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AIRCRAFT OF THE FORESTS

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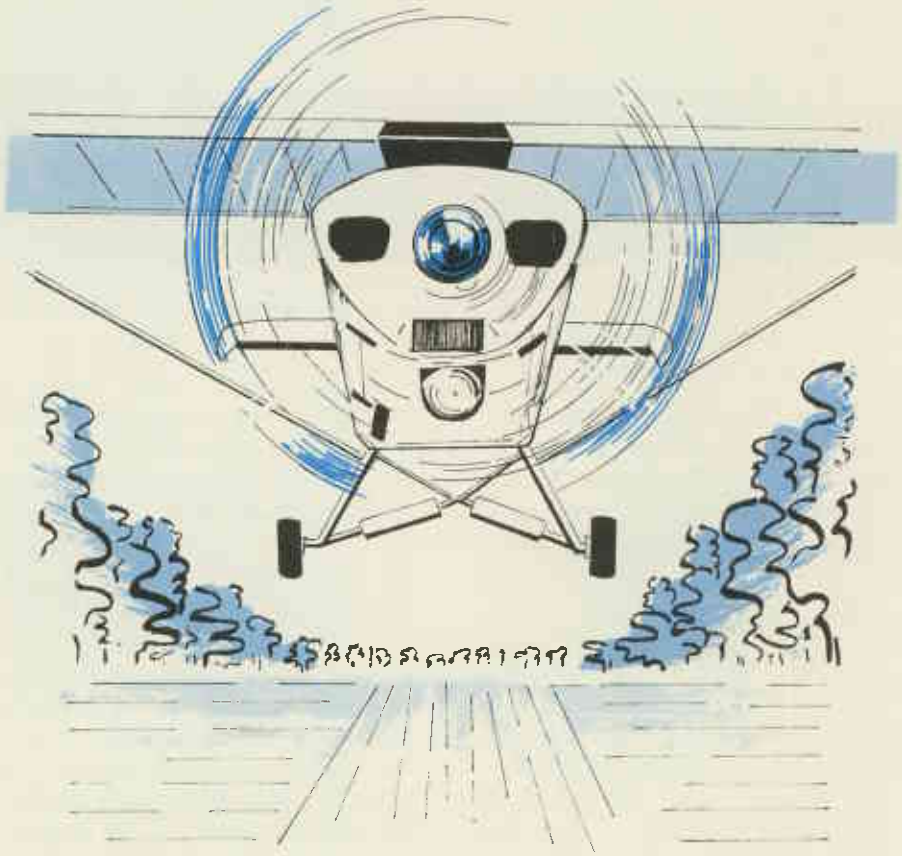


"Necessity is the mother of Invention", so the proverb says, and the development of forest management techniques is no exception to the rule. The south-west of Australia is endowed with unique eucalypt forests which have evolved under a set of specific conditions. Here we have the combination of hardy forests, flat, accessible terrain and harsh climatic variations in rainfall and temperature. Because of the climate most of Australia's open forests are subject to frequent wildfire, and have evolved with fire. In Western Australia the annual fire risk is acute. It is not surprising, therefore, that in the area of fire protection and research the Western Australian Forests Department is among the world leaders. Fire surveillance commenced locally with the well-known tree lookout system for fire spotting (see *Forest Focus* No. 23). Now with the advancement of technology, an even better system has been developed for fire management and forest protection. In 1966 aircraft were introduced into the Department to meet the need for fire management. Since then, aircraft have been integrated further into forestry and are now used not only for protection, but also for fauna, fire and dieback research, crop dusting of plantations and arboreta, broadcasting of scrub seed for revegetation of damaged forest sites, and management projects requiring aerial photography. However, the major impact of aircraft in Western Australian forestry has been in the long-term broad-scale projects of the Protection, and Inventory and Planning branches of the Department.

▲ The current model Cub is directly developed from a similar high-wing monoplane used in World War II for reconnaissance after bombing raids. It is shown here over the jarrah forest (G. van Didden)

Inside the Super Cub. The tandem seating arrangement is especially suited to surveillance work, as 180° viewing is available without tilting the aircraft (Les Harman)

Three types of aircraft are used at different times of the year for different reasons. The Britten-Norman Islanders are used for burning and photography in spring and autumn operating all over the south-west. These are twin-engined aircraft, capable of carrying ten persons. They are re-fitted for forestry operations. The single-engined Cessna and Piper Super Cubs are used primarily for fire spotting in the summer months and operate from Dwellingup, Nannup, Collie and Manjimup. They can carry two persons.

Fire Detection

The concept of fire spotting from aircraft is not new. The Forests Commission of Victoria for example, used airborne spotters as early as the 1930s, commencing an occasional usage of aircraft in eastern states forestry ever since. In Georgia, in the United States of America, the Piper Cub is now used for the same job, but on a smaller scale than that used in Western Australia. Many countries of the world use aircraft for forestry operations, but again the need for fire surveillance is not so great as it is here, and not so highly developed. It was not until 1972 that the concept was tested for Western Australian forest conditions, and found to be particularly successful. The comparatively flat terrain of the south-west is very suitable for light aircraft flight operations, compared with that of New South Wales, for example, where the mountainous terrain is too treacherous for comprehensive surveillance by aeroplane. Overall, the aerial spotting system costs less than manned tree and tower lookouts, and the efficiency of accurate and immediate aerial interpretation of a blaze far outstrips methods used in the past by foresters on the ground.

Originally the Cessna 150 was used for fire detection but has now been superceded by the more powerful Super Cubs which are lighter and provide greater visibility, with the turned-down nose and tandem seating arrangement. Nineteen pilots are contracted for six or seven months of the year, working throughout the fire season from November to April. Unlike other pilots employed seasonally, John Woodward of Dwellingup returns each summer for the spotting. The exacting job of continued surveillance would seem tedious to some, but to John, now in his fourth season, the summer spotting is very much a way of life. Boredom is out of the question he says, because of the arrangement of the shifts and flight circuits. Pilots are on a rotating roster working mornings or afternoons, for only about two to three hours at a time, and for a maximum of 30 hours per week in compliance with air safety regulations. There's no room for lapses in concentration. The aircraft must be in top condition and thoroughly checked before each take-off. Like the other centres in the south-west, the Dwellingup-Jarrahdale system is divided into circuits, which are surveyed in accordance with the fire hazard rating of the day. The circuits are flown more often as the hazard increases. John can therefore be flying as far south as Harvey and as far north as the Avon Valley, or east and west for the whole breadth of the Darling Scarp. At the height of the fire season, when the likelihood of wildfire is at its highest, the integrated surveillance from all the spotting centres covers the whole of the south-west forests every day.

Many Western Australians recall the huge wildfire which devastated the town of Dwellingup in January of 1961. The fires were caused by a heavy build-up of fuel on the forest floor and extreme weather conditions. In those days the tower system was the only method for fire-spotting, and it proved too cumbersome a method for the 19 wildfires which sprang up from lightning strikes within days of each other. Not having the benefit of the aerial over-view, sightings in the past had

▲ Made from stressed metal and fabric coated with a plastic Dacron finish, the Super Cub is strong, but light enough for one person to wheel in and out of the hangar. Here John Woodward wheels the aircraft out on to the taxi-way. *(Les Harman)*

As well as fire spotting, pilots patrol quarantine areas and check oil spillages from vehicles at the Alcoa bauxite mines pictured below. *(Les Harman)* ▲

to be confirmed by at least one other tower. A forestry officer then had to be sent in to assess and exactly locate the blaze, and finally the suppression crews sent in. Even initial sightings could have been slow using the old method, as the tell-tale smoke often needed to rise a considerable distance to be seen by the lookouts in the towers. John Woodward was the pilot flying the circuit in January 1978 when a replica of the 1961 lightning pattern occurred. Then the full value of the spotting system was realised, as John quickly located seven smokes, two of which weren't even seen by the towers. By radio he communicated the size, intensity and direction of the fires and the available access roads for the suppression crews, guiding them away from blocked roads and down free access points to the heart of the burns. Even for the spotters the visibility of the fires at times of big burns is restricted by smoke, but the advantage of the airborne spotter is manoeuvrability around the smoke, and the ability to approach from altitudes varying from 500-10 000 ft.

The keen-eyed pilots naturally become more adept at spotting fires as their experience increases. Under optimum visibility a single smouldering log can be detected. The bird's eye view is also used for spotting violators of the Forests Department dieback quarantine areas. In the Dwellingup area, oil spillages from single vehicles in bauxite mining operations can be spotted. In either instances John can determine the colour and type of vehicle, whether it be a car lost in the forest, or a haul-pac[illegible]erating a mine site.

Over the past eight years the network of aerial spotting in Western Australia has increased by leaps and bounds from one hired Cessna 150 in 1973 to eight Cubs in 1980-81. In 1979 the Department purchased four of those eight Piper Super Cubs at a cost of $31 000 each which represented a large saving over the hiring method. Obviously the use of aircraft is an important part of the Forests Department's protection operations. No other country in the world can boast the inventive, efficient surveillance system which has developed in Western Australia. The special nature of our forested environment has been at the heart of the innovation.

The "Bombers"

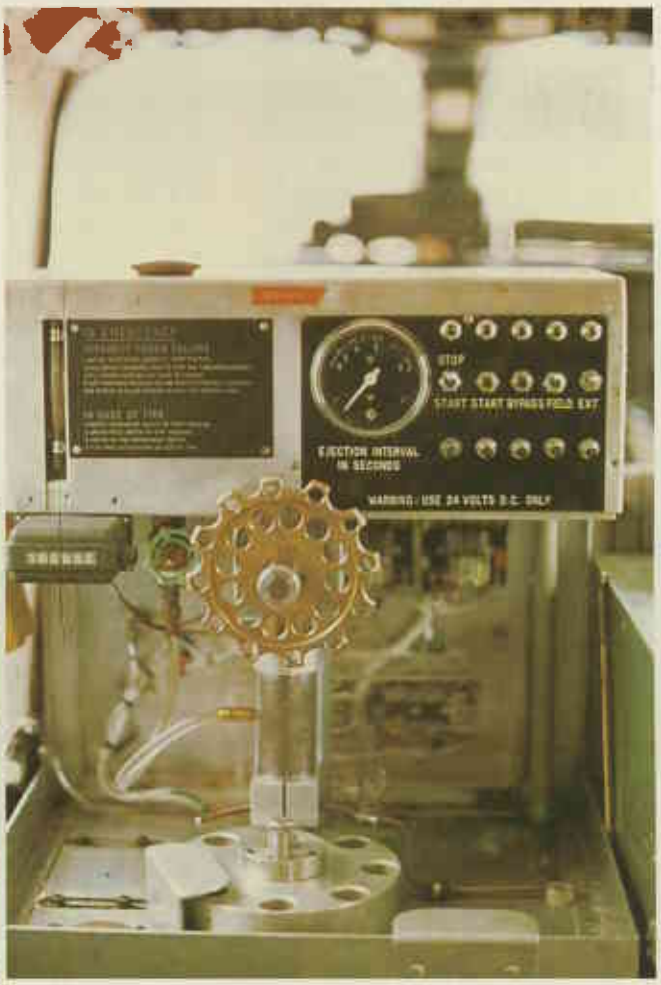
The other major way of protecting the forest from the damage of wildfire is to reduce the build-up of inflammable litter on the forest floor by burning off in the mild seasons of the year. These so called "cool" burns are done on a rotating basis, depending on the characteristics of vegetation and weather. Prior to 1965-66 this enormous task was attempted by hand, which not only proved expensive, but also inefficient. Then in 1965 tests were conducted to determine the feasibility of aerial ignition of prescribed burn areas using a Cessna 337. Even from the trial stage it was obvious that this method was far more efficient than ground burning, as the area covered within a single day increased dramatically. It now takes only one hour to light up an area of 2 000 hectares. Rapid lighting enables the Department to take advantage of optimum conditions at shorter notice. Aerial burning proved to be four times cheaper than hand burning, including the labour costs of ground crew used in each operation.

Two Britten-Norman Islanders and their pilots are hired each season for the prescribed burning programmes in autumn and spring. An aerial ignition (bombing) operation requires team work and accurate flying. The pilot, navigator and bombardier are trained on-flight for five to ten days for the special requirements of the job, learning

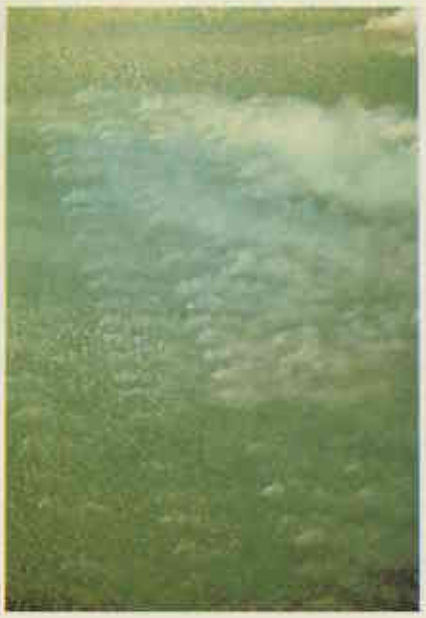
▲ The ignition capsule, an incendiary ''bomb'', has gone through many stages of development, including the current one of potassium permanganate crystals held in a plastic cylinder. It is shown here igniting 30 seconds after having been injected or ''primed'' with a catalyst. (G. van Didden)

▲ This picture shows the relative size of the capsules. (G. van Didden)

The current incendiary machine is based on an original C.S.I.R.O. design and was built by the National Instrument Company in 1968. The machine primes the capsules and drops them through a
▼ chute in the floor of the aircraft. (G. van Didden)



The incendiary capsules are made and mounted in
▼ a factory in Perth. (G. van Didden)



how to co-ordinate flight lines, drop rates and air speed. They fly very low, between 150 and 700 feet and at present can drop a maximum of 37 "bombs" per minute with the current incendiary machine. The calculated rate of spread and the required intensity burn determines the rate of drop. The latest incendiary machine being designed at the Western Australian Institute of Technology will be able to drop between 20 and 120 "bombs" per minute.

In the 1979-80 season a total of 309 597 hectares were lit, over 250 000 of these being done by aerial ignition. Safe protection operations on this large scale have been made possible by the constant refinement and development of technical equipment. The possibility of accidents has always been a major concern. Over the years the aircraft have been changed, the incendiary and radar equipment refined, and the "bombs" perfected.

Aerial Photography

The prescribed burning programmes end in January in the most southerly part of the karri forest. One of the Britten-Norman Islanders is then re-fitted for the autumn

▲ On board the BN-2A Islander during burning operations. Pictured are pilot, navigator and "bombardier". *(G. van Didden)*

◄ Typical cross-wind lighting pattern viewed from 3 000 feet. *(P. Cheney)*

▲ Deliberate intense burn conducted for research. *(G. van Didden)*

▼ Ground view of a "hot" burn in the northern jarrah forest conducted for dieback research, late summer, 1980. This was lit using aerial ignition, and regeneration patterns are now being monitored. *(Les Harman)*

project of aerial photography required by the Aerial Photography and Interpretation Section based in Manjimup. Once more the major impact of aircraft has been to open the way for sophisticated technological innovation. In this way previously impossible management and research tasks are made accessible and economical.

The "bombing", spotting and aerial photography techniques have been directly evolved from military activities of the two world wars. Stemming from the light-aircraft reconnaissance tradition, aerial photography was first used in the 1914-18 war. Later, in World War II, photography was widely used for planning and recording specific occurrences such as direct hits after bombing raids. This same type of aerial photography of specific locations is used in the Forests Department for logging operations, management and research projects. The other major task for the Aerial Photography and Interpretation group is mapping the spread of the dieback disease fungus *Phytophthora cinnamomi.* This particular type of aerial photography had no predecessors and has been developed in Western Australia for accurate broad-scale mapping of vegetation deaths. It is a constant photographic survey. Once the spread of the fungus is located, quarantine areas can be mapped and declared in order to isolate and monitor diseased pockets of the forest.

Flying Computer

On board the Britten-Norman Islander is an imposing set of equipment, including a Motorola computerised navigation system, two Vinten reconnaissance cameras and an intervalometer. The cameras take large negatives, 70 mm wide, which show a lot of detail. The intervalometer determines the time between each photograph, automatically operates the cameras and links them with the data processor.

Two crews comprising three members each are trained for dieback photography. The pilot must familiarise himself to fly by observing the Motorola track indicator (see photograph) and be capable of making fine track adjustments in order to fly at a constant accuracy of ± 20 metres. The navigator operates the airborne navigation system, feeding in all initial positioning data through a data terminal and then monitoring the print-out to ensure accuracy of direction and correct operation of the equipment. The cameraman is responsible for photograph acquisition and sets up the cameras by the remotely controlled intervalometer. The rest is done by the data processor which:

- Navigates by radar, sending and receiving signals *via* two ground-based transponders.
- Stores mapping co-ordinates on a magnetic tape along with the specific location of each photograph taken.

▼ Ground crew install a radar transponder to act as the ground reference station for the airborne Motorola navigation system at Mt. Roe, south of Manjimup. *(Neil Hamilton)*

▲ A ground view of the "dieback" death of *Banksia grandis*. *(R. Chandler)*

- Co-ordinates the intervalometer which operates the cameras. As one camera runs out of film the second camera takes over to provide continuous coverage. Every single tree, its health and position, is thus recorded. A piece of ecological history is frozen.

The flight operation, conducted in low light conditions for four months of the year, is just the beginning of the dieback mapping procedure. Once an area has been photographed and the information correlated with individual film frames, the dieback mapping interpreters take over. It is their job to read the photographs for vegetation deaths, go out in the field and physically record the cause of death, then on maps, record the progress of the dieback fungus through the forest.

Technology and Forestry

Something happens to human awareness when we get lifted out of our environment on the ground, to a position in the air where we can view the activities of the people on the earth as if they are ants. Those towering, mighty eucalypts which dwarf the forester become themselves dwarfed from the air. So as well as the ground view of individual

In 1980 Forests Department officers R. Chandler, A. Egerton-Green, M. Hamilton and K. Vear won an Award of the Productivity Promotion Council of Australia for developing the navigation system required for the photographic survey of dieback. The components of the system are pictured below.

Photographs by Neil Hamilton.

▲ A solar bank (front) provides 24-volt power to batteries which operate the transponder (rear) on top of Mt. Roe.

▲ The terminal interface (left) is operated by the navigator who types in co-ordinates of the desired flight line. The tape-deck records plotting co-ordinates for later mapping and matching with photographs.

▲ Also on board is this intervalometer which operates cameras, times exposures and interfaces with the processor. It was designed by Forests Department staff and made in New South Wales, and is believed to be the only one like it in the world.

▲ The range-finder (right) and micro-processor co-ordinate all the other parts of the navigation and photographic system. They are pictured here installed in the back of the aircraft.

▲ The Motorola Track Indicator (centre).

▲ Just touching down at the completion of a day's work near Manjimup.

trees, our perception of the forest has become balanced with the overall perspective of the whole forest spread like a carpet across the land. Man has learnt much about himself and his environment with the aid of technology. He has learnt that forests for instance, are finite, that those "unending" forests of the south-west are tiny compared with the land surface of Western Australia.

Radio, aircraft, radar, cameras, data processors—who would normally associate them with forestry? Yet advanced technology is a familiar part of modern life and it has enabled us to "get the job done". Technology = information = power. The growth of technology, it can be claimed, has made the forests vulnerable. Yet it has also given us the power to monitor the progressive health of the forests, and to observe and record broad ecological changes as they are happening. Societies need to use the double-edged sword of technology with care.

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