SOARING OKLAHOMA: AEROSPACE & DEFENSE

You Have Friends in High Places
You Have Friends in High Places

My name is Ben Robinson and I am the owner and operator of an aerospace consulting company headquartered in Oklahoma City, Sentry One LLC. Sentry One LLC has worked with aerospace companies in Kansas, Oklahoma, Texas and New Mexico. We work mostly with aerospace engineering and manufacturing companies. In Oklahoma, I am the aerospace and Science, Technology, Engineering and Math (STEM) liaison with the Oklahoma Career Technology Education Center, our Career Tech Centers. Prior to my current business, I was the executive director of Boeing Aerospace Operations, headquartered in Oklahoma City. I spent 34 years in the military, both in the Army and Air Force, as a pilot. I was able to fly all kinds of helicopters and fixed wing aircraft during that time.

My younger brother and I were always interested in airplanes of all kinds as we grew up in Texas and New Mexico. We built airplanes that we intended to actually fly. We even used our mother’s dryer as a Mercury capsule when we were growing up. We both ended up living out our passion for airplanes. He was a Navy pilot and is now a captain on the Boeing 737 for United Airlines.

Oklahoma is a great place to find a future career if you love airplanes. Our aerospace industry is one of the top 5 industries in the state with over 143,000 employees doing some kind of aerospace work. We are very fortunate to have opportunities for technical specialists, information and business specialists, engineers and innovators. The overwhelming number of careers in aerospace all require some level of technical and academic education and training. Study STEM subjects and join the great aerospace industry right here in Oklahoma.
LET’S TALK S.T.E.M.
What do science, technology, engineering and math (S.T.E.M.) have to do with Aerospace & Defense?

S.T.E.M. subjects have played, and continue to play, an instrumental role in the Aerospace & Defense industry. We use math to explain science. Engineers use science to create the technology that allows the industry to defy the laws of physics. That technology utilizes precise mathematical equations. Without science, technology, engineering and math – the Aerospace & Defense industry would not exist.

When you really think about what it takes to keep an aircraft, made of heavy and cumbersome parts, carrying large amounts of fuel and transporting a variety of passengers and cargo, in the air- you really begin to understand how amazing it is to successfully take off and land an airplane. Now take things a step farther and think about how vast the open sky is; it just goes on and on. When you think about the enormity of the area being navigated you can also begin to appreciate how fantastic it is that an aircraft can make it from its point of origin to its destination without getting lost.

Let’s take a look at some of the concepts that play a role in the Aerospace & Defense industry. Kinetic Energy, Newton’s Laws of Motion and Object Momentum are just a few scientific concepts that play a role in the success of every flight.

KINETIC ENERGY: the energy of motion
Kinetic Energy, also known as the energy of motion, is dependent upon both the Mass (the quantity of matter) of an object and the Velocity (speed) at which that object is moving. This type of energy is calculated to express the impact that one object can have on another object based on its motion. Kinetic Energy is extremely important when calculating takeoffs and landings. If Kinetic Energy is calculated incorrectly, the plane may find itself taking off or landing on too short of a run way – and both scenarios can be catastrophic to the pilot(s) and any passengers.

The following formula is used to describe Translational Kinetic Energy:

\[ KE = 0.5 \times \text{Mass} \times \text{Velocity}^2 \]

NOTE: When calculating Kinetic Energy, answers are expressed in Joules and in powers of ten.

Let’s do the math!
If an object has a mass of 3 kg and is traveling at a velocity of 12.5 meters per second (m/s) what would the Kinetic Energy be?

\[ KE = 0.5 \times 3\text{kg} \times (12.5 \text{ m/s})^2 \]
\[ KE = 0.5 \times 3\text{kg} \times 156.25 \]
\[ KE = 234.378 \]
\[ KE = 2.34 \times 10^2 \text{ Joules} \]

Now you try it!
On a separate sheet of paper, using the example above, calculate the Kinetic Energy for the following objects:
1. A plane that is landing has a Mass of 5,669 kg and is traveling at a Velocity of 12.5 meters per second (m/s)
2. A vehicle preparing to stop has a Mass of 1,200 kg and a Velocity of 20.0 m/s

Sources:
http://hyperphysics.phy-astr.gsu.edu/hbase/ke.html
http://www.physicsclassroom.com/Class/energy/u5l1c.cfm

NEWTON’S LAWS OF MOTION
Law # 1 – The Law of Inertia
Newton’s Law of Inertia indicates that an object at rest tends to stay at rest, while an object in motion will stay in motion, unless the object is acted upon by an outside, unbalanced force.

On Earth, one of the greatest forces interfering with continuous motion is GRAVITY. In outer space, if someone were to throw a ball, its motion would continue until it bumped into another object or was caught in a planet’s gravitational pull. On Earth if someone were to throw a ball its motion would continue only until the force of gravity began to slow it down causing it to eventually drop to the ground and stop moving. The motion can also change if it makes contact with another object, changing its direction or stopping its motion completely (like a baseball coming in contact with a swinging baseball bat – the collision of the two objects changes the direction of the ball).

An object’s inertia is directly related to the object’s mass – the larger the mass, the higher the object’s inertia will be.

TRY THIS:
To conduct this experiment you will need the following: a) a glass soda bottle filled half way with water, b) an index card and c) a stack of coins.
1) First place your soda bottle filled half way with water in the middle of the table.
2) Next, place your index card over the top of the bottle.
3) Now place a single coin on top of the index card, and in line with the neck of the bottle.
4) Pulling only to the side (lifting up, or down will alter the experiment), quickly slide the index card out from underneath of the coin.

If the card is removed without lifting up or down, the coin will remain in position over the neck of the bottle, offering proof that an object at rest tends to stay at rest unless acted upon by an unbalanced force. Repeat this experiment, but add an additional coin to the top of the bottle each time.

How many coins can you get up to before they come toppling down when you remove your card?
Law #2 – Acceleration is produced when a force acts on a mass

In order for an object to accelerate, an outside force must act upon it. The greater the mass of an object, the more force it will take to put the object in motion. Newton’s law of acceleration indicates that an increase in mass or acceleration will equal an increase in object force. Let’s conduct an experiment to better understand the laws of acceleration.

TRY THIS:
To conduct this experiment you will need the following:

- Three (3) balls of varying mass (a ping pong ball, a marble and a racket ball are some options),
- Two rulers with a center groove (our ruler will act as a track for the balls to travel on),
- A stationary object that will be moved by the force of the balls’ acceleration,
- Stacking UNIFIX cubes (legos, or other stacking objects can be used as well), and
- A gram scale.

a) To start, we must determine the mass of all three balls. Record the mass of each ball below:

<table>
<thead>
<tr>
<th>Ball #</th>
<th>Mass in Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td></td>
</tr>
</tbody>
</table>

It is important to note that Mass is the variable in the first portion of this experiment.

b) Create a ramp using one of your rulers and a single cube. Place your stationary object at the base of your ramp. Place your second ruler next to your stationary object so that you can measure any force caused by the balls’ acceleration. Your experiment should look something like this:

c) Take turns letting each of the three balls roll down the ramp and measure the force by recording the distance that your stationary object has moved in inches.

| Ball #1 | Force measured _______ inches |
| Ball #2 | Force measured _______ inches |
| Ball #3 | Force measured _______ inches |

In terms of Mass, which ball had the greatest measurable force?

_______________________________

Law #3 – For every action there is an equal and opposite reaction

Newton’s third law of motion states that for every action there is an equal and opposite reaction.

This is an important concept when trying to understand an aircraft’s takeoff. According to NASA, Newton’s third law of motion, “helps to explain the generation of lift from an airfoil. In this problem, the air is deflected downward by the action of the airfoil, and in reaction the wing is pushed upward.” This principle is also at work with jet engines. The backwards thrust of the engine propels the plane forward.

TRY THIS:
What you will need:

- Construction paper
- 3 straws
- 4 Life-savers, tape
- Balloon
- Rubber band
- Scissors
- A foam dice

To begin this activity we are going to make the base of our homemade car. Take your construction paper and fold it in half, hamburger style. Use the new crease in the paper as a line to cut along. Next, take one of the two pieces and fold it in half, hot dog style. Cut along this new crease in the paper.

Now take 4 life savers and thread them over the straws in each corner of your paper to form “wheels” for your car. Place a piece of tape on the straw at the outside of each life saver. Like this:

Resources:
https://www.youtube.com/watch?v=cEhFmbehHc0
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Next, using your scissors, snip the excess straw on each of
the four corners. Like this:

Next, take the other half of the paper used for your base
and fold it into a rectangle box like shape that only has
three sides and fasten it to your base using tape, like so:

Next, take your balloon, your leftover straw and your
rubber band. Place the end of the balloon over one end of
the straw. Use your rubber band to fasten the balloon to the
straw (NOTE: the rubber band needs to be tight enough
that you can use the straw to blow up the balloon without
air escaping, but not too tight as it can restrict the flow of
air if it is crushing the straw). Your balloon and straw should
look like this:

Now use your straw to blow up your balloon until it fills
up your car (hold your thumb over the end of the straw to
hold the air inside of the balloon). Place your car on a table
or desk, release your finger from the end of the straw and
watch what happens when your balloon deflates.

What did you learn?
What happened when the air began to escape from your
 car’s balloon?
What direction was the air from the balloon being released
towards?
Did your car travel in the same direction as the air being
released? Why do you think that is?

Resources:
http://teachertech.rice.edu/Participants/louviere/Newton/law3.html
https://www.youtube.com/watch?v=5eirTbW0rpI

OBJECT MOMENTUM = Mass x Velocity

The momentum of an object is dependent upon two things:
1) the mass of that object and 2) the velocity (or speed)
that the object is moving at. The larger an object is and/or
the faster it is moving, the higher the object’s momentum
will be.

To determine an object’s momentum we use the following
formula:

\[ \text{Momentum} = \text{Mass} \times \text{Velocity} \]

\[ P = M \times V \]

Momentum relates to Newton’s second law of motion
( Remember: In order for an object to accelerate an
outside force must act upon it. The greater the mass of
an object the more force it will take to put the object in
motion). Remember our experiment where we measured
the velocity of different balls based on changes in velocity
versus changes in mass.

LET’S DO THE MATH!
If the boulder weighs 45.36 k/g (100 lbs) and is moving at
a velocity of 2 miles per hour, what is the momentum of
the boulder being rolled?

\[ P = 45.36 \text{ k/g} \times 2.0 \text{ m/h} \]
\[ P = 90.72 \text{ k/g} \times \text{m/h} \]

If the rock weighs .02 k/g (.044 lbs) and is moving at a
velocity of 2 miles per hour, what is the moment of the
rock being rolled?

\[ P = .02 \text{ k/g } \times 2.0 \text{ m/h} \]
\[ P = .04 \text{ k/g } \times \text{ m/h} \]

Now you try it!
1) Both a softball and a baseball are thrown at 90 miles per
hour. The softball weighs .2 k/g and the baseball weighs .15
k/g. Find the momentum for each ball. Which ball would
need a higher momentum to reach 90 miles per hour when
pitched?

2) Both a car and an airplane are traveling at 100 miles per
hour. The car weighs 1200 k/g and the plane weighs 5,660
k/g. Find the momentum for each mode of transportation.
Which mode of transportation would need a higher
momentum to reach 100 miles per hour?
### 25 Prominent Employers in the Aerospace & Defense Industry

(List provided by The Oklahoma Department of Commerce)

- Tinker AFB
- American Airlines
- Spirit Aerosystems
- NORDAM • Boeing
- Asco • AAR • ARINC
- Northrop Grumman
- L-3 • Lufthansa Technik
- FAA • Altus AFB
- Vance AFB • McAlester AAP
- Ft. Sill • Pratt & Whitney
- Veteran’s Administration
- FlightSafety International
- Triumph Aerostructures
- Southwest Airlines
- Raytheon • Limco Airepair
- Precision Castparts
- Waldens Machine/Primus

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The following is an overview of the number of jobs currently available within the Aerospace & Defense industry as well as a projection of future jobs in the state of Oklahoma (list provided by The Oklahoma Office of Workforce Development):

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>2015 Jobs</th>
<th>2020 Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Government, Military</td>
<td>35,580</td>
<td>35,517</td>
</tr>
<tr>
<td>Engineering Services</td>
<td>7,958</td>
<td>8,771</td>
</tr>
<tr>
<td>Administrative Management and General Management Consulting Services</td>
<td>5,727</td>
<td>6,670</td>
</tr>
<tr>
<td>Machine Shops</td>
<td>5,710</td>
<td>6,486</td>
</tr>
<tr>
<td>Aircraft Manufacturing</td>
<td>5,280</td>
<td>6,340</td>
</tr>
<tr>
<td>Scheduled Passenger Air Transportation</td>
<td>5,160</td>
<td>3,950</td>
</tr>
<tr>
<td>Commercial and Industrial Machinery and Equipment (except Automotive</td>
<td>4,387</td>
<td>4,889</td>
</tr>
<tr>
<td>and Electronic) Repair and Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Custom Computer Programming Services</td>
<td>4,259</td>
<td>4,628</td>
</tr>
<tr>
<td>Computer Systems Design Services</td>
<td>3,527</td>
<td>4,355</td>
</tr>
<tr>
<td>Other Support Activities for Air Transportation</td>
<td>2,977</td>
<td>3,393</td>
</tr>
<tr>
<td>Other Scientific and Technical Consulting Services</td>
<td>2,515</td>
<td>3,386</td>
</tr>
<tr>
<td>Fabricated Structural Metal Manufacturing</td>
<td>1,795</td>
<td>2,024</td>
</tr>
<tr>
<td>Other Computer Related Services</td>
<td>1,557</td>
<td>1,812</td>
</tr>
<tr>
<td>Other Aircraft Parts and Auxiliary Equipment Manufacturing</td>
<td>1,540</td>
<td>1,622</td>
</tr>
<tr>
<td>Plate Work Manufacturing</td>
<td>1,510</td>
<td>1,375</td>
</tr>
<tr>
<td>Instruments and Related Products Manufacturing for Measuring, Displaying,</td>
<td>1,248</td>
<td>1,353</td>
</tr>
<tr>
<td>and Controlling Industrial Process Variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing Laboratories</td>
<td>1,244</td>
<td>1,406</td>
</tr>
<tr>
<td>Process, Physical Distribution, and Logistics Consulting Services</td>
<td>1,231</td>
<td>1,440</td>
</tr>
<tr>
<td>Motor and Generator Manufacturing</td>
<td>1,220</td>
<td>1,163</td>
</tr>
<tr>
<td>Flight Training</td>
<td>1,065</td>
<td>1,081</td>
</tr>
<tr>
<td>Marketing Consulting Services</td>
<td>1,050</td>
<td>1,119</td>
</tr>
<tr>
<td>Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)</td>
<td>962</td>
<td>718</td>
</tr>
<tr>
<td>Electroplating, Plating, Polishing, Anodizing, and Coloring</td>
<td>952</td>
<td>1,003</td>
</tr>
<tr>
<td>Computer Storage Device Manufacturing</td>
<td>911</td>
<td>1,045</td>
</tr>
<tr>
<td>Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers</td>
<td>793</td>
<td>903</td>
</tr>
<tr>
<td>Human Resources Consulting Services</td>
<td>786</td>
<td>956</td>
</tr>
<tr>
<td>Other Technical and Trade Schools</td>
<td>713</td>
<td>776</td>
</tr>
<tr>
<td>Prefabricated Metal Building and Component Manufacturing</td>
<td>711</td>
<td>674</td>
</tr>
<tr>
<td>Rubber Product Manufacturing for Mechanical Use</td>
<td>690</td>
<td>744</td>
</tr>
<tr>
<td>All Other Miscellaneous Fabricated Metal Product Manufacturing</td>
<td>599</td>
<td>288</td>
</tr>
<tr>
<td>Research and Development in Biotechnology</td>
<td>538</td>
<td>437</td>
</tr>
<tr>
<td>Fabricated Pipe and Pipe Fitting Manufacturing</td>
<td>522</td>
<td>282</td>
</tr>
<tr>
<td>Industrial Mold Manufacturing</td>
<td>514</td>
<td>565</td>
</tr>
<tr>
<td>Other Airport Operations</td>
<td>453</td>
<td>565</td>
</tr>
<tr>
<td>Paint and Coating Manufacturing</td>
<td>442</td>
<td>433</td>
</tr>
</tbody>
</table>
The Aerospace & Defense industry is rapidly growing in the state of Oklahoma. In 2014 a list of the top 100 Critical Occupations was published by The Oklahoma Department of Commerce and within that list were 15 jobs that directly pertain to the Aerospace & Defense Industry.

### 15 Critical Occupations within the Aerospace & Defense Industry:

- **Avionics Technician**
- **Aircraft Mechanics & Service Technicians**
- **Aircraft Structure, Resurfaces, Rigging & Systems Assemblers**
- **Aerospace Engineers**
- **Computer Specialists**
- **Electrical & Electronic Engineering Technicians**
- **Mechanical Engineering Technicians**
- **Computer Software Engineers**
- **Computer Systems Analysts**
- **Network & Computer Systems Administrators**
- **Welders, Cutters, Soldiers & Braziers**
- **Welding, Soldering & Brazing Machine Setters, Operators & Tenders**
- **Structural Metal Fabricators & Fitters**
- **Electricians**
- **Sheet Metal Workers**

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<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>2015 Jobs</th>
<th>2020 Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search, Detection, Navigation, Guidance, Aeronautical,</td>
<td>438</td>
<td>443</td>
</tr>
<tr>
<td>and Nautical System and Instrument Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonscheduled Chartered Passenger Air Transportation</td>
<td>436</td>
<td>559</td>
</tr>
<tr>
<td>Machine Tool Manufacturing</td>
<td>420</td>
<td>423</td>
</tr>
<tr>
<td>Transportation Equipment and Supplies (except Motor Vehicle) Merchant</td>
<td>400</td>
<td>385</td>
</tr>
<tr>
<td>Wholesalers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Management Consulting Services</td>
<td>378</td>
<td>232</td>
</tr>
<tr>
<td>Aircraft Engine and Engine Parts Manufacturing</td>
<td>329</td>
<td>151</td>
</tr>
<tr>
<td>All Other Miscellaneous Electrical Equipment and Component Manufacturing</td>
<td>276</td>
<td>286</td>
</tr>
<tr>
<td>Relay and Industrial Control Manufacturing</td>
<td>274</td>
<td>291</td>
</tr>
<tr>
<td>Computer Facilities Management Services</td>
<td>273</td>
<td>173</td>
</tr>
<tr>
<td>Plastics Material and Resin Manufacturing</td>
<td>261</td>
<td>260</td>
</tr>
<tr>
<td>Other Electronic Component Manufacturing</td>
<td>253</td>
<td>227</td>
</tr>
<tr>
<td>Printed Circuit Assembly (Electronic Assembly) Manufacturing</td>
<td>244</td>
<td>297</td>
</tr>
<tr>
<td>Air Traffic Control</td>
<td>229</td>
<td>169</td>
</tr>
<tr>
<td>Rolling Mill and Other Metalworking Machinery Manufacturing</td>
<td>216</td>
<td>247</td>
</tr>
<tr>
<td>Cosmetology and Barber Schools</td>
<td>203</td>
<td>207</td>
</tr>
<tr>
<td>Totalizing Fluid Meter and Counting Device Manufacturing</td>
<td>190</td>
<td>230</td>
</tr>
<tr>
<td>Other Engine Equipment Manufacturing</td>
<td>185</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Scheduled Freight Air Transportation</td>
<td>168</td>
<td>261</td>
</tr>
<tr>
<td>Other Measuring and Controlling Device Manufacturing</td>
<td>147</td>
<td>142</td>
</tr>
<tr>
<td>Switchgear and Switchboard Apparatus Manufacturing</td>
<td>130</td>
<td>66</td>
</tr>
<tr>
<td>Metal Heat Treating</td>
<td>111</td>
<td>66</td>
</tr>
<tr>
<td>Other Nonscheduled Air Transportation</td>
<td>99</td>
<td>165</td>
</tr>
<tr>
<td>Special Die and Tool, Die Set, Jig, and Fixture Manufacturing</td>
<td>82</td>
<td>68</td>
</tr>
<tr>
<td>Turbine and Turbine Generator Set Units Manufacturing</td>
<td>69</td>
<td>29</td>
</tr>
<tr>
<td>Computer Terminal and Other Computer Peripheral Equipment Manufacturing</td>
<td>69</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Apprenticeship Training</td>
<td>66</td>
<td>74</td>
</tr>
<tr>
<td>Power, Distribution, and Specialty Transformer Manufacturing</td>
<td>65</td>
<td>53</td>
</tr>
<tr>
<td>Cutting Tool and Machine Tool Accessory Manufacturing</td>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>Electromedical and Electrotherapeutic Apparatus Manufacturing</td>
<td>59</td>
<td>53</td>
</tr>
<tr>
<td>All Other Rubber Product Manufacturing</td>
<td>51</td>
<td>32</td>
</tr>
<tr>
<td>Electronic Connector Manufacturing</td>
<td>41</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Automatic Environmental Control Manufacturing for Residential,</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Commercial, and Appliance Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Arms, Ordnance, and Ordnance Accessories Manufacturing</td>
<td>37</td>
<td>47</td>
</tr>
<tr>
<td>Electronic Computer Manufacturing</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Instrument Manufacturing for Measuring and Testing Electricity and</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>Electrical Signals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthetic Rubber Manufacturing</td>
<td>23</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Analytical Laboratory Instrument Manufacturing</td>
<td>20</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Ball and Roller Bearing Manufacturing</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Nonscheduled Chartered Freight Air Transportation</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Mechanical Power Transmission Equipment Manufacturing</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Bare Printed Circuit Board Manufacturing</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

**TOTALS** 112,641 118,065
President Woodrow Wilson implements the Army Air Service as a division of the War Department. In less than a year the Air Service had grown by 19,000 officers and 178,000 enlisted service members.

The U.S. Army Signal Corps formed an Aeronautical Division.

The Aeronautical Division accepted its first airplane delivery from the Wright Brothers.

The 1st Aero Squadron is formed under the leadership of Capt. Benjamin D. Foulois.

The Army established the Aviation Section of the Signal Corps and World War I begins.

The State of Oklahoma founds two airlines: Tulsa-Oklahoma City Airways and Southwest Air Fast Express (S.A.F.E.).

The U.S. entered into World War I in alliance with the “Allied Powers” (this included Britain, France, Italy & Russia).


Soaring Oklahoma: Aerospace & Defense
American Aviator
Wiley Post breaks aviation records with his round-the-world flight.

Will Rogers and Wiley Post died in a plane crash near Barrow, Alaska.

The department of War created the Army Air Forces and under the leadership of Gen. Henry H. Arnold, the Army Air Forces initiated the largest air armada of all time in response to the attack at Pearl Harbor.

Wiley Post develops the first pressure suit allowing him to fly to an altitude of 50,000 ft.

The U.S. Air Force is formed and becomes an independent installation of the Armed Forces pairing with the U.S. Army and U.S. Navy.

The Army Air Forces awards Oklahoma City the Douglas Assembly plant employing 24,000 people. The Chamber of Commerce suggests naming the plant Tinker Field in memory of Maj. Gen. Clarence L. Tinker.

The Oklahoma City Chamber of Commerce raises $2,121,000 for the purchases of 4,270 acres to increase usable space at Tinker AFB.

Tinker Field becomes known as Tinker Air Force Base.
SECTORS OF THE INDUSTRY

Aircraft Design

Individuals that decide to work in the Aircraft Design sector of the Aerospace & Defense industry will hold positions that pertain to the actual design of various types of aircraft. There are multiple design phases that go into making a useable aircraft, including the conceptual design phase and the structural design phase.

The conceptual design phase can also be referred to as the planning stage; planning focuses on what the aircraft will be capable of by determining aircraft size, using mathematics to determine lift/thrust calculations, creating three dimensional drawings of the aircraft, calculating expected performance, performing weight and balance stability checks, and producing a layout of all aircraft components.

The structural design phase focuses on designing each individual component of the aircraft to ensure optimal performance. Throughout this process prototypes are created and tested and various aircraft components are assembled and tested.

According to Career Focus – Aerospace Careers, some of the many positions that contribute to Aircraft Design include:

- Engineers
- Designers
- Scientists
- Mathematicians
- Specialists

Some of the various types of engineers involved in the designing of an aircraft include (Career Focus):

- Computational Fluid Dynamics Engineers
- Design Engineers
- Aeronautical Engineers
- Electronics Engineers
- Equipment Engineers
- Power Plant Engineers
- Systems Engineers

TRY THIS:

Visit https://designyourown.newairplane.com/

Here, you can experience what it might feel like to put the final design touches on an aircraft by designing your own airplane.

Aircraft Inspection and Testing

Individuals that work in Aircraft Inspection and Testing are focused on ensuring the safety of the aircraft. Inspectors and testers focus on aircraft materials, components and structural integrity to ensure the safety of all crew and passengers. Careers in this sector of the industry may include (Career Focus):

- Failure Analysis Engineers
- Performance Engineers
- Weight & Balance Engineers
- Crash Site Investigators
- Aircraft Maintenance Inspectors
- Engineering Flight Test Inspectors
- Flight Safety Research Specialists
- Flight Operations Specialists
- Test Engineers
- Maintenance Inspectors
- Electronics Inspectors

Flight Crews

Flight crews for commercial airlines, focus on passenger safety, cargo logistics, in flight communications and the piloting of the aircraft itself. Each member of the crew carries out a specific task to contribute to the safety of all crew members and on board passengers. Careers in this sector of the industry may include (Career Focus):

- Air Cargo Pilots
- Test Pilots
- Corporate Pilots
- Air Taxi Pilots
- Flight Attendants
- Load Masters
- Stunt Pilots
- Navigators
- Airline Captains
- Pipeline Patrol Pilots
- Flight Engineers
- Flight Instructors
- Skywriters/Sign Draggers
- Traffic Control Pilots
- Aerial Sight-Seeing Pilots
- Check Pilots
- Co-Pilots
- Crop Dusters
- Helicopter Pilots
- Flight Simulator Instructors
- Traffic Control Pilots
- Aerial Sight-Seeing Pilots

Unmanned Aerial Systems (UAS) & Unmanned Aerial Vehicles (UAVS)

Unmanned Aerial Systems and Unmanned Aerial Vehicles are types of aircrafts that have been designed in such a way that they can be controlled remotely. This type of aircraft allows a pilot to manage all systems from afar allowing new opportunities to navigate areas that are extremely dangerous and would otherwise put the pilot at risk. Careers in this sector of the industry may include (Career Focus):

- UAV Operators
- UAV Design Engineers
- Sensor Developers
- Sheet Metal Specialists
- UAV Pilots
- UAV Systems Specialists
- Flight Trainers
- Surveillance Specialists
- UAV Camera Payload Designers
- Flightline Mechanics
- Flightline Mechanics
- Aircraft Radio Technicians
- Flightline Mechanics
- Parachute Packers
- Technical Illustrators
- Manufacturing Inspectors
- Electronic Engineering Technicians

Aircraft Repairs

Aircraft, much like the vehicles we use on the ground, require a great deal of maintenance to ensure that the engine and all of the various components remain in working order. Unlike a motor vehicle, which remains on the ground, an aircraft cannot simply pull into an emergency lane off to the side if something stops working. This makes the upkeep and general maintenance of an aircraft crucial to the safety of all crew and passengers. Careers in this sector of the industry may include (Career Focus):

- Aircraft Mechanics
- Missile Mechanics
- Avionics Technicians
- Propeller Specialists
- Aircraft Instrument Mechanics
- Flightline Mechanics
- Electromechanics
- Aircraft Radio Technicians
- Manufacturing Inspectors
- Electronics Maintenance Technicians

Resources:

Career Focus – Aerospace Careers, Curriculum and Instructional Materials Center, Oklahoma Department of Career and Technology Education

http://www.aircraftdesigns.com/designing-aircraft.html

https://designyourown.newairplane.com/
In 2013, according to the Social Security Administration, the National Average for salaries across the United States was $44,888.16. To follow is a list of careers within the Aerospace & Defense industries that require varying levels of education. Every career listed offers an annual salary that exceeds the National Average. Let’s check it out:

<table>
<thead>
<tr>
<th>Position Title</th>
<th>Education</th>
<th>Avg. Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation Consultant</td>
<td>Bachelor’s Degree</td>
<td>$71,000.00</td>
</tr>
<tr>
<td>Aircraft &amp; Avionics Mechanics</td>
<td>FAA Aviation Maintenance Technician School</td>
<td>$55,230.00</td>
</tr>
<tr>
<td>Aircraft Dispatcher</td>
<td>FAA Aircraft Dispatcher Certification</td>
<td>$41,000.00</td>
</tr>
<tr>
<td>Aviation/Avionics Technician</td>
<td>FAA-Approved Aviation Maintenance Technician School</td>
<td>$47,000.00</td>
</tr>
<tr>
<td>Welding/SHEET Metal Technician</td>
<td>Welding Certification/SHEET Metal Certification/Associate’s</td>
<td>$42,000.00</td>
</tr>
<tr>
<td>Machinists</td>
<td>FAA Technical Training/ Certification</td>
<td>$44,000.00</td>
</tr>
<tr>
<td>Aviation Safety Inspector</td>
<td>FAA Certification - Aircraft Inspector Authorization</td>
<td>$63,680.00</td>
</tr>
<tr>
<td>Aviation Planner</td>
<td>A &amp; P License</td>
<td>$41,000.00</td>
</tr>
<tr>
<td>Acquisition Specialists</td>
<td>Certified Procurement Officer (CPO) Certification</td>
<td>$62,000.00</td>
</tr>
<tr>
<td>Air Traffic Controller</td>
<td>2-4 year Air Traffic Collegiate Training Initiative Program</td>
<td>$122,530.00</td>
</tr>
<tr>
<td>Logistics &amp; Supply</td>
<td>Bachelor’s Degree in Business or Logistics or 4 yrs of exp.</td>
<td>$65,000.00</td>
</tr>
<tr>
<td>Contract Specialists</td>
<td>Bachelor’s Degree or 4 yrs of exp.</td>
<td>$66,000.00</td>
</tr>
<tr>
<td>Community Planners</td>
<td>Bachelor’s in Community Planning or 2 yrs of exp.</td>
<td>$68,000.00</td>
</tr>
<tr>
<td>Electrical Engineer</td>
<td>Bachelor’s Degree</td>
<td>$95,000.00</td>
</tr>
<tr>
<td>Aerodynamicist</td>
<td>Bachelor’s Degree</td>
<td>$103,720.00</td>
</tr>
<tr>
<td>Aerospace Engineer</td>
<td>Bachelor’s Degree</td>
<td>$103,720.00</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
<td>Bachelor’s Degree</td>
<td>$84,000.00</td>
</tr>
<tr>
<td>Structural Engineer</td>
<td>Bachelor’s Degree</td>
<td>$92,000.00</td>
</tr>
<tr>
<td>Industrial Engineer</td>
<td>Bachelor’s Degree</td>
<td>$88,000.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position Title</th>
<th>Education</th>
<th>Avg. Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Engineer</td>
<td>Bachelor’s Degree</td>
<td>$92,000.00</td>
</tr>
<tr>
<td>Information Technicians (IT)</td>
<td>Associate’s Degree or 2 years of technical training</td>
<td>$47,000.00</td>
</tr>
<tr>
<td>Electronics Technicians</td>
<td>Associate’s Degree or 2 years of technical training</td>
<td>$49,000.00</td>
</tr>
<tr>
<td>Commercial Pilot</td>
<td>Commercial Pilot’s License/ Airline Transport Pilot Certificate</td>
<td>$98,410.00</td>
</tr>
<tr>
<td>Private Pilot</td>
<td>Pilot’s License</td>
<td>$82,000.00</td>
</tr>
<tr>
<td>Military Aircraft Pilot</td>
<td>Bachelor’s Degree (Can be obtained while serving)</td>
<td>$81,000.00</td>
</tr>
<tr>
<td>Electrical &amp; Avionic Systems Repairs</td>
<td>10 Wks of Combat Training &amp; 24 weeks on-the-job instruction</td>
<td>$54,000.00</td>
</tr>
<tr>
<td>Air Traffic Control</td>
<td>10 Wks of Combat Training &amp; 38 weeks on-the-job instruction</td>
<td>$62,000.00</td>
</tr>
<tr>
<td>Aircraft Electrician</td>
<td>10 Wks of Combat Training &amp; 19 weeks on-the-job instruction</td>
<td>$46,000.00</td>
</tr>
<tr>
<td>Air Traffic Control</td>
<td>10 Wks of Combat Training &amp; 18 weeks on-the-job instruction</td>
<td>$50,000.00</td>
</tr>
<tr>
<td>Aviation Officer</td>
<td>Aviation School, Basic Combat Training, Specialized Training</td>
<td>$66,000.00</td>
</tr>
<tr>
<td>Aviation Operations Specialist</td>
<td>10 Wks of Combat Training &amp; 8 Wks of on-the-job instruction</td>
<td>$55,000.00</td>
</tr>
<tr>
<td>Aerospace Ground Equipment</td>
<td>8.5 Wks of Basic Training &amp; 95 days of specialized instruction</td>
<td>$65,000.00</td>
</tr>
<tr>
<td>Aerospace Maintenance Specialist</td>
<td>8.5 Wks of Basic Training &amp; specialized instruction based on job function</td>
<td>$62,000.00</td>
</tr>
<tr>
<td>Aerospace Propulsion Specialist</td>
<td>8.5 Wks of Basic Training &amp; 34-51 days of specialized training</td>
<td>$73,000.00</td>
</tr>
<tr>
<td>Aviation Resource Management</td>
<td>8.5 Wks of Basic Training &amp; 26 days of specialized training</td>
<td>$62,000.00</td>
</tr>
</tbody>
</table>

Resources:
http://www.ssa.gov/OACT/COLA/AWI.html
http://www.indeed.com/salary
http://www.airforce.com/careers/#interest:aircraft

Career Focus—Aerospace Careers, Curriculum and Instructional Materials Center, Oklahoma Department of Career and Technology Education
Women in the Industry

There are a number of women in the Aerospace & Defense industry that have paved the way for women today to take on a wide variety of roles related to Aerospace & Defense. Both Shannon Lucid and Lieutenant Colonel Arminta Harness are examples of women who have made significant contributions to the industry.

Shannon Lucid (Astronaut)
Shannon Lucid, Ph.D., grew up in Bethany, Oklahoma and is a graduate of Bethany High School. After High School, Lucid went on to attend the University of Oklahoma where she earned a Bachelor of Science degree in Chemistry as well as a Master of Science and Doctor of Philosophy degree in biochemistry. Dr. Lucid belonged to the first class of women astronauts selected by NASA.

Resources:
http://www.jsc.nasa.gov/Bios/htmlbios/lucid.html

Lt. Col. Arminta Harness obtained an Aeronautical Engineering degree from the University of Southern California in 1955 making her the first female engineer in the United States Air Force. During her 24 years of service, Lt. Col. Harness received the National Defense Service Medal, the Air Force Commendation Medal, a Joint Services Commendation Medal and the Air Force Meritorious Service Medal. In 1971 she also received additional recognition from the Institute for the Advancement of Engineering when she was awarded the Engineering Achievement Merit Award.

Resources:
http://societyofwomenengineers.swe.org/membership/history/2-uncategorised/43-swe-women-harness

STUDENT ACTIVITY:
Do your research and identify a woman in the United States that has made a significant contribution to the Aerospace & Defense Industry.

Create a 3-minute presentation using at least 2 credible resources and offer an overview of that woman’s life including her background, education, career and specific contributions.

For a chance to win a free iPad for both yourself AND your teacher, submit a video of you giving your presentation or provide a narrative script of your presentation via NIE’s online portal at:
http://nie.newsok.com/soaring-oklahoma-aerospace-defense-contest-entry

All submissions are due by January 29, 2016.
**Full Name:**  Brig Gen. Ben Travis Robinson, USAF (R)

**Occupation:**  President/Owner of Sentry One LLC, an Oklahoma City based aerospace consulting company

**Length of time serving in current position:**  Five years with Sentry One LLC but over 40 years in the aerospace and defense industry.

**Education Level:**  BS in Industrial Management, MA in Industrial management, MIT Fellowship

**When did you decide that you wanted to do this?**  Probably in elementary school was when I knew what I enjoyed but I did not decide I wanted an aerospace career until much later.

**What challenges and obstacles did you face to get to where you are today?**  Early on in my education, no one wanted to or was capable of discussing career opportunities or relevant education and training, career pathways. I had to discover things all on my own.

**What advice do you have for students who want to work in the industry?**  Learn as much as you can about all aspects of the industry. In aerospace, there is engineering, business, technical specialties, innovation, manufacturing, etc. Find one that interests you. Develop a career path with that career as a goal. Work to get the right education, training and experience in that part of the aerospace industry. Make it your dream career and have fun.

---

**Full Name:**  Justin Heid, A.A.E.

**Occupation:**  Airport Director, Guthrie-Edmond Regional Airport

**Length of time serving in current position:**  3 Years with Guthrie-Edmond Regional Airport

**Education Level:**  Accredited Airport Executive (A.A.E.) - American Association of Airport Executives; Master’s Degree - Aerospace Administration and Logistics - Southeastern Oklahoma State University; Bachelor’s of Science - Aviation Management with a Business Minor - University of Oklahoma; Associate’s of Science - Aviation Operations - Community College of the Air Force

**When did you decide that you wanted to do this?**  Growing up, I always knew that I wanted to be involved with aviation. I love to fly, and managing an airport allows me to be at the airport every day, while allowing me to be home every night. For this reason, I chose airport management as a career, so that I could be around aviation, fly for fun, and still be home every night with my family.

**What challenges and obstacles did you face to get to where you are today?**  One doesn’t just become a CEO or Director of an organization. There are steps to getting where you want to go. I held multiple internships and positions, some unpaid, and joined organizations that would be beneficial in networking within my industry to gain experience. It can be a challenge to build a career relevant resume. Additionally, education can be an obstacle for many, and it takes a large amount of perseverance and dedication to achieve your goals. To achieve this sometimes it means just putting one foot in front of the other, and keep moving towards the end-goal. Paying for school was a large obstacle that I overcome with the GI Bill through the Air Force. While in the military, I had time to mature and get my barrings on exactly what I wanted to do; and once I was out, I went straight to school and treated it like a job. My time in the service helped give me direction and clarity. There was a time when I would never have imagined I would hold the certifications and degrees that I do. But pretty soon you are able to look back and see everything you have done and it will amaze you. It is important to remember the old saying: “How do you eat an elephant...One bite at a time.”

**What advice do you have for students who want to work in the industry?**  For those students wanting to work in the industry I would recommend that they get involved, network, and take positions that are relevant to the careers they desire. Some jobs may be taken for what you can LEARN and not necessarily what you can EARN. Volunteer and job shadow with organizations and businesses within the industry. It adds to your resume and shows businesses how bad you want something. Organizations today are looking for dedicated individuals, so make yourself stand out. It is important to remember that your future bosses were once in your position trying to break into the industry. To be a good employee, all you have to do is your job. To be recognized as a star, just do a little bit more.
Full Name: Dr. John Vonhof

Occupation: Project Management specialist

Length of time serving in current position: 25 years with the Boeing Company

Education Level: PhD in Organizational Behavior and Management

When did you decide that you wanted to do this?
I decided I wanted to work in aerospace when I was in college and looking for a job. I have always liked airplanes – they truly are fascinating. Additionally, my brother-in-law is a Marine, and I wanted to be a part of a company that helped our warfighters.

What challenges and obstacles did you face to get where you are today?
I have been blessed to have had the opportunity to work on many different aircraft platforms. Some challenges include long hours, extended travel and time away from my family. My biggest obstacle was health-related – I had a minor stroke, which took six months to recover from. I am glad to say I was able to recover and carry with me gratitude for my family, health, and the opportunities Boeing provides me.

What advice do you have for students who want to work in the industry?
My advice is follow your dreams, and don’t be afraid to fail. I left home when I was 20 and moved from Ohio to California, even though I didn’t really know anyone. I had hopes of one day living by the ocean and having an ocean view out my office. Somewhat paradoxically, I also wanted to work with airplanes, have a cattle ranch and ride horses. When I left my previous office to move here, I could see the ocean. And now that I’m in Oklahoma, I have a cattle ranch and horses, and still work with airplanes. So don’t be afraid to dream, or to fail. Boeing is a great company to work for – they paid for my education and provided me with many opportunities to advance my career.

Full Name: Patrick Kanaly (Pat)

Occupation: Engineering & System Support Analysis

Length of time serving in current position: Been with Boeing 19.5 Years

Education Level: Bachelors – Embry Riddle / MBA – Webster University (in-work)

When did you decide that you wanted to do this?
In High School, I had a fascination with aircraft in general and was technically inclined but academically short. My parents could not afford college – and to be honest my grades probably would not have opened many doors at a University. So I joined the Air Force and was assigned to the AWACS squadron at Tinker. That decision launched my career.

What challenges and obstacles did you face to get where you are today?
My biggest challenge early in my career was to find time to go back to school to get the required Degrees to further my career – I moved around my first 14 years with Boeing, from Saudi Arabia to Hawaii, Maryland, Texas, Nebraska and Oklahoma. Finding time to earn a Bachelors was difficult, but was always my underlying objective.

Now that I am halfway through my career and a bit more settled, I see further opportunity and a renewed focus to continue towards a MBA.

What advice do you have for students who want to work in the industry?
This industry is vast and offers many opportunities, so define what you want before you begin the journey. If something else comes up that offers something different and sparks an interest, don’t be afraid to venture out and explore that new opportunity. In the end it will make you a well versed and well-rounded individual with a lot of stories to tell!
When I Grow Up…
Exploring Careers in Aerospace & Defense

When exploring your chosen career, you will need to do the following:

1) Identify the education requirements for entering into your chosen career.

2) Identify at least 3 Educational Institutions within the state of Oklahoma that you could attend to retain the required education for your chosen position.

3) Find 3 different real life job listings within the state of Oklahoma for your chosen career (you can use Monster.com, Indeed.com, USAjobs.gov, etc. to locate job listings). Identify a list of required skill sets that are common among all three job listings.

4) Create a list of 5 questions that you have regarding what it would be like to work in the career you have chosen. Choose one of the 3 job listings that you have already identified and research that company’s Human Resource contact information. Contact the human resource department for that company, identify yourself as a student doing research and seek answers to your 5 questions.

5) Summarize your findings. Write a 1 – 2 page summary of your findings including an introduction explaining why you chose the career that you did and a conclusion indicating whether or not you are interested in learning more about the career you have chosen to research or if you would prefer to look at other career opportunities.

For a chance to win a free iPad for both yourself AND your teacher, submit your 1-2 page summary via NIE’s online portal located at: http://nie.newsok.com/soaring-oklahoma-aerospace-defense-contest-entry/

All submissions are due by January 29, 2016.

2016 AVIATION ART CONTEST – AIR SPORTS IN HARMONY WITH NATURE

Enter this year’s Aviation Art Contest!
For full contest details and an entry form visit: http://bit.ly/1XCPdXC
This statewide competition offers all entrants the opportunity to move on to a national and international competition.

THEME:
This year’s theme is “Air Sports in Harmony with Nature”. Artwork is judged, at least in part, for its creative use of this year’s theme in relation to the aviation world.

DEADLINE:
Entries must be sent to your state’s sponsor office and must be postmarked by Friday, January 22, 2016.

Cheyenne Jones - Porum, Oklahoma, 2nd Place Senior Division

ELIGIBILITY:
All children in the age groups show below are encouraged to participate in the contest, even if they are related to officials or employees of the FAI or any of its member organizations.

AGE GROUPS:
Group I – Junior Category
(Born between Jan 1, 2006 and Dec 31, 2009)

Group II – Intermediate Category
(Born between Jan 1, 2002 and Dec 31, 2005)

Group III – Senior Category
(Born between Jan 1, 1998 and Dec 31, 2001)