ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 2

EO C470.02 – DISCUSS AIRCRAFT ASSEMBLY

Total Time: 30 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, 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.

Create slides of the Figures located at Attachments A and B.

Cue *The World's Biggest Airliner: The Airbus A380* DVD to the first chapter, *Toulouse, France* (seven minutes).

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for this lesson to introduce aspects of aircraft assembly methods and give an overview of them.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have discussed the assembly of aircraft components in a manufacturing setting.

IMPORTANCE

It is important for the cadets to learn about aircraft assembly methods because this will enhance their understanding of aircraft and the field of aviation.

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Teaching point 1 **Describe different methods of assembly of components.**

Time: 15 min Method: Interactive Lecture

SMALL MANUFACTURERS

For an aircraft to fly correctly, the main structural components, such as fuselage, wings, engines and empennage parts must be aligned perfectly. Any deviation or flaw, such as a twist in any component, will impair flight and have a negative effect on flight controls. Cranes hold the heavy parts in place, jigs and templates position them precisely. The development of techniques for measuring and positioning components on the structure to a high degree of accuracy have been developed, as aircraft have become heavier and faster.

LARGE MANUFACTURERS

Some aircraft are now so large that cranes cannot lift and hold the parts satisfactorily. Special carriers are custom-built to hold the parts, while computer control is used to bring them together. Lasers measure distances and angles with the use of mirrors, and send the data to high-speed computers. By using these methods, the fuselage, wings and empennage components can be assembled precisely, no matter how large they are.

Not all aircraft components are structural. A company such as Bombardier Aerospace has hundreds of suppliers that provide everything from horizontal stabilizers to airspeed indicators. All of these components fit and work together as a result of a process called Systems Integration. The aerospace engineers designing the aircraft must ensure that physical components and associated software programs work together.



Show the cadets the first chapter *Toulouse France* of *The World's Biggest Airliner: The Airbus A380*. This section covers the use of mirrors and an infrared laser positioning system and shows the fuselage components being joined.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. Why must an aircraft's structural components be aligned perfectly?

Q2. For large aircraft, what type of control is used to bring the structural parts together?

Q3. What is the name of the process that aeronautical engineers use to integrate separate systems?

ANTICIPATED ANSWERS:

A1. Any deviation or flaw will impair flight and have a negative effect on flight controls.

A2. Computer control.

A3. Systems Integration.

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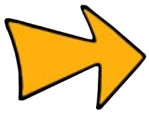
Teaching point 2 **Discuss manufacturers' assembly areas.**

Time: 10 min Method: Interactive Lecture

A SMALL MANUFACTURER'S SHOP

Small manufacturers can often perform all necessary operations in one location like Viking Air, which manufactures the new 400 series Twin Otter and remanufactures Beaver and Otter aircraft near the Victoria International Airport in Sydney, British Columbia. A small manufacturer's shop is characterized by all the aircraft parts and materials coming together at one manufacturing plant prior to final assembly. All necessary machinery and facilities are provided, sometimes under one roof. Manufacturing encompasses all phases of assembly from sheet metal bending, engine assembly, avionics and final painting and interior finish.



Viking Air is considered a small manufacturer's shop. They manufacture, assemble, modify, and repair aircraft.

A LARGE MANUFACTURER'S ASSEMBLY LINE

All manufacturers need machines to move large, heavy components such as wings and to control their motion with precision. In the assembly areas of large aircraft, these machines are also large.



Show the cadets the series of assembly area photographs located at Attachment A.



Larger manufacturers generally have more career specialization than smaller ones, such as engine, airframe or avionics specialization. Small manufacturers have fewer employees, so they need their employees to be able to handle more related fields.

Large manufacturers such as Bombardier Aerospace have facilities around the world. The materials and components for the basic aircraft structure are gathered at one assembly plant, such as Downsview in Toronto, Ontario. This plant is responsible for the final assembly of structural components for the Learjet 45 aircraft, the Q-Series turboprops and the Global family of business aircraft. The facility occupies 324 acres of land and has almost two million square feet of building floor space. At Dorval, Quebec, Bombardier has a completion facility with 31 345 square metres (337 400 square feet), housing up to 14 Global Express aircraft and a delivery centre in which customers can choose design options in a virtual reality environment. The finishing touches, such as cabin furnishings, are installed here. A separate 7 246 square metre (78 000 square foot) paint and strip shop is located next to the completion centre, capable of housing up to four aircraft at a time.

Another 38 591 square metre (415 400 square foot) facility is located in Dorval, near the Bombardier Aerospace administrative centre and the Canadair aircraft assembly plant.

Airbus has an even larger operation. The A380 is assembled and delivered in Europe and has major structural components made in Australia, Canada, England, Finland, France, Germany, Italy, Malaysia, Mexico, Morocco, Russia, Spain, Turkey and the USA.

Suppliers, for both structural and minor components, are located around the world:

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Australia	Wingtip fences	Mexico	Very large size special Hi-Lite® pull-in bolts
Canada	Pratt & Whitney Canada: Auxiliary power unit; and Goodrich: Body and wing landing gear	Morocco	Ducts for the air distribution system
England	Wings	Russia	Materials—titanium, aluminum, magnesium alloys and steel
Finland	Lift spoilers	Spain	Lateral boxes of the horizontal tail plane, the main landing gear doors, sections of the rear fuselage of the aircraft and the vertical stabilizer
France	France is the centre of A380 production	Sweden	Fixed leading edge from inner engine installation to wing tip. This includes wing spar, rib assemblies, system installation brackets and both inner and outer pylon fixed structures
Germany	Fuselage fabrication / assembly, aircraft finishing, waste water systems	Turkey	Large size special Hi-Lite® pull-in bolts of up to 28.5 mm (one inch) diameter, in both titanium and high-strength alloys, for the assembly of the most critical high-fatigue structural areas like wing spars, centre wing box and wing-to-fuselage junction
Italy	Central fuselage	USA	Airbus has an engineering design centre in Wichita, Kansas and many suppliers in the USA
Malaysia	Fixed leading edge lower panels and inboard outer fixed leading edge of wings	These are only the main supplier relationships that Airbus has developed around the world.	

Note. Created by Director Cadets 3, 2009, Ottawa, ON: Department of National Defence.

Figure 1 Airbus A380 World-Wide Suppliers



Show the cadets Figures B-1 to B-6 located at Attachment B. These pictures indicate the significance of the pylon fixed structures and pylon brackets that mount the four engines to the A380 wing. Each engine develops 31 750 kg (70 000 lbs) of thrust against the titanium pylons which transfer the thrust to the aircraft's wing.



Show the cadets Figure B-7 located at Attachment B, which lists Airbus A380 suppliers in North America.

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For more information about how an A380 is made, the cadets can visit the Airbus Navigator at web page http://events.airbus.com/A380/Default2.aspx?ArtId=644 or visit the Airbus website at www.airbus.com.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. What characterizes a small manufacturer's shop?

Q2. Where are large manufacturers located?

Q3. What happens at a large manufacturer's completion facility?

ANTICIPATED ANSWERS:

A1. All the aircraft parts and materials come together at one place prior to final assembly.

A2. Around the world.

A3. The finishing touches, such as cabin furnishings, are installed.

END OF LESSON CONFIRMATION

QUESTIONS:

Q1. Why must an aircraft's structural components be aligned perfectly?

Q2. What happens at a large manufacturer's completion facility?

Q3. What is different with respect to career specialization between large and small manufacturers?

ANTICIPATED ANSWERS:

A1. Any deviation or flaw will impair flight and have a negative effect upon flight controls.

A2. The finishing touches, such as cabin furnishings, are installed.

A3. Larger manufacturers generally have more career specialization than smaller ones.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Precise assembly of large structures is a difficult yet critically important aspect of aircraft manufacturing, which benefits from continued development and improved techniques.

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INSTRUCTOR NOTES / REMARKS

The cadets may have previously viewed The World's Biggest Airliner: The Airbus A380 if EO C270.04 was selected in Proficiency Level Two. This lesson focuses and expands on the assembly of aircraft.

Cadets who are qualified Advanced Aviation Technology – Aircraft Manufacturing and Maintenance may be able to assist with this lesson.

REFERENCES

C3-105 Brisley, T., & Pascaud, S. (Executive Producer), & Bowie, B. (Writer / Director) (2003). *World's biggest airliner: The Airbus A380* [Motion Picture]. United States: The Learning Channel.

C3-136 ISBN 0-88487-207-6 Sanderson Training Systems. (2001). *A&P technician airframe textbook*. Englewood, CO: Jeppesen Sanderson Inc.

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Verify against the official publication.



Note. From "L3 Communications Limited", 2007, SPAR Aerospace: Globally Competitive Aerospace Solutions. Retrieved October 23, 2007, from http://www.spar.ca/

Figure A-1 Rebuilding a C-130 Centre Wing



Note. From "L3 Communications Limited", 2007, SPAR Aerospace: Globally Competitive Aerospace Solutions. Retrieved October 23, 2007, from http://www.spar.ca/

Figure A-2 Placing a C-130 Centre Wing

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Note. From "L3 Communications Limited", 2007, SPAR Aerospace: Globally Competitive Aerospace Solutions. Retrieved October 23, 2007, from http://www.spar.ca/

Figure A-3 Positioning a C-130 Centre Wing



Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-4 Bombardier QR 400 Fuselage Assembly

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Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-5 Bombardier QR 400 Wing Assembly



Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-6 Bombardier QR 400 Assembly Line

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Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-7 Bombardier QR 400 Assembly Activity



Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-8 Bombardier QR 400 Engine Assembly

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Note. From "Media Centre", by Bombardier Aerospace, 2007,CRJ700 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-9 Bombardier CRJ700 Fuselage Assembly



Note. From "Media Centre", by Bombardier Aerospace, 2007,CRJ700 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-10 Bombardier CRJ700 Assembly Line

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Note. From "Media Centre", by Bombardier Aerospace, 2007,CRJ700 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-11 Bombardier CRJ700 Assembly



Note. From "Media Centre", by Bombardier Aerospace, 2007, QR 400 Assembly. Retrieved November 1, 2007, from http://www.bombardier.com/MediaCenter/Multimedia?action=view&gid=3_0&cid=295&page=1&Language=en

Figure A-12 A Q400 Fuselage Arrives from MHI, Japan

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Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-1 Building a Pylon



Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-2 Pylon Ready to Go

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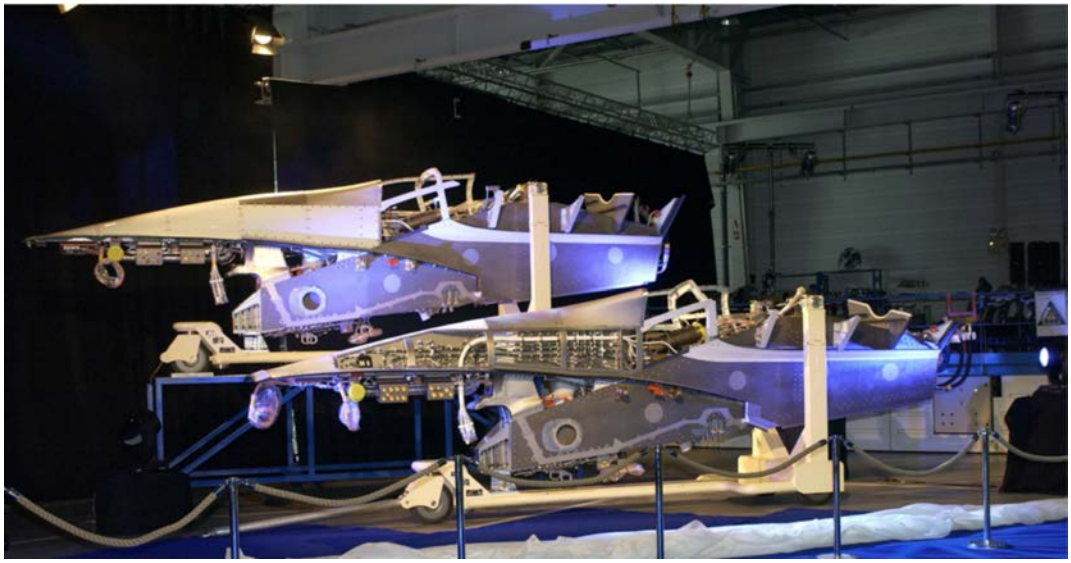

Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-3 Pylon on Display



Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-4 Empty Pylons

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Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-5 Engines on Pylons



Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-6 A380 with Engines

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Verify against the official publication.



Note. From "A380 Navigator", by Airbus, 2007, Manufacturing Process. Retrieved November 24, 2007, from http://events.airbus.com/A380/Default2.aspx?ArtId=644

Figure B-7 Pylons at Work

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L-3 COMMUNICATIONS AVIATION RECORDERS

L-3 Communications Aviation Recorders (L-3AR) provides the flight data recorder and cockpit voice recorder for the A380.

ROCKWELL COLLINS

Rockwell Collins' suite of communication and navigation sensors provides the baseline for the A380.

ALCOA

Alcoa supplies forgings, extrusions, sheet, plate, and castings for the A380's wing and fuselage skins, stringers, frames, spars, gear ribs, engine and pylon support, seat tracks and floor beams.

C&D AEROSPACE

California-based C&D Aerospace provides aircraft interior systems for the A380.

CYTEC - ENGINEERED MATERIALS

Cytec Engineered Materials produces composites, adhesives and carbon fibres.

EATON CORPORATION

US-based Eaton Corporation supplies the A380 with a highly-advanced higher-pressure hydraulic fluid power generation system, the world's first 5000-psi pump for a commercial aircraft.

M.C.GILL CORPORATION

M.C. Gill Corporation provides fully equipped composite floor panels for the cockpit of the A380, the main electronics bay situated below the cockpit and the emergency electronics bay, which sits forward of the upper deck passenger cabin.

MEGGITT SAFETY SYSTEMS

Meggitt Safety Systems Inc.(MSSI) supplies the fire detection systems for the A380's engines, auxiliary power units (APUs) and main landing gears.

MONOGRAM SYSTEMS

Monogram Systems, a unit of Zodiac's airline equipment branch in California, supplies an advanced water and vacuum waste system for the A380 that will incorporate state-of-the-art technical innovations.

NORTHROP GRUMMAN

The navigation systems division of US defence company Northrop Grumman supplies the A380 with its LTN-101E global navigation air data inertial reference unit.

PARKER

Parker Aerospace, a business unit of the Parker Hannifin Corporation, is participating in several work packages for the A380.

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HONEYWELL AEROSPACE	**RALEE**
Honeywell Aerospace will deliver 12 products and systems for the A380.	Ralee Engineering Company, a Triumph Group company based in California, supplies the wing top skin stringers (the metal structure that goes under the wing panels) for the A380.

Note. Created by Director Cadets 3, 2007, Ottawa, ON: Department of National Defence.

Figure B-8 Airbus A380 North American Suppliers

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