ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FIVE

INSTRUCTIONAL GUIDE

EO C570.01 – EXAMINE THE ASPECTS OF AIRCRAFT MANUFACTURING AND MAINTENANCE THROUGH THE DEVELOPMENT OF AEROBATIC AIRCRAFT

Total Time: 90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-805/PG-001, *Proficiency Level Five Qualification Standard and Plan*, Chapter 4. Specific uses for said resources are identified throughout the self-study package within the section for which they are required.

Self-study packages are intended to be completed by the cadet independently. More information about self-study packages can be found in the forward and preface.

Review the lesson content and become familiar with the material prior to facilitating this lesson.

Photocopy the self-study package located at Attachment A for each cadet.

Photocopy the answer key located at Attachment B but **do not** provide it to the cadets.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A self study was chosen for this lesson as it allows the cadet to examine in greater detail the aspects of aircraft manufacturing and maintenance through the development of aerobatic aircraft at their own learning pace. This encourages the cadet to become more self-reliant and independent by focusing on their own learning instead of learning directed by the instructor.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have examined the aspects of aircraft manufacturing and maintenance through the development of aerobatic aircraft.

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IMPORTANCE

It is important for cadets to examine the aspects of aircraft manufacturing and maintenance through the development of aerobatic aircraft as through the years flying skills and better aircraft development has created higher performing aircraft.

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SELF-STUDY PACKAGE INSTRUCTIONS

OBJECTIVE

The objective of this self-study package is to have the cadet examine aspects of aircraft manufacturing and maintenance through the development of aerobatic aircraft.

RESOURCES

- Self-study package, and
- Pen / pencil.

ACTIVITIY LAYOUT

Provide the cadet with a classroom or training area suitable to complete the self-study package.

ACTIVITY INSTRUCTIONS

1. Provide the cadet with a copy of the self-study package located at Attachment A and a pen / pencil.
2. Allow the cadet 90 minutes to complete the self-study package.
3. Provide assistance as required to the cadet.
4. Collect the self-study package once the cadet has finished.
5. Correct the self-study package with the self-study package answer key located at Attachment B.
6. Provide feedback to the cadet and indicate whether or not they have completed the Enabling Objective (EO).
7. Return the completed self-study package to the cadet for their future reference.
8. Record the result in the cadet's logbook and Cadet Training Record.

SAFETY

Nil.

END OF LESSON CONFIRMATION

The cadet's participation in examining the aspects of aircraft manufacturing and maintenance through the development of aerobatic aircraft will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

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CLOSING STATEMENT

The development and the performance of aerobatic aircraft have resulted in numerous flying skills and better aircraft over the years. Manufacturing and maintenance from the time of the Wright brothers has created higher performing aircraft.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

A3-183 Department of National Defence. (2009). *Full history*. Retrieved October 1, 2009, from http://www.snowbirds.dnd.ca/v2/hist/hist2-eng/asp

C3-348 Sport Pilot. (2009). *Aerobatics*. Retrieved October 1, 2009, from http://www.esparacing.com/sport_pilot.htm

C3-349 Jet Fighter School II. (2009). *Introduction to aerobatics*. Retrieved October 1, 2009, from http://www.flightsimbooks.com/jfs2/chapter1.php

C3-350 Model Aviation. (1999). *A short history of aerobatics*. Retrieved October 1, 2009, from http://jmrc.tripod.com/fa/aero.aero1.htm

C3-351 Hickok Sports.com. (2003). *Aerobatics*. Retrieved October 1, 2009, from http://www.hickoksports.com/history.shtml

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Aspects of Aircraft Manufacturing and Maintenance Through the Development of Aerobatic Aircraft



SECTION 1: THE ORIGIN OF AEROBATIC FLIGHT

SECTION 2: AIRCRAFT DEVELOPMENT

SECTION 3: MODERN AEROBATIC DISPLAYS

SECTION 4: CANADIAN AEROBATIC TEAMS

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SECTION 1

THE ORIGIN OF AEROBATIC FLIGHT

ORIGIN

Pre-World War I (WWI)



Did you know?

The first time the Wright brothers made a 360-degree banked turn, the idea of aircraft development for more thrilling control of an aircraft started.

With the development of the aircraft in 1904, each new aircraft manoeuvre was more thrilling to the public. Large paying audiences soon tired of watching pilots perform simple flying exhibits and demanded more thrills and danger. Pilots competed to develop flying tricks and stunts leading to aerobatic manoeuvres.



Did you know?

Flying clubs were created soon after the development of the aircraft. To teach new pilots how to fly and handle the numerous new aircraft being developed, clubs were created by individuals and builders such as Curtis.

In 1905, Count Henri de la Vauix, vice-president of the Aero Club of France gave a presentation to the Olympic Congress of Brussels for the formation of a universal aeronautical federation to regulate the various aviation meetings and advance the science and sport of aeronautics. The Fédération Aéronautique Internationale (FAI) was formed by countries including:

- Belgium,
- France,
- Germany,
- Great Britain,
- Italy,
- Spain,
- Switzerland, and
- The US.

Daredevils



Did you know?

A daredevil is defined as a reckless, impulsive, and irresponsible person.

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In 1910, the American, Walter Brookins was performing spiral dives and 90-degree banked turns, thrilling audiences who thought such moves were wild and dangerous. Another American, Lincoln Beachey created his "Death Dip" to counter Walter Brookins flying displays and became known as "the father of aerobatic flying". He would fly to 5 000 feet and dive straight at the ground with the engine turned off, recovering at the last second, scaring the audience.



Did you know?

Walter Brookins was the first pilot trained by the Wright brothers to fly their aircraft.

Pilots like Lincoln Beachey and Walter Brookins would barnstorm the country, appearing at county fairs as stunt fliers, thrilling audiences.



Did you know?

On arrival to a town, the pilot would perform a series of loops, rolls and spins to draw a crowd to a grass field where the pilot would land. To cover a pilot's expenses, rides were offered for a fee.

The aircraft used evolved from the military aircraft but the increased stress on the control surfaces and systems caused system and structural damage. Airframes would collapse while pulling out of diving manoeuvres.



Control surfaces include:

- ailerons,
- elevators and stabilizers, and
- the rudder.

Control systems used can be:

- cables and pulleys,
- push and pull rods, or
- torque tubes.

The aircraft used were oversized and underpowered. These factors produced an uninteresting aerobatic performance, by today's standard. Aircraft maneuverability was sluggish and the ability to climb vertically was limited. Flying at slow speeds could result in the aircraft stalling and spinning. Stalls and spins were manoeuvres not understood by the early pilots until Wilfred Parke, a test pilot for the Roe Avro Company, experienced this while test piloting for the military.



Did you know?

Wilfred Parke fell into a left-hand spin after stalling and pulled hard on the stick and pushed the rudder to the left with no correction. He then eased off the rudder and pushed the rudder to the right into the spin which caused the aircraft to right.

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With the spin correction mastered, pilots included this new manoeuvre in their routine.

Upside Down and Backwards Flying



Did you know?

Aerobatic flight is defined as precise manoeuvring in three dimensional space. Manoeuvring is divided into three components including:

- position,
- velocity, and
- attitude.

With the development of the monoplane and rotary engines, pilots found this design gave them better control and they started experimenting with unusual flight manoeuvres.

An Englishman, William Moorhouse, was the first pilot to fly an aircraft backward. During a steep climb with the nose up as far as it would go, he turned the engine off. The aircraft stopped momentarily then slipped backward for a short distance before yawing to the side and diving straight toward the ground. This became another thrilling manoeuvre for pilots to practice then perform.



Did you know?

Many pilots found themselves flying inverted as a result of wind gusts. No one had flown into an inverted position intentionally.

In 1913, Adolphe Pegoud was a test pilot with the Bleriot aircraft development team. He decided to create a new manoeuvre and in September 1913, he performed the first half roll to an inverted position. He first practiced in an aircraft suspended in a hanger, hanging upside down. He realized the controls would have to be operated in a reverse manner and from the upside-down position practised the feel of flying in this manner. During the first demonstration, the aircraft proved that inverted flight could not be accomplished for a long time as Pegoud was drenched in fuel.



Did you know?

Adolphe Pegoud was the first flyer to jump from an aircraft on August 13, 1913 at Chateaufort, France to test a parachute.

At the same time in 1913, Petr Nikolaevich Nesterov, a Russian air force officer, performed the first complete loop creating another aerobatic manoeuvre. Everyone started doing loops. In 1914, Beachey performed the outside (inverted) loop.



Did you know?

Petr Nikolaevich Nesterov was immediately arrested for taking undue risk with military equipment but his superiors recognized the advantage of this manoeuvre and he was released and promoted.

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WWI



Did you know?

Aerobatic flying was the forerunner to air combat.

Air shows and flying exhibitions were heavily attended by the public until the start of WWI. Aerobatic tricks and stunts were skills many pilots learned to survive in battle. Superior tactics gave a pilot an edge over others even when flying an inferior aircraft.

Oswald Boelcke, a German air force pilot, was a master tactician and leader and created many tactics used successfully by German aviators. He is known as the "father of air combat".



Did you know?

The first German air ace, Max Immelmann, was a master of the surprise attack. He used aerobatic manoeuvres to attack or get away from his adversaries. The Immelmann Turn is a modern aerobatics manoeuvre where the pilot combines an ascending half loop with a half roll.

With continued development of aircraft such as the German Fokker Albatross and the English Sopwith, many pilots created new tricks for the aerobatic inventory, to include:

- half loops,
- barrel rolls, and
- the split-S.

Those pilots who could master these skills over the battlefield lived the longest and were the most successful.



Did you know?

Formal training courses for the military were not set up until 1917, three years after the start of WWI.

Pre-World War II (WWII)

Rivalry between pilots returning from the WWI battlefields of Europe continued to create new manoeuvres, including:

- vertical rolls,
- flat spins,
- vertical figure eights, and
- the avalanche (roll on the top of a loop).

Manoeuvres were created, at times when a pilot was attempting a specific manoeuvre, got into difficulty and to prevent from crashing, recovered anyway possible; creating something new for others to attempt to recreate.

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Did you know?

Len Povey, a famous American barnstormer, was hired to train the new Cuban Air Force, in the early 1930s. He was persuaded to compete in Miami, Florida in a new Curtis Hawk biplane. As he was attempting to complete a triple Avalanche, three snaps at the top of a loop, he found he had too much speed for the snap. He rode over the top, coming down the back side completing a half-roll into another loop, again half rolling on the back side before pulling out.

He had created what became known as the "Cuban eight".

Air shows soon returned featuring famous barnstormer acts. Individual teams joined together to create multiple displays with ticket sellers, ground controllers and display pilots.

In 1927, the first large scale aerobatics competition was held in Zurich, Switzerland. At this time, the first aircraft fuel system capable of inverted flight appeared. Gerhard Fieseler, a German air force pilot, had an interest in inverted flight and provided the development of the new fuel system which brought inverted flight back into aerobatics.

Competitive aerobatic competition became a mature sport complete with rules and regulations.



Did you know?

With the development of motion pictures, movies were created showing the development of aviation and aerobatics. Some examples of movies you can watch, include:

- *The Lost Squadron* (1932),
- *Devil Dogs of the Air* (1935),
- *Dawn Patrol* (1938),
- *The Blue Max* (1966), and
- *The Great Waldo Pepper* (1975).

WWII and Beyond

Many of the tactics and manoeuvres effective in WWI proved obsolete and dangerous with the aircraft advancements being created during WWII. Few aerobatic manoeuvres were created during this period of global conflict but aircraft modifications made advancements for the safety of the pilots.

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Did you know?

The more powerful engines created higher gravity (G) forces; positive and negative. Flight manoeuvres which impose high G factors on a pilot include:

- steep turns,
- pull-outs,
- rolls,
- tail slides, and
- inverted loops.

The physical demands on pilots in higher performing aircraft required modifications, some including:

- adding foot straps to keep the pilot's feet from slipping off the rudder peddles during manoeuvres; and
- placing a window in the floor of the cockpit to identify the plane's dive angle.

In the mid-1950s, Czechoslovakian pilots introduced the most thrilling manoeuvre of the times, a "Lomcevak".



Did you know?

A Lomcevak is the first gyroscopic manoeuvre using the gyroscopic precession generated by the propeller. Depending on the aircraft, the result is a graceful end-for-end tumble on all three control axes.

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SECTION 2

AIRCRAFT DEVELOPMENT

Aerobatic aircraft designs can be ordered as a home-builder's kit. The aircraft is built by an individual and certified before being flown.

Through the years of aircraft development from the first flight by the Wright brothers to present high performance aerobatic aircraft, aircraft were adapted from conventional military trainers and sport aircraft using biplane or monoplane wing designs.

Can you picture this antique aircraft looping in the air?



Note. From "Aerofile", 2009, Beachey, Beachey-Curtiss. Retrieved November 23, 2009, from http://www.aerofiles.com/_ba.html

Figure A-1 Little Looper



Note. From "Virtualtourist", 2009, More Aircraft, Rare, Old or Precious. Copyright by Virualtourist.com, Inc, 1994–2004. Retrieved November 26, 2009, from http://members.virtualtourist.com/m/tt/6fa74/

Figure A-2 Tiger Moth

Early aircraft were constructed of wood, fabric and wire; very fragile and not suited for the increased stress from the demands of the pilots with limited experience.

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Early aircraft were oversized and underpowered having limited ability to climb vertically so pilots would climb to higher altitudes between manoeuvres. Many times, the contemporary aerobatic aircraft was more similar to conventional light aircraft of the day.

In the 1930s–40s, Grumman built an aircraft which could bear the high structural stresses of aerobatic flying and modified the engine to endure inverted flying for up to 30 minutes. The Grumman Gulfhawk II thrilled air show audiences from 1936–1948.



Note. From "Aerobatic Flight", 2009, U.S. Centennial of Flight Commission. Retrieved November 25, 2009, from http://www.centennialofflight.gov/essay/GENERAL_AVIATION/aerobatic/GA19.htm

Figure A-3 Grumman Gulfhawk II

In the mid 1930s, the German-built biplane, the Bücker Bü-133 Jungmeister became the dominant force in aerobatic competitions from the mid 1930s until the outbreak of WWII. Ailerons were added to both the upper and lower wings and the agility and responsiveness to the controls made this aircraft ideal for aerobatic flying.



Note. From "Virtualtourist", 2009, More Aircraft, Rare, Old or Precious. Copyright 1994–2004 by Virualtourist.com, Inc. Retrieved November 26, 2009, from http://members.virtualtourist.com/m/tt/6fa74/

Figure A-4 Bücker Bü-133 Jungmeister



Did you know?

A civilian German flying club known as the "Luftsportverband" flew the Jungmeister as a training aircraft. Some of these pilots created a secret German Air Force that evolved into the Nazi Luftwaffe.

In 1945, Curtis Pitts built the first aircraft specifically designed for aerobatics: the Pitts Special S-1. The design was a smaller aircraft than the war-era biplanes and could climb, roll and manoeuvre swiftly. The swept-wing

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aircraft was powered by a smaller, lighter, horizontally-opposed engine. With the improved centre of gravity, tighter snap rolls could be executed.



Note. From "Steen Aero Lab", Pitts Special S1 Historical Info. Retrieved November 27, 2009, from http://www.steenaero.com/PittsS1/history.cfm

Figure A-5 Pitts Special S-1

Did you know?

The continued development of the Pitts line created small, lightweight and extremely agile aerobatic aircraft with a high power-to-weight ratio.

Did you know?

Betty Skelton flew a Pitts Special S-1. She was the first woman to fly inverted only a few feet off the ground and slice a 0.6 m (2 feet) wide ribbon strung between two poles. During her first attempt at the ribbon-cutting manoeuvre, her engine stalled but she recovered close to the ground, righted the aircraft and landed safely.

The Stephens Akro competed against the Pitts Special. It was able to overcome the inability of the Pitts to climb vertically. The Stephens Akro used a single wing configuration which reduced drag, therefore allowing higher airspeed which enabled the pilot to achieve higher altitude.

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Note. From "The Museum of Flight", 2009, Stephens Akro. Copyright 2009 by The Museum of Flight. Retrieved November 26, 2009, from http://www.museumofflight.org/aircraft/stephens-akro

Figure A-6 Stephens Akro

The Stephens Akro monoplane design was soon overshadowed by the German Extra design.



Note. From "Xtra aircraft", 2009, Extra Aircraft. Copyright 2002–2009 by Extra Aircraft. Retrieved November 27, 2009, from http://www.extraaircraft.com/gallery.asp

Figure A-7 Extra 300L

During the 1950s and 60s, the aerobatic category of aircraft design continued to evolve, reaching significant breakthroughs with the first purpose-built aerobatic machines. Use of composites, more powerful engines, larger propellers and improved aerodynamic surfaces and controls created aircraft better suited for the demands of aerobatic flight.

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Did you know?

Today's best aerobatic aircraft design differs from the earlier design. Present designs includes:

- structural strength,
- power-to-weight ratio,
- inverted capability (airfoils, fuel and oil systems),
- control authority, and
- stall / snap / spin behaviour.

Today's line of aerobatic aircraft includes designs from numerous countries, including:

- Czech Republic,
- Germany,
- Russia,
- China,
- Britain, and
- the US.



Note. From "Takács Miklós", 2008, Zlin 526F. Copyright 2008 by Zlintrener.com. Retrieved November 26, 2009, from http://www.zlintrener.com/tipus.php?nyelv=angol

Figure A-8 Zlin

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Note. From "Wikimedia", 2009, Yak 52 Wairarapa. Retrieved November 27, 2009, from http://en.wikipedia.org/wiki/File:Yak_52_Wairarapa.jpg

Figure A-9 YAK 52



Note. From "EAA Young Eagles", 2006, 1 001 Aviation Photos. Copyright 2009 by Experimental Aircraft Association, Inc. Retrieved November 27, 2009, from http://www.youngeagles.org/photos/gallery.asp

Figure A-10 Sukhoi SU-26

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Note. From "Air Races", 2009, Mudry CAP 232. Copyright by Zijde Aviation Photo Publishing. Retrieved November 27, 2009, from http://www.air-races.com/aircraft/CAP%20232.htm

Figure A-11 CAP 232



Note. From "Sport Pilot", aerobatic aircraft. Copyright by www.esparacing.com. Retrieved November 1, 2009, from http://www.esparacing.com/sport_pilot/aero_aricraft.htm

Figure A-12 Cessna 152 Aerobat



Did you know?

Aerobatic displays are not limited to powered aircraft. Today's competitions include aerobatic glider displays.

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SECTION 3

MODERN AEROBATIC DISPLAYS



Did you know?

A textbook aerobatic aircraft's position would be precisely controlled and quickly reorient to any other position along all three axes being:

- pitch,
- role, and
- yaw.

The closest flying machine that can reorient to these positions is the space shuttle.

Aerobatic displays and air racing grew in Europe after WWI. European and American styles of air shows differed. By the mid-1920s, the 'can you top this?" attitude led to the development of aerobatic competitions for private cups and trophies.



Did you know?

The first competition was held in Rheims, France in August 1909. It was in the form of air racing to see which pilot could win in categories, including:

- the highest altitude achieved,
- the longest flight,
- the most passengers in the aircraft, and
- the fastest one-, two- and three-lap flights over a 10 km (6.2 mile) course.

Air racing developed into organized competitions with aircraft racing within a closed-circuit course. The average speed at the first international air race in 1920 on Long Island, New York was 251.8 km/h (156.5 miles per hour). This race led to the establishment of a national air meet which became know as the National Air Races in 1924.

Aircraft had been racing against the clock but at the 1924 competition, aircrafts started racing head-to-head with all aircraft flying a closed-circuit course around pylons.

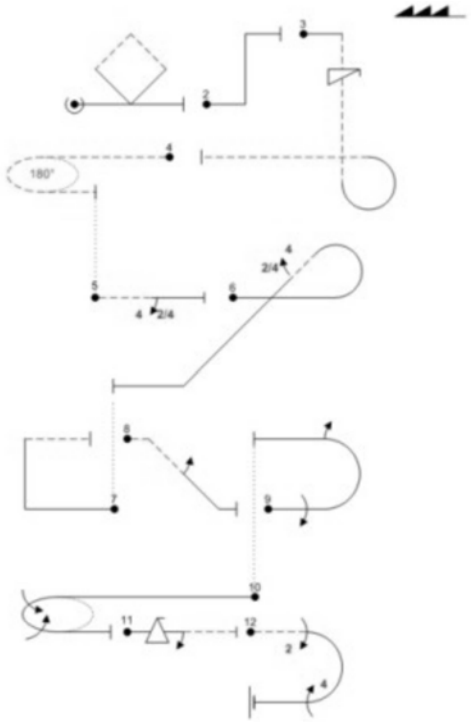
The air racing competitions soon included air show displays with aerobatic displays. Now meets that were originally just for aerobatic and air racing, combined. Specialized competitions were still held just for one purpose; air racing or aerobatic.



In 1961, Jose Luis de Aresti published his dictionary of all possible aerobatic manoeuvres for the Bücker Bü-133 Jungmeister. This dictionary has grown from around 3 000 to over 15 000 manoeuvres for all models and evolved into the FAI Aerobatic Catalogue.

The Aresti aerobatic shorthand (Sistema Aresti) and scoring system was developed in 1964. Count Jose Aresti scribed line diagrams of his sequence and taped them to his instrument panel. The Sistema Aresti evolved and was added to the FAI Aerobatic Catalogue. The FAI Aerobatic Catalogue is the undisputed last word on aerobatic figures.

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Note. From "Sport Pilot", aerobatic competition. Copyright by www.esparacing.com. Retrieved November 1, 2009, from http://www.esparacing.com/sport_pilot/aero_aricraft.htm

Figure A-13 Sistema Aresti

The FAI Aerobatic Catalogue and the Sistema Aresti were the final steps to the standardization and evaluation of formal aerobatic flight.

The progression of aerobatics developed along a dual track with some pilots continuing to display informal aerobatic air show manoeuvres while others followed the rigorous standardized competition approach.

Aerobatic Clubs have grown around the world. Many chapters of these clubs promote international competitions based on FAI and the International Aerobatic Club (IAC) rules and regulations.

Aerobatics Canada promotes aerobatic displays and competitions through its chapters, including:

- Alberta,
- British Columbia,
- Gatineau, Quebec,
- Manitoba, and
- Southwestern Ontario.

The standardization of modern aerobatic displays has evolved into a set of required manoeuvres in normal and inverted flight. The sequences must be flown with split-second timing, precise speed and altitude control, constant calculation for variables such as wind and temperature, and precise planning on the pilot's part.

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Did you know?

The Red Bull races that started in 2001 was a combination of air racing competitions in that the aircraft is racing against the clock using specialized aerobatic turns to manoeuvre through a closed-circuit course of pylons (air gates).

In 2005, the individual Red Bull Air Race World Series was inaugurated with seven races in various countries (2009 had 12 races).

At air competitions, there are five FAI levels in aerobatics, including:

- basic,
- sportsman,
- intermediate,
- advanced, and
- unlimited.

Each competition has five to nine judges with assistants, positioned about 150–250 m from the edge of the box. Corner judges monitor the pilot's position at the edge and give penalties for aircraft leaving the box.

Each judge grades each individual figure as well as how well the sequence is positioned within the box. Each judge has a copy of the performing pilot's routine and scores for the level of difficulty of each manoeuvre.



Imagine flying within a space 3 000 feet by 3 000 feet box with an upper limit of 1 000 feet, at high speed. You must complete specific manoeuvres and you are penalized for leaving the box.

Sounds like similar rules for a drill competition.



Anyone with a computer can perform aerobatic displays using early aircraft to modern high performance aircraft. New simulator designs can assist you in finding the aerobatic sensation.

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Did you know?

Programmes are classed as:

- known:
  - determined each year by the FAI and all competitors fly at all contests;
- free:
  - each pilot demonstrates their personal flying skills, creative talent and aircraft performance by designing own sequence;
- unknown:
  - the chief judge chooses and announces the figures to the pilots 24 hours before the competition; and
  - no prior practice is permitted; and
- 4-minute free:
  - top unlimited pilots are invited to fly this final program; and
  - new figures are allowed to be flown at this time to increase the pilot's score.



For more information and descriptions of aerobatic figures or how to get started in aerobatics, you can look online at http://www.esparacing.com/sport_pilot/aerobatic%20figures.htm

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SECTION 4

CANADIAN AEROBATIC TEAMS

Many countries have both civilian and military demonstration teams to amaze and thrill the public at air shows. US Army Air Corps Red Knights was formed in the 1930s, the same time period the Canadian "Siskins" started flying. The pilots and ground crews demonstrated the skill and proficiency common to the level of other teams flying.

Siskins

The "Siskins" was a demonstration team consisting of a team of three Siskins from the Royal Canadian Air Force (RCAF) from 1926–1932. They were formed at Camp Borden, Ont. and toured Canada demonstrating formation and individual displays.



Note. From "Airforce", 2004, Armstrong Whitworth Siskin. Retrieved November 30, 2009, from http://www.airforce.forces.gc.ca/v2/equip/siskin-eng.asp

Figure A-14 Siskin

RCAF Golden Hawks

In 1959, the RCAF Golden Hawks demonstration team was formed. The team flew until 1963. The team consisted of nine F-86 Sabres and represented Canada's first jet-powered aerobatic team. The team perfected many of the aerobatic stunts adopted by other flying teams. The team introduced the two-solo-pilot routine and were the only team to loop and roll the five-card formation. The team flew low and fast over the heads of the air show crowds.

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Note. From "The Torch", 2009, RCAF Golden Hawks Reunion/F-86 Sabre Flying with Snowbirds/RCN Grey Ghosts. Retrieved November 30, 2009, from http://www.toyoufromfailinghands.blogspot.com/2009/04/rcaf-hawks-reunion-86-sabre.htm

Figure A-15 Golden Hawk

RCN Grey Ghosts

The Royal Canadian Navy (RCN) was flying the Banshee from the deck of the Canadian aircraft carrier, Her Majesty's Canadian Ship (HMCS) Bonaventure. The four plane aerial display team called the "Grey Ghosts" flew during the 1960's. The Banshee was Canada's only operational naval jet fighter.



Note. From "The Torch", 2009, RCAF Golden Hawks Reunion/F-86 Sabre Flying with Snowbirds/RCN Grey Ghosts. Retrieved November 30, 2009, from http://www.toyoufromfailinghands.blogspot.com/2009/04/rcaf-hawks-reunion-86-sabre.htm

Figure A-16 Grey Ghosts

The Golden Centennaires

The Golden Centennaires were formed for Canada's centennial year (1967). The demonstration team flew the CT-114 Tutor but also had a CF-101 Voodoo and CF-104 Starfighter as part of the air demonstration team. They flew a hundred shows across Canada and performed eight shows in the United States.

The team was disbanded at the end of the centennial year but was the forerunner for the Snowbirds.

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Note. From "Cold Lake Airshow", 2009, Golden Centennaires. Retrieved November 30, 2009, from http:// www.coldlakeairshow.com/main/index.php?option=com_contnent&view-article&id=123&Item=133

Figure A-17 CT-114 Tutor

The Snowbirds

In 1971, the Snowbirds first performed and on April 1, 1978, the squadron was established as the Canadian Forces Air Demonstration Team (CFADT); 431 (Air Demonstration) Squadron. For seven years, the team from CFB Moose Jaw, Sask., operated on a year-to-year basis, performing aerobatic formation manoeuvres. Performances increased yearly to include:

Abbotsford, B.C.,

Canadian National Exhibition (CNE), Toronto, Ont, and

Arctic Circle.



Note. From "National Defence", 2009, Snowbirds, Multimedia, Photo Gallery. Retrieved November 30, 2009, from http://www.snowbirds.dnd.ca/v2/multimedia/photo-eng.asp

Figure A-18 Snowbirds

Since the formation of the Snowbirds as an official unit within the CF, the demonstration team has performed above millions of spectators across North America.



Did you know?

During the 100th anniversary of flight in 2009, various aircraft demonstration shows included an F-86 and CF-18 painted in anniversary colours and other demonstrations by the Snowbirds.

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Non-military

With affordability of aircraft, individuals can purchase and train on aerobatic category aircraft. With research, individuals can find flight centres that have aerobatic training aircraft and skill instructors.

Non-military solo pilots and teams come and go but these individuals provide exciting aerial demonstrations at their local airport or scheduled air shows across the country.



Aviation enthusiasts perform yearly as solo pilots and formation civilian teams. Have you seen non-military aerobatic demonstrations at any air show you have attended?

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CONCLUSION

The history of aerobatic aircraft and the creation of all manoeuvres included in the FAI Aerobatic Catalogue progressed over the years mainly for the premise "can you do this?". The use of aerobatics over the years provided military pilots with new skills to support the combat role during WWI and WWII.

The manufacturing of aircraft provided better control by the pilot to invent new ways to manoeuvre the aircraft in flight. Designers learned and produced better aircraft frames, control surfaces and systems leading to higher performing aircraft. Pilots then produced new manoeuvres.

With the continued aeronautical development of aircraft, pilots will push the envelope further for their personal accomplishments and for the thrill of showmanship for the air show public.



Congratulations, you have completed your self-study package on EO C570.01 (Examine The Aspects of Aircraft Manufacturing and Maintenance Through the Development of Aerobatic Aircraft). Complete the following exercise and hand your completed package to the Training Officer / Proficiency Level Officer who will record your completion in your Proficiency Level Five logbook.

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SELF-STUDY REVIEW

Place an X in the column which relates to the information about the era of aerobatic development.

Information	Pre-WWI	WWI	Pre-WWII	WWII and on
Adolphe Pegoud was drenched in fuel				
Airframes collapsed when pulling out of dive				
FAI Aerobatic Catalogue				
First air race on Long Island, New York				
G forces				
Immelmann Turn				
Individual teams joined together to barnstorm				
Len Povey - Cuban Eight				
Lincoln Beachey - father of aerobatic flying				
Lomcevak				
Oswald Boelcke - father of air combat				
Wilfred Parke recovered from stall and spin				
Zurich, Switzerland's large scale aerobatic competition				

Place an X in the column to identify the era when the aircraft was first flown.

Aircraft	Pre-WWI	WWI	Pre-WWII	WWII and on
				
				
				

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Aircraft	Pre-WWI	WWI	Pre-WWII	WWII and on
				
				
				

Mark the Canadian Demonstration teams in sequence of Operation (1-5).

Canadian Demonstration Teams	Operational sequence
RCN Grey Ghosts	
RCAF Golden Hawks	
The Golden Centennaires	
Siskins	
The Snowbirds	

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SELF-STUDY REVIEW ANSWER GUIDE

Place an X in the column which relates to the information about the era of aerobatic development.

	Pre-WWI	WWI	Pre-WWII	WWII and on
Adolphe Pegoud was drenched in fuel	X			
Airframes collapsed when pulling out of dive	X			
FAI Aerobatic Catalogue				X
First air race on Long Island, New York	X			
G forces				X
Immelmann Turn		X		
Individual teams joined together to barnstorm			X	
Len Povey - Cuban Eight			X	
Lincoln Beachey - father of aerobatic flying	X			
Lomcevak				X
Oswald Boelcke - father of air combat		X		
Wilfred Parke recovered from stall and spin	X			
Zurich, Switzerland's large scale aerobatic competition			X	

Place and X in the column to identify the era when the aircraft was first flown.

	Pre-WWI	WWI	Pre-WWII	WWII and on
				X
	X			
			X	

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	Pre-WWI	WWI	Pre-WWII	WWII and on
				X
			X	
		X		

Mark the Canadian Demonstration teams in sequence of Operation (1-5).

Canadian Demonstration Teams	Operational sequence
RCN Grey Ghosts	3
RCAF Golden Hawks	2
The Golden Centennaires	4
Siskins	1
The Snowbirds	5

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