TOPIC

Engineering & Design – Aerospace Engineering, Advanced Manufacturing

LEARNING OBJECTIVES

- Learn the basic structure of commercial and military aircraft.
- Learn to optimize the design of the aircraft based on design criteria.
- Topics include standards-based content.

CONTENTS OF THIS GUIDE

In the PlaneWorks CAD activity, students learn about aerospace engineering & design and advanced manufacturing. This is a great activity for those exploring STEM content or for career exploration. The activity allows students to build various kinds of aircraft within a CAD program. Once they've built viable aircraft they can compete for clams in Olympics challenges against other Whyvillians.

The activity is a simulation of a CAD software application. Students can build a variety of aircraft including airliners, business jets, and fighter jets. Students piece together components of the aircraft until they have a completed model. They have the option to alter design specifications of the aircraft including fuel capacity, passenger capacity, and number of engines. They can also augment the materials used in the aircraft - from simple wood to exotic alloys. The simulations uses real airplane lift formulas to determine whether these modifications will allow the plane to fly. If the design passes initial tests, students can visit the Olympic Events and race their custom aircraft against other Whyvillians' designs. If they win, they'll get fifty clams!

MATERIALS

- Properly configured computers. See our Technical Guide for more information.
- Student handout for daily grade, included in this lesson plan.

WHAT TO DO BEFORE CLASS

1) Watch the associated WhyPak video *CAD & PlaneWorks Olympics Walkthrough*.
2) Navigate through Whyville and find the CAD & Olympics activity within the PlaneWorks.
3) Browse through the content and determine whether additional content is needed, based on your particular class's needs.
4) Play through the game and design a few aircraft. Try to run one of them at an Olympic event.
5) Detailed game instructions can be found by clicking on **More instructions** at the bottom of the introductory paragraph on the CAD webpage.
6) Skim through the attached worksheet. Decide if it is applicable for your class.

SAMPLE LESSON OUTLINE

1) Conduct a short class discussion on what the students know about aircraft, their components, and how design criteria (such as fuel capacity) impact the design of aircraft. Hand out the student worksheet. [Recall]
2) Have your students log into Whyville, direct them to PlaneWorks and then to the CAD activity.
3) Have the students read through **More instructions** at the bottom of the introductory paragraph on the CAD webpage. Let them begin to design, test, and save their aircraft designs. [Explore]
4) Conduct a short class discussion on what the students learned about designing aircraft. What factors impacted their designs? What caused their designs to fail during testing? [Reflect]

WhyPaks Lesson Guide Framework

Recall – Ask the students what they already know about the subject.

Explore – The students self-direct themselves through the activity. Teacher facilitates.

Reflect – Refine the students' understanding by using directed inquiries.

Accomplish – The students are presented with a goal to achieve.

Connect – Connect what was learned to standards-based content.

5) Have students design and save an aircraft of each type. They'll receive a salary bonus for each successful design. Encourage them to think critically about their designs. How can they augment their designs to achieve the challenge criteria presented at the Olympic Events? [Accomplish]
6) Have students complete the attached worksheet for a daily grade. [Connect]

WHERE TO NEXT? RELATED CONTENT WITHIN WHYVILLE

SUBJECT MATTER	WHYVILLE DESTINATION
Advanced Manufacturing	PlaneWorks – Wing Fling, Dell Plaza – Dell Laptop Game
Aerospace	WASA
Engineering & Design	WASA – Rocket Launch, WASA – Ion Engine Game, WhyPower - Power Planner, WhyPower – Green Build, House Builder, Robodome

Next Generation Science Standards (NGSS)

NGSS Subcategory	*Standard ID*	*Standard Description*
Interdependence of Science, Engineering, and Technology	MS-PS1-3	Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.
Analyzing and Interpreting Data	MS-PS1-2	Analyze and interpret data to determine similarities and differences in findings.
Constructing Explanations and Designing Solutions	MS-PS1-6	Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
Constructing Explanations and Designing Solutions	MS-PS3-3	Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.
Engaging in Argument from Evidence	MS-LS2-5	Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
Engineering Design	MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Engineering Design	MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Engaging in Argument from Evidence	MS-PS3-5	Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

NGSS Subcategory	*Standard ID*	*Standard Description*
ETS1.A: Defining and Delimiting Engineering Problems	MS-ETS1-1	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.
ETS1.B: Developing Possible Solutions	MS-ETS1-4	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
ETS1.B: Developing Possible Solutions	MS-ETS1-2, MS-ETS1-3	There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
ETS1.B: Developing Possible Solutions	MS-ETS1-3	Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
ETS1.C: Optimizing the Design Solution	MS-ETS1-4	The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
ETS1.C: Optimizing the Design Solution	MS-ETS1-3	Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.

Common Core – ELA: Science and Technical Subjects (CC-ELA)

CC Subcategory	*Standard ID*	*Standard Description*
Writing for History/Social Studies, Science and Technical Subjects	WHST.6-8.1	Write arguments focused on discipline content.

CC Subcategory	*Standard ID*	*Standard Description*
Writing for History/Social Studies, Science and Technical Subjects	WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
Speaking & Listening	SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
Speaking & Listening	SL.8.1.c	Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.

Texas Essential Knowledge & Skills (TEKS)

TEKS Category	*Chapter*	*Standard ID*	*Standard Description*
CTE – Career Portals	127.4	1.A	The student explores one or more career clusters of interest. The student is expected to: (A) identify the various career opportunities within one or more career clusters.
CTE – Career Portals	127.4	2.A	The student explores pathways of interest within one or more career clusters. The student is expected to: (A) investigate career opportunities within the pathways.
CTE – Exploring Careers	127.3	4.A	The student evaluates skills for personal success. The student is expected to: (A) implement effective study skills for academic success.
CTE – Exploring Careers	127.3	4.C	Use a problem-solving model and critical-thinking skills to make informed decisions.
CTE – Exploring Careers	127.3	4.D	Use effective time-management and goal-setting strategies.
CTE – Exploring Careers	127.3	4.E	Effectively use information and communication technology tools.

TEKS Category	*Chapter*	*Standard ID*	*Standard Description*
CTE – Exploring Careers	127.3	7.E	The student develops skills for professional success. The student is expected to: (E) explore and model characteristics necessary for professional success such as work ethics, integrity, dedication, perseverance, and the ability to interact with a diverse population.
CTE – Exploring Careers	127.3	7.F	Complete activities using project- and time-management techniques.
CTE – Exploring Careers	127.3	8.A	The student identifies and explores technical skills essential to careers in multiple occupations, including those that are high skill, high wage, or high demand. The student is expected to: (A) complete actual or virtual labs to simulate the technical skills required in various occupations.