I become a pilot? How long does it take? What if I want a career in aviation that does not involve flying an airplane?</i>	
Lesson Objective(s)		
<i>Students will be well-versed and able to recall the following:</i>		
<ol style="list-style-type: none"> <i>1. Legal requirements and processes to obtain pilot certificates</i> <i>2. Legal requirements and processes to obtain maintenance certificates</i> <i>3. Legal requirements and processes to obtain dispatch certificates</i> <i>4. Legal requirements and processes to become an air traffic controller</i> 		
Terms and Definitions		
<i>Private Pilot Certificate</i>	<i>Flight Instructor</i>	<i>Airframe and Powerplant Ratings</i>
<i>Instrument Rating</i>	<i>Certificate</i>	<i>Aircraft Dispatcher Exam</i>
<i>Commercial Pilot Certificate</i>	<i>Airline Transport Pilot Certificate</i>	<i>Air Traffic Control Specialist</i>
<i>Multi-Engine Rating</i>	<i>Checkride</i>	
	<i>Mechanic's Certificate</i>	
Assessment/Evaluation		
<i>Students will demonstrate understanding of the concepts presented by participating in class discussion, with 75% of the students correctly answering the instructor's questions.</i>		
Instruction		
<p>Set/Motivator: <i>Show video embedded in provided presentation slides.</i></p> <p>Carousel (Word Bomb/Brainstorm): <i>4 large sticky notes/posters are placed around the classroom, labelled "Pilot," "Dispatcher," "Aircraft Mechanic," and "Air Traffic Controller." Students will walk around for 4-5 minutes at the beginning of the lesson, writing what they know about each career path.</i></p> <p>Instructional Procedures/Learning Tasks:</p> <ol style="list-style-type: none"> I. Private Pilot Certificate (Source: PHAK – Ch. 1) <ol style="list-style-type: none"> a. Find an instructor and/or flight school and apply for a Student Pilot Certificate. b. Obtain a 1st, 2nd, or 3rd class medical certificate. <ol style="list-style-type: none"> i. Private Certificate only requires 3rd Class. 		

- ii. MTSU requires 2nd Class.
 - c. Pre-solo flight training
 - i. Learning to take off and land
 - ii. Basic maneuvers
 - iii. Pre-solo Knowledge Test
 - d. Solo
 - i. Signed off by instructor
 - ii. Includes flights to other airports (cross-country flights)
 - e. Conclusion
 - i. Knowledge test
 - 1. Written exam
 - ii. Checkride
 - 1. Oral and practical exam
- II. Instrument Rating (Source – IFH)
 - a. Allows pilot to fly in bad weather
 - i. Every airline pilot has instrument rating.
 - b. Training can be done by instrument instructor
 - c. Conclusion
 - i. Knowledge test
 - ii. Checkride
- III. Commercial Certificate (PHAK 1-18)
 - a. Allows pilot to fly for compensation or hire
 - b. Conclusion
 - i. Knowledge test
 - ii. Checkride
- IV. Multi-Engine Rating (Source: FAR 61)
 - a. Needed to operate aircraft with more than one engine
 - b. Conclusion
 - i. Checkride
- V. Airline Transport Certificate (PHAK 1-18)
 - a. Required to fly for an airline.
 - b. Must have 1,500 hours of flight experience
 - i. 1,000 if graduated from MTSU (Restricted ATP)
 - c. Conclusion
 - i. Knowledge Test
 - ii. Checkride
- VI. Flight Instructor Certificate (FAR 61)
 - a. Allows one to act as a Certified Flight Instructor
 - b. Conclusion
 - i. Two knowledge tests
 - ii. Checkride
 - iii. Certificate expires after 2 years
- VII. Mechanic’s License (Source – faa.gov)
 - a. Airframe and Powerplant Ratings
 - i. 30 months’ experience working as an intern OR FAA Training Program
 - 1. MTSU is FAA-Approved Aviation Maintenance Technician School

ii. Conclusion

- 1. Written exam**
- 2. Oral exam**
- 3. Practical exam**

VIII. Repairman's Certificate (Source – faa.gov)

- a. Need recommendation from repair station and 18 months' experience there**

IX. Aircraft Dispatcher (Source – Sheffield School of Aeronautics)

- a. Must be 21 years old to take exam**
 - i. 23 to receive certificate**
- b. Conclusion**
 - i. Written exam**

X. Air Traffic Control Specialist (Source – faa.gov)

- a. Regulate traffic across U.S.**
- b. Must be under 30 to be hired**
- c. Work for federal government**
- d. Toughest requirements of all aviation**
- e. Must be willing to travel and relocate**
- f. MTSU Collegiate Training Initiative gives early training to those wanting to become controller.**

Questions and/or activities for higher order thinking:

1. What pilot certificates/ratings should you pursue if you are planning to fly locally for fun? What about for a career?
2. Can you become an aircraft mechanic with just a few month's training? Why or why not?
3. What is considered the most difficult aviation career for which to qualify?
4. What are the safety repercussions if mechanic training requirements were less strenuous? Air traffic controllers? Pilots?
5. Why do you think the FAA requires very strict age requirements for dispatchers? Air traffic controllers?

Closure: Pilots, mechanics, dispatchers, controllers, and many other occupations must all cooperate to ensure a safe aviation industry and national airspace system. As a result, there are strict regulations and procedures to follow to become qualified for any one of these positions. Talking to an instructor, mechanic, dispatcher, or controller yourself will greatly help reduce confusion and stress when you are getting ready to begin your aviation journey.

Material/Resources: *None*

Reflections/Future Modifications:

09/28/2018

The very last lesson in the course was a bit dry to the students but was extremely necessary in order to convey information about the future. While the instructor did not see any students take immediate interest in the prospect of a future aviation career, he was impressed with the interest and inquisitiveness shown by the students. At the end of the course, the students have relaxed and have shown both a fascination and a genuine curiosity to the workings of the industry.

Due to time constraints, the opening activity was omitted. It should, however, be used at the beginning of this class session in order to bring energy into an admittedly dry subject area for any student not immediately interested in a career in aviation.

Final Analysis of Course

Overall, the students appeared to gain much information and experience from the curriculum. The students, each of whom personally selected to take the course, were initially reluctant to participate and quite quiet in class. By the course's conclusion, however, most of the students had greatly warmed to the instructor and were eager to discuss the topics and subjects taught during the lessons, with many students sharing their respective knowledge and personal experiences.

The most effective activities were the ones with direct student involvement. In the instructor's opinion, lecture has a place, of course, but should be combined with experiential and hands-on activities in order to foster student interest, engagement, and participation. A good instructor will ideally adapt this course to fit his or her needs, gauging student personalities and the instructor's own strengths and weaknesses in order to craft a satisfying, informative, and exciting educational experience.