CHAPTER 23

CAMOUFLAGE, CIVIL DEFENCE AND MAPPING

As early as March 1939 each State had assumed responsibility for the detailed planning of measures for the protection of civil populations from enemy attack. As was more or less inevitable in the absence of a common plan, divergences in organisation and in the nature of the measures adopted soon developed. This condition of affairs was allowed to persist until about the middle of 1941 when the imminence of war in the Pacific gave a sense of greater urgency and compelled the Government to place civil defence on a national basis. This it did by setting up in July 1941 the Department of Home Security. The work of two sections created within the new department, namely the Research and Experiments Section and the Camouflage Section, falls within the scope of this volume.

The Research and Experiments Section, comprising a small group of full-time scientific officers in charge of Mr Vincent,\(^1\) was constituted to handle the problems associated with protecting the population against air raids.\(^2\) With the help of advisory committees drawn from other scientific organisations, and with the cooperation of the Australian Scientific Research Liaison Offices in London and Washington, it covered a wide range of scientific and technical problems. Structural engineers were called in to advise on the design of air-raid shelters, on the treatment of shatterable materials such as glass and asbestos cement, and on the strengthening of existing buildings. Physicists were consulted about the effects of bomb blast and problems of controlling lighting during the dimming and blacking out of cities. Chemists cooperated in training air raid wardens in methods of detecting and counteracting poison gases; they also studied new types of incendiary agent introduced by the Japanese and advised on methods of counteracting their effects. Physiologists investigated the efficiency of the methods used for ventilating air-raid shelters; botanists investigated the efficacy of methods for protecting timbers used in air-raid shelters against the destructive attacks of insects and fungi; and bacteriologists gave advice on the best ways of disinfecting respirators. This by no means exhausts the list of the activities of the Research and Experiments Section of the Department of Home Security but it is a representative cross-section of them.

The department's second scientific section, that of Camouflage under Professor Dakin,\(^3\) grew out of activities which began long before July 1941 and whose influence went beyond civil defence.

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\(^1\) J. M. Vincent, DScAgr. Lecturer in Agriculture, Univ of Sydney, 1939-55; Scientific Officer, Dept of Home Security 1941-43; Assoc Prof Microbiology, Univ of Sydney, since 1955. B. Narrabri, NSW, 14 Aug 1911.


\(^3\) W. J. Dakin, DSc. Prof of Zoology, Univ of Sydney, 1928-49; Technical Director of Camouflage 1941-44. B. Liverpool, Eng, 23 Apr 1883. Died 2 Mar 1950.
The use of artifices to deceive or surprise an enemy is probably as old as warfare itself, but the first organisation to work out scientifically based principles of concealment was instituted by the French in the war of 1914-18. It was then that the practice of using tricks to conceal any object completely from the naked eye, or to conceal an object by making it look like something entirely different, came to be known as camouflage. At first much effort was directed to concealing objects from observation at ground level, but with the advent of the aeroplane as an instrument of war the art of concealment assumed a new importance and entered a stage where it had to contend with detection by photography and the air observer.

Although there were great developments in aeronautics in the inter-war period, the study of camouflage, in England and the United States at all events, did not appear to keep pace with these changes. Little attention was paid to static camouflage in Australia until about 1938, when the Defence Committee asked the Services and Munitions Supply Board to consider and report on measures for the protection by camouflage of important defence factories. Up to that time there had been no establishment for investigating the technical problems of camouflage, or for producing the special materials needed for camouflage. Early in 1939, acting on advice from the Defence Committee, the Prime Minister asked the Naval, Military and Air Boards to submit reports on the steps being taken to provide camouflage protection of their respective establishments. Since it was beyond doubt that any future war would be fought in the air as much as on land and sea, it was obvious that in addition to purely military objectives important civil establishments would also need camouflage protection. The subject was therefore likely to be of interest to civilians and to members of the Services alike.

A short time before the outbreak of war a group of citizens, comprising engineers, architects, artists and several members of the Services, got together under the leadership of Professor Dakin to consider the principles and problems of camouflage. As a zoologist Dakin had long been interested in animal colouration, concealment and vision, and he was moreover familiar with the part played by camouflage in the war of 1914-18. A man of great energy and infectious enthusiasm, Dakin soon succeeded, through the contacts made by the army officer members of the Sydney Camouflage Group, in bringing its work under the notice of the Department of the Army, which at this time (1939) was not greatly impressed with the need for the costly static camouflage of civilian installations. Undaunted by the official attitude, the Sydney group investigated schemes for camouflaging important water, gas and oil installations and aerodromes in and around the Sydney area.

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4 Camouflage may be classified roughly as follows: (i) static camouflage, as of aerodromes, factories and fortifications; (ii) field camouflage—in fighting zones; (iii) operational (strategic or offensive camouflage).

5 Members of the Sydney Camouflage Group, which was entirely unofficial and voluntary, were: Prof W. J. Dakin (Chairman), Mr V. F. Tadgell (Hon Sec), Prof L. Wilkinson, Sydney Ure Smith, Frank Hinder, R. Emerson Curtis, Russell Roberts, P. Dodd and Douglas Annand, Col D. A. Whitehead, Capt B. F. Hussey, Gp Capt H. F. de la Rue and John D. Moore.
Magazine at Bankstown, New South Wales, camouflaged by surrounding with cheap iron, etc., to make a disreputable hovel.

Covering of aircraft almost completed.
Though this work was without official recognition and laboured under the consequent disadvantages, no effort was spared to bring it to the notice of appropriate authorities. It was first officially recognised in August 1940 when the Defence Committee urged that plans should be made for camouflaging establishments of national and military importance, and recommended that some organisation should be set up for this purpose. Accordingly a meeting of representatives of the Services, the Department of Defence Coordination, Departments of Interior and of Munitions, together with civilians from New South Wales and Victoria, which was held on 8th and 13th November 1940 at Victoria Barracks, recommended the formation of a body to be known as the Defence Central Camouflage Committee. In the most general terms, it was to be responsible for development, control and coordination of all matters of camouflage—both Service and civilian, within the Commonwealth, and for advice, if called upon to give it, on matters of camouflage affecting the Australian Imperial Force. Subject to the Defence Committee, technical approval of all schemes of camouflage was to rest with the Defence Central Camouflage Committee.

A sum of £5,000 was recommended for the setting up of a camouflage workshop and research station at George's Heights, Sydney. Subsidiary to the central camouflage body there were to be State Camouflage Committees whose duty it was, among other things, to furnish technical advice and to supervise camouflage schemes for establishments within the States.

The recommendations were duly agreed to by the War Cabinet on 9th April 1941, and the Camouflage Committee met for the first time on 2nd May 1941. At this meeting Dakin, in recognition of his earlier activity and great interest in the subject of camouflage, was appointed to the post of Technical Director of Camouflage.

The responsibilities of the Camouflage Committee were more specifically defined under the National Security (Camouflage) Regulations in August 1941 at the time of its incorporation in the Department of Home Security. They were

(i) to prepare lists of places of national and military importance which in the opinion of the committee should be camouflaged;
(ii) to conduct experimental work in relation to camouflage and types of defence and civil camouflage equipment;
(iii) to prepare and approve plans for camouflage schemes and to coordinate and control all such schemes;
(iv) to maintain records of all available information relating to camouflage;
(v) to coordinate and direct the activities of State Defence Camouflage Committees; and
(vi) to advise the Minister (for Home Security) concerning any matters referred by him to the Committee.

*Those present were: Cdr A. R. B. Phelp, RN (Dept of Navy); Lt-Cdr G. A. Gould, RAN (Dept of Navy); Lt-Col J. J. L. McCall, General Staff AHQ (Dept of Army); Maj T. H. B. Foot (Dept of Army); Sqn Ldr W. L. Hely (Dept of Air); W Cdr A. Hepburn (Director of Works); R. M. Baxter (Dept of Interior); J. R. Cochrane (Dept of Munitions); Lt-Col R. M. W. Thirkell (Director of Civilian Defence and State Coordination, Dept of Defence Coordination); Prof W. J. Dakin (Chairman Sydney Camouflage Committee); V. F. Tadgell (Secretary, Sydney Camouflage Committee); Daryl Lindsay (Curator of Art Museum and Keeper of Prints); D. J. Mahony (Director, National Museum, Melbourne).
No camouflage could be carried out without the permission of the Government, but the Government could order it to be carried out where it was advised to be necessary.

The need for an official controlling and coordinating body had been clearly demonstrated by experience in Britain where early in the war a good deal of valuable material and energy had been wasted in unnecessary camouflage. In both Britain and Australia the need for civil camouflage was small compared with the requirements of the Services. The Civil Camouflage Assessment Committee in Britain, for example, in a review of 2,500 individual civil establishments where it was thought camouflage would be in the interest of national defence, decided that by reason of the local topography, camouflage would be practically useless in 70 per cent of the cases. No similar figures were ever published for this country but it is reasonable to expect that the proportions would have been much the same.

One of Dakin’s activities during the months preceding the establishment of the Camouflage Committee was to write a small book, *The Art of Camouflage*. The general principles of camouflage are relatively few in number and easy to grasp, though perhaps not always so easy to apply. They have been discovered mainly from the study of the often remarkable colourings and shapes assumed by living creatures, as a result of ages of evolutionary modification, to enable them to escape destruction by their enemies. Most readily understood among the principles of concealment is the one which states that the colouring of an object should resemble that of its background. A moth with markings and colouring to match the bark of the tree upon which it rests is a manifestation of this principle, which found application in practically all camouflage work.

An opaque body may stand out from its background by reason of its colour, the texture of its surface, its contour and the form and intensity of its shadows; even though its colour blends with its background, it may yet stand out against it if illuminated from above, when the dark shadows of its under surface contrast with the light of its upper surface. Many animals, fishes and birds with a dark back and lighter coloured belly exemplify this principle, known as counter-shading. Not much use was made of it in military camouflage for its effectiveness depended on horizontal, or at most oblique, observation.

A pattern of contrasted colours and, or, tones could be arranged so that the surface of an object was broken up and the eye distracted by patches of colour and, or, tones having no relation to the shape of the object disguised. This principle was known as disruptive patterning. The popular conception of camouflage as the art of daubing an object with random patches of colour arose from the widespread application of this principle. However, any kind of patchy colouration was not necessarily camouflage. There was more to it than might appear at first sight and a good deal of

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poor camouflage in Australia resulted from a failure to appreciate fully the nature of disruptive patterning.

Lastly, there was the problem of avoiding shadows, an objective usually attained by the intelligent use of netting.

These, briefly stated, were some of the basic principles of concealment. Their successful application in war called for the services of many different kinds of expert—physicists, chemists, geologists, architects, artists, zoologists and engineers—and herein lay one of the difficulties of building up a camouflage organisation.

The Camouflage Research Station at George’s Heights, Sydney, was completed and ready for work by the middle of 1941. There experiments were carried out on such subjects as the permanence of paints and dyes, the fire-proofing of camouflage materials, and on quick-growing plants for covering new earthworks and buildings. Camouflage was both an art and a branch of applied science. The discovery and elaboration of techniques of camouflage were scientific matters which called for men with a scientific background. The preparation and execution of schemes of camouflage, on the other hand, were matters requiring visual training and a knowledge of design, and thus called for architects, artists, engineers and town planners. Men with both kinds of qualification were required and in fact well represented among the Deputy Directors of Camouflage.8

Additional staff, in New South Wales for instance, was recruited largely by chance. A number of men, chiefly commercial artists and photographers, were appointed in December 1941 by the Department of the Interior as camouflage workers. After they had been given courses of instruction at George’s Heights they were sent to aerodromes where in a very practical fashion they learned a good deal about the execution of camouflage schemes. From there they were recruited to the Department of Home Security and graded as senior camoufleurs or camoufleurs grade I, II, or III, according to their qualifications and experience.

Successful camouflage required not only trained men but special materials, the chief of which were netting (string and wire), paint of all kinds, and materials for garnishing netting, such as hessian and wool. Realising that there would be some difficulty in providing netting, because it was all imported, Dakin had quite early taken steps to meet possible emergencies by obtaining instructions from Lowestoft, England, where some years earlier he had seen fishing nets being made, and having women students of the Zoology Department at the University of Sydney taught the art of netmaking. In an emergency these women could, he believed, teach others. Fishing nets were not machine-made anywhere and unless their making were well organised it would be a long time before requirements could be met.

As in the war of 1914-18, netting was used to support the garnishing which played a great part in camouflage, and also as a screening curtain.

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8 The Deputy Directors of Camouflage for the various States were: NSW, John D. Moore, architect and artist; Vic, V. E. Greenhalgh, artist; SA, Louis McCubbin, Director of National Art Gallery, SA; Qld, R. A. McInnes, town planner and architect; WA, Prof A. D. Ross, scientist; Tas, Dr J. Pearson, Director of the Tasmanian Museum and Art Gallery.
Netting alone was usually not sufficiently opaque for camouflage; opacity was produced by garnishing the netting with materials whose surface matched the background in colour and tone. When used as an overhead cover, netting suitably disposed and garnished could also be used to make shadows less obvious. The first nets were used for experiments and demonstrations, and a few were given to army officers leaving for the Middle East.

Towards the end of 1940, after a lecture had been given by Dakin to officers of the 8th Division, stationed at Rosebery, near Sydney, the advantages of taking away supplies of camouflage netting began to be appreciated. When it had been explained to Major-General Gordon Bennett⁹ that if the army could provide money for the string, nets could be made in large numbers, he saw to it that ample funds were provided.

With two lecturers from the Zoology Department acting as instructors, the training of members of the Women’s Defence League began in earnest. Much credit is due to Miss Kay McDowell, who so ably organised the work of the league. Mainly through the publicity given by women’s journals, voluntary netmaking extended all over Australia and was undertaken not only by women but also by men from such organisations as golf clubs and police associations.

Some time later Major Young,¹ G.S.O. III Camouflage Eastern Command, following the lead given by the civil organisations, organised a team of voluntary workers, mostly women, to garnish nets and wire netting for anti-aircraft and coastal defences. Much of this work was carried out on the actual sites and was efficiently and enthusiastically done. Similar teams of voluntary civilians were later employed in other centres not only for garnishing but for preparing special types of garnish, such as metal garnish made from the waste cuttings of tin manufacturers.

The cheapest material for weaving into netting was hessian, and the demand for it was therefore heavy. Although supplies had been frozen in 1940 because the hemp and jute from which it was made were not grown in Australia and it was needed for wheat sacks and wool bales, the great reduction in the export of wheat and wool that occurred during the early years of the war had enabled private firms to build up stocks of hessian, and these were diverted to camouflage.

One of the first problems in using hessian for camouflage was to find a method of colouring it suitably and permanently. At first it was cut by hand into strips 2 to 3 inches wide and then dyed by dipping it (again by hand) into a vat. Experience showed that costly camouflage works lost their effectiveness with alarming rapidity—within a few weeks—because of the fading of dyed hessian and other materials. The bright sunshine and high temperatures of the more northerly regions of Australia caused a far more rapid deterioration of camouflage materials than was experienced in Britain, for example. In fact the success of camouflage was

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⁹ Lt-Gen H. Gordon Bennett, CB, CMG, DSO, VD, (1st AIF: CO 6 Bn 1915-16; comd 3 Inf Bde 1916-19.) Commanded 8th Division in Malaya 1940-42; GOC III Aust Army Corps, 1942-44. Company director and orchardist. B. Balwyn, Vic, 16 Apr 1887.

¹ Maj W. A. Young, GSO III att to Staff of Cmd Camfg Offr, E Commd, 1941-43; DCRE 46 Aust DCRE (Wks) 1943-45. Engineer; of Auburn, NSW; b. Sydney, 13 Jan 1896.
so seriously threatened at one stage by the failure of materials that it became necessary to revise completely the specifications of camouflage materials.

A Camouflage Paint Committee was set up and meetings were arranged with the Paint Manufacturers' Association for the purpose of devising systems of paint testing. Until controlled tests on the performance of paints had been made it was difficult to pinpoint the causes of failure, which were mainly due to the instability of colour. It was found that to obtain stable colours the pigment must be almost wholly free of extenders. For covering fibro cement, paints of the pigmented alkyd-resin emulsion and oleo-resin emulsion types were found most suitable. A similar type of emulsion paint so thinned as to reverse the emulsion to one of oil in water, was found to be flexible and to have a particular affinity for jute fibres, and was therefore especially suitable for painting hessian.

Owing to the development (in Europe and the United States) of infra-red-sensitive photographic emulsions for aerial reconnaissance work, it was imperative that green pigments should have infra-red reflecting characteristics similar to those of vegetation. Whereas greens made from prussian blues failed badly in this respect, some of the natural greens—cobalt green, viridian and chromic oxide—were most successful. The high cost of several blue pigments that were suitable and available for the manufacture of satisfactory greens prevented their widespread use.

Having discovered suitable paints the next problem was to find a method of applying them to the hessian, which arrived in Australia in the form of rolls 6 feet wide and 5 miles long. One of the most notable achievements of the Camouflage Section of the Department of Home Security lay in solving this problem, with the collaboration of Michael Nairn and Co (Aust) Pty Ltd, Sydney (a linoleum manufacturing firm). This firm had a battery of seven ovens unique in Australia: each was over 100 feet long and 60 feet high and capable of drying 50 miles of hessian in one loading. The hessian was fed into a machine which applied the paint and then squeezed out the excess by means of rollers, in such a way that a specified weight of paint per unit area was obtained. From this machine the hessian was fed into the drying ovens where it was festooned in long drapes and allowed to dry for 24 hours or more. In the final step, the wide rolls were cut into 2½-inch strips by a special machine consisting of a series of rotary knives capable of cutting 100 square yards a minute.

Other camouflage materials were devised. Linoflage, for example, was a better quality hessian of the kind used for linoleum, which had been impregnated with a fire retardant chemical and then painted on both sides with specially prepared paints. In strip form it was used for garnishing; uncut it was used for making dummy buildings.

Another innovation achieved by Messrs Michael Nairn and Company was the construction of a machine to convert a continuous sheet of material into a net. Sheets of painted hessian, linoflage or "camsheen" were slit by rotary knives to give slots 6 inches long, spaced at 2-inch intervals and
staggered in rows. Sapper Boyle's invention of a machine to garnish wire netting is described in the chapter on Inventions.

During the early part of 1941 the Camouflage Committee worked out schemes (often based on models) for the camouflage of some sixty different establishments. By about the middle of the year Rear-Admiral Muirhead-Gould had succeeded in persuading the Government to make funds available for camouflaging the naval magazines and oil tanks at Chowder Bay and Garden Island, Sydney. This work, carried out by the Department of the Interior to plans drawn up by officers of the New South Wales Camouflage Committee, was the first large-scale camouflage project undertaken in Australia. Before the end of the year the R.A.A.F. aerodromes at Bankstown and Richmond, New South Wales, were fully camouflaged so that they could be used for demonstration purposes.

With the entry of Japan into the war the question of camouflaging civil establishments became a matter of some urgency.

Using the authority granted by the War Cabinet on 17th November 1941, the Minister for Home Security on 12th December 1941 ordered the dull painting in one colour of all bulk oil tanks which had been previously listed as needing camouflage. The decision to apply only one dull colour was made by Dakin after considerable experiment and observation. Time after time it was seen that disruptive patterns and other supposedly effective camouflage paint treatments did not in fact conceal more completely but rather tended to advertise the fact that an attempt at concealment was being made.

In order to coordinate camouflage work, conferences of the chairmen of the State camouflage committees were called from time to time. The first was held in Canberra on 10th January 1942 to discuss the problem of appeasing the more fearful members of the public who were clamouring for camouflage in the belief that it was a complete safeguard against air attack. Dakin warned State chairmen against all but the most needful action and the following were granted first priority: petrol tanks, water-supply buildings; munitions works; gas works; electricity undertakings; white-roofed buildings in areas associated with defence works; food stores; special transport points and all pointers to important and vulnerable objectives.

About a year before Japan entered the war, the Director-General of Engineer Services asked for advice concerning the camouflage of Larakeyah Barracks at Darwin, whose shining roofs could be seen from the air at a distance of 50 miles. In the course of discussion it was decided that camouflage of establishments at Darwin would be unusually difficult:

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Minute 1507: Financial Responsibility for Camouflage at Non Service Establishments. The Minister for Home Security was empowered to bargain with occupiers of buildings selected for camouflage to determine the proportion of cost to be borne by the occupier and by the Commonwealth Government respectively.
and probably futile, because Japanese pearl-divers were already well acquainted with the area. Several months later the army revived the subject and invited the cooperation of the Camouflage Committee. Detailed maps and aerial photographs of the district were provided and from these the committee made models of a number of objectives and drew up an elaborate scheme of camouflage. The Department of the Interior sent 23 workmen and a cargo of materials to Darwin on the Zealandia, to carry out this scheme. The work had hardly begun when Darwin had its first and heaviest raid, during which the Zealandia was sunk, with the bulk of the camouflage material still on board.

In the confusion that followed little thought was given to camouflage for a month or so, but the lesson of what could happen without command of the air was plain enough. It was impossible to say just what effect this lack of preparation had on the severity of the Japanese attacks on Darwin, but it was realised that even adequate camouflage would have been only a small part of its defence.

This conclusion was reinforced a few weeks later when large numbers of seasoned and experienced troops returned from the Middle East. Officers of the returning army were impressed with some of the elaborate efforts at camouflage they saw in South Australia, but with vivid memories of much-bombed cities in the Middle East where the presence or absence of camouflage seemed to have made little difference to the degree of devastation, they thought such efforts were out of proportion to the needs of the situation. Dakin, resenting the opposition of the newly returned army leaders to many of the camouflage schemes, became critical of their judgment in these matters, and pointed out that the lessons of concealment learned in the Middle East were not always relevant to Australian conditions.

The inevitable clash between army and civilian authorities came not over the question of who had the more experience but over the question of who should control camouflage activities. The army's real concern was with what it believed in the circumstances to be a serious waste of manpower on unnecessary camouflage schemes. This concern is reflected in the following instructions issued by the Deputy Chief of the General Staff to all commands:

ENGINEER POLICY—FIRST THINGS FIRST

It should be recognised that the Japanese expect Australia to fall into their hands as readily as previous countries, and that therefore, until our resistance warrants it, they will not attack anything that may be of use to themselves, but will concentrate on the destruction of our Field Armies and anything that these Armies are immediately dependent upon.

In an effort to settle what was clearly a fundamental difference in policy the Department of Home Security on 7th July 1942 arranged a conference between the Secretary of the department, the Engineer-in-Chief, the Technical Director of Camouflage, and the Secretary, Department of the Army.⁵

⁵ Mr A. W. Welch, Maj-Gen C. S. Steele, Prof W. J. Dakin and Mr F. R. Sinclair respectively.
The conference decided that the powers granted by clause 5c of the National Security (Camouflage) Regulations, whereby the Camouflage Committee was “to prepare or approve plans for camouflage schemes and to coordinate and control all such schemes”, were too extensive to be acceptable to an army in the field. Two amendments were therefore proposed, and were approved by the War Cabinet in October 1942, which would restrain the committee from interfering with Service action on camouflage. The effect of these instructions was to make the Camouflage Section of the Department of Home Security a purely advisory body to the Services and to leave with it the responsibility for civil defence and for conducting investigations on the development of materials and schemes for camouflage. Each Service now assumed control over its policy on camouflage.

While making instructional films to demonstrate the principles of field-craft and individual concealment, the Department of Home Security made many experiments to discover the best colour for uniforms in the jungle. The uniform first suggested was patterned in two or more shades—that is, the principle of disruptive colouring was used—but as a result of strong resistance by clothing manufacturers, and of experiments which showed that this type of uniform had very little in its favour, the army adopted “jungle green”. The first troops to wear jungle greens went into New Guinea in September 1942. The original jungle green was a most uncertain colour and varied even in the one garment. Material from a dozen different rolls which originally looked exactly alike would come from the dyeing vat in as many different shades. The army, however, managed to insist that each shirt should come from one roll of material only, though this involved a certain amount of waste cutting. Such uniformity of shade was not really necessary for camouflage in the jungle, but it did appeal to the men, who objected to looking like harlequins when they went on leave.

The deception scheme employed by Australian troops on Goodenough Island affords an interesting example of the use of strategic or offensive camouflage. While the Buna-Gona operations were in progress it was feared that the enemy might land in force on Goodenough Island. A small Australian unit, having overcome a Japanese occupying force, was then holding the island. To hold it against an attack in strength would have required a brigade group, but since no such body was then available it was decided to camouflage the island so that it would look as though a brigade was occupying it. A scheme was evolved for dummying all the equipment of a brigade group: vehicles, tanks, weapons, tents, and even flashes, smoke, fires and dumps. Signals traffic to the island was increased and Japanese intelligence was permitted to “discover” that a movement of troops was intended. Entering into the spirit of the scheme, and displaying

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*The scheme was carried out with the advice of Capt R. L. H. Hall and was under the supervision of Lt W. B. King, officer commanding the New Guinea Forces Camouflage Training Unit. I am indebted to Capt K. H. McConnel, RAE, for these details.*
great keenness and ingenuity, the men achieved a most realistic deception in which no detail was overlooked. The island was eventually fully occupied by Australian troops and became a base for air operations.

For a long time it had been known that the pink or light brown of a European skin stands out with striking clarity against green foliage. This fact was brought home with great force to the Australian troops as they fell back on Port Moresby early in September 1942. During that month the Army Inventions Directorate received an urgent request for a non-toxic green dye suitable for camouflaging the skin. After a hurried consultation with experts of Imperial Chemical Industries of Australia and New Zealand Ltd, the dye lissamine green (B.T.R.) was quickly tried and found suitable. At first it was supplied in the form of a powder, but as it was a very expensive material this wasteful method of using it was later superseded by one in which it was mixed with starch and magnesium stearate and made up into tablets. Curiously enough, men in forward areas were disinclined to make use of this aid to concealment, one reason being that they felt that the bearded and dirty faces of those who had been trekking through the jungle for days offered just as good a means of escaping detection. In much the same spirit as they used mosquito repellent for hair brilliantine, the men found in the dissolved green tablets a ready-to-hand ink for writing their letters home.

A more effective contribution to camouflage was a contrivance known as a "spider", a light-weight collapsible machine-gun cover of wire-rod construction over which a camouflage net could be draped. This invention, made by Frank Hinder, proved so successful that it was adopted by the army.

Once the army had decided to go its own way, the Department of Home Security soon found that its camouflage activities were mainly confined to the R.A.A.F., for after October 1942, when the threat of Japanese invasion had disappeared, all civil camouflage was discontinued. Since the R.A.A.F. had no camouflage organisation of its own, men recruited from the groups of volunteer camoufleurs in Sydney and Melbourne were attached to it as civilian field officers.

When the army took over the Camouflage Research Station at George's Heights, the Department of Home Security began courses for R.A.A.F. officers at the University of Sydney, using rooms and equipment there for lecture purposes and taking the men out to Bankstown and other nearby aerodromes for practical demonstrations. The courses began on 18th July 1942 and ceased on 23rd May 1944; some fifteen classes were held, at which between 400 and 500 officers attended.

One of the difficulties experienced by officers of the Department of Home Security who were sent to operational areas at the request of the R.A.A.F. was their lack of a uniform, which they needed not for camouflage but

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*Lt F. H. C. Hinder. Artist; of Wollstonecraft, NSW; b. Summer Hill, NSW, 26 Jun 1906.*
to identify them and their purpose. Officers on R.A.A.F. aerodromes were not always willing to cooperate with civilians, who in any event were there only as advisers. At first the camouflage officers had no official status whatever. In order to obviate these difficulties warrant cards were issued, but camouflage officers still felt themselves in an anomalous position. Uniforms were eventually provided without badges of rank, on the understanding that the Department of Home Security supplied its own marks and buttons. From all accounts this was not considered a satisfactory arrangement.

By far the greater part of the efforts of the Home Security camouflage section for the R.A.A.F. was directed to camouflage of airfields and ancillary installations. Although full information on British practice of camouflaging airfields was available to the R.A.A.F., some of the methods found to be effective there were impracticable in Australia because of the vastly different countryside. In Britain, where airfields were often situated in farmland, it was not difficult to make one look like the small cultivated patchwork of surrounding country. It was quite another matter with airfields cut out of the Australian bush, as many of the newer air strips were. The wide dispersal of airfields over Australia and the difficulty of reaching many of them by ordinary means of transport, offered problems very different from those of Britain.

At Dakin’s suggestion the Chief of Air Staff agreed in October 1942 to the formation of the Aerodrome Camouflage Committee so that the problems peculiar to this type of camouflage might receive special attention. The most successful effort to “dull tone” runways was achieved at Williamstown where they were top dressed with crushed green slag (furnace slag). This method was however not widely used. A good deal of effort was concentrated on dispersed aircraft, magazines, petrol stores and any specially important buildings. The idea behind this was that if an objective could be sufficiently well concealed to delay recognition by the raiding bombers until fighters and anti-aircraft guns could get into action, defence might be made a little easier. Even though runways and taxiways were often pointers to the hideouts, concealment of aircraft did prevent the discovery by aerial reconnaissance of the number and types of planes at an airfield. A screened dispersal point might be occupied or not; it might even be a dummy. The aim of camouflage was not always complete concealment—deception was just as important.

At one period large numbers of aircraft were being lost on the ground. For this reason greater attention was paid to concealment of aircraft. Dull painting or disrupting patterns on a plane’s surface did not always provide very helpful camouflage. A better method was to screen the plane by garnished netting, usually supported above the aircraft by wires slung from trees or posts. Special care was needed with the garnishing, particularly to see that the net was not uniformly garnished to its edges. The intention was that the centre of the net should be more or less opaque while the margin areas should allow the background to show through so that the whole net melted into the background.
Dakin treated the problems of airfield camouflage in great detail in a publication entitled *Aerodrome Camouflage*, which was of considerable help to those concerned with this problem. No attempt will be made to describe the wealth of information contained in this document but its preface is worth quoting, if only to show Dakin's approach to his subject.

Camouflage in war is a duty and responsibility in which everyone in the Services may play a part. It is not a cloak solely developed for the protection of the weak. The tiger is protectively coloured. Offensive action needs concealment both for its preparation and consummation. Camouflage has become a recognised device in modern war. It ranges from the large scale costly devices used to conceal very valuable property to the simple discipline for the concealment of the individual. One man with a tractor or a few men with their own feet may spoil the finest large-scale concealment work. It is the business therefore of all members of the unit, and a duty for all officers, even though they take no more active part in it than a recognition of the necessity for camouflage discipline and camouflage maintenance. The greatest necessity in the Air Services is the recognition of the fact that camouflage is not a means which, coming in at the end, can conceal badly constructed ground work and badly planned aerodromes.

The camouflage requirements of any project must be realised and considered at the beginning. Until this becomes a natural procedure, camouflage will be both inefficient and costly.

Among the effective devices used by the R.A.A.F. were decoys. Three-ply imitations of Kittyhawks (P-40's) and cheap "flat" Wirraways, along with gun pits, small shacks and trucks, were used in the Darwin area. There is some evidence that the flat decoys about which considerable arguments raged were attacked by the Japanese, sometimes so successfully that army personnel in nearby areas broke up the dummies at night to prevent further attention by the enemy.

The difficulty about decoys was that, when they were favoured, which was not often, the Services usually wanted something which was complete in itself and required neither skill nor labour to set it up, and which yet had no weight and occupied no space in transport. The nearest approach to this somewhat exacting requirement was discovered overseas, in the form of inflatable rubber decoys, but it was impossible to import them and their manufacture in Australia was out of the question, if for no other reason than the shortage of rubber.

The Japanese temperament was such as to favour the use of decoys, and they achieved success and some subtlety at times. On one occasion, for example, they set up seven decoy planes so crudely that American airmen laughed at them and left them alone, only to discover later that the dummies covered stockpiles of materials.

Camouflage of radar stations received a good deal of attention because many of them were isolated and had little protection other than conceal-

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*A superb example of offensive camouflage was described by Churchill in his address to the House of Commons (11 Nov 1942) on the battle of Alamein. "By a marvellous system of camouflage a complete tactical surprise was achieved in the desert. The Germans knew an attack was about to be launched, but where, when or how was completely hidden from them. The 10th Armoured Corps which German reconnaissance planes had spotted fifty miles in the rear moved silently elsewhere in the night. In its place it left an exact duplicate of its tanks and other equipment."*

*Quoted in a report by W. J. Dakin based on statements made by a U.S. colonel.*
ment. During a raid on Darwin in July 1943 a formation of nine low-flying Japanese aircraft strafed every type of installation in the neighbourhood except the radar station, which was so cleverly concealed that it was invisible from the air. But it was not always practicable to conceal radar stations since the requirements for their operation sometimes conflicted directly with those for camouflage.

Ships observed from ships are often silhouetted against the sky, and under these circumstances camouflage is almost impossible; but ships seen from an aircraft against the background of the ocean may gain some advantage from appropriate colours. It was found that the most concealing colours in the dull misty weather of the Atlantic were, surprisingly enough, very light colours; but in the brilliant sunlight of the tropical waters of the Pacific, dull, dark grey blues offered better concealment. No colour or patterning was suitable for all conditions.

On behalf of the Research and Experimental Section of the British Admiralty the Camouflage Committee arranged for observations to be made at different latitudes of the relation between the intensity of light reflected from the sides of ships in sun and in shade and from the surface of the sea. With the help of a telephotometer devised by the National Standards Laboratory, Sydney, a thorough study of these factors was made in conditions of bright sun and of haze, and at dusk and dawn, and the results communicated to the Admiralty. However, as more and more ships and aircraft were equipped with radar, the value of such findings was greatly reduced.

R.A.A.F. pilots returning from England drew Dakin's attention to the fact that in the Mediterranean in calm weather the passage of a ship could be recognised when the ship was out of sight and over 50 miles away. It was due to some curious effect left on the surface of the sea in the ship's wake. Professor Earl made experiments with cheap solutions which by their action on the surface tension of the water markedly reduced this wake effect, but the results were considered to have no practical value at the time and the investigation was discontinued.

It would be a mistake to regard the energy and material expended on camouflage for civil defence and for the R.A.A.F. on the Australian mainland as misguided effort. Like many another precautionary measure it seemed essential at the time. If the Allies had not quickly gained aerial ascendency in the South-West Pacific Area camouflage would undoubtedly have been of much greater importance than it was. If one factor emerged more clearly than any other from the experience with camouflage, it was the difficulty of coordinating scientific effort and defining limits of authority in a sphere of activity of interest alike to the armed services and civil defence.

**MAPPING AND CHARTING THE CONTINENT**

In Australia, in peace and war, the navy charted the seas round the continent and the army produced detailed contour maps: two scientific
tasks of great importance. The production of one-inch-to-the-mile contour maps was a task of the Army Survey Corps, established in 1909 when six experienced men were brought from England to form a nucleus. By 1939 the corps, recently expanded until it was about 100 strong, had produced 77 standard sheets (each, as a rule, 29 miles by 17½). These mainly covered relatively small areas round five capital cities and along the adjacent coasts.

In 1940 the mapping program was vastly accelerated. It was decided to produce, from data available in State Lands Departments and the Department of the Interior, a series of 4-inches-to-the-mile maps covering the coastal strip from Townsville to Port Augusta to 200 miles inland, the strip from Albany to Geraldton to 100 miles inland, and areas in Tasmania and the Northern Territory; and, with the help of civilian draftsmen in the Lands Departments to produce one mile and four miles to one-inch "emergency" maps of vital military areas while field survey units were being trained to produce standard one-inch maps. The program was steadily expanded, the quality improved, and the rate of output increased until, by the end of the war, the Survey Corps, then with a staff of about 1,800, had published 219 sheets on scales of 1:20,000 or 1:25,000, 645 sheets on a scale of one-inch to a mile (1:63,360) and 355 on larger scales. The one-inch sheets and those on smaller scales were distributed between the mainland and "the islands" thus:

<table>
<thead>
<tr>
<th></th>
<th>1 mile to an inch</th>
<th>1:25,000</th>
<th>1:20,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainland</td>
<td>399</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>New Guinea mainland</td>
<td>118</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Dutch New Guinea</td>
<td>6</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>New Britain</td>
<td>17</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Bougainville</td>
<td>24</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Borneo</td>
<td>83</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>(1:50,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>647</td>
<td>219</td>
<td></td>
</tr>
</tbody>
</table>

Much of the mapping of the areas outside Australia had to be swiftly done and was based on inadequate data, as the troops painfully discovered, but the over-all achievement was immense. On the mainland the area covered by first-rate one-inch maps included, at the end of the war, still only a fringe round the eastern and south-eastern coasts and relatively small sections round Hobart, Adelaide, Perth, Wyndham and Darwin, but at the pre-war rate so much mapping would have taken more than 100 years. For Western Australia, for example, where there were only five sheets at the end of 1939, there were 75 in 1945. In the same period the number of Queensland sheets was increased from 12 to 130. Until 1940 sheets had been produced by the small Survey Corps at an average rate of fewer than three a year. In the six years from 1940 to 1945 sheets covering areas of the Australian continent, apart from those covering adjacent oversea territories, were produced at a rate of more than 50 a year.
The air force played a large part in these mapping achievements. The practice of using aircraft as an aid to mapping, which began during the 1914-18 war, was adopted in Australia about 1927. The first standard topographical map based partly on aerial photography was compiled by the Australian Survey Corps in 1936. In the war, as a result of their collaboration with specialist members of the American Armed Services, Australian cartographers were able to introduce new photogrammetric techniques and instruments and perfect them for Australian conditions. This work was greatly helped by Adastra Airways Pty Ltd. Towards the end of the war the government, aware of the importance of adequate mapping in the development of the Commonwealth’s natural resources, set up an Aerial Survey Branch within the R.A.A.F.

The needs of the fighting Services also led to the production of a series of comprehensive geographical handbooks concerning the areas to the north of the continent, and to the compilation of much geographical information about Australia itself. Before the Pacific war began small teams in Australian Army Intelligence had been busy compiling the kind of geographical information that would be needed if military operations were undertaken in Australia. For example, in Eastern Command, from August 1940 onwards two officers—a geographer and an agricultural scientist—were employed collating topographical and military-economic information. They made military reconnaissances over as wide an area as they could in the time, and elsewhere collated information from Department of Main Roads, Shire Councils, the National Roads and Motorists’ Association, the Lands Department, the Forestry Department, the University of Sydney and other sources. At its peak the staff employed on this work in Eastern Command up to 1942 totalled eight.

Early in 1942 an urgent need arose for geographical information about New Guinea and the Solomons. At this stage the framework for all topographical reports consisted of a series of rather indifferent maps compiled from government surveys and traverses by patrolling officers of the Civil Administrations, exploratory surveys by oil search companies, and sketches by missionaries. Hydrographic charts were also used but were in general quite faulty both as to depiction of land masses and offshore information. In addition there were available many useful reports of a geological and anthropological nature. No attempt had been made by military intelligence to collect this information, which was widely scattered throughout Australia in repositories of every conceivable nature. It was evident that the hard pressed intelligence staff was not in a position personally to search for it.8

In March Lieutenant Williams,9 Government Anthropologist of Papua, was appointed by the Director of Military Intelligence to collect information about New Guinea and Timor. The staff of this section included only three officers when on 17th June General MacArthur’s headquarters directed the establishment of a Combined Geographical Intelligence Section

8 Operations of the Allied Geographical Section, GHQ, SWPA.
under an officer nominated by General Blamey, and including representatives of naval and air Intelligence and the Netherlands Indies forces. On 19th July G.H.Q. issued a second and more comprehensive directive establishing the Allied Geographical Section. This was at first commanded by Lieut-Colonel Mander-Jones, an expert Intelligence officer until recently serving with the A.I.F. in the Middle East; on 1st August Major Blake took over.

The section gradually developed into a fairly large organisation including many people with high qualifications not only in geography but also in various other studies, for example, geology, meteorology, navigation services, airfield construction, anthropology, engineering, and—of crucial importance—military Intelligence. By July 1943 it included 36 Australians and 3 Americans; by July 1944 84 Australians and 15 Americans; by July 1945 117 Australians and 77 Americans. The section published 110 terrain studies, 62 terrain handbooks, 101 "special reports", and other works. The terrain studies were comprehensive geographies, some of them covering more than 150 pages of text and including 30 or more maps. The handbooks, of which a total of 114,000 copies were distributed, were briefer but more up-to-date. The studies covered virtually the whole of the South-West Pacific Area and, eventually, much of Japan. One of the section's main achievements was the production with the cooperation of 76 Australian libraries of a four-volume work, An Annotated Bibliography of the South-West Pacific and Adjacent Areas.

The charting of Australian waters, which began with the Dutch and English navigators, became an organised service in 1860 when an agreement was made between the Admiralty and the Australian colonies for a series of surveys, the costs of which were to be shared. About 1890 the Admiralty began to employ surveying ships to chart the more isolated areas not covered by the earlier agreements. In 1922 H.M.A.S. Geranium was commissioned by the Australian Navy as a surveying ship, and in 1925 Captain Edgell came to Australia to command H.M.A.S. Moresby, which worked in collaboration with the Geranium. From Captain Edgell the Australian navy surveyors learned the science of hydrographic surveying. The service was disbanded in 1929 until 1933, and then again on the outbreak of war. The demands of the Allied navies led to its being resumed and greatly increased until it consisted of two sloops (the Warrego and the Moresby), one frigate (the Lachlan), five corvettes, three tenders, two lighthouse tenders, and three harbour defence motor launches. Other vessels were attached to the service from time to time.

The R.A.N. Hydrographic Service carried out operational surveys for the Commander-in-Chief, South-West Pacific Area, and made extensive and complex surveys of the difficult waters of the Torres Strait and of

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1 Col E. Mander-Jones, OBE, ED; MA, Ch Instr, Sch of Mil Intell, 1944-45; Dep Dir of Mil Intell, Adv LHQ, 1945. Dir of Educ, SA, since 1946. B. Homebush. NSW, 6 Jul 1902.

2 Col W. V. J. Blake, ED. (Served 1st AIF.) OC Army Section, Allied Geographical Section LHQ, 1942-46. Officer in British Colonial Service; of Kalorama, Vic; b. Sydney, 1 Feb 1894.

3 Vice-Adm Sir John Edgell, KBE, CB, FRS; RN. (Served North Sea and Dardanelles in first world war.) Hydrographer of the Navy 1932-45. B. 20 Dec 1880.
northern Australia, along the northern coast of Arnhem Land and round to Yampi Sound. It also undertook the reproduction and printing of the charts for these areas and their distribution to the Allied services, and the reproduction of all Admiralty charts of the Pacific and Indian Oceans, and of Netherlands charts of the Dutch East Indies. During the war nearly 1,500,000 charts were printed in Sydney.

In 1946 an agreement was signed between the British Admiralty and the Australian Naval Board making the Hydrographic Office the charting authority for Australian waters and certain neighbouring islands. The work was carried on actively, and by 1955 the areas shown in the accompanying map had been surveyed. As can be seen, much has yet to be done.

The impetus given to mapping by the Services carried through after the war: the Government took the opportunity provided by the wartime advances to set up the National Mapping Office within the Department of the Interior, to arrange geodetic and topographical surveys and mapping for Commonwealth purposes and to coordinate them with similar activities of the States. Several years later the Department of National Development published the first numbers of the *Atlas of Australian Resources*, an ambitious map-making project planned to cover in a series of approximately 50 maps almost every natural characteristic likely to affect the country's development.

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