From dark matter to the Roman family

A commitment to research

Most weekdays in 1992, Susan Serjeantson, Professor of Human Genetics, rose at 4:00 a.m., wrote and read until breakfast with her family at 7:00, and left for the fifteen-minute drive to the John Curtin School where she arrived about 8:30. Her routines at work differed from day to day, depending on how many meetings or seminars she had to attend; but most of her time was spent conducting research in the laboratory, where she remained until 5:30 p.m. Tall, slim and softly spoken, self-effacing yet single-minded, in many ways she exemplified the dedicated and successful researcher.

Born near Sydney in 1946, Serjeantson had attended the universities of New South Wales and Hawaii, and had spent several years pursuing research in Papua New Guinea before joining the ANU in 1976. For the next seventeen years she worked as part of a small team, first as a research fellow and from 1988 as professor and group leader, on a project to improve the effectiveness of organ transplantation by developing ways of identifying antigens, the foreign substances present in donor organs which often lead to tissue or organ rejection. The project began in the early years of surgical transplantation and was transformed by the emergence of DNA techniques in the early 1980s. These allowed Serjeantson and her colleagues, including dedicated PhD students, to analyse the genes responsible for encoding transplantation antigens and to suggest methods which vastly improved the potential for matching donors with recipients, a process especially critical in bone marrow transplants. The techniques they developed were adopted in laboratories throughout the world.
Their research also led to unexpected contributions to knowledge about the origins of the peoples of the Pacific. Having analysed genetically, in the course of their transplantation work, large numbers of Micronesian and Polynesian volunteers, they were able to contest the traditional view of physical anthropologists that these two groups were closely related, suggesting instead that Polynesians were more likely to have come from South-east Asia across New Guinea to the islands of Polynesia without island-hopping through Micronesia.

In 1992 Serjeantson received a National Clinies Ross Award for Science and Technology, which specifically acknowledged the success of her work in transferring science from a laboratory to a technological environment. It also referred to her persistence in pursuing valuable research over a long period. Much of her time in the laboratory was spent in the slow, meticulous collection of data from DNA testing, gradually extending the bounds of knowledge, like ‘little drops of water ... dripping away at stone’. Yet she never found the work monotonous. She told Ann Moyle in 1993:

one of the most wonderful things I think in science, in the laboratory, is to experience the first extraction of DNA from blood, because you’re shaking up all this protein and digesting it with proteinase [an enzyme which acts as a catalyst] and precipitating it with ethanol, and all of a sudden out pops this beautiful pure DNA in long swirling strands that one can actually visualise with the naked eye.

As so often happens to talented researchers, her achievements in the laboratory helped take her out of it: for most of 1993 she was Acting Director of the John Curtin School and later that year she was appointed Director of the Institute of Advanced Studies and the University’s first female Deputy Vice-Chancellor.

Iain McCalman, Professor and Associate Director of the Humanities Research Centre from late 1993, rose at 5.00 a.m. and worked for two hours on his laptop computer until interrupted by the appearance of two small boys demanding breakfast. A twenty-minute bicycle ride brought him to the office by 8.45. Born in Nyasaland in 1947, he had come to Australia in 1965, taken an ANU Honours degree in History in 1970, followed by an ANU MA and a PhD from the University of Melbourne. He taught and researched at several universities and colleges of advanced education, passing through the Research School of Social Sciences in the mid-1980s, and returning to a tenured position in the Faculty of Arts in 1987, where his success as a teacher won him ar. inaugural Vice-Chancellor’s Award for Excellence in Teaching.
Energetic and wiry, in 1994 he spent about half his time on the work of the Humanities Research Centre: organising the seven annual conferences relating to the HRC theme, chairing and attending the twice-weekly work-in-progress seminars, selecting the visiting fellows for the 1995 theme on Africa, planning the annual summer school for postgraduate and postdoctoral students, supervising and editing the Centre’s quarterly Bulletin and numerous published collections of conference papers, communicating with colleagues in the humanities spread around Australia and the world, and trying to win extra resources to enable the Centre to fulfil its local, national and international roles. In the first semester he also taught a well-attended undergraduate course on history and literature in the Faculty of Arts and held regular meetings with the four postgraduates working under his supervision in the Graduate School.

The remaining time was devoted to his own projects on British cultural history, including writing prefaces for the paperback editions of his two books, *Radical Underworld* and *Horrors of Slavery*, both dealing with the rich, strange underworld of ideas that circulated among artisan revolutionaries, ex-slaves, thieves, pornographers, preachers, prisoners, artists and writers in late eighteenth-century Britain and the West Indies. He also prepared and delivered five papers in universities in Britain and the United States, and spent much time editing the *Oxford Companion to British Culture: the Age of Romanticism and Revolution*. In 1993, in recognition of these and other achievements, he was made a Fellow of the Royal Historical Society and a Fellow of the Academy of Social Sciences in Australia.

In addition to being much the same age and early risers, Serjeantson and McCalman had in common a commitment to research. Yet their immediate objectives and methods were so different that the term ‘research’ scarcely seems sufficient to embrace them both. Where Serjeantson sought to learn more about the human body by interpreting the results of scientific experiments, McCalman pursued understanding of the past through documents. Where Serjeantson spent much of her time at a bench, making use of indispensable scientific equipment, McCalman’s research time was mostly spent combing record offices, archives and libraries, reading semi-literate scrawled notes of spies and informers, polemical pamphlets, prosecution reports of government legal officials, fugitive novels, poems and newspapers, as well as keeping up with books and articles by fellow historians and literary critics. Serjeantson worked as part of a team; McCalman (until he became involved in the *Oxford Companion to British Culture*) worked on his own. Serjeantson and her team presented most of their findings in articles in specialist journals, and wrote in a style intended for their scientific colleagues; McCalman wrote books as well as articles, and aimed to reach general readers as well as his peers in history, literature, politics and related disciplines. Serjeantson expected her work to have practical applications for patients undergoing organ transplants; McCalman expected no immediate benefits, beyond the hope of resurrecting lost ideas, visions and social possibilities, and so contributing to larger understandings of humankind.

Yet the link between them was strong. They and their fellow researchers across the campus shared a commitment to the idea of research as a means of advancing the
boundaries of knowledge and understanding. They also shared a belief that research, in whatever form it might take, was something that no advanced western nation could afford to be without. This was their association with the founders of the University and the researchers of previous decades, and it was sufficient to give an underlying coherence to the University’s research endeavour.

Work in progress

In other respects, that endeavour was most remarkable for its diversity. At any one time, hundreds of research projects were being conducted across the campus. These were often described in work-in-progress seminars, which gave researchers the opportunity to test their theories and findings on colleagues before exposing them to the wider world. Some projects might involve many researchers, including academics from outside the ANU, continue for decades, and lead to major books or discoveries. Others might be the work of a single researcher, last less than a year, and result in a short article in a scholarly journal.

ANU annual reports sought to convey the research achievement by listing the year’s publications (until the list became too long for inclusion) and describing a selection of projects in detail. In attempting to represent research over the past two decades, we follow this lead and identify projects, not as a definitive list of outstanding achievements, but rather to illustrate the range and diversity of the ANU’s research activity.

Dark matter

ANU scientists at the Mount Stromlo and Siding Spring Observatories (MSSSO) remained at the forefront of international research in astronomy and the related field of astrophysics. Major contributions during the 1970s and 1980s included the discovery that disc galaxies such as the Milky Way have origins far more complex than had previously been understood, and that shells around elliptical galaxies, the other main form of galaxy in the universe, result from mergers between the galaxies. ANU astronomers also provided convincing evidence that about 90 per cent of disc galaxies take the form of ‘dark matter’, the unseen matter in the galaxies’ haloes.

Astronomy and astrophysics illustrate graphically how knowledge advances, as one discovery builds on another. In 1990 staff at MSSSO began a collaborative project with scientists in the United States to test the theory that dark matter comprised objects collectively known as ‘massive compact halo objects’, or MACHOs. Such objects give out no light themselves but occasionally deflect the light of background stars, thereby offering evidence of their existence. If a star is observed over a period of a year, the chance of such an event being observed is about one in two million.

The MACHO project set out to observe many millions of stars on a continuous basis, making use of the oldest telescope at Mount Stromlo, known as the Great Melbourne Telescope, which had been built in 1868 and transferred to Canberra in
1953. The telescope was modernised and brought under computer control, and the survey began in 1992. By late 1994, the program had made 26,000 exposures of 20 million stars, and had discovered 50 MACHO ‘events’, accumulating more quantitative data than any other project in the history of astronomy. The ultimate significance of the MACHO project lay in what it revealed about the total quantity of matter in the universe, which would determine its ultimate fate of either expanding to infinity or eventually returning to the primeval Big Bang with which it all began.

ION PROBES AND SYNTHETIC ROCKS

Ted Ringwood served as Director of the Research School of Earth Sciences from 1978 to 1983 and as Professor of Geochemistry until his premature death in 1993. In 1991, when accepting the V.M. Goldschmidt Medal of the Geochemical Society (USA), awarded in recognition of major achievement in geochemistry and cosmochemistry, he reflected on the spectacular improvement in our understanding of the earth over the preceding 25 years. It was now possible to investigate in a laboratory the chemical and physical properties of materials which occur in the earth’s mantle and core. These advances, he said, ‘are now setting the stage for a fundamental enquiry into the dynamical behaviour of the mantle and into the nature of the engine that drives the system and ultimately, I hope, into the origin of the Earth itself’.

William Compston and Ian Willis from the Research School of Earth Sciences with the instrument Compston invented, a Sensitive High Resolution Ion MicroProbe, better known as SHRIMP. Photograph by Giulio Saggini in 1989. Canberra Times.
The research school was widely acknowledged as a world leader in several areas of geophysics and geochemistry. Research during John Jaeger’s time on the theory of continental drift led to a program in palaeomagnetism during the 1970s. Work in geochronology during the 1980s, using an ion-probe instrument developed at the ANU, revealed insights into the evolution of the earth’s crust. (The instrument, which fills an entire room, was later manufactured commercially by Anutech.) Much of the school’s research had practical applications: for example, by providing a detailed chronology for the old geological terrains in Australia, the ion-probe generated valuable data for mineral exploration. As a by-product of fundamental research, Ringwood developed a synthetic rock which he called SYNROC, which was widely recognised in the mid-1990s as promising the safest method so far invented for disposing of high level nuclear waste.

In the Faculty of Science, Douglas Haynes had been given leave by his employer, the Western Mining Corporation, to enrol for a PhD degree and ‘find out all about copper’. His research showed that continental basalts will release copper to circulating hot ground waters and that, under certain geochemical conditions which depend on geological age and setting, the copper is then trapped as copper sulphide in large bodies of copper ore. Having made this discovery in the laboratory, Haynes and his colleagues set out to locate sites which fulfilled the necessary geological conditions. They found one at the Olympic Dam, near the northern tip of Lake Torrens in South Australia. There were no indications on the surface of the existence of an immense deposit. Production began in 1988 and was expected to continue for several hundred years, yielding a total revenue (in 1990s values) exceeding $50 billion. While the ANU had been an expensive undertaking, this one project promised to pay for it many times over.

SHOCK TUNNELS, ACCELERATORS AND MATHEMATICAL MODELS

In the early 1960s, engineers in the Physics Department in the Faculty of Science set out to reproduce in devices known as shock tunnels the aerodynamic conditions which exist when space vehicles re-enter the earth’s atmosphere at orbital speeds. In 1969 the major ANU shock tunnel became the first in the world to reproduce re-entry speeds of up to eight kilometres per second. As well as enabling researchers to diagnose aerodynamic flows, shock tunnels produced heated gases that were used for spectroscopic studies, the analysis of the chemical nature of substances by examination of their spectra. Assisted by contracts from space agencies in the United States and Europe, shock tunnel research continued into the 1990s, with emphasis on developing laser techniques for measuring gas temperatures and densities under the extreme conditions of vehicle entry into planetary atmospheres. This work had direct applications for developing a new generation of aerospace engines.

The year 1975 signalled a turning point in the Department of Nuclear Physics in RSpHysS with the installation of a new generation heavy ion accelerator, known as a 14UD Pelletron. For a time the highest voltage electrostatic machine in the world, it
continued to operate efficiently, beyond its original specifications, providing the prerequisite for a productive research program. Nuclear physicists used accelerated heavy ion beams to explore the shapes of atomic nuclei and the mechanisms by which they could form and decay. The 14UD Pelletron was also applied to accelerator mass spectrometry, an ultra-sensitive technique used to measure minute concentrations of naturally occurring radioisotopes. One of these, Chlorine-36, is a unique ‘marker’ of many hydrological processes, allowing scientists to determine, for example, the age of water basins or to investigate problems of salinity in one of Australia’s major agricultural areas, the Murray–Darling basin.

In contrast with team research using large-scale equipment, Rodney Baxter worked alone with little more than pen, paper and personal computer to explore basic questions relating to the nature of matter. When a substance transforms from gas to liquid, or liquid to solid, its individual molecules remain the same, but their collective behaviour changes markedly. Baxter was one of the few scientists in the world to develop mathematical models which accurately explain examples of this behaviour. An ANU PhD and member of the Department of Theoretical Physics in RSPhysS from 1965, he received international physics prizes, including the Boltzmann Medal of the International Union of Pure and Applied Physics in 1980 and the American Physical Society’s Heinemann Prize in 1987. In 1992 he was appointed (concurrently with his ANU positions) Royal Society Research Professor at Cambridge University.

Surface forces

By the mid-1990s, the Young Turk Barry Ninham had become one of the longest-serving professors in the University, having been appointed to a chair in RSPhysS in 1970, at the age of 35. Although he was styled Professor of Applied Mathematics, he insisted that the title was unimportant. In his view, ‘the tyranny of discipline’ inhibited the exchange of ideas among scientists. His own area, surface science, encompassed chemistry, physics, mathematics, biology and earth sciences. ‘You can’t find an apt name for the work we do here’, he told the ANU Reporter in 1993. ‘I think we should sometimes call it natural philosophy and be done with it.’ Irrespective of their scientific backgrounds, Ninham and his colleagues sought ‘ultimately to understand structure and function and how, in nature, molecules self-assemble into weird and wonderful shapes, exemplified by the diversity of life on earth’.

Some of the major questions in this field relate to the forces that exist between solid surfaces separated by a liquid, when the surfaces are almost touching. Such forces control colloid science, lubrication and adhesion. Their behaviour was explained by theoretical models until Jacob Israelachvili, a member of the Department of Applied Mathematics who had worked at Cambridge on forces between surfaces separated by gases, designed and demonstrated an apparatus capable of measuring the force between two smooth panes of mica immersed in a liquid. As the panes come within a minute distance of one another, the measured force shows up the grainy molecular nature of the liquid.
Such measurements have applications in various industries, including printing, food and mineral processing, and the surface forces apparatus was successfully marketed around the world. When Israelachvili moved to a chair in California, others in the department continued to develop the technology. A versatile new instrument was manufactured and marketed in 1995.

**Muscle disease**

Research in the John Curtin School continued to concentrate, as Florey had intended, on the science behind clinical medicine, that is, the molecular and cellular basis of medicine. From the 1970s to the 1990s there was a gradual shift in emphasis towards clinical outcomes, partly to satisfy public expectations that a school of medical research should have demonstrable relevance to the people’s health. That relevance was evident in the many areas of medicine explored in JCSMR: pain and drugs, the molecular structure of viruses, immunity, genetic responses to disease, the initiation and spread of cancer, reproduction, transplantation, neurological disorders such as impaired vision and multiple sclerosis, environmental conditions affecting the incidence of disease, and more.

Nevertheless, the school continued to emphasise the benefits of long-term research, of pursuing specific lines of inquiry wherever they might lead. This was the school’s comparative advantage over other universities and medical research institutes. Many projects extended over decades, gradually accumulating knowledge and sometimes yielding spectacular outcomes.

Michael Denborough joined the Department of Clinical Science in 1974 and devoted himself over the next two decades to exploring the syndrome known as malignant hyperpyrexia (MH). In 1960 he was working in the Casualty Department of Royal Melbourne Hospital when a 21-year-old student was brought to him with an injured leg. The patient was less concerned about his leg than with the prospect of having to receive a general anaesthetic, as ten members of his family had died as a result of anaesthesia with ether. Denborough described the syndrome, and ten years later, having studied reports of similar cases in the world literature, he established a link between MH and an inherited muscle disease. Pursuing the problem at the John Curtin School, he and his colleagues conducted biochemical and physiological experiments on a particular breed of pigs which responded to anaesthesia in a similar way to humans who suffered from MH. Having discovered the nature of the muscle disorder, they developed a test to establish susceptibility to MH in families known to be affected and to identify which anaesthetics could be used in individuals susceptible to MH. As well as saving many human lives, the discoveries were of practical value to
the pig industry. In 1982 Denborough was awarded a gold medal at the Fifth International Congress on Neuromuscular Diseases in Marseilles, where the syndrome of malignant hyperpyrexia was named after him.

**The immune system**

Another of the John Curtin School’s continuing interests was the way in which humans combat viruses. In 1973 Peter Doherty and Rolf Zinkernagel in the Department of Microbiology discovered how a gene complex in the cells of vertebrates operates as a ‘flag’ to attract T-cells (the body’s defences) to cells infected with a virus. The T-cells then kill the infected cells. The gene complex, MHC (major histocompatibility complex), is genetically different in each individual, and this difference, known as polymorphism, prevents viruses wiping out whole communities. This discovery, and later work on the biological role of MHC, had a profound international impact on immunology, and won for Doherty and Zinkernagel the Paul Ehrlich Prize and the Albert Lasker Prize, an award of near-Nobel eminence.

**Cancer**

Drawing on research which began in the 1970s, Chris Parish’s laboratory in the Division of Immunology and Cell Biology in JCSMR developed a novel family of sugar-based anti-cancer drugs. One class of drugs inhibits the spread of cancer by preventing cancer cells from migrating through the walls of blood vessels and entering new tissues. Another class starves solid cancers of blood supply by preventing the growth of new blood vessels into the tumours. The sugar-based drugs have considerable clinical potential, as they are subtle in their mode of action and should have minimal side effects.

Research in the Department of Biochemistry in The Faculties was directed towards management of the drastic weight loss and progressive weakness caused by tumours. Studies on animals with different types of cancers indicate that a combination of chemical agents which inhibit muscle breakdown can delay the development of wasting. Such medication should sustain patients receiving stressful treatments such as chemotherapy and radiotherapy.

**Vision and optics**

Visual sciences began at the ANU when Peter Bishop succeeded Sir John Eccles in 1967 as head of the Department of Physiology. Where Eccles had studied motor neurons in the spinal cord to probe the workings of the brain, Bishop and his colleagues studied sensory cells in the visual system, attempting to unravel how information in the images formed within the eye is analysed by nerve cells of the eye and brain.

Research on vision could be approached from a physical as well as a biological direction. In 1988 the University created a Centre for Visual Sciences to bring
In 1982 Peter Bishop, left, uses a plotting table and mirror to explore the properties of binocular visual neurones, while Shigeru Yamane, visiting fellow, checks the settings on a Zeiss fundus camera, used here to guide the alignment of the two eyes.

The ANU also had a long history of involvement in the related field of optics, in one direction through the work of Hans Buchdahl, Professor of Theoretical Physics in the Faculty of Science from 1962 to 1985 and later a University Fellow. Buchdahl sought to explain optical aberrations, developing computational schemes that were incorporated into the design of high performance optical systems, such as those used in satellites.

Optics was another area which attracted researchers from various disciplines. An Optical Sciences Centre, created within RSPhysS in 1988 around Allan Snyder, an unconventional American from the Age of Aquarius, quickly became a world centre for research on optical fibres and vision. Again, research benefited from synergies (a term then coming into fashion) between biological and physical approaches. Research on insect vision, for example, stimulated theoretical work leading to significant discoveries about optical fibres, which in turn suggested the possibility of designing a number of unique optical fibre devices with high commercial potential.

Research in optics was strengthened by the amalgamation in 1987 of a number of laser groups to form the Laser Physics Centre, which encouraged cooperation in the use of major laser facilities, with programs in photonics, spectroscopy, materials science and atomic physics. In the 1990s, scientists in the Optical Sciences Centre developed theoretical design concepts for novel, non-linear photonic devices with the potential to revolutionise telecommunications. These concepts, involving the creation and interaction of so-called ‘spatial solitons’, were realised experimentally by colleagues in the Laser Physics Centre, who demonstrated the attraction and spiralling of optical solitons in non-linear media, the seemingly bizarre pro-cesses proposed by Snyder and his team in 1991, for use in optical switching.
The chemistry of cages

In 1958 Alan Sargeson had joined Frank Dwyer in the John Curtin School to work in the relatively new field of biological inorganic chemistry. With the foundation of the Research School of Chemistry in 1967, the group—now led by Sargeson after Dwyer’s death—moved to the new school, where in 1975 he made a discovery which was to retain his interest for the next twenty years and which, in the world of chemistry, became invariably associated with his name.

Sargeson and his colleagues showed that it was possible through a straightforward chemical reaction to create organic molecules that would trap metals. These encapsulating molecules, which became known as ‘sarcophagine cages’, effectively isolated the metals from the substances in which they occurred.

This process was shown to have many potential uses. The group produced a new class of detergents and a nylon-like compound which removed almost every trace of copper, zinc, cadmium, mercury or lead from water. In the 1990s they were exploring how the cages might be used as imaging agents to provide images of organs such as the brain and heart. The technique also had potential as a means of combating Wilson’s Disease, a genetic disorder whose sufferers have no natural mechanism for eliminating the copper which accumulates in their liver and brain cells.

Population health

J.C. Caldwell, who succeeded W.D. Borrie as head of the Department of Demography in 1970, was a firm believer in the value of social and anthropological approaches to demographic research. An inveterate traveller, he spent much of his time in the field, often in the remote villages and crowded towns of developing countries throughout the world. Empirical research translated into theory: his 1982 book, Theory of Fertility Decline, showed how the changing flow of wealth between generations and within families influenced fertility.

In Nigeria in the mid-1970s, he became interested in the influence of maternal education on child survival. Pursuing the subject in South India and Sri Lanka, he moved gradually into the fields of mortality, morbidity and epidemiology. In 1988 he was appointed Advisor to the Rockefeller Foundation on Health Transition and head of a new Health Transition Centre in the Department of Demography, which aimed to explore the cultural, social and behavioural determinants of health change and discover ways of improving health around the world. About this time, he and his colleagues, including his wife Pat Caldwell, began to investigate the causes of the AIDS epidemic in sub-Saharan Africa.

The Health Transition Centre soon moved to a new

Demographers in the field: I.O. Orubuloye (ANU PhD and Professor at Ondo State University), Jack Caldwell and Pat Caldwell interview a Yoruba ‘Queen’, interim ruler between male chiefs, Nigeria, 1990. By courtesy of J.C. Caldwell.
part of the University, the National Centre for Epidemiology and Population Health, where Caldwell continued to work after his formal retirement in 1993. Established with Commonwealth government funding, the National Centre undertook research and training in epidemiology, health economics, sociology, statistics and population studies, providing an institutional link between medicine and the social sciences much as Coombs and his colleagues had contemplated in the mid-1940s.

Efficient plants

When RSBS was founded in the late 1960s, one of the areas identified for investigation was the water economy of plants, an appropriate topic for a predominantly arid continent. In the 1970s Ralph Slatyer, Professor of Environmental Biology (and later a Director of the school) initiated a research program on photosynthesis, seeking to discover the relationship between carbon gain, which is the basis of plant growth, and water loss. In due course Barry Osmond (a later Director) elucidated a variety of methods by which different kinds of plants capture carbon. Research by other team members showed how stomata work to optimise the ratio of water vapour and carbon dioxide exchange.

Further investigation demonstrated that the efficiency of a plant's use of water could be assessed by measuring the relative amounts in plant tissue of the two stable isotopes of carbon, because of discrimination between the isotopes during photosynthesis. Such measurements made it possible to identify varieties of agricultural crops that use water with better than average efficiency. For Australia alone, the potential economic gains were impressive. If genetic selection could be used to increase the efficiency of food crops by just 1 per cent, the potential benefits in a dry year would be several million dollars. By the 1990s researchers were reaping rewards from the techniques of genetic engineering. According to an external review in 1995, the school's work on water efficiency was at the cutting edge of plant molecular and physiological research. It was also an outstanding example of teamwork, unexpected outcomes, and the steady accumulation of knowledge and expertise over some 25 years.

Understanding the environment

The Centre for Research and Environmental Studies developed as its makers, Sir John Crawford and Frank Fenner, had intended it should, bringing together various disciplines and offering a unified response to environmental issues in Australia and other parts of the world.

One of its projects in the 1980s was to devise computer-based methods for the analysis of resource and environmental issues and for environmental management. Led by Henry Nix, the Centre's head from 1986, a research team developed a system to incorporate data on the attributes of landscape and biology that regulate key physical and biological processes, such as climate, vegetation, topography, geology
and soils. The information is linked to computer models of biophysical processes
which help researchers describe and interpret the changing environment.

The system has many uses, relating for example to agriculture, forestry, park
management, pest control, tourism and water use. With the help of CRES researchers,
national, state and local governments can develop balanced environmental plans that
successfully accommodate competing interests.

Saving forests in Nepal

In 1975 the Department of Forestry became closely involved in an Australian
government project to save forests in Nepal. The project covered two regions,
inhabited by about half a million people who were heavily dependent on
fodder from the forests to feed farm animals and on forest wood for
cooking and heating. The country was facing a critical shortage of forested
land and forest products necessary to sustain its mainly rural, subsistence
economy.

ANU foresters, led by the head of the Forestry Department, David
Griffin, conducted research into the causes of the deterioration of the
forests and provided practical help to the villagers. Where previous aid
activities had attempted to impose western styles of management, which
turned out to be inappropriate to the circumstances, the Nepal–Australia
Forestry Project achieved remarkable success through working closely
with local panchayats (councils) and villagers. Over the next decade, more
than 6000 hectares of government owned and community land were
replanted, many nurseries were established, and scores of villagers were
trained as nurserymen. The next stage of the scheme, now managed by Anutech,
concentrated on technically feasible and socially acceptable methods of managing and
harvesting new and remnant old forests in the context of community forestry.

Economics and policy

ANU economists were never far removed from policy issues. Within the context of
Australia’s fourfold increase in unemployment since 1975, researchers in RSSS
contributed to international literature on the economics of the labour market and to the
analysis of unemployment in Australia and other parts of the world. The Centre for
Economic Policy Research provided advice to Australian government departments and
international agencies including the World Bank. Individual members of the centre,
acting as consultants or serving on government committees, made recommendations
which sometimes had far-reaching effects on government income and savings on
expenditure, such as the introduction of the Higher Education Contribution Scheme,
which required all tertiary students to pay something towards the cost of their education,
and a tighter assets test for old age pensions, which promised to save the Australian
taxpayer up to one billion dollars in the first eight years of its operation.
The Australia–Japan Research Centre, a legacy of Sir John Crawford’s close relations with Japan, had a similar practical orientation, with major projects on specific trading commodities, Japanese corporate organisation, the internationalisation of Japanese financial markets, and economic reform in China. Ross Garnaut’s report on *Australia and the Northeast Asian Ascendancy*, originally prepared in RSPaCS as a report to government, helped shift the country’s thinking about its economic future.

**Law and society**

In view of the pervasive influence of the federal system in Australia, it is not surprising that academic lawyers at the ANU focused much of their attention on federalism. Geoffrey Sawer continued to work in the area until and beyond his retirement from RSSS in 1975. Leslie Zines, a member of the Faculty of Law from 1962 and a professor from 1973, analysed the recent role of the High Court in reshaping both the federal aspects of the Australian constitutional system and the relationship of the citizen to state and Commonwealth governments. His study *The High Court and the Constitution*, first published in 1981, became required reading for judges of the High Court and counsel who appeared before it. In 1988 he explored federal issues in Australia, Canada, New Zealand, Britain and the European Community in a series of lectures at Cambridge, later published as *Constitutional Change in the Commonwealth*.

Although gregarious, Sawer as a researcher was a productive lone:, who created no school of research lawyers and left no following. When Sawer left, the Law Department in RSSS wound down, to be wound up again with new appointments in the late 1980s. Researchers in the mid-1990s, including Zines (now retired from the Faculty of Law) and a former Chief Justice and Pro-Chancellor of the ANU, Sir Anthony Mason, carried forward his interests in the law and government; others joined in multidisciplinary projects to open up new areas of social and political theory. The ‘Regard’ Project, for example, analysed how the good regard of other members of a community functioned as a force for social order.

**The Australian people**

As the founders had intended, much of the University’s research in the social sciences and humanities focused on Australia and Australians. Although Manning Clark had retired in 1975, he continued to present his inimitable view of the nation’s past and speak out on the issues of the day. The sixth and final volume of *A History of Australia* was published in 1987, four years before his death.

Ken Inglis worked at the ANU from 1962 to 1994, with a spell as Professor of History and then Vice-Chancellor at the University of Papua New Guinea from 1967 to 1975 and several visiting appointments, including Professor of Australian Studies at Harvard. Soon after joining Clark’s Department of History in the School of General Studies in 1963, he set out to explore the meaning of Anzac Day, which had so far attracted little
serious historical attention. The Anzac tradition became ‘a base from which to explore areas of Australian history not yet well mapped’ and inspired The Australian Colonists in 1974. As a professorial fellow (briefly) and professor in RSSS from 1975 to 1994, he maintained his interests in Australians at war and the impact of war on Australians, digressing to write a history of the first 50 years of the Australian Broadcasting Commission (later Corporation) and to play a crucial role in creating the eleven-volume series Australians: A Historical Library (1987–88), a project which involved many other researchers not only at the ANU but throughout the university system.

Inglis also served as chairman of the editorial board of the Australian Dictionary of Biography which, after the difficulties surrounding its birth, was one of the ANU’s most successful collaborative ventures. With headquarters in RSSS, the series drew on the expertise of working parties and individual writers throughout Australia. By 1990 twelve volumes had been published, covering in more than seven thousand entries the period from 1788 to 1939 and representing, as the Melbourne writer and critic Stephen Murray-Smith said in a review, a ‘remarkable gift to the nation’. In 1993, when the first volume for the period 1940 to 1980 appeared, the project looked set to continue in perpetuity.

ANU researchers remained at the forefront of work relating to the composition of the Australian population, including immigration and cultural diversity. W.D. Borrie and his colleagues in the Department of Demography coordinated the National Population Inquiry, publishing in 1975 their first report, which analysed population trends in the preceding century and forecast future movements. By showing the effects of population growth on society and the environment, they provided for the first time a systematic basis for immigration policy-making. Charles Price, a Professorial Fellow in Demography, and Jerzy Zubrzycki, Professor of Sociology in The Faculties, explored the processes of migration and settlement. In RSSS, James Jupp edited The Australian People, subtitled An Encyclopedia of the Nation, its Peoples and their Origins, which was published to mark the bicentenary of European settlement in 1988 and which spawned a small Centre for Immigration and Multicultural Studies.

Many projects focused, from different disciplinary perspectives, on Aboriginal Australians: anthropological studies of communities and the relations between them, historical surveys, archaeological studies which built on the work that John Mulvaney had begun. In 1983 Noel Butlin exploded traditional assumptions about the size of the Aboriginal population at the time of European settlement, then turned his hand to the economics of Aboriginal societies. In the 1960s, F.L. Jones, Fellow and later Professor of Sociology in RSSS, had conducted the first major demographic study of the Aboriginal population; 30 years later, researchers in the National Centre for Epidemiology and Population Health and the Centre for Aboriginal Policy Research,
a small unit in the Faculty of Arts, were analysing social change in Aboriginal populations and generating data which contributed to government policy-making.

Asia

The University’s research on Asia ranged across countries, centuries and disciplines. In the Faculty of Asian Studies, Pierre Ryckmans (writing as Simon Leys) won international awards for his publications on China. In RSPacS, C.P. FitzGerald’s successor as Professor of Far Eastern History, Wang Gungwu, served the University from 1968 to 1986, including a term as Director of RSPacS. Born in Java in 1930 to Chinese parents, Wang had attended university in Nanjing before the Communist revolution, and had then taken out degrees from the University of Malaya in Singapore and the School of Oriental and African Studies at the University of London. At the time of his appointment to the ANU he was Professor of History at the University of Malaya in Kuala Lumpur. He published widely on Chinese history and politics and on the Chinese diaspora in South-east Asia. An eloquent speaker, he was in frequent demand to comment on contemporary events in Asia.

The ANU continued to be a world centre for the study of South-east Asia. Research on Indonesia included historical, anthropological and archaeological surveys, ethnographic films, and studies of the economy which built on the early work of H.W. Arndt. Notable publications included Anthony Reid’s two-volume survey of Southeast Asia in the Age of Commerce (1988–93), from the fifteenth to the seventeenth centuries. The University also remained at the forefront of scholarship on Vietnam, chiefly though the work of David G. Marr in RSPacS.

The research agenda responded to changes within Asia and in Australia’s relationships with Asian countries. To fill a gap in Australian scholarship, RSPacS set up a Northeast Asia Project in 1989, focusing on Taiwan and Korea. In the mid-1990s, Yang-hi Choe-Wall, a native of Seoul and an expert on the Korean language, whose translations from English into Korean included Manning Clark’s Short History of Australia, was editing the world’s first extensive encyclopedia on Korea in English.

Past and present

Historical research was not restricted to Asia and Australia. The University became an antipodean centre for scholarship on British and Irish history, chiefly through the work of Oliver MacDonaghy and F.B. Smith, and visitors and students who came to RSSS to work with them. In several books, Smith brought new understandings to disease, health and medicine in nineteenth- and twentieth-century Britain. MacDonaghy’s publications during his sixteen years as a professor at the ANU included acute analyses of Irish history and culture, a study of Anglo-Irish conflict over two centuries, a two-volume biography of the nineteenth-century Irish patriot Daniel O’Connell, and an elegant exploration of the ‘real and imagined worlds’ of Jane Austen (published in 1991, after his retirement).
Much historical work centred on the Pacific islands. Oskar Spate distilled decades of profound scholarship into a three-volume publication *The Pacific since Magellan* (1979–88), which promised to remain one of the world’s great works on the Pacific and one of the ANU’s great contributions to the world. Pacific researchers continued to play a part in the events and places they were studying, just as Spate and J.W. Davidson had done in earlier years. In 1995 Brij Lal, a historian attached to RSPAS and the Faculty of Arts who had written extensively on Fiji history and politics, was appointed by the Fiji government to a committee of three to review the constitution established after the 1987 military coups.

T.H. Rigby, who first joined Canberra University College in 1955 and retired as Professor of Political Science in RSSS in 1990, built up a corpus of publications on Soviet politics and history, including major studies of *Lenin’s Government* (1979) and *Political Elites in the USSR* (1990), and was one of the few scholars to comprehend the fatal weaknesses in Soviet economic statistics. The radical and unforeseen changes in the communist world from 1989 emphasised the value of his expertise and the long-term research that lay behind it.

**Language**

ANU researchers were responsible for most linguistic work relating to the Pacific islands and a large proportion of research on the languages of Australia and Southeast Asia. These three areas account for some two thousand languages, or about one-third of the languages of the world. The surveys begun by Stephen Wurm in RSPacS in the 1950s culminated in 1981, with the publication of the first part of the *Language Atlas of the Pacific Area*.

In the 1990s, the RSPacS linguists joined with anthropologists and prehistorians in the school to study the peoples of Austronesia, a linguistic term which refers to a family of languages found in Indonesia and the Philippines, the coastal and island areas of Melanesia, and throughout the Pacific. The project aimed to explore the dispersion of Austronesian speakers which began some six thousand years ago, as they moved southwards from Formosa, eventually reaching Madagascar in the west and Easter Island in the east. The linguists traced the historical development of these languages, publishing a *Comparative Austronesian Dictionary* which contained vocabulary from some eighty languages representative of the family tree; the prehistorians studied archaeological evidence of migration; and the anthropologists examined social parallels that still exist between contemporary Austronesian societies.

Meanwhile, R.M.W. Dixon, Professor of Linguistics in the Faculty of Arts from 1970, worked with his colleagues to record and document Aboriginal languages, including fifty or so that were still in use...
and another fifty that had died out. As well as compiling academic grammars chiefly of interest to linguists, the team prepared dictionaries and literacy materials to ensure that unique evidence of Aboriginal culture survived.

**The Roman family**

Ancient Rome, said Beryl Rawson, Professor of Classics in the Faculty of Arts, ‘is a complex, urbanised, sophisticated, affluent society which has much to tell us about our own society’. Like her prehistorian colleague John Mulvaney, Rawson was a prominent advocate of the relevance of the humanities, enjoying the rare distinction of having feature articles written about her in airline club and newspaper magazines.

Rawson joined the ANU in 1964, served for a time as Dean of the Faculty of Arts, and became Professor in 1989. Throughout this period her research concentrated on the family in ancient Rome. Looking at old evidence in new ways, she described relationship patterns and showed how they were often similar to those existing in modern families. Contrary to the widely accepted view that the concept of childhood dated from the seventeenth century, she demonstrated that Roman children were ‘not just little adults’, but real children, ‘tugging on adults’ togas’.

Rawson’s publications won praise at home and abroad. In the 1990s she convened a series of conferences at the Humanities Research Centre, which attracted scholars from throughout the world and confirmed the University’s status as an international centre for the study of ancient Rome.

**Measuring achievement**

How was the University’s overall research achievement to be assessed? In the 1970s the task was relatively easy. The Annual Report for 1975 affirmed the ANU’s academic standing by listing the year’s publications, outlining selected research programs, and referring (in the Vice-Chancellor’s report) to the numbers of ANU academics who were members of the learned academies. Each category suggested impressive achievement, enabling the Vice-Chancellor, Anthony Low, to assert that of all the universities created across the world since the Second World War, none had achieved a greater reputation for scientific and scholarly work.

That may well have been true. But where was the proof? As other Australian institutions strengthened their own research reputations and competed vigorously for diminishing funds, people in government and in other parts of the higher education system looked for precise evidence for such confident assertions. The review process which Low had initiated hastened the trend towards precision. Reviews implied comparisons. Initially these were qualitative and highly subjective; but as reviewers became more searching and the government more demanding, the research schools in particular sought to prove their worth by presenting some hard figures.

Under the leadership of Paul Bourke, Director of RSSS, the University entered the complex field of performance indicators. Bourke was familiar with detailed
quantitative research through his work on nineteenth-century voting patterns in the United States. Soon after his arrival at the ANU in 1985, he published for the Commonwealth Tertiary Education Commission a paper entitled Quality Measures in Universities, which drew attention to the potential uses of publication and citation data gathered by the Institute of Scientific Information, based in Philadelphia. These records show, among other things, the number of times individual publications are cited in major international scientific journals. Bourke initiated a data survey, modest by later standards, for the review of RSSS in 1988, and a more substantial study of the Institute of Advanced Studies for the 1990 Stephen review.

Increasingly complicated and refined studies followed. Responding to an approach from the University of Sussex, Bourke and his colleague Linda Butler embarked on an ambitious project to replicate for Australia a proposed database designed to render machine readable all British entries in the Institute of Scientific Information indices from 1981 to 1990. The companion studies would permit comparisons between British and Australian research output, and suggest how quantitative indicators might be used to evaluate research in modern multidisciplinary universities. That collaboration provided the basis for the creation in 1992 of the Performance Indicators Project in RSSS, which prepared detailed analyses relating to the past and future of Australian science, including the distribution of fields of research among Australian university science departments and patterns of international collaboration among Australian universities. Within the ANU, the Project embarked on a bibliometric survey for the projected reviews in 1995 of all research schools, centres and the Institute as a whole, intended to provide an impartial assessment of the impact of Institute research relative to that of other Australian universities.

How much significance could be attached to these analyses? Bourke was quick to point out their limitations, especially in relation to the humanities and social sciences, where research often found its way into books rather than the international journals captured by the citation data banks, and scholars in any case were not bound by convention to acknowledge every work that influenced them. For the natural sciences too there were many traps. The irreverent Barry Ninham, Professor of Applied Mathematics, claimed on returning from outside studies leave in 1994 that science citations had become ‘quite meaningless’: ‘virtually no one at the cutting edge of research in my fields reads the literature, and all exchange is by personal interaction’. As Bourke recognised, tacit linkages, as they were called, rather than formal interaction through publications, were becoming increasingly significant, and electronic communications were hastening the trend. In certain areas of scholarship, the pace of research was accelerating so fast that traditional means of publication, and hence the methods designed to assess their impact, were becoming redundant. Would the revolution in electronic communications signal the fate of ‘traditional’ performance indicators, just as the computer revolution had allowed them to come into being?

Nevertheless, whatever the future of performance indicators, in the 1990s research performance was a major issue for resource allocation in higher education, and a subject of special importance to the ANU. As Geoffrey Brennan, Bourke’s successor as Director
of RSSS, pointed out in 1991, if the University did not provide the government with reliable data for assessing its research performance, it would be vulnerable to 'back-of-the-envelope stabs'. Bibliometric evaluation was 'simply something we must do'.

The 1995 review of the Institute showed that the exercise to date had been well worth the effort. Although the reviewers recognised the limitations of such evaluation, they noted especially the work of the Performance Indicators Project, observing that publications by members of the Institute tended to be cited more often than those by members of institutions selected for detailed comparison. They were also impressed by an analysis of highly cited publications, which showed that the Institute outperformed its 'comparator institutions', sometimes by more than twofold. The reviewers concluded that these quantitative measures confirmed the results of peer group assessment.

Similar conclusions could be drawn for the University as a whole. This chart, based on citation figures for the period 1988 to 1992, shows the six areas of science (excluding the social sciences) where the ANU is most active. As well as demonstrating the University's large share of the publishing output of all Australian science, it shows that the overall impact of those publications was far greater than their numbers might otherwise suggest.

The Science Citation Index, produced by the Institute for Scientific Information in the United States, indexes over 3000 scientific publications. It covers publications from all major Australian research institutions, including all universities, the CSIRO and other government organisations.

The chart shows the proportions of Australian publications, in six relevant fields, that have an ANU author; and ANU proportions of the most highly cited publications in each field. Citations are recorded against a publication when it is referred to in other publications. The more citations a publication receives, the higher visibility it has in the international research community. The Performance Indicators Project database, compiled by RSSS, enables the most highly cited publications (in this case, the top 1 per cent) to be identified, together with their institutional affiliation.
The ANU diaspora

The University’s influence could be measured in other ways. Each year’s Annual Report listed instances of academic staff giving expert advice and assistance to federal and state government departments and to other institutions, both within Australia and overseas. By the 1990s the list ran to many hundreds of individual entries and included secondments, consultancies, committee memberships, and large and small contributions to specific projects.

More difficult to quantify was the University’s impact through its graduates, its staff who moved on to appointments in other institutions, and staff from other institutions who came to the ANU for any period between a few weeks and a year. The visitors’ program in the schools and centres was by far the most extensive in Australia. The Research School of Earth Sciences, for example, in the decade to 1994, welcomed over 400 visitors for between one and twelve months, including 285 from outside Australia. As well as ensuring a continuing flow of information and ideas, visitors helped confirm the national and international significance of ANU research.

The influence of ANU graduates varied from one discipline to the next. The University remained at the forefront of teaching and research in prehistory (though in keeping with current fashion, the term ‘prehistory’ was no longer used in departmental titles). In the 1990s the ANU still accounted for most graduates with chairs in prehistory and directly related areas. Likewise, ANU graduates in linguistics filled over half the Australian teaching positions in the field. In Applied Mathematics, Barry Ninham remarked in 1993 that eighteen of the research fellows who had come out of his department were now full professors at other institutions in Australia and abroad. On a larger scale, the National Centre for Development Studies had produced by 1993 some 900 alumni who were, according to a review submission prepared by RSPAS, ‘a powerful resource for regional economies and for the School’s networks within the region’.

For evidence of the University’s international influence, figures from the Department of Demography in RSSS were hard to beat. The department attracted students from every continent. Of the 200 students who graduated between 1959 and 1988 with a PhD, a Master’s degree or a diploma in Demography, 58 per cent came...
from Asia, 15 per cent from Africa, 12 per cent from Australia and New Zealand, 8 per cent from North America, and the remainder from the Pacific, Europe, Latin America and the Caribbean. While many returned to the countries from which they had come, others remained in Australia, left Australia for overseas, or moved via Australia from one continent to another, so that the department functioned as an international clearing house for studies in demography. Of the 74 students who were awarded PhDs during the period, by the mid-1990s about a quarter occupied chairs or positions of equivalent status in research institutions in various parts of the world.

The Research School of Chemistry measured its influence through the locations and positions of its former graduates, postdoctoral fellows (which it included in its definition of ‘alumni’) and research fellows. Detailed lists showed how the school had permeated universities, research institutions, government and private industry over a period of 25 years. In 1993, 117 doctoral graduates, former postdoctoral fellows and former research fellows occupied research, teaching or administrative positions in over 30 Australian tertiary institutions, while another 118, including 28 full professors in 13 countries, were members of tertiary institutions abroad. Of those who had moved outside universities, 24 were members of CSIRO, including the head of one division, and many occupied senior positions in government and industry worldwide, including a senior public servant and science adviser to the Australian government, the managing director of a technological enterprise in South Australia and the research director of a multinational company in the Netherlands.
In mathematics and statistics, the impact of the ANU was profound. Between 1959 and 1986, the University graduated 168 PhDs in these fields, over 20 per cent of the national total. In 1989, ten of the sixteen professors of statistics in Australia had been associated with the Department of Statistics in RSSS, either as students or staff, and seven had ANU PhDs. The department that Patrick Moran had created was an international force, especially in the area of applied probability. In the 1990s, however, the relative influence of the department (now a Section in the School of Mathematical Sciences), as measured by direct links through graduates and former staff, was gradually receding, as the discipline gathered strength in other universities. The ANU had been the cradle of advanced statistical research in Australia.

Across the disciplines, the University had generated a vast intellectual diaspora that would have gladdened the hearts of its makers.
The University in 1995

The view from Red Hill across the lake to the campus, with balloons in the early morning.

Students

Undergraduate Students by Faculty

Origins of Undergraduate Students

Origins of Postgraduate Students
Staff

CENTRES - ACADEMIC 2%
ITA - ACADEMIC 2%

FACULTIES - ACADEMIC 13%
IAS - ACADEMIC 17%

SUPPORT STAFF 66%

IAS Academic Staff

JSMRI 13%
RSB 14%
MSISO 3%
RSISE 3%
SMS 3%
RSES 7%
RSPAS 19%
RSS 12%
RSYSSE 14%

* Includes administration, library, technical, service areas and independent operations.

SOURCE: ANU STATISTICAL HANDBOOK 1995

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Humanities Research Centre

Centre for Information Science Research

NH&MRC Social Psychiatry Research Unit

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Centre for Continuing Education

Research School of Biological Sciences

Research School of Chemistry

Research School of Earth Sciences

Research School of Information Sciences and Engineering

John Curtin School of Medical Research

Mount Stromlo and Siding Spring Observatories

Research School of Pacific and Asian Studies

Research School of Physical Sciences and Engineering

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Faculty of Arts

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