

# The A.I.R.O.H. house: industrial diversification and state building policy

by Brian Finnimore

In the decade immediately following the Second World War a new material of construction appeared on the building market. Between 1946 and 1956 a considerable number of buildings were constructed either wholly or mainly from aluminium alloys, including 70,000 bungalows, 500 schoolbuildings, the Dome of Discovery and a number of large aircraft hangers. In 1948 the amount of aluminium used for building purposes exceeded 32 per cent (by weight) of the total output of fabricated aluminium<sup>1</sup>. In considering the use of aluminium in building this paper will concentrate on the aluminium bungalow, which proved to be the most successful aspect of the aluminium industry's diversification into building. Although the A.I.R.O.H. house was financed as part of the Temporary Housing Programme, sponsored by the Ministry of Works in the years immediately following the Second World War, this explanation will deal with those issues and processes, largely of a material nature, peculiar to the aluminium bungalow as distinct from the other designs in the programme. Accordingly the ideas which informed the concept of a substandard and temporary prefabricated dwelling will not be considered, for, in the manner of a magpie, the aluminium bungalow found a nest in the Temporary Housing Programme well after it had been conceived by the Ministry of Works and financed by parliament. It will be shown that the A.I.R.O.H. house resulted from circumstances peculiar to the aluminium and aircraft industries and cannot be accounted for satisfactorily simply by reference to the government's postwar emergency housing measures. Rather it will be shown that the dwelling did not arise from considerations of housing policy at all, but from the peculiar

nature of the relationship that developed between a major war industry and the state, the origins of which may be found in the rearmament programmes of the late 1930s.

## The birth of a major industry

Between 1936 and 1945 the aluminium producing industry, the aluminium fabricating industry and the aircraft industry experienced a spectacular growth and transformation which resulted in all three becoming a major part of the war economy.

In 1936 domestic production of raw aluminium stood at 16,300 metric tons per annum; by 1943 state capital investment had raised this to 56,000 metric tons per annum. However this accounted for only one-sixth of the country's total requirement. The remaining five-sixths were provided by two important new sources, recycled scrap and imported pig, both of which appeared during the war in an attempt to expand supplies and both of which were to influence aluminium house production. By the end of the war 100,000 tons of scrap aluminium was re-entering production as a result of improved methods of recovery. Prior to the war Britain was a modest exporter of raw aluminium; by its end the nation imported two-thirds of its supply from Canada<sup>2</sup>. Both of these new sources created a growing problem by the war's end. On the one hand, an ever growing mountain of scrap aluminium had appeared; on the other, the industry was dependent on foreign supplies, bought with scarce dollars, at a time when the reconstruction government was preoccupied with reversing the balance of payments deficit<sup>3</sup>.

During the war the growth of the semi-fabricating industry was even more dramatic than the growth of the primary producing in-

dustry. Between 1939 and 1943 its output rose seven times. Apart from its meteoric growth the industry changed in two further ways, undergoing a process of concentration and specialization. Before the war semi-fabricating was distributed between two large primary producing firms and a multitude of small firms. This high level of fragmentation was reduced by the state, which invested £30 million in only 22 firms with the 11 largest absorbing two-thirds of this sum. Increasing specialization resulted from the aluminium industry's preoccupation with the emerging aircraft industry. From the thirties onwards this had reduced the incentive to develop uses in other areas and at the onset of the war any such work was effectively stopped by the government. More than any other basic material aluminium was appropriated by the armaments industry; in 1944 99 per cent of the nation's supply was absorbed in aircraft manufacture. By the end of the war the aluminium semi-fabricating industry had become an adjunct of the aircraft industry.

In 1930 little more than 50,000 workers were employed in the assembly of aircraft. Many of the factories in use were those that had been making aircraft during the First World War. As the nation's air defence programme grew, so did its capital expenditure in factories and plant, which by 1940 had reached £110 million. By 1943 300,000 workers were employed in the manufacture of aircraft and the industry had changed in three ways, each of which was significant for the future production of aluminium houses. First, the industry became organised around a system of group production, whereby one design could be made by a number of plants. Second, with enlarged production came the systematization of the manufacturing process; as with the motor industry components made by subcontractors were put together on an assembly line. Third, whereas prewar aircraft design involved a number of materials such as canvas, timber, wire and a variety of metals, by the end of the war the entire plane was manufactured from aluminium alloys<sup>4</sup>.

As it burgeoned throughout the war the light alloys industry was increasingly

assimilated into the government's 'total war' organisation. In 1939 the state acquired the nation's entire stock of aluminium and initiated a central purchasing scheme for further supplies; the use of the material was administered by the Light Metals Control, which consolidated its authority by statute in 1940. Much of the enlarged capacity was owned by, or operated on behalf of, the state; and the Ministry of Aircraft Production (M.A.P.) assumed control of the component manufacture and assembly plant. By the war's height a new major industry had been created, employing perhaps 1.5 million workers. While much of its capacity could be turned to other uses, its central core and the bulk of its expensive plant could make only one specialised commodity, aircraft, or something very similar. Furthermore the entire industry was based on one raw material, aluminium. But perhaps the most dramatic outcome was the development of a symbiotic relationship between a highly specialized and vulnerable industry and the state. The industry depended on the state's demand for aircraft: and the state — apart from any considerations of postwar economic policy — relied on the good health of the aluminium industry for its military capability.

## Impending crisis: the industry

By 1942 the aluminium and aircraft industries had begun to evolve a strategy for meeting the crisis that would ensue when the demand for aircraft dried up. A central element in this strategy was a large scale diversification into the building market.

Such a proposal was under consideration by Morrison's Engineering, an aircraft component manufacturing firm, when its managing director, Mr. McGiveney, opened discussions with a number of other aircraft firms in 1942. The proposal was that the firms should make use of the large stocks of scrap aluminium that would have built up by the end of the war to manufacture houses. Over a dozen firms were invited to join an organisation for the purpose of making further investigations. As a result the Aircraft Industries Research Organisation for Housing (A.I.R.O.H.) was

set up, with each firm undertaking to meet a proportion of the costs. Eventually the council approached the M.A.P. who gave their support on the basis that the aluminium house should be similar in its layout and specification to the Ministry of Works' temporary bungalow then under development. After preparing a design the Council erected a prototype at the works of the Bristol Aircraft Company, the costs of which were met by the M.A.P.<sup>5</sup>.

Perhaps the closest that the aluminium fabricating industry came to a declared strategy was set out in a paper on the future of the industry by E.C. Goldworthy, Development Officer of High Duty Alloys Ltd., given to the Royal Society of Arts in February 1944. Aircraft manufacture, he suggested, presented an adverse prospect as only ten per cent of the industry's current capacity would be required for this purpose, and furthermore there existed an abundant stock of both airframes and engines that would take years to exhaust. He continued by pointing out that 'such a situation makes it only the more imperative to find and develop markets that will spread the products of the industry'<sup>6</sup>. These markets, he suggested, included those that had existed before the war and potential postwar markets such as road, rail and marine transport, portable and semi-portable buildings, semi-structural parts and fittings in all buildings, and any form of machinery requiring moving parts. Unfortunately, he continued, the size of prewar markets was not large, and the transport and engineering markets, although promising, required several years of technical development. The building market, however, presented a different prospect as housing would be one of the Government's first postwar priorities. In addition to this, he maintained, perhaps with the work of A.I.R.O.H. in mind, the technical development needed was not great and was well under way, so that production could commence 'almost immediately'.

If by 1944 the aluminium industry possessed a strategy, by 1945 it possessed an organisation for promoting it in the form of the Aluminium Development Association

(A.D.A.). The aim of the A.D.A. was to protect the wartime gains of the light alloys industry, as the organisation pointed out in its introductory pamphlet; 'This movement (the A.D.A.) is a critical one for it is only by creating new designs and uses for aluminium that we shall be able to keep this vastly expanded industry in being'<sup>7</sup>. As well as producing advertising material and technical information the Association published numerous articles, one much the same as the other, drawing attention to the merits of aluminium as a building material. Its most conspicuous activity of the immediate post-war years was the 'Aluminium From War to Peace' exhibition held at Selfridges in 1945. As its title suggested, the exhibition signalled the return of aluminium to the commercial market, presenting the full range of its existing and potential uses. A great deal of space was taken up by architectural applications, which included a curved bay window and accessory furniture, a large number of sculptures, a highly figured door and frame, Regency-pattern chairs and table, and a collection of ornamental screens<sup>8</sup>. In the main the architectural exhibits were confined to decorative and prestigious uses and did not promise to form the basis of a substantial diversification into the building market. The fact that most of the designs were traditional, and in the case of furniture mimicked timber construction, was noted by the *Architect and Building News*, whose overall verdict was: 'In general the non-architectural exhibits are conspicuous for their excellent design, whereas the furniture and architectural exhibits are, with a few exceptions, of a low standard of design'<sup>9</sup>. The 'few exceptions' which stood out as dramatically new applications of aluminium to building were the A.I.R.O.H. house — a prototype of which was erected in the street behind Selfridges — and an all-aluminium fitted 'Kitchen of the Future'. Whilst the former was regarded as an unqualified success, in that it attracted up to 3,000 visitors each day, the latter presented a serious problems in terms of a significant venture into building. The 'Kitchen of the Future' was aimed at the luxury market, and

as such was quite unsuited to the contemporary era of austerity, a drawback admitted by its sponsors as preventing the design from entering production. By 1945 the aluminium industry had only one building product on offer capable of finding a mass market — the A.I.R.O.H. bungalow. It was on this design that its building fortunes in the immediate post-war years rested.

#### Impending crisis: the state

As well as being a source of concern to the aircraft and aluminium industries, the impending reduction in air defence demands — and its effects — began to worry the state during the latter years of the war.

In a memo addressed to the Committee of Reconstruction Priorities in 1943 the Minister of Aircraft Production, R.S. Cripps, drew attention to the fact that after the war only 10 to 20 per cent of the industry's existing capacity would be needed for the manufacture of commercial aircraft. This presented a problem in view of the future of the extensive plants financed by the government, and had prompted discussions between the M.A.P. and the industry on the use of light metals in such new fields as rolling stock, motor vehicles and marine transport. The memo continued by suggesting that light alloys could emerge as a major postwar industry capable of superseding the ailing coal and cotton industries, and warned that the government's postwar policy of full employment could not be attained if hundreds of thousands of the country's engineering workers were made redundant. Cripps concluded his memo by recommending 'that the maintenance of an engineering industry substantially in excess of that existing before the war, be accepted as a major objective of the Government's industrial and war potential policy'<sup>10</sup>. In this document the two elements of future government policy in relation to the aluminium industry were set out: long term economic planning and national security. At this stage no mention was made of a housing programme.

This suggestion was made, however, in a further memo of 1944, some time after

A.I.R.O.H. had approached the M.A.P. with their suggestion for making houses out of scrap aluminium. The tone of this memo is one of alarm at the drastic reduction in the air defence programme. In order to alleviate the crisis Cripps suggested that the rapid implementation of an aluminium housing programme would ease the further cut expected to take place at the beginning of 1945. Cripps qualified the suggestion by pointing out that at this stage it was very likely that the cost of the aluminium house would preclude such a venture<sup>11</sup>. This was certainly a real problem as the cost of the A.I.R.O.H. house was estimated at £776, whereas the equivalent Portal temporary bungalow under development by the Ministry of Works was estimated at £600. Upon this basis the War Cabinet Sub-Committee on Housing, meeting in November 1944, rejected the suggestion<sup>12</sup>.

Undeterred, the M.A.P. produced a further document describing in detail the relationship between the aluminium house and defence policy. The central issue, it emphasized, was that it is necessary, both on war potential grounds and in the interests of the development of home and export trade, to secure the emergence of an industry operating at a sufficient level of activity and under sufficiently competitive conditions to secure the highest degree of efficiency and low costs ...<sup>13</sup>

The M.A.P. estimated that the production of parts for 50,000 houses over 12 months would raise the production of aluminium sheet and strip from a projected 17 per cent to 50 per cent of capacity, and the production of extrusions from a projected 19 per cent to 23 per cent of capacity. If the programme was not undertaken then the following would result. Firstly, the unemployment of the bulk of factory capacity would leave an insufficient nucleus of firms for either war potential or healthy competitive conditions. As well as leaving the country vulnerable in the event of future conflict this state of affairs would add greatly to the cost of future government defence contracts. Secondly, existing stocks would be used up while the war with Japan



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was concluded: but in the event of the war being prolonged, the industry's capacity might be found to be half that required to maintain an extended conflict. A third consideration, the paper pointed out, was that three of the most modern semi-fabricating plants were owned by the government and were the programme not adopted, the chances of their present occupiers purchasing them would be greatly diminished. The arguments, which had now shifted to an emphasis on defence, had the required effects on the War Cabinet Housing Committee, which in February 1945 approved the proposal. The fact that the price had since risen to £950 was noted but, in the light of such persuasive arguments, did not affect the outcome<sup>14</sup>.

By September 1945 the war with Japan had been concluded earlier than expected, removing much of the weight of the M.A.P.'s argument. Furthermore, the price of the house had risen to £1,317 and the estimated completion date of the programme had moved back 18 months to December 1947. This parlous state of affairs was discussed in the penultimate meeting of the War Cabinet Housing Committee in October 1945. Three alternatives were discussed. The order could be reduced to such a number as would bring the programme back within its budget, increasing the overheads per unit. The order could be abandoned, leaving the industry to its fate, which Cripps' successor, J. Wilmot, insisted might be disastrous. Or, as was eventually agreed, the Committee would approach Parliament for more funds<sup>15</sup>. The spiralling costs were commented on by the new Chancellor of the Exchequer, H. Dalton, in a letter to Wilmot; 'I find it alarmingly and disappointingly expensive ... There has been some very sloppy estimating under our predecessors ...'<sup>16</sup>

A sequel to these events — showing how the aluminium bungalow, originally the brainchild of the aircraft industry, was taken out of A.I.R.O.H.'s hands and made subject to the government's needs — is provided by an unsigned report, deposited in the Ministry of Health's files. The report, entitled *A Short History of the A.I.R.O.H. House*, complained

that the eventual allocation of the contracts did not quite reflect the intentions of A.I.R.O.H.'s founders:

Five aircraft factories are now making the house, one of them being Vickers ... the only big firm who refused to come into A.I.R.O.H. They said they were not interested. On the other hand Mr. McGivney, the kingpin of the whole show, after telling his Works Council how he was going to find work for them after the war, has been left high and dry ...<sup>17</sup>

#### A Partnership prolonged

Under the Housing (Temporary Accommodation) Act of 1944 54,000 temporary aluminium bungalows were manufactured. This programme was followed immediately by the production of a further 17,000 bungalows for permanent use. By the time that the permanent programme was initiated the survival and future good health of the aluminium industry seemed assured. What lay behind this second programme was not a concern over the survival of the aluminium industry, but the Labour Government's attempt to redistribute the industrial labour force and stimulate the production of exportable goods.

A memorandum prepared by the Ministry of Health in May 1947 set out the reasoning behind permanent aluminium house production.

The object has been to find a system of construction which makes little or no demands on local labour ... The conclusion was reached that the aluminium bungalow was most suitable for this purpose as they are almost entirely prefabricated in the factory and erected by mobile teams ...<sup>18</sup>

The main aim of the permanent programme was to attract new labour to areas with a labour shortage, by providing a type of accommodation that would not divert the existing local labour force from the factory floor to the building site. To achieve this the permanent bungalow was offered to the local authorities for 56% of its real cost, compar-

ing favourably with the price of brick construction for a dwelling of the same area. It was stipulated, however, that the bungalow would be allocated only to areas with an industrial labour shortage, and that of those supplied no less than 75 per cent would be let to immigrant labour<sup>19</sup>.

The idea of exporting the aluminium house had occupied the thoughts of A.I.R.O.H. prior to the time of its production for the British market. By June 1946 the Export Promotions Department (E.P.D.) of the Board of Trade was showing a keen interest in A.I.R.O.H.'s sales in South America and was co-ordinating the actions of other government departments in order to assist this export initiative. As well as persuading the Ministry of Works to release bungalows to demonstrate the product to potential overseas buyers, the E.P.D. influenced the Ministry of Supply's efforts to dispose of surplus aluminium house producing plant. The Ministry of Supply had received offers from commercial interests intending to resell the plant — much of which was now surplus to the needs of the permanent programme — to overseas buyers. At a meeting convened by the Board of Trade the E.P.D. pointed out that

The sale of the specialised plant to markets in need of such houses would jeopardise the sale of the houses, and the meeting has been called to consider whether in the national interest the Ministry of Supply might be justified in retaining the plant ...<sup>20</sup>

The meeting concluded with a resolution by the Ministry of Supply to suspend sale of the plant.

A further example of government intervention in the aluminium house market illustrates the Board of Trade's concern for the A.I.R.O.H. house. In 1948 a British firm applied to the Bank of England for financial support in concluding a royalty agreement with an American firm for the manufacture of its aluminium roof design in England. In April the Board of Trade turned down their request, and provided three reasons for doing so. Firstly, the product might compete with the A.I.R.O.H. house. Secondly, the royalty

agreement prevented it from being sold in America and, as such, it would be unable to earn scarce dollars. Thirdly, the design of the roof was such that insufficient British labour would be expended in converting the imported raw material, aluminium, bought with Canadian dollars, into a finished commodity with a high resale value<sup>21</sup>. These concerns are reiterated in a memo prepared by the Ministry of Supply a month later;

The Ministry of Supply and Board of Trade encourages the use of aluminium in any exported articles which have a high 'uplift'. Aluminium houses come within this category. There are further advantages if they are exported to hard currency areas ...<sup>22</sup>

By the time that the permanent aluminium house entered production in 1948, concern at the import from Canada of most of Britain's requirement of pig aluminium had prompted the Ministry of Supply to classify it as a scarce material. Licenses for its use in building structures could only be obtained for 'essential' projects. Nonetheless, not only did the permanent programme go ahead, but sanction was obtained to manufacture a further 3,000 houses for Northern Ireland to help Hawksleys convert its production to their modified export design<sup>23</sup>. Furthermore, the last document in the available Ministry of Health files contains a proposal to provide the Blackburn Aircraft Company with an order for a further 1,000 houses in order to prevent it from going bankrupt before it received enough orders to commence the manufacture of its tropical aluminium house design<sup>24</sup>.

At about the same time the government began to favour the use of scarce aluminium in schools. In January 1948 the Bristol Aircraft Company (B.A.C.) and Northern Aluminium published in the building press designs for a jointly-developed aluminium schools system<sup>25</sup>. If aluminium houses could attract immigrant labour to growing industrial areas, and could be exported in panel form, then so could schools. In March 1949 the first B.A.C. aluminium school was built for the new aluminium housing estate, manufac-



tured by the same company, at Locklease in Bristol. By Autumn 1954 the Company had erected over 500 schoolbuildings in Britain alone.

It is difficult to estimate the degree to which the aluminium industry fulfilled the Government's export expectations, as figures for the total number of houses and schools exported are not available. However it seems that from 1949 to the mid-1950s a number of factories were able to support themselves on this type of work. In 1949 B.A.C. provided 123,000 school places in Britain and exported the remainder of their production. By 1951 the equation had reversed: 56,000 places were built in Britain and the remaining 71 per cent was exported<sup>26</sup>. In March 1952 Hawksley Constructions announced that they had £2 million worth of factory-made buildings on order for various government departments in Australia, including 129 schools for the New South Wales Government; and in June 1953 reported that in total they had supplied over 400 schools to Australia with accommodation varying from two classrooms to 21<sup>27</sup>. In 1953, as well as B.A.C., Hawksley and Blackburns, aluminium buildings were being exported by Booth and Company, G.H. Burgess and S.M.D. Engineers<sup>28</sup>. Although prefabricated buildings were sighted as far afield as Arabia and Baghdad there are no reports of them being bought by 'hard currency' nations and, in fact, the bulk of production stayed firmly within the British Commonwealth.

#### The technology of excess capacity

An examination of the design and production of the aluminium bungalow suggests that rather than seeing it, as contemporaries did, as a breakthrough in the history of prefabrication<sup>29</sup>, it should be regarded as a commodity for consuming aluminium that entailed considerable problems – and a unique degree of state involvement – in its production.

The arrangements for financing and producing the aluminium house differed significantly in the temporary and permanent programmes. But in both the role played by central government was crucial. In the case

of the temporary programme the houses were funded outright by Parliament under the Housing (Temporary Accommodation) Act of 1944. This legislation allowed the provision of a range of types of temporary dwelling, of which the aluminium bungalow was one. Its manufacture and erection was controlled directly by the various government departments previously responsible for the production of military aircraft. The only addition was the Ministry of Health, which acted as client and opened its files on the subject in December 1944. The M.A.P., having sponsored the project until its inclusion in the Temporary Housing Programme, retained control throughout of the aircraft plants in which it was manufactured. As with aircraft production the M.A.P. was not prepared to tolerate any disruption of the programme: 'I have told my people that if there is any nonsense we will take over the factories and run them ourselves'<sup>30</sup>. The Ministry of Supply supervised the ordering and supply of materials, and administered the subcontracts with the semi-fabricators. The otherwise redundant transport organisation developed for the transport of aircraft parts was used to carry the houses to site. The Ministry of Works laid out the site services, constructed the foundations and slab for the houses, and supplied the prefabricated kitchen and bathroom service units. The only responsibility of the local authorities, who secured their allocation by making a bid on the basis of their needs, was the construction of access roads and off-site services. The contracts and all payments were made by central government<sup>32</sup>.

For the later permanent programme the arrangements were altered. Responsibility for placing the orders and paying the contractors was devolved to the local authorities which, with the aid of a government subsidy, financed the programme with their own funds. The existing central planning organisation was abandoned – much to the dismay of the manufacturers, each of whom became responsible for securing their own supplies of materials and components. Although these changes represented a move towards the

familiar pattern of state housing provision, important controls were retained by the Government. Firstly, it negotiated the unit price of the houses, nominated the manufacturers, and guaranteed the size of the orders. Together with the subsidy such measures ensured that there were both buyers and producers for a product that could not otherwise have competed on the housing market (the guarantees could not have been introduced to cover the capital cost of plant as this had been amortized by production for the temporary programme). The second measure, which emphasizes the importance of the venture to government policy, was the option retained to compel the manufacturers to meet the contracts if their other interests threatened to impede the production of the house<sup>32</sup>.

The actual design of the house was undertaken by A.I.R.O.H. who, in the course of its evolution, consulted a number of specialists, some of whom subsequently claimed responsibility for the design. In September 1945 a contract was placed with a firm called Structural and Mechanical Development Engineers (S.M.D.) by the M.A.P. for the 'development and supply of foam panels for aluminium house production, and for design and technical assistance in connection with large scale production plants for the same purpose'<sup>33</sup>. The name Hiduminium Applications appeared on a number of the detailed drawings (Hiduminium was the trade name of an aluminium alloy marketed by High Duty Alloys). A.F. Hare and Partners were credited as architects for the project by the building press, and the firm's name was mentioned in connection with further projects sponsored by S.M.D.<sup>34</sup>.

The design of the house was determined by two particular requirements: it should consume the maximum amount of aluminium, and it should be made in an aircraft factory with the minimum modification to existing plant. The basic components of the house were to be those of aircraft construction: thin gauge aluminium sheet (an alloyed core to provide strength, coated on both sides with pure aluminium to prevent corrosion) and extruded section. In order to utilise existing fac-

tory capacity to the maximum, the house was manufactured in four complete sections in the factory and these were then transported to site. These sections, emerging fully wired, glazed and painted, were joined together on site by a snap-on aluminium cover bead which features prominently on the front and rear elevations. One section contained the plumbing system (a kitchen/bathroom unit supplied to all the bungalows by the Ministry of Supply); as a consequence no site plumbing joints were required. The need to construct the house in four complete sections, sufficiently rigid to be transported to site, dictated a structure more akin to aircraft and automobile construction than contemporary building methods.

The structure is founded upon a chassis which forms the floor and carries the bodywork of the house. To lighten the sections of the floor chassis, the deflection is transferred to the roof trusses through the framework of the external wall panels and through the internal central spinal partitions ... This is doubly important as, for lifting and final assembly, the load points are at different moments ...<sup>35</sup>

The degree of work carried out in the factory distinguished the A.I.R.O.H. house from the other types of temporary bungalow; R.B. White commented that 'the aluminium bungalow was much the most highly prefabricated house in the programme (and) must be regarded as a great historical achievement in prefabrication'<sup>36</sup>. However, the requirement for so much of the work to be carried out in the factory imposed severe restrictions on the external appearance of the bungalow; its windows were not grouped in the currently fashionable manner of modern design found in the Tarran and Arcon bungalows – the former of which featured a wrap-around corner window – but were equally distributed among the four sections. Also the roof required a pronounced degree of pitch whereas in the Arcon bungalow the pitch was reduced to a minimum and the roofs to the Tarran and Uni-seco bungalows

were flat, reflecting more characteristically the alliance between the modern movement and mechanised house production. The design of both the windows and the roof was determined by the sectional design of the bungalow; the pitched roof imparted rigidity to the sections and the small widely spaced windows minimised the concentration of stresses imposed by handling. To many architects, convinced of the need to update building technology, such compromises between external form and production methods were of minor importance:

Some will complain that the result has little in its appearance to recall the taut lines of the Spitfire or of the Beaufighter. It must be conceded that the design has not yet in outward expression fully found itself. That is not the point. What is much more significant is that the minds which have created the modern aircraft have turned their attention to the solution of an almost equally urgent problem ... the substance of the method may equally well be applied in the future to the provision of permanent homes ...<sup>37</sup>

However, not all shared this complacency. The first Ministry of Works architect to examine A.I.R.O.H.'s drawings was moved to comment: 'I don't know what we can do about the architecture. The windows are ugly; the canopy is feeble (and) the change in texture of the outer walls just plain stupid'<sup>38</sup>.

An example of the way in which the house was designed around the needs of the semi-fabricating industry, rather than the client, is provided by the window design. According to the Ministry of Health the use of aluminium castings would have saved up to £30 per house; nonetheless the windows were eventually made of extruded sections 'due to the pressure exerted by the aluminium companies'<sup>39</sup> for the greater use of extrusions.

In August 1945 the Ministry of Health received two letters from the bungalow's original designers, both conveying a similar message. They suggested that the method of

manufacture and the design were ideal for factory production but disputed the use of aluminium as its cheap supply under Lend-Lease had just stopped. The letters stated: 'At least three-quarters of the aluminium in the house could be replaced by steel showing an overall saving when taking into account the easier weldability of steel of probably £270'<sup>40</sup>. The fact that neither letter found a response is not surprising; to have replaced the aluminium in the aluminium house would have removed the purpose of the programme.

In the original estimate provided by the M.A.P. the house was costed at £675. Of this, £165 was absorbed by the service unit, which included all the bathroom fittings, the hot water system, stove, living room fire and boiler, and all the kitchen equipment. Of the remaining £510, 77 per cent was consumed by the purchase, fabrication and assembly of aluminium; and £168 was spent on other materials which could not be replaced by aluminium, such as insulation, timber floorboards, plasterboard, paint and glazing. In all, 188 tons of aluminium was used for each house, 82 per cent of which was recycled scrap<sup>41</sup>. As the original founders of A.I.R.O.H. had envisaged, the house did much to remove the mountain of scrap aluminium created by the war. One Lancaster bomber, the *Aluminium and Non Ferrous Review* reported, was consumed by the manufacture of three bungalows<sup>42</sup>. The scrap was collected for the programme by the Ministry of Supply at its two Metal and Produce Recovery Depots from crashed aircraft, and was sold to the fabricators at its market price of £46 per ton for the temporary programme, and £80 per ton for the permanent programme<sup>43</sup>. If the permanent and temporary programmes are aggregated, amounting to 70,000 houses, the total amount of scrap used exceeded 118,000 tons, which was greater than the amount recovered in any single year of the war.

Evidence suggests that the factory production of the complete house sections was by no means an easy undertaking. Initially the programme was envisaged as commencing in mid-1945 and finishing in twelve months: in

fact production did not begin until mid 1946, and took 24 months to complete<sup>44</sup>. In his lecture Goldworthy had suggested that production could start 'almost immediately', but this proved not to be the case; the Hawksley plant took 18 months to retool, during which time the workforce was dispersed and the plant lay idle<sup>45</sup>. However, once production was underway the sections were manufactured to a uniquely mechanised degree, in relation both to traditional and contemporary non-traditional building practice. Completed houses were literally rolling off the production line:

With the exception of the nailing down of the floor boards, which was done by hand, the entire production was a mechanised process. The wall frames, like shallow trays, were first sprayed on the inside with hot bitumen, then immediately passed under a battery of cement pourers to be filled with air entrained grout which provided an insulating layer. The partly made wall panels were then passed through low pressure steam drying ovens which enabled the grout to reach full strength in 48 hours ... The final assembly of the components was done on the moving belt system, during which the final paint spraying was carried out ... Each unit of the house emerging fully wired for electricity, glazed and painted ...<sup>46</sup>

Impressive though this was to a generation of post-war modernist architects such systematization of the production process carried with it considerable drawbacks. One of the most significant of these was soon apparent; the units were too bulky to store and 'any problem in getting them away therefore could only be dealt with by stopping the entire factory'<sup>47</sup>. Problems concerning delays in site preparation, labour disputes and fuel shortages encountered in the temporary programme led the manufacturers when tendering for the permanent programme to make their prices subject to unforeseen costs. As one manufacturer complained when the Ministry of Health balked at this: 'All

departments are interdependant and a shortage of materials in one department, for example, can in fact stop the whole works in a very short time'<sup>48</sup>.

When the Housing (Temporary Accommodation) Act of 1944 was passed the aluminium house had not yet been accepted into the programme. By 1948 this latecomer had been manufactured in larger numbers than any other type: 54,500 had been produced, exceeding the Arcon house by 15,641 units and the Uni-seco house by 25,501 units. The aluminium house started as the most expensive, entered production as the most expensive, and finished production as the most expensive. In fact the disparity in cost widened at each stage. In 1944 it was 29 per cent more expensive than the estimate for the Portal house; in 1945 it was 25 per cent more expensive than the Arcon house and 33 per cent more expensive than the Uni-Seco house; by 1947 these figures had widened to 33 per cent and 43 per cent respectively. The soaring cost of the A.I.R.O.H. house arose from the fact that it was the most prefabricated house in the programme. While the cost of all the temporary houses rose due to unforeseen production difficulties, the particularly complex nature of the design and production of the A.I.R.O.H. house dictated that its costs rose the fastest. The most expensive house, and increasingly so, was made in the largest numbers – a situation quite alien to the established dictates of building economics.

## Conclusion

Although this paper has concentrated on the aluminium house it must be emphasised that this building type was part of a much broader diversification into the building market undertaken by the light-alloys industry. Other types of building included a large number of schools, a number of aircraft hangers, the Dome of Discovery and a series of roofs for reservoirs and oil tanks. Throughout the late forties and early fifties at least nine firms were employed in the manufacture of aluminium buildings for both the home and export markets. However, with the aluminium houses completed and alternative



methods of school construction available, the British Government turned its attention away from aluminium buildings and left the material to compete on the open market. In 1948 32.5 per cent of aluminium consumption was in the form of buildings; by 1953 this had fallen to six per cent. With the popularity of curtain walling in the sixties this was to rise again to between eight and ten per cent, but not in the form of complete buildings or structures. During the mid-fifties most of the aluminium building factories moved into other areas of light-alloy engineering, or in the case of Hawksleys adopted a method of system building which did not rely on the use of aluminium. The price of aluminium, which had been steadily rising, made it uneconomic as a basic building material either at home or abroad. More lucrative markets for aluminium existed elsewhere. In 1955 the Bristol Aircraft Company announced that it was dissolving its Buildings Division and returning its entire capacity to aircraft in order to take advantage of the increasing programme of aviation work<sup>49</sup>. Three schools left unfinished in Coventry were completed in other materials.

Although the activity of commercial producers was a major theme of post-war aluminium building, more fundamental was the role played by the state. It was the government that provided patronage for the bulk of aluminium buildings in the form of houses and schools. Had this client not existed, the amount of aluminium building accomplished would have been negligible and the industry's diversification unsuccessful. There is little doubt, as the costs of the A.I.R.O.H. house demonstrated, that aluminium buildings could not have entered the market without the large subsidy offered by the government.

Perhaps the most remarkable feature of this study is that the Government's concern for the aluminium house lay outside considerations of welfare provision. At no time in the discussions leading up to the implementation of the programme was there any mention of housing need. Neither was there discussion of production techniques or the bungalow's suitability as a dwelling. The

debate revolved around issues external to the aluminium bungalow's value for housing. For the Churchillian War Cabinet its worth lay in defence policy; for the Keynesian Labour Government its significance was as a means of economic management. If the aluminium house is taken as an example, this study suggests that the investigation of post-war building technology should look beyond the simple classical model of 'increasing supply to meet rising demand' and consider more diverse and complex themes. Perhaps the most fruitful approach would be to examine the emergence of the Welfare State as the largest building client, and the degree to which its peculiar demands and policies influenced the development of building technology during the postwar period in a way that was not concerned solely with providing a larger number of better and cheaper buildings.

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