ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 7

EO C370.04 – CONSTRUCT AN ALUMINUM MODEL BIPLANE

Total Time: 360 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/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.

View reference C3-160 *Building the B.C. Air Originals Biplane* DVD.

Photocopy all templates and construct one set of wood jigs and wood templates located at Annex T for the cadets. Make Mylar templates of Figures 17T-1 and 17T-2. Using these templates and wood jigs, create parts for two aluminum model biplanes.

Assemble one aluminum model biplane for demonstration purposes, as shown at Annex AG.

Assemble one part for each assembly line.

Photocopy assembly line instructions at Annexes U to AF for each assembly line.

Photocopy one set of final assembly plans at Annex AG for each cadet.

Set up the classroom for the first set of assembly lines outlined in TP 1.

The workstations using power tools for cutting and tapering wood require supervisors.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to introduce cadets to aluminum model biplane construction in a safe, controlled environment. This activity contributes to the development of these skills and knowledge in a fun and challenging setting.

INTRODUCTION

REVIEW

N/A.

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OBJECTIVES

By the end of this lesson the cadet shall have constructed an aluminum model biplane.

IMPORTANCE

It is important for cadets to construct an aluminum model biplane because it will allow them to learn about mass production. The aircraft manufacturing industry employs precision mass production techniques to produce modern aircraft.

Teaching point 1 **Explain and Prepare Mass Production of Aluminum Model Biplane Parts**

Time: 70 min Method: Practical Activity



Show the cadets a completed aluminum model biplane.

At the beginning of the 20th century, vehicles were produced one at a time in a manner that today would be called customized. An American named Ransome Eli Olds applied the idea of an assembly line to produce his 1901 Curved Dash Oldsmobile in greater numbers. Henry Ford then improved the assembly line so that his 1914 Model T Ford was assembled in 93 minutes, thus making it possible for the majority of people to afford an automobile.

The Wright brother's 1903 Flyer was produced in a customized manner as well, but Olds' methods were soon applied to aeronautical manufacture when the Wright Aircraft Company was formed in Dayton, Ohio in 1909. Although the mass market for aircraft was slower to grow than the market for automobiles, World War I prompted the United States government to order thousands of aircraft.

Mass production is not limited to large assemblies. It can also be applied to production of models.



Production of parts for the aluminum model biplane will be carried out using a simple assembly line. However, final assembly will be by customization so that each cadet can make a unique model using mass-produced parts.



Show the cadets the parts needed for one aluminum model biplane as well as the templates, tools and raw materials that will be used in mass production.

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This EO is intended to introduce the cadets to the methods of mass production. All the parts for the aluminum model biplane will be fabricated by cadets working in assembly lines. However, this cannot be one big assembly line. There are more than 30 pieces, but because each part is very simple, the assembly lines are small and also simple. Some parts must be fabricated first, since other assemblies require them. To begin the process, start as many of the following 13 assembly lines as resources permit, providing work for each cadet:

- raw aluminum material assembly line (described at Annex U),
- wood assembly line (Annex V),
- aluminum billet assembly line (Annex W),
- aluminum panel shearing assembly line (Annex X) using billets from the previous line,
- cardboard insert assembly line (Annex Y),
- wire station assembly line (Annex Z), and
- drill station assembly line for bottle caps (Annex AA).

As soon as these assembly lines have produced materials for stock, the fuselage assembly line, the top wing assembly line, the empennage assembly line and the propeller assembly line can be formed to begin those processes.

Except for certain assembly lines, such as the Wood Assembly Line and the Drill Assembly Line, the cadets will be seated at their tables or desks within proximity of each other so that materials can be passed on for processing. For example, once a cadet with the template has marked an aluminum billet with the shape of the horizontal stabilizer, the billet must be passed on to the next cadet with scissors to be cut out. This is also the case with cardboard inserts. All such work takes place at a desk or table.



Beyond the initial start-up phase, timings for other assembly lines cannot be predicted since this depends on the speed at which individual lines work and the parts for aluminum model biplanes are made. As well, additional manpower may have to be provided for assembly lines that cannot keep up; any cadet can do this work but some cadets will be faster than others. The instructor is expected to balance manpower as work progresses.

To allow for spare parts, an additional 10 per cent of parts should be made above the amounts required. This is due to inevitable losses as a result of poor workmanship. Make enough parts so that each cadet can assemble at least one aluminum model biplane. If some cadets finish ahead of others, they can make additional models or be assigned to making additional parts for additional models.

ACTIVITY

Time: 65 min

OBJECTIVE

Two objectives of this activity are for the cadets in each work group to set up their work area and also for the cadets to learn to mass produce the parts for aluminum model biplanes.

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RESOURCES

- Instructions for constructing an aluminum model biplane,
- Example parts for each assembly line,
- Templates for constructing aluminum model biplane parts,
- Mechanic's gloves,
- Aluminum cans (36 per cadet),
- Softwood, 20 mm thick (fence boards),
- Bottle caps (ten per cadet),
- Corrugated cardboard,
- Tape (masking),
- Glue (two-part epoxy),
- Poster board (thin cardboard not corrugated),
- Mylar,
- Copper-coated welding rod or music wire (two sizes 1/16 inch and 3/32 inch),
- Ball-peen hammer,
- Pliers,
- Flat screwdriver,
- Rasp,
- Hand stapler,
- Staple gun,
- Push-pin,
- Hot glue gun,
- Awl,
- Wire cutter,
- Box knife,
- Scissors,
- Ruler,
- Felt-tipped pen,
- Needle-nose pliers,
- Adjustable wrench,
- Electric hand drill, and
- Hole saw bits (2-3/4 inch and 1-7/8 inch).

ACTIVITY LAYOUT

- Arrange assembly lines as shown in the layout figures located at Annexes U to AA.

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- Provide a shop environment for the wood assembly line.

ACTIVITY INSTRUCTIONS

1. Organize the cadets into the work groups described at Annexes U to AA, providing them with wood jigs and prefabricated wood templates constructed from the templates in reference C3-146, or those located at Annex T, as required.

2. Assembly line assignments include:

Raw Aluminum Material Assembly Line (Annex U)

Prepare aluminum billets from aluminum cans by:

a. washing the aluminum cans and removing the pull tabs;

b. removing the bottom from one can per biplane (parts B-1 to stock);

c. removing the bottom from one can per biplane leaving 2-inch tops (parts B-3 to stock); and

d. removing the top and bottom from fifteen cans per biplane (raw blanks to stock).

Wood Assembly Line (Annex V)

Produce wood rounds for aluminum model biplane fuselages by:

a. cutting 3/4 inch thick rounds (2-3/4 inch and 1-7/8 inch diameters); and

b. tapering wood rounds 10 degrees to create F-1 and F-2.

Aluminum Billet Assembly Line (Annex W)

Cut cans vertically on the nutrition label (blanks).

Aluminum Panel Shearing Assembly Line (Annex X)

Using raw aluminum billets from stock, fabricate the following parts:

a. aluminum panels (dimensions 2-5/8 inch by 8-1/8 inch) for under-wing panels, and

b. aluminum panels (dimensions 3-5/8 inch by 8-1/8 inch) for wing panels bent 90 degrees on the1/8 inch edge.

Cardboard Insert Assembly Line (Annex Y)

Fabricate the following parts from corrugated cardboard sheets:

a. cardboard inserts for Bottom Wing (BWC) 7-1/4 inch by 2-5/8 inch,

b. cardboard inserts for Bottom Wing (BWAS) 6-1/2 inch by 3/4 inch,

c. cardboard inserts for Top Wing (TWC) 18-1/4 inch by 2-3/4 inch,

d. cardboard inserts for Top Wing (TWAS) 18-1/4 inch by 3/4 inch,

e. cardboard inserts for Horizontal Stabilizer (HS) from Template No. 8, and

f. cardboard inserts for Vertical Stabilizers (VS) from Templates No. 9/10.

Wire Station Assembly Line (Annex Z)

Fabricate the following parts from wire stock:

a. 3/32-inch welding rods 7-3/4 inches long and bend landing gear wire,

b. 1/16-inch welding rods 6-3/4 inches and bend landing gear support wire,

c. 3/32-inch wire 15-3/4 inches long for wing spars, and

d. 3/32-inch wire 18 inches long for propeller shaft.

Drill Station Assembly Line (Annex AA)

Perform the following operations:

a. Drill a 3/32-inch hole in the centre of bottle caps for wheels.

b. Drill a 3/32-inch hole in the centre of can B-1 for front fuselage.

c. Drill a 3/32-inch hole in the centre of can P-2 for propeller.

d. Drill a 3/32-inch hole in the centre of can P-1 for propeller face.

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e. Enlarge holes A, B and C in fuselage assembly to 3/32 inch.

f. Enlarge hole D in fuselage assembly to 1/16 inch.

g. Enlarge holes E and F in fuselage assembly to 10-24 bolt size, as required.

h. Enlarge eight bolt holes in top wing for 10-24 bolts as required.

I. Enlarge four bolt holes for 10-24 bolts in bottom wing as required.

3. Inform the cadets that they will be rotated among the workstations.

4. Assign the cadets to workstations.

5. Have each work group produce units for prototype assembly as well as stock for assembly line start-up in subsequent mass production sessions.

6. When sufficient parts have been fabricated for building more than two aluminum model biplanes, halt production and, as a demonstration in front of the class, assemble a prototype aluminum model biplane by combining the fuselage, upper wing and empennage. Do not attach propeller or landing gear at this stage.

SAFETY

- Supervised assembly lines, including the hole-saw station and the rasp station, will be used by one cadet at a time. Each of the supervised stations, using electric power tools, must be constantly supervised.
- Before beginning, ensure each cadet can perform the activity safely.
- Cadets shall wear mechanic's gloves while working with sharp materials.

CONFIRMATION OF TEACHING POINT 1

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

Teaching point 2 **Demonstrate, Explain and Have the Cadets Manufacture the Parts for Aluminum Model Biplanes**

Time: 120 min Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets experience mass production of various aluminum model biplane parts at a variety of workstations.

RESOURCES

- Instructions for constructing an aluminum model biplane,
- Templates for constructing aluminum model biplane parts,
- Mechanic's gloves (one pair per cadet),
- Empty aluminum beverage cans (36 per cadet),
- Bottle caps (ten per cadet),
- Corrugated cardboard,
- Tape,

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- Glue (two-part epoxy),
- Poster board (thin cardboard not corrugated),
- Mylar,
- Copper-coated welding rod or music wire (two sizes 1/16 inch and 3/32 inch),
- Ball-peen hammer,
- Pliers,
- Flat screwdriver,
- Hand stapler,
- Staple gun,
- Push-pin,
- Hot glue gun,
- Awl,
- Wire cutters,
- Box knife,
- Scissors,
- Ruler,
- Felt-tipped pen,
- Needle-nose pliers,
- Adjustable wrench,
- Electric hand drill, and
- Hole saw bits (2-3/4 inch and 1-7/8 inch).

ACTIVITY LAYOUT

A classroom with desks or tables for work groups with assignments.



Assembly lines can be combined to work together if space and manpower permit. Lines should be selected and set up based on resources such as cadet manpower, working area and also manufactured parts that are available from previous work sessions. For example, the Top Wing assembly line cannot begin without the aluminum panels and cardboard panels provided by previous assembly lines. However, the Top Wing Assembly Line (Annex AD) can operate concurrently with the Aluminum Panel Shearing Assembly Line (Annex X) and the Cardboard Insert Assembly Line (Annex Y) if space and manpower permit.

ACTIVITY INSTRUCTIONS

1. Assign cadets to workstations.

2. In addition to the work groups and assembly lines already used, if still required, the following work groups and assembly lines will be established as manpower becomes available:
Aluminum Rear Fuselage Assembly Line (Annex AB)
Fabricate the rear fuselage from the following parts:

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a. raw billets from scissor station,
b. softwood parts F-1 from stock,
c. softwood parts F-2 from stock, and
d. fabricated rear fuselages from assembly stations 1–6.

Fuselage and Bottom Wing Assembly Line (Annex AC)

Combine parts B-1, B-2, wood rounds and staples to make fuselages and bottom wings.

Top Wing Assembly Line (Annex AD)

To fabricate top wings:

a. combine cardboard parts TWC, TWAS and three pre-bent aluminum panels dimensions of 3-5/8 inch by 8-1/8 inch to form top wing (all from stock);
b. insert panels (dimensions of 2-5/8 inch by 8-1/8 inch) under wing (from stock);
c. staple top wing (ten staples); and
d. apply Wing Bolt Hole Placement Template (WBHPT) to top of top wing and with a push-pin, make eight holes for bolts in the top wing (top wing to stock).

Empennage Assembly Line (Annex AE)

Fabricate the empennage by combining the following parts:

a. aluminum horizontal stabilizer – Bottom,
b. aluminum horizontal stabilizer – Top Right,
c. aluminum horizontal stabilizer – Top Left,
d. cardboard insert HS – Horizontal Stabilizer, and
e. cardboard insert VS – Vertical Stabilizer.

Propeller Assembly Line (Annex AF)

Fabricate the fan propeller by combining the following parts:

a. aluminum propeller, and
b. aluminum propeller cover.

3. Inform each work group of the number of parts they will make.

4. As each work group completes fabrication of a particular part, have the cadets produce other parts until all parts required are in stock.

5. Ensure that each cadet fabricates a variety of parts.

SAFETY

- Supervised assembly lines, including the hole-saw station and the rasp station, will be used by one cadet at a time. Each of the supervised stations, using electric power tools, must be constantly supervised.
- Before beginning, ensure each cadet can perform the activity safely.
- Cadets shall wear mechanic’s gloves while working with sharp materials.

CONFIRMATION OF TEACHING POINT 2

The cadets’ participation in the activity will serve as the confirmation of this TP.

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Teaching point 3 **Demonstrate, Explain and Have the Cadet Construct an Aluminum Model Biplane**

Time: 150 min Method: Practical Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadet assemble an aluminum model biplane.

RESOURCES

- One complete set of parts for one aluminum model biplane per cadet,
- Instructions for assembling an aluminum model biplane parts located at Annex AG,
- Tape (masking),
- Glue, and
- Tools, to include:
  - ball-peen hammer,
  - pliers,
  - flat screwdriver,
  - hand stapler,
  - staple gun,
  - glue gun,
  - awl,
  - wire cutters,
  - box knife,
  - scissors,
  - ruler,
  - felt-tipped pen,
  - needle-nose pliers, and
  - adjustable wrench.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Divide the cadets into groups of four.
2. Demonstrate the assembly of the aluminum model biplane.
3. Ensure that every cadet is ready to proceed before moving to the next step in the assembly.

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4. Assist each cadet with installation of landing gear to prevent tearing the aluminum fuselage.

SAFETY

Cadets shall wear mechanic's gloves while working with sharp material.

CONFIRMATION OF TEACHING POINT 3

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

END OF LESSON CONFIRMATION

The cadets' participation in aluminum model biplane parts fabrication and aluminum model biplane assembly will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Construction of an aluminum model biplane using mass production of parts demonstrates one of the ways that society produces large volumes of equipment, including increasingly complex aircraft.

INSTRUCTOR NOTES/REMARKS

Templates, models and spare parts should be preserved for future training years.

Scheduling this lesson as a weekend activity will reduce preparation and cleanup.

Before beginning the instruction of this EO the instructor shall be familiar with the aluminum model biplane assembly techniques shown at references C3-146 and C3-160.

This lesson may be conducted over a number of separate sessions.

REFERENCES

C3-146 Mathis, D. P. (2005). *Step by Step Construction Plans: Classic Biplane*. Helena, MT: BC Air Originals.

C3-160 Mathis, D. P. (2007). *Building the B.C. Air Originals Biplane*. Helena, MT: B.C. Air Originals.

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