DEFENCE SCIENCE
AND TECHNOLOGY
FISHERMANS BEND
80TH ANNIVERSARY

80 YEARS OF INNOVATION AT FISHERMANS BEND

PRE 1930s

Home to the Boonwurrung & Woiwurrung

For many thousands of years, the area now known as Fishermans Bend was home to the Woiwurrung and Boonwurrung language speakers of the Kulin nation.

From sand mines to sand traps

In the years after British settlement, fishing, shipping and sand mining activities shaped the area. Throughout the late 1800s, the newly established Victorian Government rejected proposals for major residential development in the area, instead seeing potential for further harbour and port activity. Nevertheless, they leased out some land, including for a golf course.

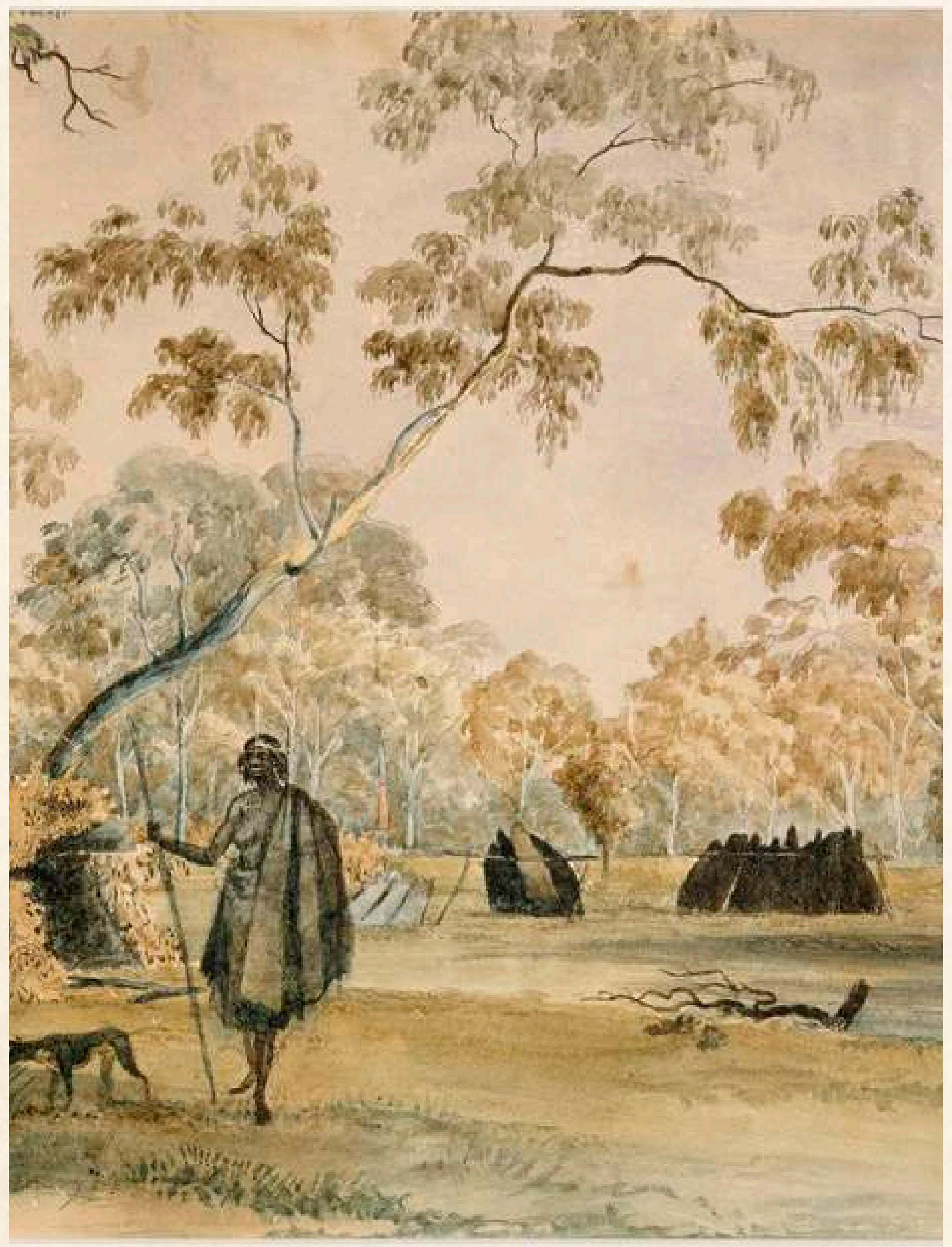
1930s

The seeds of industry

By the 1930s, the Victorian Government's cautious stance on development in the area began to soften, and in 1935 they permitted the first freehold land purchase to General Motors Holden.

With war imminent, and concern growing at the lack of an Australian manufacturing capability, Essington Lewis, then Chief General Manager of BHP, lobbied for the establishment of a modern aircraft industry. His efforts met with little resistance and in 1936, the Commonwealth Aircraft Corporation was born, with its Fishermans Bend factory completed the following year.

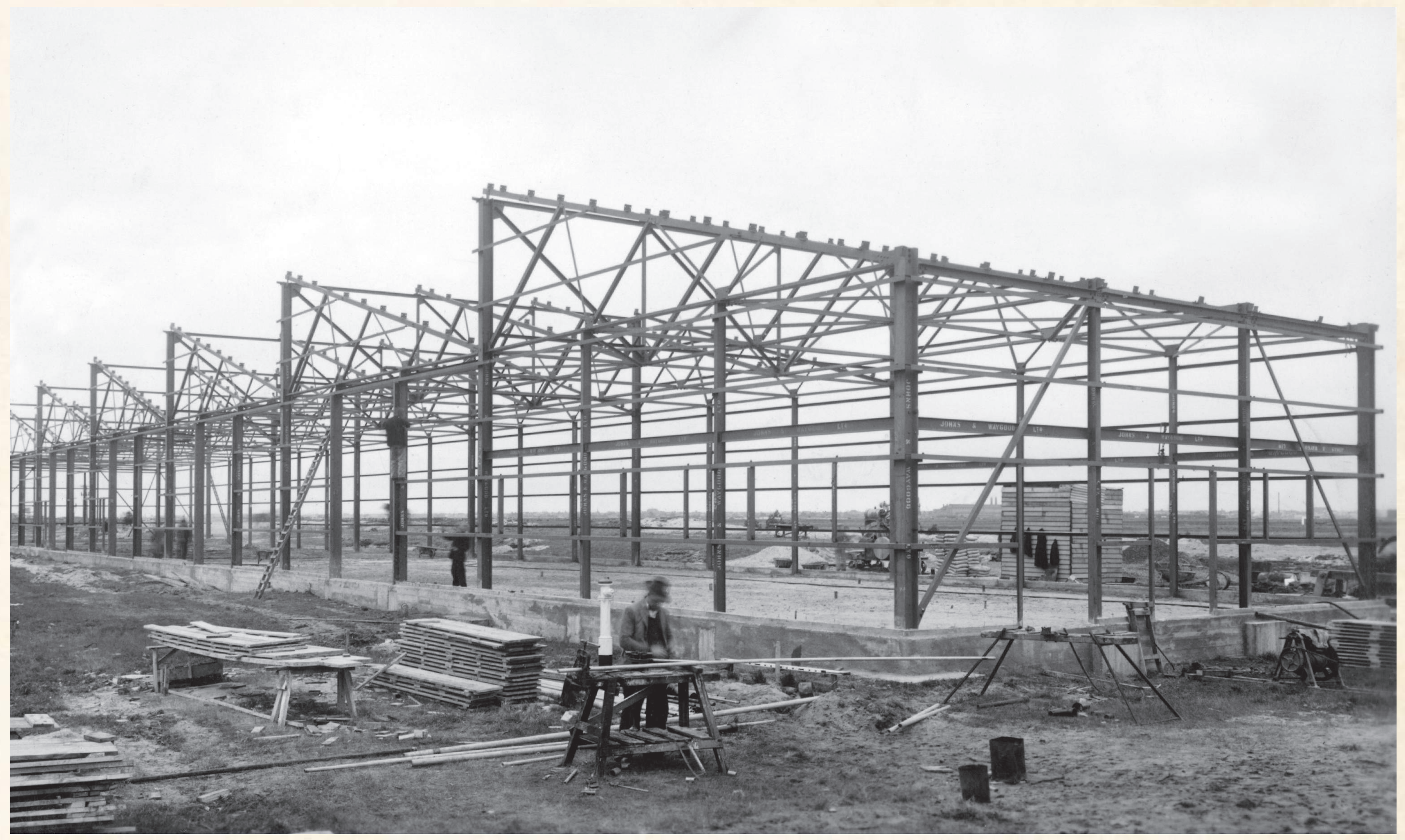
Around that time, the Council for Scientific and Industrial Research (CSIR) sought the advice of H.E. Wimperis, a former Director of Scientific Research in the British Air Ministry, on the establishment of an aeronautical research facility. Among his recommendations, he advised locating the laboratory close to centres of aeronautical industry and performance testing. Fishermans Bend fitted the bill.



Aboriginal camp on the banks of the Yarra, John Cotton, 1845

Melbourne Harbour Trust. Thomas Kell, 1879

Essington Lewis



Construction of the Fishermans Bend site started in August 1939, one month before the start of the Second World War

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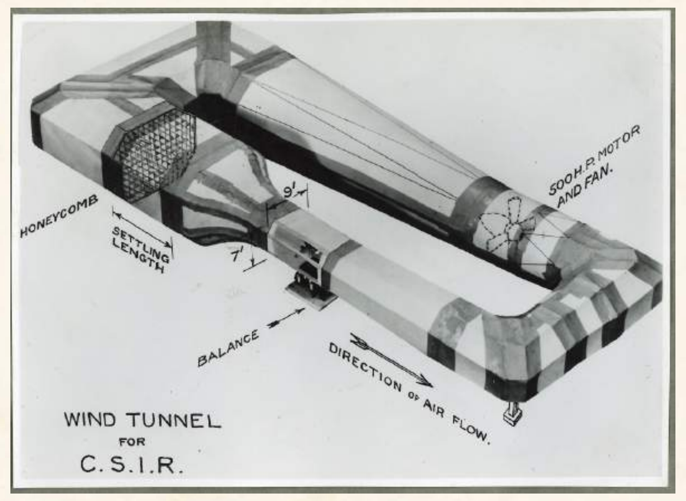
1940s

Research commences

The first laboratory buildings were occupied by 16 staff in March 1940. The following year, just two days before the attack on Pearl Harbour, the first major research facility, a nine-foot by seven-foot wind tunnel was commissioned.

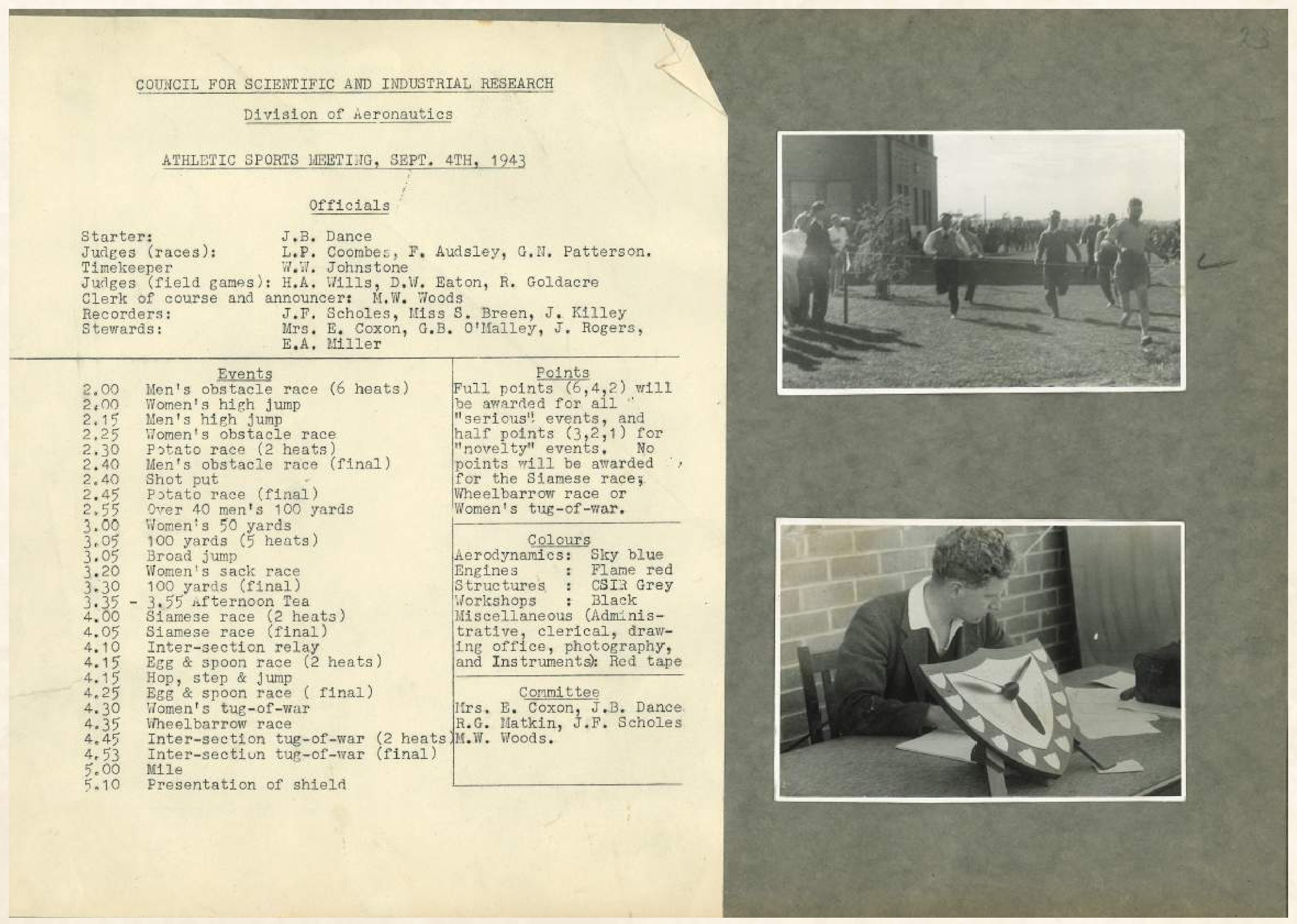
Early images of the foyer of Building 1/51 including the iconic parquetry



Plans for the first major research facility, the wind tunnel

Not 'all work and no play'

In 1943, the Division of Aeronautics held what is thought to be the site's first athletics meet. Officials included names that have been immortalised on the Fishermans Bend site, such as L. P. Coombes and H. A. Wills.



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Division of Aeronautics

ATHLETIC SPORTS MEETING, SEPT. 4TH, 1943

Officials

Starter: J.B. Dance
Judges (races): L.P. Coombes, F. Audsley, G.N. Patterson.
Timekeeper W.W. Johnstone
Judges (field games): H.A. Wills, D.W. Eaton, R. Goldacre
Clerk of course and announcer: M.W. Woods
Recorders: J.F. Scholes, Miss S. Breen, J. Killey
Stewards: Mrs. E. Coxon, G.B. O'Malley, J. Rogers, E.A. Miller

Events

2.00	Men's obstacle race (6 heats)
2.00	Women's high jump
2.15	Men's high jump
2.25	Women's obstacle race
2.30	Potato race (2 heats)
2.40	Men's obstacle race (final)
2.40	Shot put
2.45	Potato race (final)
2.55	Over 40 men's 100 yards
3.00	Women's 50 yards
3.05	100 yards (5 heats)
3.05	Broad jump
3.20	Women's sack race
3.30	100 yards (final)
3.35 - 3.55	Afternoon Tea
4.00	Siamese race (2 heats)
4.05	Siamese race (final)
4.10	Inter-section relay
4.15	Egg & spoon race (2 heats)
4.15	Hop, step & jump
4.25	Egg & spoon race (final)
4.30	Women's tug-of-war
4.35	Wheelbarrow race
4.45	Inter-section tug-of-war (2 heats)
4.53	Inter-section tug-of-war (final)
5.00	Mile
5.10	Presentation of shield

Points

Full points (6,4,2) will be awarded for all "serious" events, and half points (3,2,1) for "novelty" events. No points will be awarded for the Siamese race, Wheelbarrow race or Women's tug-of-war.

Colours

Aerodynamics: Sky blue
Engines : Flame red
Structures : CSIR Grey
Workshops : Black
Miscellaneous (Administrative, clerical, drawing office, photography, and Instruments): Red tape

Committee

Mrs. E. Coxon, J.B. Dance
R.G. Matkin, J.F. Scholes
M.W. Woods.

Schedule and photos from the Athletics Sports Meeting, 4 September 1943

Defence-focussed research

Initially operating as CSIR's Division of Aeronautics, in 1949 the Fishermans Bend facility was transferred to the Department of Supply and renamed the Aeronautical Research Laboratories (ARL) with specific responsibility for defence research.

1940s milestones

- Commencement of full-scale structural testing (1943)
- Commencement of research on high temperature alloys, gas turbine combustion, fuels and lubrication (1944)
- Construction of Australia's first subsonic, variable wind tunnel (1945)
- First involvement in accident investigation following Stinson A2W crash (1945)
- Presentation by H. A. Wills on DST's pioneering work in aircraft fatigue life prediction (1949) at 2nd International Aeronautical Conference, New York.

Construction of the wind tunnel commenced in 1945

Jindivik earns international attention

In 1948, ARL was involved in the design and development of Jindivik, a subsonic uncrewed jet-propelled target plane designed to measure missile performance. The first successful Jindivik test was carried out on 28 August 1952 from Evetts Field near Woomera. Jindivik technology was eventually sold overseas, helping to raise Australia's profile in international defence markets.

Jindivik – jet-propelled target plane

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1950s

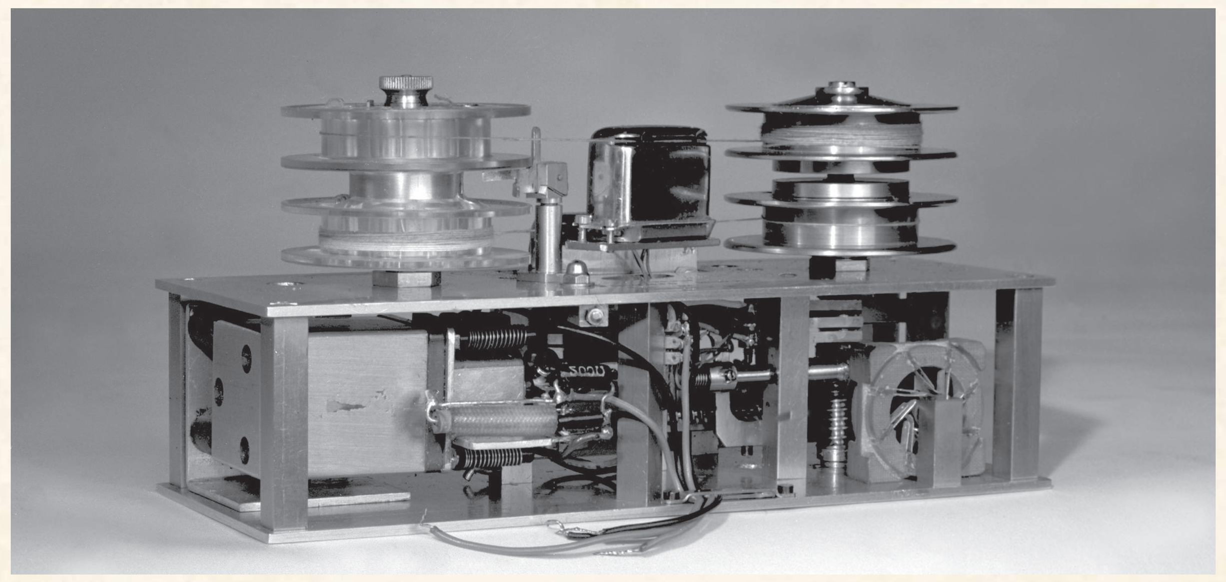
Towards more applied science

In the post-war period, ARL moved from being primarily focussed on fundamental research to become an applied laboratory undertaking research and development tasks for industry and Defence. This shift produced some notable innovations and inventions, including the Black Box Flight recorder.

Home to the Black Box

ARL scientist David Warren invented the world's first Black Box flight recorder in 1953. David and his team — Kenneth Fraser, Lane Sear and Dr Walter Boswell — spent the next several years developing the technology. A demonstration model of the Black Box was produced in 1957, and in 1960 Australia became the first country in the world to make cockpit voice-recording mandatory. Since then, more than 100,000 flight recorders have been installed in commercial aircraft.

In 2000, David was awarded the Royal Society of Arts Hartnett Medal, and in 2002 he was made an Officer of the Order of Australia (AO). In 2001, David, Ken, Lane and Walter received the Royal Aeronautical Society Lawrence Hargrave Award.



The flight recorder

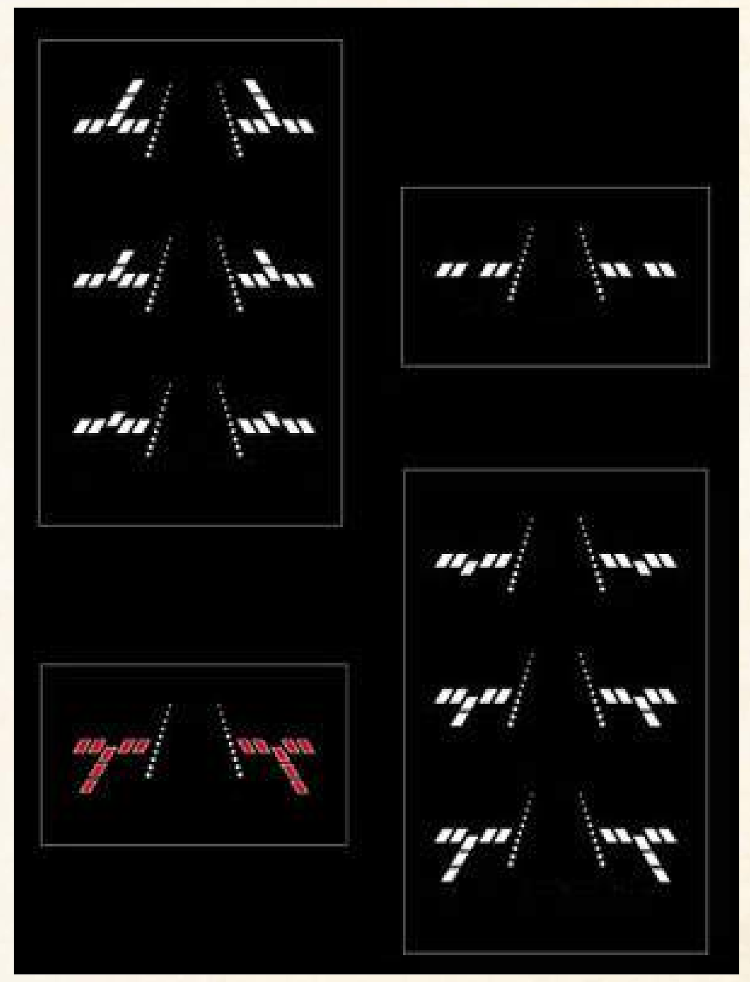
David Warren with the flight recorder

L-R: Former Minister for Transport and Regional Development, John Anderson, Ken Fraser, Dave Warren and members of the Royal Aeronautical Society

T-VASIS: an innovative aid for pilots

The Tee-Visual Approach Slope Indicator System (T-VASIS) was developed in the 1950s by ARL scientists Ron Cumming and Russ Baxter, in conjunction with Bruce Fraser, John Lane and Jack Leevers of the then Department of Civil Aviation (DCA).

The system was designed to assist aircraft pilots in the final stages of landing and was adopted as the international standard in 1971. The T-VASIS won the Prince Philip Prize for Australian design and the Diplome d'Honneur from the Federation Aeronautique Internationale.

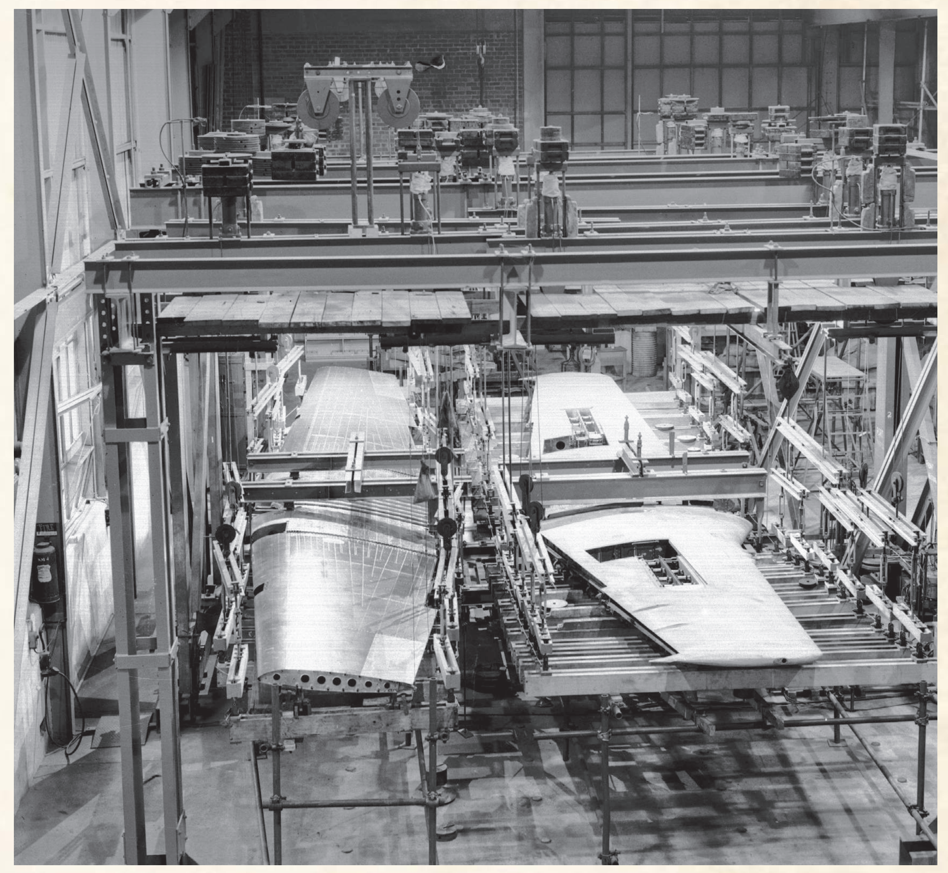


The Tee-Visual Approach Slope Indicator System

Pioneering fatigue testing

In 1950, ARL's Alf Payne and W. W. Johnston led a pioneering research program into the fatigue behaviour of aircraft structures.

Over 12 years, 222 Mustang aircraft wings were tested under a repeated complex series of loads representing the load history of an aircraft in service. This program helped Australia become the world leader in aircraft fatigue research.



Mustang wing test

80 YEARS OF INNOVATION AT FISHERMANS BEND

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1960s

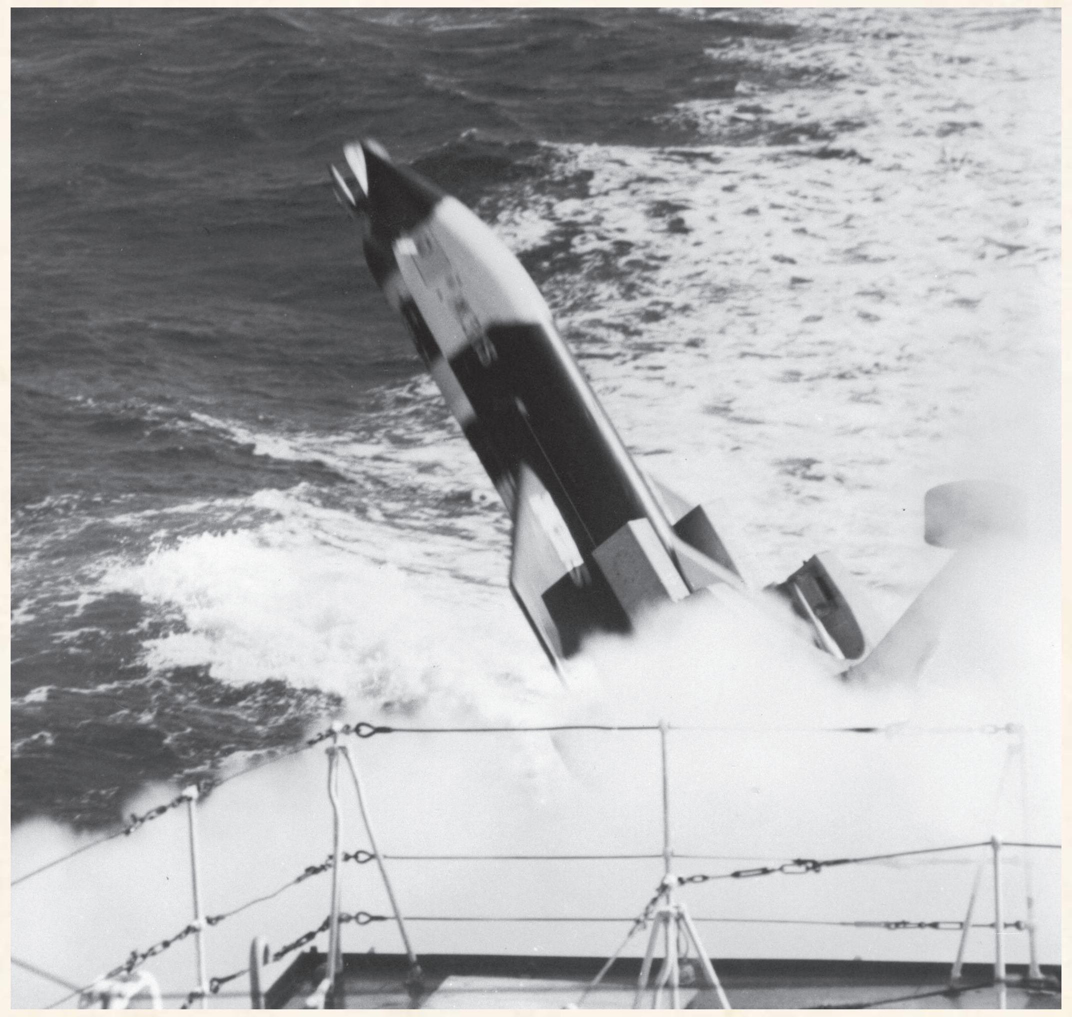
A greater client focus

The 1960s saw relations between ARL and the various armed services become closer, with a great deal of work focussed on resolving specific problems identified by the Services, rather than more exploratory research. ARL's role in military and civil air crash investigations also increased significantly; however the development of Ikara showed the organisation was no longer obsessively aeronautically focussed.

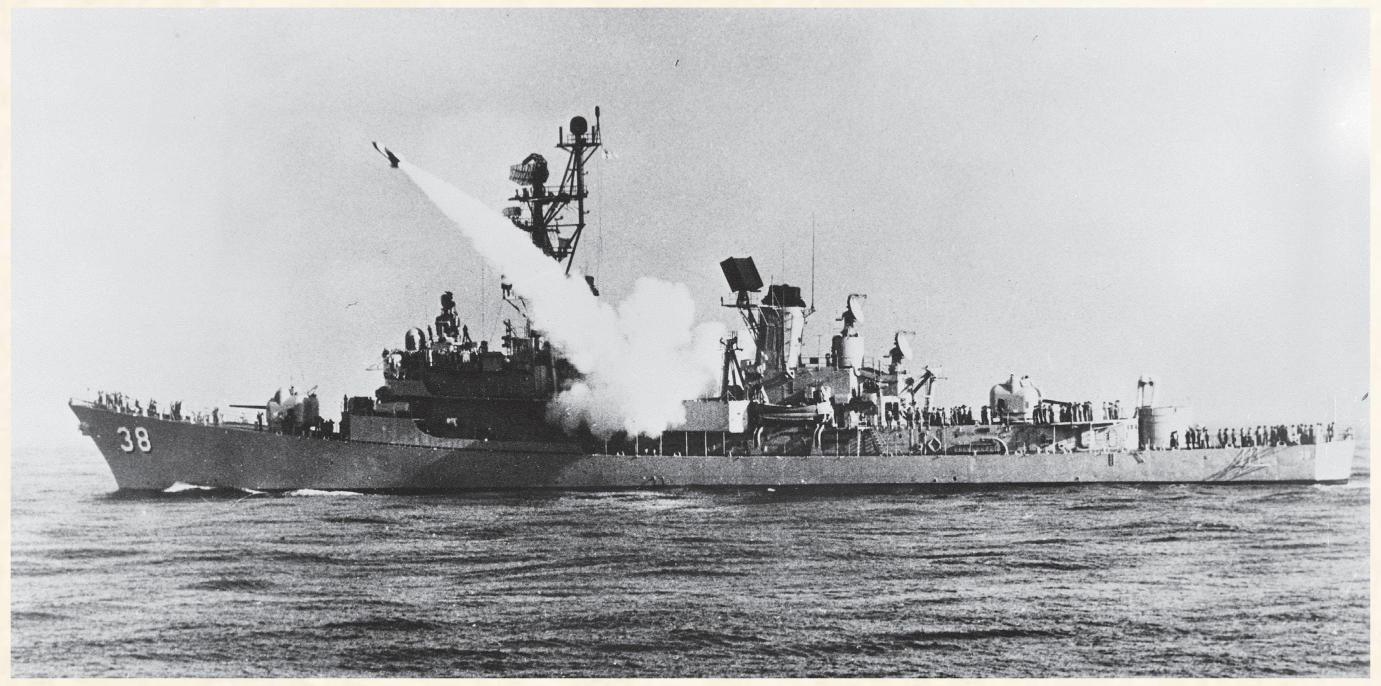
Ikara: Australia's anti-submarine guided weapon

Ikara was an Australian-designed ship-borne long-range anti-submarine guided weapon developed for the Royal Australian Navy (RAN). Design and construction of Ikara began in 1960 under the guidance of Murray Evans. The first full-size Ikara missiles were launched at Woomera in 1963; and the first full-scale trials were conducted from HMAS *Stuart* off Sydney later that year. Ikara was eventually adopted by the RAN, Royal Navy, the Brazilian Navy and the Royal New Zealand Navy.

For his work on Ikara, Murray was awarded the Queen's Silver Medal (1977), and became an Officer of the Order of the British Empire (OBE) (1978) and a Member of the Order of Australia (AM) (1982).



Ikara – long-range anti-submarine guided weapon



HMAS Perth II firing an Ikara

World leading alloys

From 1960 to the mid-1970s, defence scientists in Melbourne led the world with their research into alloys with defence applications.

Dr Noel Burley who worked at Maribyrnong invented the highly stable nickel-base alloy, thermocouple nicrosil/nisil, now universally known as the 'Type 'N' Thermocouple System'. The technology used in making this alloy was accepted worldwide and international standards revised accordingly.

Through the 60s and 70s a lot of alloy research was conducted across both the Fishermans Bend and Maribyrnong sites, including the ill-fated 'Chromium project'. This project was aimed at producing a non-brittle chromium alloy of such high purity that it might be used in the extreme temperature environment of gas turbine engines. More than a decade was spent on the research, but despite some promising signs, the problem of brittleness was never overcome. The Chromium project slowly came to a halt, however it is still regarded by many as an example of the high quality research that was conducted at both Maribyrnong and Fishermans Bend in the 60s.

Nicrosil/Nisil Type N Thermocouples

The Nicrosil/Nisil Type N thermocouple offers better stability than existent base-metal Types E, J, K and T. It is now available and in widespread use worldwide.

DR. NOEL A. BURLEY

The ANSI standard base-metal thermocouples, designated E, J, K and T (Ref. 1), show inherent thermoelectric instability related to time- and/or temperature-dependent instabilities in several of their physical, chemical, nuclear, structural and electronic properties. This paper reviews the major thermoelectric properties of the new nickel-base thermocouple system Nicrosil *versus* Nisil (designated type N), in which very high thermoelectric stability has been achieved by a judicious choice of elemental component concentrations.

INSTABILITY OF CONVENTIONAL BASE-METAL THERMOCOUPLES

There are three principal characteristic types and causes of thermoelectric instability in the standard base-metal thermoelement materials:

1. A gradual and generally cumulative drift in thermal EMF on long exposure at elevated temperatures. This is observed in all base-metal thermoelement materials and is majnly due to compositional changes caused by oxidation, in particular internal oxidation (Figures 1 and 2), and to neutron irradiation which can produce transmutation in nuclear reactor environments.

2. A short-term cyclic change in thermal EMF on heating in the temperature range about 250° to 650°C, which occurs in types KP (or EP) and JN (or TN and EN). This kind of EMF instability is thought to be due to some form of structural change like magnetic short-range order (Figures 3 and 4).

3. A time-independent perturbation in thermal EMF in specific temperature ranges. This is due to composition-dependent magnetic transformations which perturb the thermal EMF's in type KN in the range of about 25° to 225°C (Figure 5), and in type JP above about 730°C.

ULTRA-HIGH STABILITY OF NICROSILINISIL (TYPE N) THERMOCOUPLE

Nicrosil and Nisil thermocouple alloys (Ref. 2) show greatly enhanced thermoelectric stability (Ref. 3) relative to the other standard base-metal thermocouple alloys because their compositions (Table 1) are such as to virtually eliminate or substantially reduce the causes of thermoelectric instability described above. This is achieved primarily by increasing component solute concentrations (chromium and silicon) in a base of nickel above those required to cause a transition from internal to external modes of oxidation, and by selecting solutes (silicon and magnesium) which preferentially oxidize to form a diffusion-barrier, and hence oxidation inhibiting films.

The thermal EMF instabilities of the short-term cyclic kind occurring in KP and JN alloys have virtually been eliminated in nicrosil (NP) by setting the chromium content at 14.2 weight-%.

The increase in the silicon content of nisil (NN) to 4.4 weight-% has suppressed the magnetic transformation of this new alloy to below room temperature.

Virtual freedom from nuclear transmutation effects is achieved by eliminating such elements as manganese, cobalt and iron from the specified compositions of both alloys.

The very high thermoelectric stability of the Nicrosil/Nisil (type N) thermocouple is illustrated in Figures 1 and 2. The influence of thermoelement conductor cross-sectional area upon the thermal-EMF constancy of Nicrosil/Nisil is shown in Figure 6.

Z-41

Noel Burley's paper on Type N Thermocouples

80 YEARS OF INNOVATION AT FISHERMANS BEND

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1970s

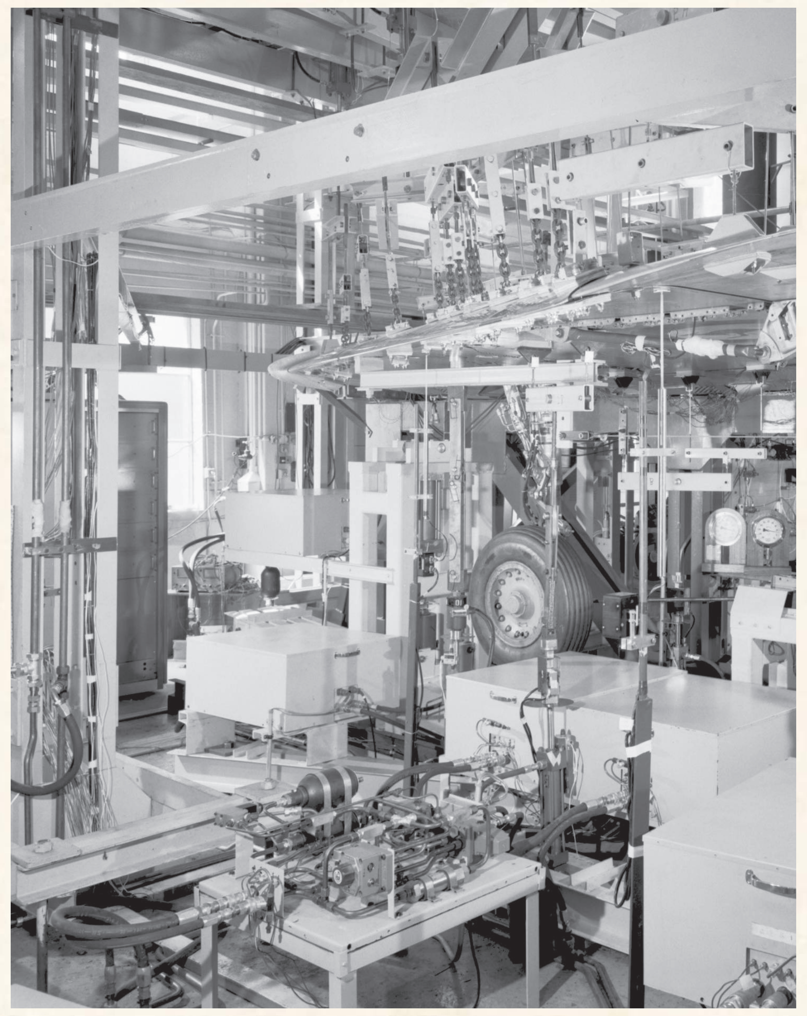
Departmental shake-up

The 1970s saw a major shake-up of the Department of Defence and, as a result, the nation's defence science structure. The Defence Science and Technology Organisation (DSTO) was established in 1974 and had the effect of fostering even closer relations between the nation's defence scientists and the armed services.

Major fatigue testing programs

During the 1970s, four major military fatigue programs were carried out at Fishermans Bend which involved:

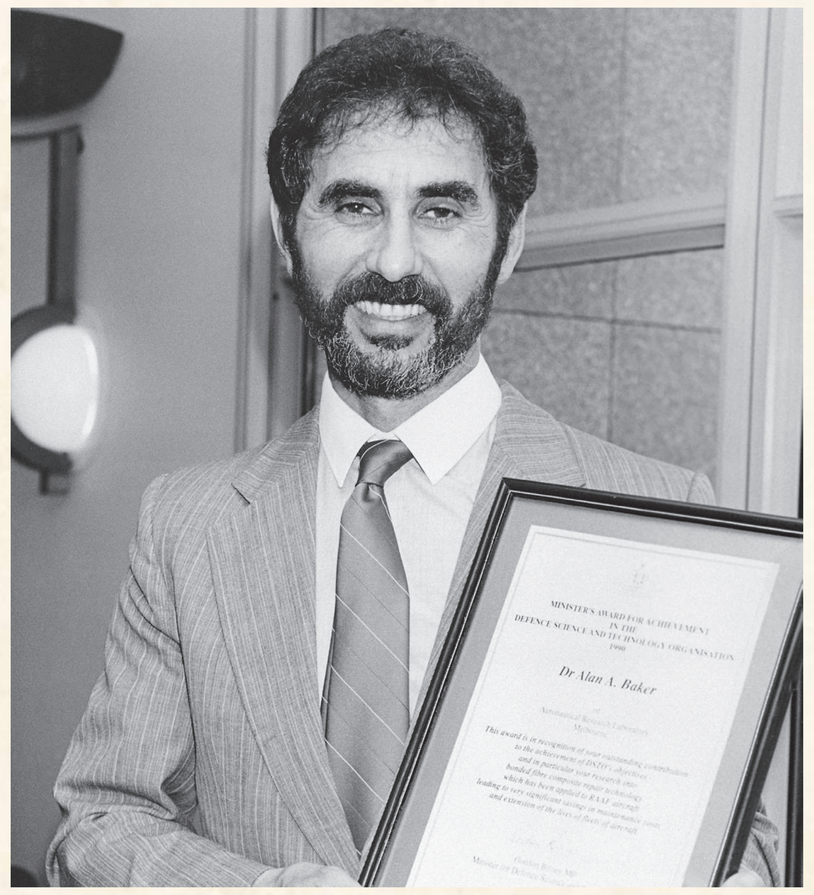
- improving the wing-carry-through boxes of the Australian F-111C aircraft
- investigating the crack growth rates of Macchi centre-section booms
- flight-by-flight fatigue testing on a Mirage wing
- flight-by-flight fatigue testing on a Nomad airframe.



Mirage wing test

Leading the world in composite bonded repair technology

Thanks to work undertaken at Fishermans Bend by Dr Alan Baker and his team in the 70s, 80s and 90s, DSTO became a world leader in the use of adhesively bonded fibre composites to repair aircraft structures and arrest stress corrosion cracking. In 1990, DSTO licensed Australian-owned private company, Helitech Industries Pty Ltd to market and develop the composite bonded repair technology. The same year, Dr Baker received the Minister's for Defence Award for Achievement. The technology is used in commercial airliners as well as other military aircraft belonging to the Australian, US and the Belgian Air Forces.



Alan Baker with his Minister's Achievement award

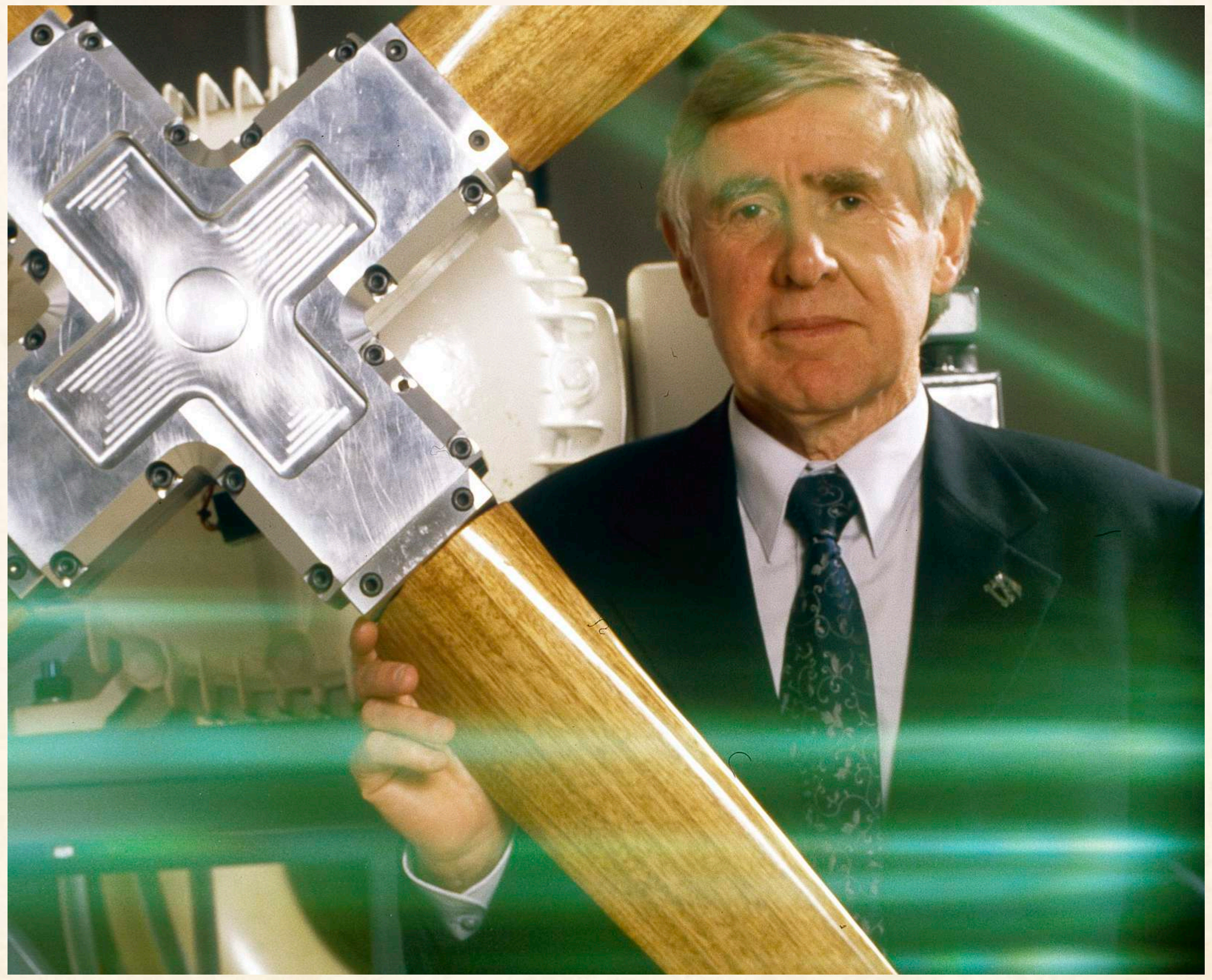
1980s

Expansion of the Fishermans Bend footprint

During the 60s and 70s, relatively little investment was made into the Fishermans Bend site, as its future was continually in question. However, a long-term commitment was made in 1988 with the Department of Defence purchasing the entire 12.3 hectare site from the Victorian Government.

Experts in gearbox technology

Since the 1980s, scientists at Fishermans Bend have earned widespread recognition for improving the safety of helicopters through the development of advanced gearbox technology. A major research program was begun by Peter McFadden, following investigation into a gearbox failure in a Wessex helicopter. A decade later, following in the same tradition, Brian Rebbechi developed a vibration-based diagnostic method of assessing the condition of F/A-18 Hornet gearboxes already installed. The work led to a redesign of the gearbox, savings of millions of dollars in operational costs to the RAAF and United States Navy.



Brian Rebecchi

80 YEARS OF INNOVATION AT FISHERMANS BEND

1990s

Structural change and consolidation

Following the tabling of the Commonwealth Government's 1994 Defence White Paper, DSTO's four research laboratories (the Aeronautical Research Laboratory; Maritime Research Laboratory; Surveillance Research Laboratory; and Electronic Research Laboratory) were reduced to two: the Aeronautical and Maritime Research Laboratory (AMRL) headquartered at Fishermans Bend and the Electronics and Surveillance Research Laboratory, headquartered in Edinburgh South Australia. AMRL comprised five divisions: Air Operations; Airframes and Engines; Ship Structures and Materials; Weapons Systems; and Maritime Operations.

Ground-breaking structural testing of the F/A-18

DSTO's largest fatigue project commenced at Fishermans Bend in 1995. It involved the full-scale testing of major components of the F/A-18 Hornet, and over subsequent years involved 24,000 hours of test 'flying' in a specially designed rig that duplicated the stresses and loads that an F/A-18 Hornet would experience in real flight. Along the way, many new test techniques were pioneered and an invaluable set of operational data was collected to support the aircraft for RAAF service.

In recognition of this achievement the International Council of the Aeronautical Sciences awarded its prestigious Von Karman Award in 2001 jointly to DSTO, the RAAF and the Institute for Aerospace Research, National Research Council, Canada.

Full-scale structural fatigue test of the F/A-18 Hornet, known as IFOSTP, the International Follow-on Structural Test program

Advances in measuring structural stress

In 1985, DSTO purchased a highly-sensitive infrared temperature detector known as SPATE; Stress Pattern Analysis by Thermal Emission, which was used to determine the stress in structures under dynamic loading conditions. DSTO's Albert Wong who worked at Fishermans Bend from 1985 to 2018, discovered an anomaly in Lord Kelvin's Law (1824-1907) which cast doubt upon the accuracy of the measurements obtained with SPATE. Together with Jim Sparrow and Shane Dunn, Albert used the anomaly to yield algorithms which made the measurement of total stress possible. In 1992, SPATE was replaced with a system known as Focal-plane Array for Synchronous Thermography (FAST), developed by Albert and Thomas Ryall. The first of its type in the world, this pioneering work led to the design of sophisticated instrumentation now used in routine engineering applications on a day to day basis not only in the aviation sector but in other areas such as the automobile industry.

Albert Wong and Tym Ryall

F-111 sole operator program

When the US withdrew the F-111 from service in 1996 and Australia became the sole operator of the aircraft, the advice provided by DSTO's structural integrity experts at Fishermans Bend was relied on to ensure that the aircraft could continue to fly safely until its retirement in 2013.

F-111 wing test

80 YEARS OF INNOVATION AT FISHERMANS BEND

2000s

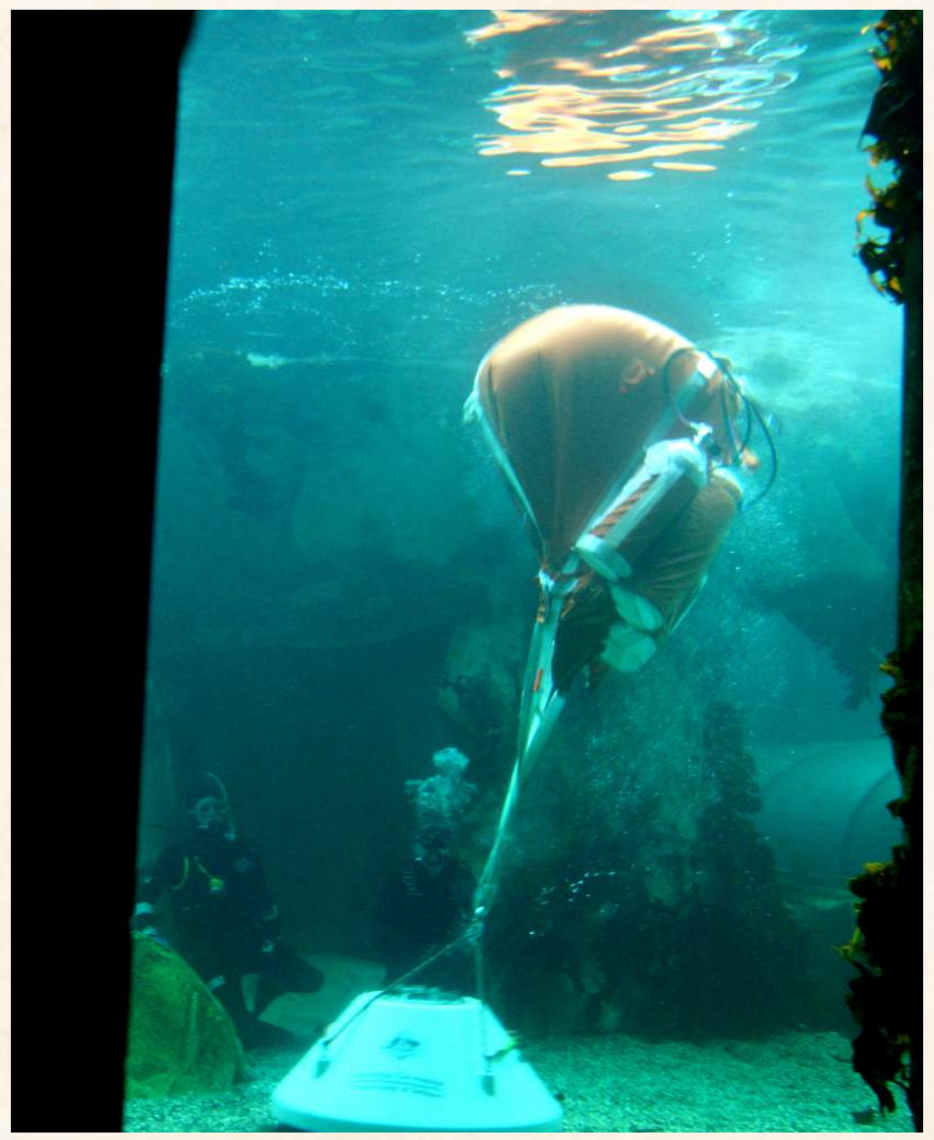
Centralisation at the 'Bend

In 2007, DSTO's Maribyrnong facility (Australia's oldest working laboratory at the time) closed after 85 years and the last of its staff and operations were transferred to the Fishermans Bend site. A new three-storey building, 94, was constructed at Fishermans Bend to accommodate the Maribyrnong staff. It was named the Cecil Napier Hake building after the first defence scientist. The redeveloped complex, completed at a cost of $106 million, was officially opened by Parliamentary Secretary Peter Lindsay on 29 August 2007.

David Warren opens the David Warren Auditorium 2007

Innovative mine clearance

While Fishermans Bend had established an international reputation for aeronautical research, the relocation of staff from Maribyrnong led to innovation and invention in other areas. Leading the way was the development of the Cormorant Lift Bag. Named after the wading bird, the Cormorant Lift Bag was designed to recover explosive mines remotely and safely from the sea. The bag was capable of lifting underwater objects weighing up to 1000 kg from greater depths than conventional recovery systems without the use of an explosive charge. In addition to mine clearance, it could be used for civilian applications such as search and rescue and salvage operations. In 2004, the Cormorant Lift Bag was formally accepted into naval service after extensive safety and operational testing and was deployed on Australia's six Huon class Coastal Minehunter ships.



The Cormorant Lift Bag

Ever improving kit and equipment

With the relocation of staff from Maribyrnong, Fishermans Bend became the home of DST's physical protection and camouflage experts. Since developing the original 'rabbit ears' camouflage pattern for the Australian Army in the early 1970s, this research area continued to deliver ever-improving advancements to soldiers' equipment and kit including breathable rain gear, high-tech 'cooling' vests, and desert camouflage uniforms suited to the 'new' theatre of war in Afghanistan.

More recently, using state-of-the-art facilities at Fishermans Bend such as the Environmental Test Facility, DST has continued to develop innovative combat clothing for the Australian soldier, including an advanced chemical biological combat suit, integrated ballistic and blast protection, and improved combat body armour.

The Environmental Test Facility

Graeme Egglestone received the 2002 Minister's Award for Achievement in Defence Science for developing a range of innovative combat clothing for Australian soldiers.

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2000s

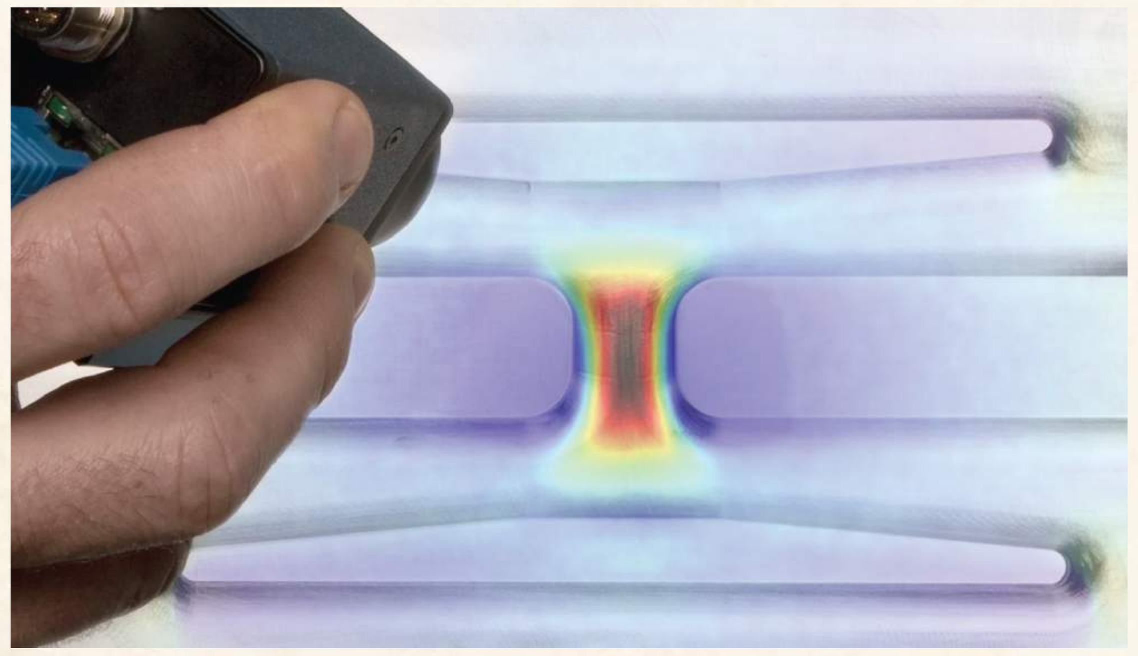
Continuing to save the RAAF time and money

For decades, Fishermans Bend has been the source of innovation that has saved Defence time and money.

That tradition continues today with devices such as DST's Non-Intrusive Flight Test Instrumentation (NIFTI) and Microbolometer Thermoelastic (MiTE) technology.

NIFTI is a state-of-the-art wireless system that allows data from aircraft-flight test to be acquired without the need for time-consuming aircraft modifications. MiTE technology images the stresses in structures undergoing cyclic loading — like a camera for stress — and is a powerful tool for validating assumptions about structural behaviour.

NIFTI – Non-Intrusive Flight Test Instrumentation



Microbolometer Thermoelastic (MiTE) technology

THE FUTURE

Grand plans for Fishermans Bend

Fishermans Bend is now on the verge of a major transformation, with plans underway to develop the area into a leading precinct for advanced manufacturing, design, engineering and technology excellence.

DST is perfectly positioned, both literally and figuratively, to integrate closely into this 'innovation hub'. Land adjacent to DST that once belonged to General Motors Holden is set to become a new University of Melbourne campus, accommodating over 1000 engineering and IT students and academics. With additional technology and innovation businesses expected to invest in the precinct, there will be exciting opportunities for extensive collaboration and sharing of resources.

As DST reflects on eight decades of scientific accomplishment at "the 'Bend", the future is shaping up to deliver more of the same — continued inspiration, innovation and ingenuity.

Artist's impression of the proposed redevelopment