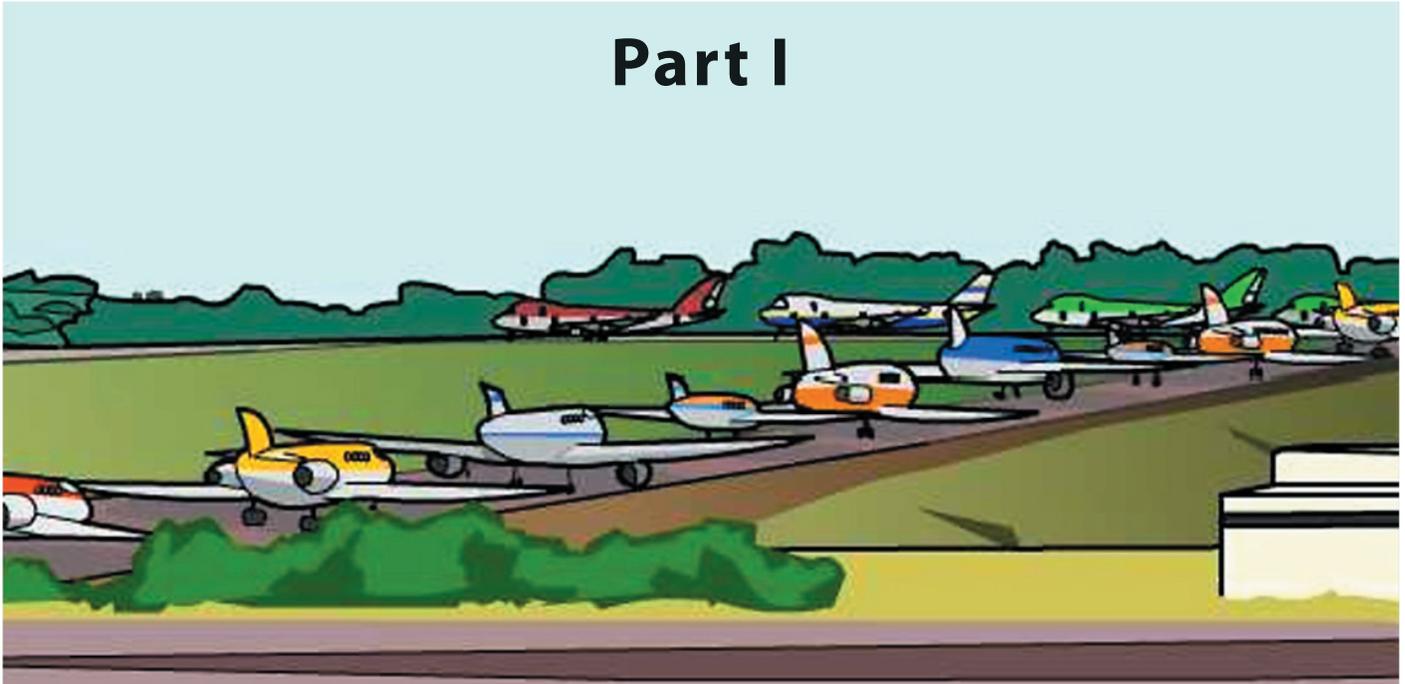


Future Flight Design

Part I



AIR TRANSPORTATION PROBLEM

I Introduction

Welcome to Future Flight Design! In this program, you will become a NASA researcher and, with your team, design the air transportation system of the future! When cars were invented, scientists and engineers had to design a ground transportation system with roads and traffic rules. A similar system was designed for air transportation. With more people traveling by air than ever before, your challenge is to improve this system for the future!

Start by watching the introduction movie at: <http://futureflight.arc.nasa.gov/intro.html> that shows the problems with air travel today. Then, click on to The Air Transportation Problem (<http://futureflight.arc.nasa.gov/capacity.html>). Here you will learn more about the problem and find the tools you need to conduct research.

This design log is a record of your progress at each step of the Future Flight Design program. Your teacher may use portions of this log to evaluate your work. Be sure to keep it with you as you conduct your research and take good notes!



STEP 1

Letter from NASA



Dear Students:

NASA is asking for your help to solve an air transportation problem.

- Crowded roads make it difficult to get to the airport.
- At the airport, flights are often delayed. Current runways and air systems can't handle the growing number of people and goods that need to travel by air.

Do the research and come up with a solution to the air transportation problem. Your solution must protect the environment from noise and other sources of pollution.

Good luck and thank you for your assistance in solving this problem.

NASA Official



STEP 2 Get a Team Together

Now that you have agreed to assist NASA, get your team together.

Write down the names of the members of your team:

1. _____
2. _____
3. _____
4. _____
5. _____



STEP 3 Discuss the Air Transportation Problem

B Background

What is the maximum number of people that can drive on our streets at one time? How about the maximum number of people and cargo that can be in the air at the same time? Can these numbers be increased? Sound difficult? Well, the solutions will make a big difference in our future air transportation system.

When we talk about the “maximum number a system can handle at a time” we are talking about “capacity.” The capacity of our air transportation system is a major challenge that both NASA and the Federal Aviation Administration (FAA) are looking at together.



Why is this a big focus? The current air transportation system is already running at its maximum capacity. The FAA predicts that the demand for air traffic will triple in the next 20 years, as a growing population will need to move themselves, their mail, and other cargo across the United States. So, the question is, how will this system be able to increase its capacity?

In order to answer that question, we need to look at the kinds of things that determine the capacity of our air system. The number of people and amount of cargo that can be in the air at one time depends on a number of factors including the size of aircraft, the number and length of runways, and the amount of space required between flights on runways and in the air. Bad weather can also affect capacity, often lowering it, as runways or whole airports are shut down. Finally, it’s important to consider how the current system is organized to see if a different organization might increase capacity.



T Teams and Roles

STEP 4 Select a Role

Before you begin your research, each team member will select a different role. As you conduct your research, think about the kinds of information that might be important to your role.

Roles

Read the biographies that are posted at the Future Flight Design Web site and the descriptions of the roles. The descriptions are also included below.

Meteorologist

A meteorologist gathers information about the weather, and looks for clues about how weather behaves. They use this information to predict the weather. Meteorologists give advice to air traffic control and other groups about weather dangers such as thunderstorms, turbulence, tornadoes, icing, flooding and flash floods. They give weather warnings for road, air and water vehicles to various government groups and the public. They use complex computer software programs to model the strength and movement of storms. Meteorologists also do research projects that help make better weather predictions.

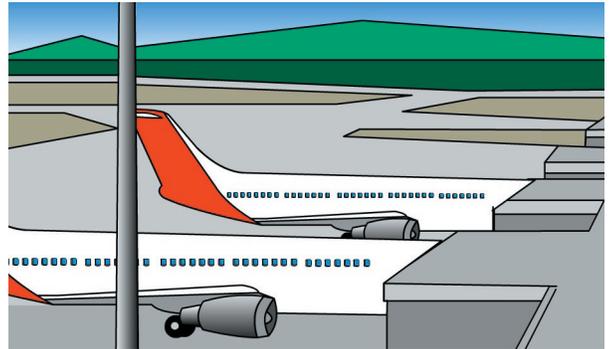
Human Factors Researcher

Human factors researchers do studies to help make flying safer for pilots and passengers. Researchers study how pilots work with cockpit controls and how they are affected by loss of sleep on long flights. They also study how air traffic controllers react to being stressed out, tired, or bored.

Researchers use the scientific method. They make hypotheses, set up experiments to test their hypotheses and come up with explanations. Some studies happen over a long period of time, while others take a few weeks, days, or hours. Researchers must be good observers who take excellent notes. They need fine writing skills so they can write reports. The results of human factors research improve the design of cockpit controls and planning of long flights so that pilots and air traffic controllers can be rested and alert.

Computer Software Engineer

A software engineer writes the software that is used to help air traffic controllers. This software gives people information and advice, performs repetitive tasks, or actually controls a system or part of a system. The computer software has the instructions that tell the system what to do. The first job of a software engineer is to understand the tasks that are going to be done by the computer. Then, a systems analyst decides how the software can help or improve how those tasks are done. After that, the software engineer (usually working in a team) creates programs to do those tasks. The software engineer tests the system to make sure it works the way it is supposed to work.



Research Pilot

Usually, research pilots are experienced pilots and aeronautical engineers with an excellent knowledge of how an aircraft works. They use these skills to develop new aircraft ("X" planes) or to write flight and aircraft design rules. They share what they've learned over the years to help develop safer and faster aircraft.

Research pilots fly new aircraft in tests. During these tests, they observe how the aircraft reacts to different tests and how easy it is for them to interact with the machine. For each hour in the air, the research pilot spends many more hours on the ground writing detailed reports about the flight test. Some of this ground time is also spent in flight simulators testing everything from new software programs to new cockpit controls.

Pilots must be able to give information clearly in order to make a new design successful. The pilot must talk with the team of researchers working on each project often. Test pilots also help to write technical papers for government groups, companies and aeronautical engineers.

Civil Engineer

Civil engineers design and manage the construction of roads, buildings, airports, tunnels, dams, bridges, and water supply and sewage systems. Many civil engineers hold jobs such as managing a construction site or working as a city engineer. Others may work in design, construction, research, or teaching. Often civil engineers help to develop designs for new construction. Others work for some form of government or industry. Some of their work requires them to be at construction sites. Sometimes travel is required.

Senior Airport Planner

This work includes managing people and information. A senior airport planner reviews papers such as Airport Master Plans to make sure that they follow all environmental and safety laws. (An Airport Master Plan includes airport drawings and descriptions.) It is especially important for airport planners to read these plans carefully to make sure they follow the National Environmental Protection Act. The planner must tell airport leaders when groups have questions about changing or making additions to an airport. They also give government money to approved airport projects.

Airline Flight Planner

Airline flight planners work for airline and aircraft companies. Flight Planners understand weather charts and weather maps, and can read aeronautical charts. They use these skills to gather data to plan the many flight routes that aircraft for their company will be flying that day. Their flight plans must include the airplane's route, updated weather data, airspeed, and departure and arrival times.

Airline Pilot

One of the careers you might know about is a pilot. You've probably heard of pilots that fly aircraft with people and cargo. Did you know that pilots also fly aircraft for, police work, search and rescue missions, checking traffic, fire fighting and spreading pest killer on farms? A pilot's duties include much more than climbing aboard and flying the airplane. Pilots must check weather conditions and plan a safe route. The pilot then flies the aircraft according to the flight plan with help from air traffic control.



Most airline pilots are given a weather report and then handed a prepared flight plan. They must review the weather data and flight plan carefully before they leave the gate. Before the flight, the pilot must check the aircraft completely to make sure that all systems are working properly and that all the electrical equipment and flight controls and parts are working correctly. During the flight, pilots check their progress and talk with air traffic control on the ground. After the flight, the pilot fills out the paperwork for the flight and closes out the flight plan.

Aeronautical Engineer (also known as Aerospace Engineer, Mechanical Engineer, Aviation Systems Engineer)

Aeronautical engineers design, develop, test and manage the building of aircraft, aircraft propulsion systems, aircraft structures and parts. When designing a new aircraft, engineers first decide on its purpose. Based upon research that has already been done and the design guidelines, aeronautical engineers design a first model. They figure out how to test the model and then run the test using a small team of experts. The engineer then studies the results and writes a report. In this report, the engineer gives advice on whether the design should be continued as is, should be changed a little, or totally redesigned. The research is done in an office building or lab using very fast computers and complex software. Models can be tested in a wind tunnel or “flown in a computer” using complex software that helps to see how the air moves around the aircraft. Aeronautical engineers spend a lot of time studying information, doing math, using computers and talking about designs with others.

Air Traffic Controller

Air Traffic Specialists use radar, graphs, pictures and radio communications to watch and direct air traffic. It is their job to make sure air traffic flows smoothly, quickly and safely through the air.

Some controllers work from airport control towers. They watch the movement of aircraft and give instructions to pilots for takeoff, landing and moving on the ground at an airport. They give pilots current weather information. One important task they have is to make sure there is enough room between aircraft that are taking off and landing at the airport.

Other air traffic controllers are located at Centers. Centers control larger airspaces along aircraft routes, once aircraft have left the airport. These air traffic controllers provide weather information, watch movement of aircraft, and give instructions to pilots who enter the airspace around their Center.



W What You Need to Know

STEP 5 Write Down What You Need to Know

NASA has collected several articles, videos, and animations for your research team. These contain information and ideas that will help you think of creative ways to increase the capacity of our air transportation system. You have already made a list of the problems with the current system. What can you find out about these problems that will help you devise a solution?

Brainstorm a list of questions that you can research. Here are some questions to get you started—add other questions as you think of them. As a team, assign at least five questions appropriate for each role to research including at least one of your own.



Airports

- What causes delays at airports?
- What is the hub and spoke model?
- How are the routes of airplanes set?
- How do people decide where to build airports?
- What are the factors to consider when building a new runway?
- How many small airports are there in the US, and how are they being used?
- Are there different kinds of runways used for different aircraft?

Flights

- How do commercial airlines know where they can fly?
- What does an air traffic controller do?
- What does the air traffic controller do when there is a storm that might affect aircraft in the area?
- How does weather affect an aircraft's flight?
- Can pilot change routes in flight?
- How do safe distances affect how many aircraft can take off or land at one time?

Aircraft

- How far can a small aircraft fly without having to land and refuel?
- How many passengers can fit in a small plane?
- What types of aircraft require short runways? Long runways?
- What types of aircraft require no runways?



Human Factors

- Can airplanes fly without a pilot?
- What is the role of the co-pilot?
- What issues do air traffic controllers face?
- What tools can help air traffic controllers?
- What causes stress and tiredness?
- What can be done to help stress and tiredness?

Other Questions:

My Role: _____

My Questions:



S Solutions

Now that each team member has done individual research, it is time to work together to brainstorm one or more solutions. Later, you will plan a presentation to give in front of an Air Transportation Committee.

STEP 7 Discuss Your Solutions

Each team member should take a few minutes to summarize his or her research findings for the group. Take time to discuss how this information can be used to come up with a solution. While discussing your solutions, keep in mind that solutions must be based on your research, should solve one or more problems in today's air transportation system, and should be environmentally friendly.

Remember, there is no perfect solution. Every solution involves trade-offs. A trade-off is when you have to give up something to get something else. For example, in order to make a car faster, it might have an engine that uses more fuel, making it more expensive to drive. The trade-off is paying more money and creating more pollution in order to have more speed. What are the trade-offs for your solutions? Use the table below to list your solutions and the trade-offs that have to be made in carrying out your solution.

Solution	Trade-off



STEP 8 **Create a Presentation**

You and your team are going to present your results to an Air Transportation Committee who will evaluate your work. Each committee member will be evaluating your presentation according to this rubric. You will also have to provide an abstract of your presentation that will be used by the committee.

4	<ul style="list-style-type: none"> • The poster/presentation clearly and accurately describes two or more solutions, how it solves the air transportation problem, addresses trade-offs for each solution, and is backed up with facts from research. • The poster/presentation is creative and persuasive and has accurate and clear descriptions and illustrations that match the solution and make it easy to understand.
3	<ul style="list-style-type: none"> • The poster/presentation clearly and accurately describes one or more solutions, how it solves the air transportation problem, addresses at least one trade off, and is backed up with facts from research. • The poster/presentation is persuasive and has clear descriptions and illustrations that match the solutions.
2	<ul style="list-style-type: none"> • The poster/presentation is not completely clear or accurate in describing a solution, how it solves the air transportation problem and may be missing trade-offs for each solution, or is not backed up with facts from research. • The poster/presentation lacks organization. Illustrations or descriptions are a difficult to read or do not match the solutions.
1	<ul style="list-style-type: none"> • The poster/presentation is not clear or accurate in describing a solution, how it how it solves the air transportation problem, is missing trade-offs for each solution, and is not backed up with facts from research. • The poster/presentation is incomplete, lacks organization, readability, or does not contain illustrations or descriptions

You may want to divide the following tasks among team members:

- Collect graphics, charts, visuals and captions to go with solutions
- Organize solutions and their trade-offs
- Write presentation abstract
- Proofread and edit solutions, trade-offs, and abstract
- Assemble poster/presentation
- Check to make sure presentation meets rubric requirements
- Deliver the presentation



PRESENTATION ABSTRACT

Title of Presentation: _____

Team Member	Title
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Write a brief summary of the main points of your presentation:



PRESENTATION ABSTRACT

For Air Transportation Committee Member Use:

1. Please make some general comments on the presentation:

2. Please rate the presentation according to the rubric, with comments:

4	<ul style="list-style-type: none">• The poster/presentation clearly and accurately describes two or more solutions, how it solves the air transportation problem, addresses trade-offs for each solution, and is backed up with facts from research.• The poster/presentation is creative and persuasive and has accurate and clear descriptions and illustrations that match the solution and make it easy to understand.
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STEP 9 Present the Results

Here are a few tips for presenting before the Air Transportation Committee:

- Make an effort to know your material well so you do not have to read off your poster or slides.
- Speak loudly, clearly, and slowly enough your audience to hear and understand you. Many students rush their presentations because they are nervous.
- Make eye contact with your audience.
- Be prepared to answer questions.

Good luck and congratulations on completing Part 1 of Future Flight Design!



Glossary

aerodynamics. The science of learning how air flows over objects.

aeronautics. The study of flight and the science of building and operating an aircraft.

airfoil. A special shape that helps to create lift.

aircraft. A machine used for flying.

airline. A system made up of aircraft, pilots, flight attendants, and passengers that flies on scheduled routes and operates out of an airport.

air traffic system. The system that controls and regulates air transportation and travel.

altitude. Height above sea level (on the Earth), or height above the surface level of a planet or moon.

ascent. The act of rising up into the air. Ascent occurs when the force of lift is greater than the force of weight.

aviation. The operation of aircraft.

cabin. The part of an aircraft that is used to transport passengers or cargo. It is usually located in the middle of the aircraft.

capacity. The largest and heaviest amount of cargo or passengers that an aircraft can safely carry.

cargo. The goods that are carried onboard an aircraft.

center of gravity. An imaginary point on an object that is used as the object's center of weight. It is the point on which the object would balance on a flat surface.

cockpit. The part of an aircraft where the pilot sits to control the aircraft. It is usually located near the front of the aircraft.

combustion. Explosion created in an engine when air is compressed inside a chamber and then mixed with fuel. The air and fuel mixture explodes when it is ignited by a spark. Energy released by the explosion is used to power the engine.

composite. A very strong, lightweight material made from carbon fibers.



compress. To squish or tightly pack together.

computational fluid dynamics (CFD). The science of using computers to solve mathematical equations that predict how air moves around objects such as aircraft. CFD allows engineers to “fly an aircraft in a computer.”

constraints. Things that limit a design.

cost-effective. When the benefits gained by doing a project are worth the amount of money and time it takes to do that project.

crankshaft. The part of an engine that rotates using the energy created by the piston and cylinder. This rotation can be used to power a rotor.

criteria. Things a design needs to be able to do.

cylinder. A piece of machinery (shaped like a tin can) inside which a piston moves up and down to power an engine.

descent. The act of lowering to the ground. Occurs when the force of weight is greater than the force of lift.

downwash. The flow of air forced downward by the rotor blades.

drag. A resistant force created by air molecules bouncing off an object.

empennage. The tail of the aircraft. It usually includes parts that help steer the aircraft.

flight plan. A report written by a pilot before an aircraft is flown. It tells all of the details of the flight, including the aircraft’s route and scheduled times of departure and arrival.

fuselage. The body of an aircraft that contains the cockpit, cabin, empennage, and tail cone.

horizontal. Flat and level with the horizon, like a straight line drawn on the ground.

hover. To hang suspended in the air, without rising or falling. Hovering occurs when the forces of lift and weight are equal.

lift. The upward force that causes an object to fly.

piston. A plug-shaped piece of machinery that moves up and down inside a cylinder to power an engine.

piston engine. An engine that uses piston-and-cylinder machinery to operate small aircraft, like helicopters, that don’t need a lot of power.



propulsion. The act of pushing something.

range. How far an aircraft can travel without refueling.

rotor. The set of rotor blades, or propellers, on a helicopter or tiltrotor that spin very fast to create lift and thrust.

rotor blade. A single blade or propeller in a rotor that turns very fast and creates lift and thrust on a helicopter or tiltrotor.

rotor tip speed. The speed at which the tips of the rotor blades turn.

route. The already-planned path of travel that a pilot uses to fly an aircraft to its destination.

runway. A very long road or strip that aircraft use to take off and land.

runway independent aircraft. Aircraft that do not need to travel a long distance on a runway in order to take off or land.

spark plug. The part of an engine that creates the spark the engine needs for combustion.

system. A set of parts (like the pieces of an engine) that come together to work as one.

tail cone. The part of an aircraft that has the mechanical parts and wiring that connect the tail to the rest of the aircraft. It is found near the rear of the aircraft.

tail rotor. The set of rotating blades found on the tail of a helicopter that are used to keep the aircraft from spinning in circles.

thrust. A force that moves an object forward.

tiltrotor. A type of aircraft that takes off and lands like a helicopter but flies like an airplane. It does not need the long runways that airplanes do and may be able to carry more passengers than helicopters.

torque. The force that causes an object to rotate or spin, or the measurement of this force.

trade-off. When an improvement in one area of something results in worse performance somewhere else.

transportation. A way to get from one place to another.

turboshaft engine. An engine that generates a lot of power and is used to operate large aircraft or aircraft that carry heavy loads.



vertical. Straight up and down, like a line drawn from a flat surface up into the air.

weight. The force created when gravity pulls on an object's mass.

wind tunnel. A tube or cylinder where a model of an aircraft or part of an aircraft is placed to test how the aircraft responds to very fast winds. Air is blown past the model so it experiences the same forces as it would if it were actually flying.

