The Canadian Aircraft Mechanic: An Introduction

INTRODUCTION

If you are considering a career as an aircraft mechanic, you should be encouraged by this brief look at the history and the present situation of Canadian aviation. You will discover that air travel has been of particular importance in this country, due to our vast geographical territory, and long distances between population centres.

Canada is the sixth leading country in the world in terms of total kilometers flown. This translates into an annual load of sixty million passengers and over 550 thousand cargo tons. Moreover, Canada is second only to the United States in the number of registered civil aircraft and the size of the airway and air route system.

Canada's role in aviation is further strengthened by our being the host country for two important international organizations: the International Civil Aviation Organization (ICAO) and the International Aviation Management Institute, both of which are located in Montreal.

Despite harsh weather conditions, Canada has one of the most impressive aviation safety records in the world. This is due in large part to the skills and diligence of more than 12,000 (and growing) aircraft mechanics and repair persons employed in this country. This course will hopefully allow you to find a place among the ranks of this proud and highly successful group of people.

A BRIEF HISTORY OF POWERED AIRCRAFT

Early Successes

As one who will be spending their working lives in the field of aviation, you should be aware of its historical highlights and its rapid development throughout the twentieth century.

The earliest attempts at aviation involved odd contraptions attempting to imitate the flight of birds. Some had disastrous results, while none were significantly successful. On the other hand, the first successful flights involved balloons and gliders; and, although both have survived into the present era, in this section we will concentrate on only the development of powered aircraft.

After many misguided attempts worldwide, the first successful powered aircraft flight was undertaken in 1903 by Wilbur and Orville Wright. Their first flight travelled only 120 feet—about as far as a reasonably long football pass, but later that day they managed to stay up 850 feet. This rapid progress would soon become characteristic of the budding aviation industry.

In 1905, the Wrights' third aircraft managed a flight of 24 miles. By this point there was little doubt that they and several other early inventors were onto something that would have a profound effect upon the industrial development of the era.

In 1906, a string of ambitious European failures ended with Alberto Santos-Dumont's flight of 722 feet with a plane whose wings resembled a box kite. Although the design would later be scrapped, the flight inspired many other European aviators.

The Wrights' design was the biplane, with two parallel wings. Fearing the fierce competition of other pioneers, they were prompted to immediately explore the possibility of military applications for their invention.

In 1908, Wilbur Wright went to France to demonstrate his “Flyer.” By that time, the designs of other successful European inventors showed great stability, but still the Europeans benefited greatly from the piloting expertise of the brothers.

The invention of the monoplane is credited to Trajan Vuia. Although he never managed a sustained flight with his experimental craft, his work directly inspired another ambitious inventor, named Louis Bleriot. In 1909, Bleriot made it across the English Channel in a monoplane design with the most powerful engine of that time.

By 1910, there were so many other successful aircraft that the Wrights and their designs were no longer particularly influential. Improvements followed at a rapid pace. In 1911 a German crew pioneered a primitive forerunner of the retractable landing gear. By this point getting off the ground was no longer a problem. Designers were already looking for speed and efficiency.

Early pioneering in aviation was not without risk. Noted French pilot Leon Delagrange was killed in an accident while flying a Bleriot plane in 1910. In 1913, the best known British aviator of the day, Samuel Cody, also lost his life during an air show.

The Impact of World War I

In 1911, airmail services began, and the first aircraft were armed for war.

World War I led to the rapid development of aircraft for military purposes by governments. Most early planes were biplanes (the British, for example, stubbornly stayed with biplane designs well into the 1930s). The Germans were instrumental in pioneering the monoplane. Early models were built primarily of wood and wire type structures. However, well before World War I, planes made largely of metal were becoming successful. They sported a tube-shaped fuselage to which the wings, tail, and landing gear were attached. Some of these planes showed an amazing similarity to small planes that are still flying today.

Dutchman Anthony Fokker was instrumental in building military aircraft for the Germans during World War I. The Germans were the first to achieve military successes in the air. Fortunately the allies were able to turn the tide as the conflict progressed with Canada playing a key role, as will be described in a later section.

A Steady Parade of Advances

During the 1920s, several minor refinements were made, but basic designs still included wire bracing, external struts, and water-cooled engines. In 1927, Charles Lindberg set a milestone in aviation history when he flew across the Atlantic Ocean in the “Spirit of St. Louis” to win a well-publicized international contest. One result of this famous success story was the proof of the reliability of air-cooled engines and their subsequent widespread acceptance.

Many early design improvements were spurred by these international competitions. By the late 1920s, the engines were much better designed and more efficient. Retractable landing gears were perfected, but did not see widespread use until the early 1930s.

Pratt & Whitney, perhaps the most famous builder of aircraft engines, launched its first engine, the Wasp, in 1926. It soon became a significant competitor of the Wright Company for U.S military contracts.

Around 1930 the first experimental helicopters were developed. Actually, the first helicopter was designed by Leonardo da Vinci back around 1500. The predecessor of the modern helicopter was the autogyre, or gyroplane, developed by Juan de la Cierva, and was in use in many parts of the world between 1925 and 1940. Many of these resembled a cross between airplanes and modern helicopters.

The first true helicopter was built and flown in 1942 by Igor Sikorsky who was an American of Russian descent. Other than in size and speed they have changed relatively little since first developed. From the 1930s onward, the pace of progress was even more rapid. Artificial wind tunnels were constructed in order to study, test, and perfect wing shapes.

The first twin-engine aircraft were flown in the early 1930s, but by the end of the decade several four-engine designs had been introduced. By World War II, some very sophisticated aircraft were used in battle and in transport. Aircraft from this era are still in use today, though mainly in association with museums and air shows.

By the mid 1930s, the major American and international aircraft manufacturers were already active. Boeing introduced its model 247 in 1933. The Douglas DC series soon followed. These were large aircraft that were reasonably soundproof and equipped with electronic navigational instruments. Other major manufacturers active at the time included de Havilland and Hawker Siddeley.

The development of avionics kept pace with that of aircraft design. For example, the first automatic pilot was developed by Sperry in 1914. It was designed to sense deviations in flight patterns and automatically adjust the movable control surfaces. While flight control was the first major concern, avionics soon progressed into the areas of navigation and communications.

World War II provided the impetus for rapid development of jet engine technology, though relatively few jet-powered planes saw action during the conflict. The British Gloster, American Bell and German Messerschmitt were early pioneers. During the war many experiments were also undertaken in supersonic flight, although the first successful flight did not occur until 1947, with the famous Bell X-1.

The Jet Age

Jet engines came into their own in the late 1940s. The de Havilland Comet of 1949 was a pacesetter in high-speed, jet-powered flight.

From the 1950s onward, two major trends would infiltrate the industry: an increased emphasis on civilian over military use, and a steady escalation in the size of commercial passenger aircraft.

Between 1958 and 1961 several propeller-turbine (turboprop) airplanes were developed for short to medium routes. Similar aircraft are still in use in many parts of the world today.

Today's Boeing 747 and 767 are examples of the successful development of safe and efficient "jumbo jets" that have revolutionized international air travel. The other main area of rapid innovation has been in the design and production of small corporate jets capable of high speed and high altitude flight, such as those pioneered by Learjet. By contract, the commercial supersonic jets such as the Concorde are fast and reliable but are very expensive to operate and have not proved that they are practical for widespread use.

Today, the makes and models of international aircraft are far too numerous to mention. The American firms like McDonnell Douglas, Boeing and Lockheed continue to lead the industry among aircraft manufacturers. General Dynamics is a major manufacturer of U.S. military aircraft. As for engine manufacturers, the "big three" are Pratt & Whitney, Rolls-Royce, and General Electric. Prominent helicopter manufacturers include Kaman, Bell, Westland and Sikorsky.

Virtually all of these manufacturers have suffered in recent years. Reduced government spending on military aircraft and a poor economic climate has resulted in a lower demand for aircraft engines. Despite the fact that air travel is a permanent and indispensable factor of modern life, most major airlines today are losing money, and several have folded or have been swallowed up by more successful competitors.

The last three decades have also seen worldwide proliferation of small planes, helicopters, and private jets. The basic small planes introduced by Piper, Cessna, Beech, as well as others, continue to be popular. Most often these small planes land at smaller airports and flying clubs. Occasionally, they take their places in line-ups on larger runways, dwarfed by the large commercial jets around them, thus showing how much has changed—and how little has changed—since the days of the Wright Brothers and Charles Lindberg.

MILESTONES IN CANADIAN AVIATION

1909	First flight of a Canadian powered aircraft took place in Baddeck, NS. This flight was the culmination of efforts by a group of inventors organized by Alexander Graham Bell. On February 23, 1909 John McCurdy flew the “Silver Dart” a distance of four and one half miles. The “Silver Dart” was the most sophisticated aircraft developed at that time.
1910	First use of radio communication between an aircraft in flight and the ground.
1914–1918	Canada starts large scale manufacturing of various types of planes and training of military pilots.
1919	Federal government began regulating civil aviation. This move was in response to the fact that during World War I, 2500 Canadians were trained as pilots. Initially, the regulations were to promote safety concerns. Following the war, many of these trained pilots purchased aircraft and some involved themselves in “barnstorming”—acrobatic flying at air shows.
1928	De Havilland Aircraft of Canada was established in Toronto, Ontario.
1929	Pratt & Whitney was established in Longueuil, Quebec.
1937	Trans Canada Airlines was established. This airline became the first large national airline.
1940–1949	Establishment of Canada’s major regional carriers: Quebecair, Pacific Western, Eastern Provincial Airways and Nordair. Canadair Ltd. was established by the federal government as a Crown Corporation and took over the aircraft operations of Canadian Vickers in Cartierville, Quebec. Canadair played an important role in producing military aircraft.
1953	Wardair began as a charter operation.
1964	Trans Canada Airlines changed its name to Air Canada.

BASIC AIRCRAFT COMPONENTS AND TERMINOLOGY

Airplane Components

Although you will be given more complete definitions and illustrations once you enter the technical portion of your program, it might be helpful at this time to run through some of the general components of a “typical” airplane. This will allow us to refer to some of these items throughout the balance of this study unit.

The body of an airplane contains the fuselage (cigar-shaped portion), wings and tail. Various movable control devices are distributed around the aircraft. The flaps (nearer the fuselage) and ailerons (nearer the wind tips) are hinged sections of the wing that can be raised and lowered. A typical airplane tail has two horizontal pieces and a vertical section, all of which have hinged control surfaces on their tailing edges. The control devices on the horizontal tailpieces are called elevators. The control piece on the vertical section of the tail is called the rudder. All of these devices work together for controlling climb, descent, and bank (turning).

The cockpit is located at the front of the fuselage. In a small plane it is equipped with fairly simple column and pedal controls that slightly resemble those of an automobile. These devices operate the movable control surfaces described above. The pedals control the rudder. The column is turned like a steering wheel to operate the ailerons, and is moved forward or backward to operate the elevators.

Aircraft engines vary greatly from simple gasoline piston engines, much like those used in cars, to large jet engines. Most gasoline piston engines rotate propellers, although jet engines can also be incorporated with propellers. Most true jet engines have a fan or “turbofan” in the front, and a thrust cone at the rear. These components are visible and familiar to most airline travellers.

Larger modern aircraft are constructed with metal frames over which a metal skin is stretched. In some portions of the aircraft, the structure looks a bit like studs and wallboard used in home construction. In other places, however, the design is more sophisticated, such as the fin torsion boxes built into many tailpieces.

Helicopter Components

Helicopters (rotorcraft) also contain some general features. Instead of wings, helicopters use rotating rotor blades that are attached to a rotor assembly. Small helicopters have as few as two rotors: a main one, and a smaller one at the tail. Complex designs can incorporate half a dozen or more rotors. Helicopter engines are located directly beneath the main rotor.

The body of the helicopter includes the main cabin. It usually lies beneath the main rotor and the tail. The tail is invariably equipped with an "anti-torque tail rotor." The main purpose of the tail rotor is to prevent the action of the main rotor from simply spinning the helicopter around in circles.

Maintaining control of a helicopter is slightly more complicated than that of a traditional airplane. The angle to which the rotor is tilted, and the pitch of the leading edge of the rotor blades, affect the control. Both of these are adjustable in flight. A helicopter hovers when the speed of rotor rotation and the pitch of the blades exactly overcome the gravitational pull on the helicopter. Climbing is achieved by increasing the pitch of the blades.

You may be surprised to hear that rotor speed remains fairly constant during all flying conditions. However, the amount of power that the engine must produce to maintain that constant speed varies significantly as the helicopter climbs, descends, or moves forward.

In order for the helicopter to move forward or sideways, the rotor is tilted slightly in the desired direction. The degree of tilt also affects the speed of forward movement.

THE WORK OF AIRCRAFT MAINTENANCE ENGINEERS

Maintenance Organizations

No doubt, as someone interested in a career in this field, you have some idea of the work, which Aircraft Maintenance Engineers (AMEs) undertake. However, you may be amazed by the diversity of duties and responsibilities which fall under a general job description for this occupation. Not only is there considerable variety in types of aircraft, but there are also various specialties or areas of concentration regarding the type of work to which a specific AME is assigned. There is too much work to be done for any one person to do everything. Thus, particularly among larger maintenance organizations, there is a tendency toward specialization.

Many AMEs in Canada work for an Approval Maintenance Organization (AMO). As you get deeper into your program, and in particular when you study the Canadian Aviation Regulations, you will learn much more about what an AMO is, how it is certified and how it functions. In brief, an AMO may be a company, which only services aircraft, and does not own or operate them, or it may be internally set up by an airline as a maintenance organization. If the AMO is part of a major airline, it might perform a wide range of servicing functions, while still jobbing out certain specialized tasks to an outside firm. If the AMO is an independent company, it may offer a wide range of services, or it may tend to specialize in one particular field, such as engine overhaul.

The work you perform after you obtain your AME license will depend upon several factors, including the category (or categories) in which you are certified, as well as the requirements of your future employer. It is possible that you may specialize in one facet of aircraft maintenance for awhile, and then change jobs or move on to other duties. This is one reason why this program is broad-based, attempting to teach you a little bit of everything and provide you with a foundation that can easily be expanded with detailed training in many different directions.

In this section, we will describe the work of AMEs in general terms, covering all of the work which any AME is likely to undertake. No one person would do all of these things on a routine basis. However, it will be useful for you to view the range of possibilities. Because we are taking a broad approach, not all specialized tasks are mentioned in this brief introductory presentation.

There are many ways that duties can be classified. For example, regardless of the aircraft type, specific tasks will tend to fall into one of the following headings: routine maintenance, periodic inspection, routine repairs and replacement of components, major repairs or overhauls, record keeping, log keeping, certification of work, and administrative duties.

General Duties

Duties on a routine maintenance can be as simple as charging systems such as those containing oxygen, nitrogen, or freon; refueling; or de-icing. AMEs also become involved in moving aircraft from place to place on the ground, whether by towing or taxiing. They must know how to park and secure an aircraft and how to moor it (particularly in the case of light aircraft that may be exposed to high winds).

All aircraft and major components must undergo special, detailed inspections after a predetermined period of operation, such as after 100 hours of flying time. The specific nature of inspection duties on such occasions will vary greatly, depending upon the type and make of aircraft.

There are some record keeping and administrative duties, however, that tend to apply generally to any type of aircraft. For example, government regulations dictate precise steps, which must be taken to record all maintenance work, which is performed on any aircraft. An AME must ensure that maintenance work performed on an aircraft, or an aircraft part, is done in accordance with airworthiness standards. An AME must sign a maintenance release (indicating name and license number) for any work done. Signing a release acknowledges that the AME takes responsibility that the work was done correctly, even if the work was performed by other maintenance personnel.

AMEs record most of what they do in specially designed log books. You will be given a detailed presentation on the types of logbooks used in Canada later in your program. There are also various types of maintenance tags that are affixed to components undergoing maintenance. Again you should be aware that the use of such items is often prescribed by law, and is not merely a matter of company procedure.

In general, you would do well from the outset to understand that maintenance records are often considered as important as the maintenance itself. Any time that you make a written record of something you have done, you must do so with great care, precision, and honesty. For example, there are many circumstances in which a mechanic may be unable to complete a repair, for any number of reasons. By making a correct log entry explaining exactly what you were—and were not—able to do, you not only cover yourself, but you may avert a disastrous misunderstanding. There is no room for assumptions in aircraft maintenance. Other people will come onto that aircraft after you have walked away from it. They need to know the exact status in which you left things.

There are various other administrative duties, besides the keeping of logbooks. Examples of other technical documents or records include weight and balance reports, service difficulty reports and calibrations records. Mechanics also become involved in matters such as inventory control systems, preparing shipping documents, and waste disposal.

Working on Airframes

Duties on an aircraft can be subdivided according to the general area of the aircraft involved. The major categories are: airframes, engines, avionics and electronics, and special systems related to rotorcraft (helicopters).

Airframes serve as a good starting point, since they cover the bulk structure of the airplane itself, independent of its engines and technical equipment. This is not to suggest, however, that there is little technical know-how required for airframe maintenance. Airframe structure has become quite complex particularly on large commercial aircraft. Airframes also include secondary systems such as oxygen, pressurization, anti-ice, brakes and fuel supply.

Many portions of the airframe experience high levels of stress. As a result of these high stress levels, engine mounts and landing gears are given rigorous, detailed inspections. However, attention must be given to virtually every section of the airframe: including windows, doors, emergency exits, lavatory components and even seat belts. A wide range of these sections are repaired or replaced regularly.

Some smaller aircraft also have special equipment such as floats, skis or installations that allows them to conduct specialized tasks such as aerial spraying. These items also require maintenance and inspection.

Working on Engines

Aircraft engines can be classified as either piston (similar to those in an automobile) or turbine (jet). Obviously many specific tasks will vary greatly from one type to another, or even among models of the same type.

However, some general tasks apply to all aircraft engines. These tasks fall into two broad categories: certification of airworthiness, and maintenance and repair.

Certification of Airworthiness involves a variety of inspection duties and tests. Many components and subsystems must be examined on a regular basis, such as engine controls, exhaust systems, fire detection systems, or reverser systems. Sometimes a test will focus on one very specific item, such as a magnetic chip detector. In other cases, inspections focus on general engine performance. Most aircraft have procedures for conducting an engine run-up as well as for trend monitoring and vibration tests.

Maintenance and Repair occurs after periods of operation. At such time, engines are partially stripped down, internal tests conducted, and measurements taken. On a piston engine this might involve a measurement of tappet clearance, or using a borescope to view internal components. On a jet engine, this might involve the measurement of fuel spray patterns. Of course, there are also general duties, such as reviewing records and service manuals, cleaning engines, oil inspection, and fuel filter replacement.

Working on Avionics and Electronics Systems

Detailed work on avionics instruments is a specialty field that requires training above and beyond the scope of apprenticeship programs. However, all AMEs should have a general understanding of aircraft instruments, and be prepared to participate to some degree in their inspection and routine maintenance.

Perhaps the best way to grasp the complexity of this portion of aircraft maintenance work is simply to list some of the areas that fall into this category. They would include

- antennas
- communications systems
- auto pilots
  - flight management systems
- ice protection systems
- flight data and cockpit voice recorders
- lighting and emergency lighting systems
- compasses and a broad range of navigational instruments
- altimeters
- fuel gages
- a wide range of warning systems (e.g., stall warning)
- a wide range of indicators (e.g., trim indicator)
- annunciator systems
- engine indicators

Any one of these areas could be further separated into subheadings. For example, navigational instruments could include compasses, inertial and global positioning systems, emergency locator transmitters, radio direction finders, radar and storm scopes, as well as microwave landing and distance measurement equipment.

At first glance the avionics field appears intimidating. However, the introductory level presented in this program can actually be a fascinating area of study. Later in your program, we will take you through each area or system in the smallest to the largest of aircraft. These study materials focus on presenting what each item does and how it works, rather than list the troubleshooting procedures. Once you understand the basics, it is easy to pick up traditional skills in the field through hands-on training, and access to manufacturers' service manuals.

As mentioned earlier, detailed repairs to the avionic and electronic systems of the aircraft are left to specialists. Typical duties carried out by an AME might involve replacing a component, conducting relatively straightforward field tests, adjusting instruments on a regular basis and maintaining an update of their performance records.

Working on Helicopters

Some AMEs end up working on helicopters, rather than airplanes. If so, there are various specialized systems related to helicopters that can be broken down into two main categories: inspection and maintenance of propellers, and inspection and maintenance of the rest of the rotary system.

As well, most of the types of maintenance requirements that we have already discussed are applicable, since helicopters also have airframes, avionics, instruments and engines.

You will learn as you get deeper into your course that propellers are more complex than they appear. There are many routine tests and inspections for propellers, including measuring blade dimensions and angles, checking blade tracking, and confirming the security of blade mounting. Propellers must also be balanced and lubricated. Relatively few actual repairs are made to a propeller. If one becomes damaged, it is generally replaced.

The rotor system includes the rotor and hub assembly, mast assembly, transmission, clutch assembly, and a wide range of secondary systems and components. Routine maintenance involves inspection of almost every area in the system, as well as vibration testing and may indicate the need to replace such items as belts, rod ends and bearings.

Level of Work

In a presentation such as this, we can only scratch the surface of the maintenance work required on modern aircraft. As you begin to work through the more detailed training material, which follows, you will gain a greater appreciation of the actual tasks. We will present numerous, detailed illustrations of aircraft parts being serviced, and highlight the appropriate tools, materials and work methods.

You should not be overwhelmed by how much there is to learn. At this point, you are undertaking required theory training. Your goal is to understand what is presented rather than memorize it. You would never be expected to put your books down, walk over to an aircraft that you have never seen before, and begin working on it all by yourself. Before this happens, you will have gone through practical training, much of it provided by the company that will hire you. Your specific assignments will depend on the level of your experience and AME license. In the beginning you will always work closely with someone else. As you progress, you will be able to undertake increasingly difficult tasks. The most difficult tasks will usually be saved for senior personnel, often working together with outside consultants or manufacturers' representatives. Even senior mechanics do not know everything and must continuously update their knowledge through seminars, special courses, and working with experts brought in to help with special situations.

However, just as you cannot become fully qualified to repair and rebuild an aircraft simply by theory training, neither can you go out and learn in the field without it. Without the background, which this program provides you, you would not be able to have a sufficient understanding of an aircraft to be able to work on it competently, no matter how many times you watched someone else perform a particular task. This is why theory training is required by Transport Canada as an important foundation for AME licensing requirements. Your program is recognized by Transport Canada as fulfilling the Basic Training requirement for AMEs.