ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL TWO

INSTRUCTIONAL GUIDE

SECTION 1

EO M270.01 – IDENTIFY ASPECTS OF AIRCRAFT MANUFACTURING

Total Time: 60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-802/PG-001, Chapter 4. Specific uses for said resources are identified throughout the Instructional Guide within the TP for which they are required.

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

Photocopy career information sheets located at Annex A for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP1 and TP2 to orient the cadets to the topic, to generate interest, to introduce aircraft manufacturing and to give an overview of it.

A group discussion method was chosen for TP3 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions and feelings about aircraft manufacturing.

INTRODUCTION

REVIEW

N/A.

OBJECTIVES

By the end of this lesson the cadet shall be expected to identify aspects of aircraft manufacturing.

IMPORTANCE

It is important for cadets to learn about the aircraft manufacturing industry to gain an awareness of the aircraft systems, materials and careers in the industry. Developing an interest in aircraft manufacturing may lead to future opportunities in the Air Cadet Program and aircraft manufacturing.

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Teaching point 1 **Identify Aircraft Systems**

Time: 15 min Method: Interactive Lecture

When assembling an aircraft, there are multiple aircraft systems included that are manufactured for the aircraft. The following are just a few aircraft systems and components that are manufactured to be used in assembling aircraft.

AIRCRAFT INSTRUMENT SYSTEMS

The development of efficient flight instruments is one of the most important factors that contributed to the growth of the present air transportation system. Prior to World War II, few airplanes were equipped for flight without using ground reference navigation or pilotage.

Aircraft instrument systems include flight instruments that depict the attitude, airspeed, and altitude of the aircraft, making up the aircraft instrument systems. Other instruments provide information such as engine operational parameters and electrical system performance. Other components manufactured to support these systems include electrical wiring and fluid-line plumbing.

Integrated circuits, containing microprocessors and other digital electronics, have revolutionized flight instrumentation and control systems. New generation flight instruments show textual and analog information on brightly coloured displays.

AIRFRAME ELECTRICAL SYSTEMS

These systems generate and route electricity to various aircraft components such as generators, motors and inverters. There are many manufacturers of these components that make up the airframe electrical systems. Because of the expense of the tools, test equipment and current technical publications, component manufacturers or certified repair stations service many of the electrical components.

HYDRAULIC AND PNEUMATIC POWER SYSTEMS

Early aircraft were equipped with flight controls and systems that were connected directly to the cockpit controls. As aircraft became more complex, it became necessary to operate systems remotely and the first of these was the brake system. Instead of cables or pushrods operating the brakes, hydraulic pressure was used to solve routing problems and multiple forces on the braking surfaces. While small aircraft continue to use cables or pushrods for operating flight controls, aircraft manufacturers equip larger aircraft with hydraulic or pneumatic control systems for their primary system.

AIRCRAFT LANDING GEAR SYSTEMS

The landing gear of the very first airplanes was not very complex. The Wright Flyer, for instance, took off from a rail and landed on skids. However, soon after the basic problems of flight were solved, attention was turned to providing better control and stability of the aircraft while it was operated on the ground. Retraction systems, shock absorbing and non-shock absorbing systems, aircraft wheels, nose wheel steering systems and aircraft brakes are some of the other components involved in manufacturing the landing gear.

AIRCRAFT FUEL SYSTEMS

Aircraft fuel systems vary in complexity from the extremely simple systems found in small, single-engine aircraft to the complex systems in large jet transports. Regardless of the type of aircraft, all fuel systems share many of the same common components. Every system has one or more fuel tanks, tubing to carry the fuel from the tank(s) to the engine(s), valves to control the flow of fuel, provisions for trapping water and contaminants and a method for indicating the fuel quantity.

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CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. List the aircraft systems manufactured to be used in assembling an aircraft.

Q2. What do aircraft manufacturers equip larger aircraft with for their control systems?

Q3. What are some of the other components involved in manufacturing landing gear?

ANTICIPATED ANSWERS

A1. The aircraft systems are:

- aircraft instrument systems,
- airframe electrical systems,
- hydraulic and pneumatic systems,
- aircraft landing gear systems, and
- aircraft fuel systems.

A2. Aircraft manufacturers equip larger aircraft with hydraulic or pneumatic control systems for their primary control systems.

A3. Retraction systems, shock absorbing and non-shock absorbing systems, aircraft wheels, nose wheel steering systems and aircraft brakes are some of the other components involved in manufacturing landing gear.

Teaching point 2 **Identify the Materials Used in Aircraft Manufacturing**

Time: 15 min Method: Interactive Lecture

The techniques and materials used in the early years of aviation were quite primitive by modern standards. The Wright brothers' "Flyer," for example, was made from steel, wire, cable, silk and wood. However, as aircraft development advanced, a breakthrough occurred in the aircraft aluminum industry. Metallurgists found that mixing, or alloying aluminum with other metals resulted in a much stronger material. In fact, alloying increased the tensile strength of pure aluminum from about 13 000 pounds per square inch (psi) to a tensile strength of 65 000 psi or greater, which is equivalent to structural steel. As the need for aluminum alloys grew, manufacturers continued to refine them to produce materials with better corrosion resistance and greater strength.

Today, military aircraft are constructed of about 65 percent aluminum and 35 percent of other alloys, including titanium, inconel, silver and nickel. Civilian aircraft are approximately 80 percent aluminum alloy and 20 percent other alloys.

Today, military aircraft are constructed of about 65 percent aluminum and 35 percent of other alloys, including titanium, inconel, silver and nickel. Civilian aircraft are approximately 80 percent aluminum alloy and 20 percent other alloys.

NON-FERROUS METALS

Much of the metal used on today's aircraft contains no iron. The term that describes metals which have elements other than iron as their base is non-ferrous. Aluminum, titanium, nickel and copper are some of the more common non-ferrous metals used in aircraft manufacturing and repair.

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Aluminum and Its Alloys. Pure aluminum lacks sufficient strength to be used for aircraft construction. However, its strength increases considerably when it is alloyed, or mixed with other compatible metals (e.g. when aluminum is mixed with copper or zinc, the resultant alloy is as strong as steel with only one third the weight).

Titanium. Titanium and its alloys are lightweight metals with very high strength. Pure titanium weighs 0.163 pounds per cubic inch (4.5 g/cm^3), which is about 50 percent lighter than stainless steel, yet it is approximately equal in strength to iron. Furthermore, pure titanium is soft and ductile with a density between that of aluminum and iron.

Nickel. Aircraft technicians need to be familiar with two nickel alloys. They are monel and inconel.

- **Monel.** Monel contains about 68 percent nickel and 29 percent copper, along with small amounts of iron and manganese. Monel works well in gears and parts that require high strength and toughness, as well as for parts in exhaust systems that require high strength and corrosion resistance at elevated temperatures.
- **Inconel.** Inconel contains about 80 percent nickel and 14 percent chromium, and small amounts of iron and other elements. Inconel is frequently used in turbine engines because of their ability to maintain their strength and corrosion resistance under extremely high temperatures.

Copper. Neither copper nor its alloys find much use as structural materials in aircraft construction. However, due to its excellent electrical and thermal conductivity, copper is the primary metal used for electrical wiring.

COMPOSITE FIBRES

Graphite, Kevlar and fibreglass are composite materials used to form various types of aircraft structures.

Graphite Fibres. Graphite fibres are manufactured by heating and stretching rayon fibres. This produces a change in the fibres' molecular structure that makes it extremely lightweight, strong, and tough.

Kevlar Fibre. Kevlar fibre is one of the most commonly used cloth-reinforcing fabrics. In its cloth form, Kevlar is a soft yellow organic fibre that is extremely light, strong and tough. Its great impact resistance makes it useful in areas where damage from sand or other debris can occur. These areas include around landing gear and behind propellers. Kevlar is rather difficult to work with however, and does not perform well under compressive loads.

Glass Fibre/Fibreglass. Fibreglass greatly enhances the strength and durability of thermosetting resin, which is a material that hardens when heated. For high strength requirements, the glass fibres are woven into a cloth. On the other hand, where cost is of greater importance than strength, the fibres are gathered into a loose mat which is saturated with resin and moulded into a desired shape.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. What was the breakthrough that occurred in the aircraft aluminium industry?

Q2. Name four non-ferrous metals.

Q3. What are some of the more common non-ferrous metals used in aircraft manufacturing and repair?

ANTICIPATED ANSWERS

A1. Metallurgists found that mixing, or alloying aluminum with other metals resulted in a much stronger material.

A2. Four non-ferrous metals are:

- aluminum and its alloys,

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- titanium,
- nickel, and
- copper.

A3. Aluminum, titanium, nickel and copper are some of the more common non-ferrous metals used in aircraft manufacturing and repair.

Teaching point 3 **Discuss Careers Within the Aircraft Manufacturing Industry**

Time: 20 min Method: Group Discussion



Distribute Career Information Sheets located at Annex A to the cadets.

BACKGROUND KNOWLEDGE

The following careers are available in the aircraft manufacturing industry:

AIRCRAFT INTERIOR TECHNICIAN

An aircraft interior technician's primary responsibilities include the removal, disassembly, cleaning, inspection, repair and re-installation of aircraft cabin furnishings. The technicians work both in an aircraft cabin and in a shop, and are familiar with the function, operation and safety requirements of aircraft passenger support systems. They maintain oxygen, water, waste, entertainment, and emergency systems and equipment. In addition, they refurbish seats, seat belts, carpets, interior panelling, windows, and galley and washroom modules. Their duties often overlap with those of other aviation technicians, such as aircraft maintenance engineers.

AIRCRAFT MAINTENANCE ENGINEER CATEGORY "E" (AVIONICS)

Students prepare for a career in aircraft maintenance and begin to qualify for an aircraft maintenance engineer (AME) – Category "E" license. Aircraft avionics technicians are responsible for the servicing, repair and modification of aircraft electronic systems and components. The job includes removing and installing components, bench testing and troubleshooting complex electronic aircraft systems. Today's aircraft can be quite sophisticated with "fly by wire," auto flight, global positioning, satellite navigation, in-flight entertainment, and automatic communication and receiving systems.

AIRCRAFT MAINTENANCE ENGINEER CATEGORY "M" (MAINTENANCE)

Students prepare for a career in aircraft maintenance and begin to qualify for an aircraft maintenance engineer (AME) – Category "M" license. AMEs are responsible for the release (certification) of an aeronautical product (aircraft), after maintenance or inspection. The job responsibilities include a variety of tasks including removing and installing components and troubleshooting complex systems. A qualified AME is able to maintain small aircraft, helicopters, and large transport category aircraft. Larger aircraft are quite sophisticated as they possess many different electrical, electronic, pneumatic, hydraulic, mechanical and propulsion systems, and the AME must understand and maintain them.

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AIRCRAFT MAINTENANCE ENGINEER CATEGORY “S” (STRUCTURES)

Students prepare for a career in aircraft maintenance and begin to qualify for an aircraft maintenance engineer (AME) – Category “S” license. Category “S” structures technicians are responsible for the assessment, planning and implementation of aircraft structural fabrication and repairs. Structures technicians are often an integral part of repair crews including maintenance technicians, avionics technicians and professional engineers. They are expected to precisely follow aircraft fabrication and repair schemes for aluminium, titanium and stainless steel structures, as well as plastics and composites.

AIRCRAFT MECHANICAL COMPONENT TECHNICIAN

Aircraft mechanical component technicians are involved in the overhaul, repair, modification, inspection, testing and certification of aviation components of pneumatic, hydraulic, fuel, electrical, environmental and mechanical aircraft systems. Working in a shop environment, technicians are thoroughly familiar with the set-up and operation of tools and shop equipment as well as some semi-automatic processes. Possessing a high degree of manual dexterity, and a strong interest in mechanics, they work cooperatively with others and are able to follow directions precisely.

AIRCRAFT GAS TURBINE TECHNICIAN

Aircraft Gas turbine technicians enjoy a challenging occupation requiring a high degree of responsibility and skill. Technicians perform the disassembly, inspection, repair, assembly and testing of gas turbine engines in a clean shop environment with regular working hours. Qualified technicians experience many opportunities for advanced training and continued career satisfaction.



The point of the group discussion is to discuss careers within the aircraft manufacturing industry using the tips for answering/facilitating discussion and the suggested questions provided.

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GROUP DISCUSSION



TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, e.g. everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

SUGGESTED QUESTIONS

Q1. Share with the class three pieces of interesting information that you did not know about careers in the aircraft manufacturing industry.

Q2. Why did you find this information interesting?

Q3. What was the most interesting career to you?

Q4. What are the primary responsibilities of the career that you found most interesting?



Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.



Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.

CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

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END OF LESSON CONFIRMATION

The cadets' participation in the discussion on careers in the aircraft manufacturing industry will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Learning about the aircraft manufacturing industry will help the cadet gain an awareness of the aircraft systems, materials and careers in the industry. This new knowledge will help develop the cadets' interest in aircraft manufacturing and may lead to future opportunities in the Air Cadet Program and the aircraft manufacturing industry.

INSTRUCTOR NOTES/REMARKS

N/A.

REFERENCES

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AIRCRAFT MANUFACTURING INDUSTRY CAREERS

AIRCRAFT INTERIOR TECHNICIAN

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Job Opportunities

Aircraft interior technician jobs have historically been filled by automotive upholsterers who required intensive on the job re-training. Organized training for this trade has been put in place due to the demand for trained personnel. Jobs are found in national and regional airline companies and approved Aircraft Maintenance Organizations (AMOs).

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Job Opportunities

Opportunities are available across Canada in aviation electronic shops, helicopter operations and large and small aircraft operators/airlines. Other job opportunities such as fixed-based airport equipment servicing are also available.

AIRCRAFT MAINTENANCE ENGINEER CATEGORY "M" (MAINTENANCE)

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Job Opportunities

Graduates from the AME M program have, for the last 40 years, found employment in both the Canadian and foreign aviation industry. First employment is as a log book-controlled work experience and then as an AME. Some graduates have gone on to become managers and owners of domestic and international aircraft maintenance establishments. Overall, through the year 2005, aircraft mechanics, particularly those with work experience, are expected to have excellent job opportunities since the number of job openings is expected to exceed the supply of qualified applicants (Aerospace Industry Association of BC AIABC study of October 2000). It is an exciting and rewarding industry with opportunity for travel and career development.

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Job Opportunities

First employment is as a log book-controlled work experience. Then, as an AME, graduates from this program have found employment in a variety of companies in the aerospace industry across Canada. They may be employed in helicopter or light aircraft repair, airline maintenance of aircraft and component manufacturing. Some graduates have gone on to manage or own repair businesses.

AIRCRAFT MECHANICAL COMPONENT TECHNICIAN

Aircraft mechanical component technicians are involved in the overhaul, repair, modification, inspection, testing and certification of aviation components of pneumatic, hydraulic, fuel, electrical, environmental and mechanical aircraft systems. Working in a shop environment, technicians are thoroughly familiar with the set-up and operation of tools and shop equipment as well as some semi-automatic processes. Possessing a high degree of manual dexterity, and a strong interest in mechanics, they work cooperatively with others and are able to follow directions precisely.

Job Opportunities

The men and women who enter this career path can expect to find employment with companies that specialize in aircraft component overhaul, Approved Maintenance Organizations (AMOs) involved in the manufacture and overhaul of airframe systems, as well as major airlines. As a CAMC-developed course, the training and associated jobs skills provided are recognized anywhere in Canada. Recent trends indicate a strong demand for individuals trained in aviation component overhaul.

AIRCRAFT GAS TURBINE TECHNICIAN

Aircraft gas turbine technicians enjoy a challenging occupation requiring a high degree of responsibility and skill. Technicians perform the disassembly, inspection, repair, assembly and testing of gas turbine engines in a clean shop environment with regular working hours. Qualified technicians experience many opportunities for advanced training and continued career satisfaction.

Job Opportunities

The men and women who enter this career path find employment in both aircraft and industrial gas turbine engine repair and overhaul facilities across Canada. There is also a demand for trained technicians with this skill set in the aircraft component and propeller over-haul trades.

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