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THE INDUSTRIALISATION OF BUILDING: BUILDING SYSTEMS AND SOCIAL HOUSING IN POSTWAR BRITAIN 1942 TO 1975

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ABSTRACT

This study describes the development of system building in postwar social housing.

System building required major transformations in the nature of the building producer and client. The transformation in the producer consisted of a change from the conventional pattern of selling the capacity to build individual buildings to selling a specific product, the building system, a general feature of which was its use of new building technologies and requirement for considerable capital investment. The transformation in the client consisted of a departure from the historical pattern of conceiving each building as an individual project to presenting large programmes of standardised buildings. These transformations took place within a specific historical epoch - the Welfare State.

While the Welfare State provided conditions favourable to system building, it is argued that the policies persued by central government, the building industry, local authorities, the architectural profession and building trades unions played a crucial role in its development. These are examined in turn. The concept of mass production was continually associated with postwar developments in building technology, and the attraction of this idea to Welfare policy makers is also discussed. Chapters Six and Seven look in detail at the types of system promoted, both by government research and development architects and by

commerical sponsors. The last chapter examines the architectural character of the housing produced by system building and the relationship between technology and design theory in social housing.

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INTRODUCTION

Between 1946 and 1978 the state produced as much as 41% of its annual housing in building systems. In these years nearly one million houses were built by means which radically departed from conventional methods of building. System building was undoubtedly the most dramatic feature of technological development in the postwar building industry. More than just a different way of putting buildings together, system building was a complete revision of the building process that had developed under capitalism over the previous two centuries. System building significantly altered the demands and contribution of each of the major parties involved in the building process: the client, the designer, the building materials and components producer, the building contractor and the labour used to put the houses together on site. To many, system building was more than just the most recent advance in building methods, it was indisputably the construction technology of the 20th Century: it was the direction in which building had to progress if society was to be provided with the volume of housing it both needed and desired. To some politicians it was the path to an industrial revolution in building methods, and to many housing experts it was the panacea to the 'housing problem'. To the historian looking back at system building it is evident that it proved to be neither of these things. Rather, it was but another stage in the historical development of the building process. Furthermore, it was by no means long-lived - in all system building produced significant numbers of houses for only 35 years. Upon looking at the history of system building more closely, what is remarkable is the fact that it was directly connected with a particular form of social policy: the Welfare State. The aim of this study is to explore the relationship between a way of organising the building process - system building - and the social and political epoch within which it developed.

I. THE TECHNOLOGY OF SYSTEM BUILDING.

System building was different in many ways from conventional methods of construction, and this section will attempt to describe these in relation to technical advances in building generally.

A number of terms were commonly used to refer to the development of building technology in postwar Britain, each with distinct meanings. Prefabrication referred to the practice of making building components away from the building site and then transporting them to the place of erection. Prefabricated components, such as windows and doors, were present in building well before the 20th Century. After the Second World War staircases, trussed rafters and precast concrete panels were all added to this type of manufacture. Prefabricated components can be, and are, embodied in traditional building to a considerable extent. While, as a government committee pointed out in 1945, prefabrication "has been following a rising curve" from the mud hut to the motor-car trailer, [1] the term came to have an added meaning in the period covered by this study. E.D.Simon, a former Parliamentary Secretary to the Minister of Health, saw, in 1945, a vital link between prefabrication and contemporary manufacturing methods: "The possibilities of economy and improved design through prefabrication are great, but its main advantage... depends on the next stage: large scale production". [2] It was thought that the assembly of houses from prefabricated components would mean that these components could themselves be mass produced in factories like other commodities. The significance of prefabrication to 20th Century building technology was that it represented the application of mass production to dwelling construction. Prefabrication was constantly associated with building systems, indeed, previous writers, such as R.B.White, have tended to regard the two as synonymous. [3] Nevertheless, many systems were not based on the use of prefabricated components - No-Fines, by far the most successful system [Tab.V] was fabricated on site to as great a degree as a traditional house. While of crucial importance to the development of postwar building technology, and a concept referred to many times in this study, prefabrication was not synonymous with system building.

Industrialised building was another term used in association with the development of postwar building technology, and in particular, system building. During the 1960s, industrialised building, or 'IB' as it was known, tended to replace prefabrication as a term to describe the rapid technological changes which it was thought building should undergo. This terminological adjustment was made as it became apparent that industrialising the building process was not as simple as the concept, prefabrication, suggested. Industrialised building referred to the application of those features commonly associated with the development of other manufacturing industries. It was summarised by Geoffrey Rippon, the Minister of Works, in 1963 as "the application of power and machinery and quantity production". [4] In December, 1965, the Ministry of Housing and Local Government (M.H.L.G.) described industrialised building in greater detail as:

> "all measures needed to enable the industry to work more like a factory industry. For the industry this means not only new materials and construction techniques, the use of dry processes, increased mechanisation of site processes, and the manufacture of large components under factory conditions of production and quality control; but improved management techniques, the correlation of design and production, improved control of the selection and delivery of materials, and better organisation of operations on site. Not least, IB entails training teams to work in an organised fashion on long runs of repetitive work, whether the men are using new skills or old"[5]

It is undoubtedly true that building systems, to varying degrees, embodied these qualities: however, it is also true that such qualities could also be found on a well organised traditional building site. Nevertheless, it is significant that when the Ministry came to the measurement of IB, it in fact did no more than list each of the current building systems and their production figures. Industrialised building, particularly in the eyes of the government, was inseparable from system building. When the Ministry promoted IB, as it did, system building was the means by which this was done. Being a broader term than prefabrication, IB does indeed encompass all forms of system building, however, at the expense of also including the more efficient forms of that which system building tended to replace - traditional building.

To compare system building with <u>traditional</u> building tells us a great deal about technological development in housebuilding. Indeed, <u>non</u> traditional building was a generic term for system building during the 1940s. During the 1950s the government encouraged the term, <u>new</u> traditional building to refer to the building systems which had established themselves on economic grounds. This tendency arose from the desire to establish a wider acceptance of new methods, but should not be allowed to obscure the fact that traditional and system building tended to be very different.

One area of divergence concerned the construction of the building fabric. In 1917, the Tudor Walters Committee identified a salient feature of house construction which in 'traditional' construction had remained largely unchanged. Taking the cost of labour and materials together they found that of the 11 trades involved in housebuilding, bricklaying accounted for 31% of the total cost. Carpentry and joinery accounted for a further 26%. Together two trades accounted for nearly two-thirds of the cost of two-storey housing. [6] While carpentry and joinery were aspects of building made very much subject to prefabrication and the introduction of mechanisation during the 20th Century, brickwork was not. 'Traditional' building might be characterised as a way of building in which bricklaying remained the dominant element of cost - the matrix into which other materials and components were built. A feature common to many building systems was that they replaced brickwork with other materials of construction. However, this was not always the case. For instance, 'rationalised traditional' systems used brickwork for structural crosswalls, and 'timber frame' systems used it frequently for cladding. The abandonment of traditional walling techniques in favour of new methods was thought to confer a number of advantages. Construction time was frequently speeded up, the need for building labour on site - skilled or unskilled - was often reduced (although it is significant that these savings were in most cases outweighed by the addition of labour in the pre-site stages of production) and, in a few cases, overall costs might be lowered. Each of these potential features of system building were powerful attractions both to producers and social policy makers and formed an ever present theme in the history of system building.

System building introduces the notion of a 'system' of construction, which might be described as a method of building departing from traditional construction. During the 20th Century such techniques have ranged from a codification of a conventional approach to building, such as the combination of timber panels with loadbearing crosswalls, or an entirely new approach to building, such as reducing the building shell to a series of large precast concrete panels connected by a specially developed joint. A particularly evident characteristic of system building resulting from the use of new techniques was the development of new contracting and tendering procedures. As the National Building Agency (N.B.A.) pointed out in 1969: "Before the introduction of industrialised systems the method of choosing a contractor was straightforward". [7] Traditional building used conventional methods of construction familiar to all parties in the building process. The architect could design the building down to the last detail and the role of the contractor in the tendering procedure was solely to attach a price to each item of work. The prices given by different contractors for the same item of work could then be compared - like was compared with like. The process by which it was carried out was known as competitive tendering. However, to purchase a system built dwelling involved the purchase of a distinct method of construction most fully understood by the contractor familiar with it. The design of the system-built dwelling had to reflect this. System building involved the 'sponsor' of the system in the design process, and the detailed solution to a given design problem differed from system to system. Like was no longer comparable with like. Furthermore, the architect was no longer the sole arbiter of building design. Indeed, in the early non traditional housing programmes of the late 1940s and early 1950s, the individual client's architect was excluded from the dwelling design altogether. The client purchased a complete house from the producer for a fixed price - normal competitive tendering was eliminated altogether as each system produced different products not amenable to direct comparison. In addition to this, to realise the claimed time, building labour, and cost saving potential of system building, larger quantities of building had to be offered to one sponsor than were normal in a single building project such as a school or small housing development. Buildings were no longer bought individually but in large quantities. Together, these features gave rise to a number of new contracting methods designed to introduce the eventual producer at a much earlier stage in the design process, and offer a quantity of building appropriate to the system. The first use of serial contracting was by the Hertfordshire County Council in association with its school building system in 1947. [8] Nevertheless, it should be pointed out that traditional building could also be made subject to new contracting methods, and frequently was during the 1960s, although not on the same scale as system building.

A further difference between system building and traditional building, which was noted on a number of occasions, [9] was the introduction of a new party to the building process: the <u>sponsor</u>. The sponsor was the body responsible for initiating and operating the system. Every building system had a sponsor. One sponsor might operate a number of systems, or similar types of system might be operated by a number of sponsors. The sponsors of building systems were various but fell into three types; building firms, non building firms, and client groupings (or consortia). Building firm sponsors tended to be the larger contracting firms. Non building firm sponsors ranged from primary materials producers, such as steel firms wishing to enter new markets, to building component manufacturers. In most cases, non building firms sub-contracted building firms to erect their system. Client organisations tended to be groupings of the larger local authorities or government building departments.

Despite their different origins, one feature which sponsors had in common was the assumption of a host of expensive responsibilities not found in traditional building. Foremost of these was the fact that building systems required a far higher degree of investment in plant and equipment than traditional construction. Although varying widely, the degree of investment/worker in system building was considerably higher than in traditional construction. It was estimated in 1966, by A.W.Cleeve Barr, a senior government architect, to be on average two to three times more than the 400 pounds/worker of traditional construction. [10] As well as financing the initial investment needed to design, develop, and manufacture prototypes, a sponsor had to finance the manufacturing plant and the higher management costs associated with operating sophisticated building technologies. While these costs might be offset by higher profits when the system was operating at an economic capacity, they represented considerable burdens when demand was low. The introduction of this new party, the sponsor, to the building process was undoubtedly a major distinction between system building and traditional building.

The tendency of sponsors to willingly assume these onerous financial burdens in the postwar period is all the more exceptional in the light of one of the most salient features of the traditional contracting industry - its historical aversion to capital investment. This aversion arose from the structure of the building market which was such as to deter firms from investing in technologically sophisticated production and marketing methods. Indeed, throughout the 20th Century, the contracting industry has generally been considered exceptional in its degree of low capital investment, lack of innovation and technological backwardness. According to Donald Bishop of the B.R.S., this state of affairs was the result of the adaptation of the industry to its market. As he pointed out in 1966, building was traditionally a bespoke activity - the construction of individual buildings to the directions of individual customers. Furthermore, the demand for building work was highly unstable. Regional fluctuations, uncertainties in timing, and the financial capriciousness of clients presented contracting firms with the prospect of considerable uncertainty. In addition to this, contractors generally avoided a high degree of specialisation in distinct building types, taking whatever type of work was offered:

'The building industry, as at present structured, is amorphous in character in that its resources are widely dispersed. The demands of the market, characterised by bespoke construction, uncertain in volume and timing, have produced an industry which must be adaptable, so that its resources can be deployed on whatever work is available, wherever this is. The employment of subcontractors, the availability of plant on hire, the presence of a casual labour force, all contribute to flexibility but create production units which are ephemeral. In these circumstances there is little incentive for firms to invest heavily either in forward planning or in development because there is no certainty that the work in hand will be required again"[11]

The character of the traditional building industry, in particular its reluctance to invest resources in sophisticated technologies directed towards specific building types, arose as a response to an uncertain building market. Indeed, rather than being producers in the normal sense of the word, Bishop suggests that "Building firms viewed in this light are merely organistions capable of building". [12] During the post Second World War period, system building was the antithesis of the pre-existing state of affairs: substantial investment in technological resources directed towards specific building types and the marketing of a specific building product by a sponsor rather than the sale of a building service by a general contractor.

II. THE WELFARE BUILDING MARKET.

This section will describe the historical conditions under which the changes in building construction technology and organisation described in the previous section took place. A new type of building market appeared during the 20th Century which generated the conditions under which building producers could depart from the traditional model of contracting, and become system building sponsors. This market arose under the Welfare State, a form of social policy which had a distinct effect on the techniques by which housing was produced.

Improvements in the living conditions of the working class through the redistribution of wealth under state control has been dated to the end of the 19th Century. [13] A concern on the part of government for the national "economic and military 'deterioration'" which followed the Boer War prompted limited legislation designed to improve the health of the existing and potential labour force and armed services. A further stimulus to social reform was provided by the growth of the labour movement and the fear of radicalisation of the working classes. [14] Among these reforms were tentative moves by the state to assist in the provision of public housing. Beginning with the Labouring Classes Dwelling Houses Act (1866) a series of Acts were passed which sanctioned local authority housebuilding at low rates of interest: 22,000 houses or 1% of the nation's output up to August 1914 were provided by these means. [15] The years immediately prior to the First World War saw a renewed discussion by social policy makers of housing provision with tentative signs of an increase in state intervention. This, coupled with the housing shortage created by the war and renewed fears of social unrest prompted the launching of the Addison Housing Programme in 1919. As "an insurance against revolution" half a million houses were promised. State housing, subsidised by the Exchequer for the first time, was adopted as the major element of the government's postwar stabilisation policy. [16] With the onset of the depression and the consequent waning of labour power, the 'Homes Fit for Heroes' programme was reduced in 1921 to an anticipated 176,000 houses. [17] Nevertheless, a precedent for state subsidised housing had been set and an administrative machinery established to produce large quantities of a new building type - social housing. The state continued to build throughout the interwar period, providing a total of 579,000 houses between 1924 and 1935 under the Wheatley and Chamberlain Housing Acts (1923 & 1924). [18]

The events of the interwar years were crucial to the subsequent development of the Welfare State. On the one hand, heightened class conflict manifested itself in the protracted labour disputes of the mid-1920s. On the other hand, the period witnessed the rise of the political strength of the Labour movement - the first Labour Government was formed in January 1924 under Ramsay MacDonald. According to D.Thomson, the crushing of the General Strike in 1926, and the rise of the Parliamentary Labour Party killed the notion of "syndicalist revolution as the road to better times... What gained new life... [following the strike]... was parliamentary socialism and the prospect of building a democratic Welfare State". [19] The legislation passed under Baldwin, MacDonald and Chamberlain between 1925 and the Second World War, notwithstanding retrogressive measures such as the 1931 dole cut and family means test, extended health insurance and pensions schemes and unified the local authority apparatus though which the state alleviated the harshest aspects of working class living conditions. [20]

The Second World War saw renewed demands for a more even distribution of resources. The notion that the working class was suffering deprivation and sacrifice in order to secure a more equable postwar society was a crucial element in the prosecution of the war effort and ensuring social harmony in the years of austerity which followed. The need to perpetuate class unity through social legislation underlay the following Terms of Reference of the War Cabinet Reconstruction Committee established in 1941:

> "To arrange for the preparation of practical schemes of reconstruction... These plans should have as their general aim the perpetuation of the National unity achieved in this country during the war, through a social and economic structure designed to secure equality of opportunity and service amoung all classes of the community"[21]

The 1945 Labour landslide ensured that the deliberations of the Reconstruction Committee were translated into legislation. In 1946 the National Insurance Act and National

Health Service Acts were passed with the avowed intention of "covering the whole population and all risks from the cradle to the grave". [22] The immediate postwar years saw the emergence of the three features identified with what has become known as the Welfare State: the nationalisation of essential, although not necessarily profitable, staple industries, such as steel and coal; a taxation structure designed to mitigate the excesses of inequality and finance the state welfare apparatus; and the avowed intention of the state to intervene in the economy in order to prevent a recurrence of the economic crises which had generated unemployment on the scale found in the interwar years. By 1945, the state had accepted Keynesian economic theory based on the principles of government regulation of demand and direction of investment as a means of reducing unemployment and keeping the workforce productively employed. [23] The government's intentions were made explicit in the Employment Policy White Paper (1944): "The government accept as one of their primary aims and responsibilities the maintenance of a high and stable level of employment after the war". [24] However, the wielding of state power was to extend beyond the management of potential unemployment crises to the most efficient use of the nation's resources:

> "In framing these proposals, the Government have in mind the more general aim of securing for the nation the most effective use both of its manpower and its material resources. That aim can be achieved only if the whole productive power of the nation is employed efficiently: it is not enough that it should be

employed"[25]

For the first postwar decade the state was the major supplier of housing and built an unprecedented number of subsidised dwellings. The War Cabinet Reconstruction Committee had pointed out in 1942 that:

> "It is certain that the country will expect an even more vigorous policy after this war... Every family who so desires should be able to live in a separate dwelling possessing all the amenities necessary to daily life in the fullest sense"[26]

It was recognised early that, in the light of the certainty of continuing rent controls and inflated postwar building costs, the state would have to assume responsibility for the bulk of working class housing supply. In the absence of a "prospect of a profit", private enterprise was not expected to rise to the task of building housing for rent. [27] By 1944 opinion polls were indicating that housing was popularly regarded as the most important issue [28] and in March 1945, the Government announced its target of 300,000 houses "built or building" within the first two postwar years. [29] Under conditions of strict controls on the building industry and the effective curtailment of private housing and commercial building this target was achieved. In 1950 the Cabinet stabilised the overall housing programme at 200,000 dwellings per annum. [30] The defeat of Labour in the 1951 election was not immediately accompanied by a lessened commitment on the part of the incoming Conservative Government to state housing. The new Minister of Housing and Local Government, Harold MacMillan, was as aware as any politician of the importance of ensuring a well-housed working population: "The People need more houses. They need them quickly. This is the most urgent of all social services. For the home is the basis of the family, just as the family is the basis of the nation". (1952) [31] As part of its election campaign, the Conservative Party promised to provide 300,000 houses a year by 1954. [32] This was achieved, largely by reducing space standards in council housing by over 10%, under the same system of controls over private building as had been imposed by Labour. Indeed, for the first eight postwar years private enterprise played a residual role in housing provision - it was not until 1952 that it produced more than 15% of overall housing completions; 1954 that it produced more than a quarter; and 1958 that it produced more than half. [Tab.I]

In 1954, the Conservative Government abolished controls over private housebuilding and restrained the output of local authorities. This was followed in 1955 by a revision of housing policy which moved away from general needs (the provision of state housing to supplement the existing stock) and concentrated on redevelopment (the replacement of sub-standard stock with new housing). The late-1950s saw a fall both in state subsidised and private housing completions. [33] The Conservative Party was firmly entrenched in political power and, while it had no intention of abolishing the Welfare State, was intent on restoring a greater degree of autonomy to the market place and restricting the increasing burden of social expenditure on the Exchequer. Nevertheless, local authority housing completions dipped below 100,000 in only three years during the Conservative parliamentary hegemony; 1959, 1961 and 1963. Thus, while there was no speech on housing at the 1961 Conservative Annual Conference its provision was still considered a necessary and appropriate activity of the state. [34]

The early 1960s saw a redirection of economic and social policies. Living standards were rising, but, in the opinion of many commentators and politicians, by comparison with the rest of the Western World, not fast enough. [35] A higher level of growth was demanded by the electorate and thought within the capacity of the nation's resources. Furthermore, increased growth was to be accompanied by greater welfare expenditure. 1961 saw the publication of Homes For Today and Tomorrow, the first major review of social housing design since the Second World War. The report pointed out that social housing was not keeping pace with the living standards of the population - greater space and more amenities were needed. [36] As well as promising higher standards, the Conservatives pledged higher numbers of houses. In May 1963 the housing target in future years was raised to 350,000. In the run up to the 1964 election the target was raised again, in December 1963, to 400,000. [37] According to D.V.Donnison, housing issues formed the focus of the 1964 election debate: "Government was being drawn ineluctably back into deeper involvement in the housing field". (1967) [38] In the event, so far as the electorate were concerned, the Labour Party provided the most convincing response to issues such as housing, but also to the larger problem of securing faster economic growth. In 1964 Harold Wilson was returned to power and his government immediately began preparing plans to secure this. The basis for Labour's expansionist policies was the National Plan, a document published in 1965 covering all areas of economic activity including housing provision. In view of the "vast and ever increasing need", the plan targeted housing - to be provided in tandem by state and private capital, at an unprecedented level of half a million completions by 1970. Under state supervision housing production was to rise to its highest ever. [39]

By the mid 1960s, welfare policy, in association with other aspects of expenditure, had made the state the major investor in the economy. Indeed, it has been suggested that the unusually high growth rate experienced by postwar Europe resulted largely from the consistently high demand created by its Welfare social policies. According to B.Ward, it is likely that Welfare policy "was a more important stabilizer of demand and stimulator of growth than monetary fiscal policy". [40] In 1960 government investment, including that of local authorities, amounted to 40% of the Gross National Product (G.N.P.). This state of affairs was not peculiar to Britain. E.Hobsbawm noted that at least 11 capitalist economies (including the United States) had government expenditures in excess of 25% of G.N.P., with some, such as Austria and France exceeding even Britain. [41] Just as it became the major investor in the economy, the British state also became the major customer of the building industry. In 1968, it bought 48.9% of the new work produced by the construction industry. [42] Approximately half of this investment was in the form of social housing. Indeed, the postwar period saw the forging of an intimate relationship between the state and the industry upon which its social policy goals rested. This newly found relationship between government and the building industry was signified in 1947 by the Ministry of Work's exhibition, 'The Builder and the State', held at Olympia in 1947. [43] As Geoffrey Rippon pointed out in 1963: "The social and economic progress of this country depends on an ever-increasing output from the building industry". [44]

The Welfare State created a new type of building market. The organisation of social housing investment was certainly different to the type of market which Donald Bishop described as having generated traditional approaches to building. By comparison, the social housing market was highly organised. Subsidised housing was commissioned on a large scale by centrally funded authorities, usually on the basis of nationally declared programmes which, as an element of government policy during the 1960s, were guaranteed for a number of years. Social housing was a highly specialised product, the spacial and amenity standards of which were established centrally. The degree of variation upon these was limited by ministerial loan sanctions and the tendency for local authorities to provide the minimum in order to increase the number of units produced at the least burden to the ratepayer. Furthermore, the production of social housing was not controlled by the consumer but by the makers of social housing policy. This immediately removed a layer of resistance to new technologies which threatened to undermine the traditional architectural character of housing, and created within social housing the freedom to exercise technical policies which would be unacceptable to the private market. Indeed, had local authority tennants possessed more control over the housing in which they lived, the development of postwar building technology might have developed on very different lines. It could certainly be suggested that some of the forms particularly suited to system building, such as high-rise, might never have been introduced in the first place had social housing design been controlled by the consumer. In comparison to private building, social housing was a more certain market, typified by the large scale purchase of standardised products, and very amenable to centralised policy making.

The considerable size of a large portion of individual state housing contracts played its own part in encouraging new technology and the type of builder able to utilise it. Furthermore, the tendency was for state housing contracts to grow in size throughout the post Second World War period. Between 1960 and 1968 the proportion of contracts for over 250 dwellings rose from 12.2 to 41.3% [45] encouraging the growth of the large building firm at the expense of small builders. In its Annual Report for 1967 - in which year the state sector accounted for 50% of building work - [46] the National Federation of Building Trades Employers (N.F.B.T.E.) noted the effect of state building on the industry:

"There is an increasing trend towards the concentration of the industry's work in the public sector. This creates problems for the medium and smaller firms in the industry which rely upon obtaining contracts of less value than those normally placed by government departments and local authorities. This problem... [is]... caused by the increasing trend towards larger orders"[47]

Between 1949 and 1960 the portion of the labour force employed by firms with between 6 and 19 operatives fell from 19.2% to 16.7% while the portion employed by firms with between 1,000 and 4,999 rose from 8.6% to 12.6%. [48] This trend continued throughout the 1960s with firms employing over 1,000 operatives increasing the value of work undertaken by 56%, and those employing between 6-10 increasing their value of work by only 35%. [49] While state building policy was not the sole cause of the growth of large building firms using technologically sophisticated methods, it undoubtedly played a contributory part. The size of state building programmes, and in particular, housing, encouraged the large building firm which in turn could apply technologically sophisticated methods to increasingly large contracts. As Industrialised Building Systems and Components (I.B.S.A.C.) noted in 1965:

"Public sector housing is without question the ideal market for industrialised building, meeting as it does all the basic requirements of large contracts and continuity of orders from land owning clients"[50]

To recapitulate, welfare building gave rise to important changes in the building process creating a market suited to investment in technologically sophisticated methods. The Welfare State created a new type of building customer, the "corporate or multiple client" [51] and a new type of building producer, the sponsor. Indeed this relationship between producer and client together with the technologies to which it gave rise is the sense in which system building is understood by this study. In Welfare building programmes the emphasis changed from commissioning a unique product tailored to a particular individual's need, to the purchase of large programmes of standardised building products in which the market preferences of the consumer could be subordinated to the demands of new production technology. To some, the investment in capital intensive, technologically sophisticated building methods on the part of producers seemed the most appropriate response to the postwar building market. In common with Marian Bowley, many contemporaries felt that time honoured methods of organising and carrying out the building process were no longer applicable to contemporary conditions:

> "changes in the character of consumers, have developed so far that the traditional organisation of the process of design and construction of new buildings has obviously become unsatisfactory" (1965)[52]

III. SCOPE AND METHODOLOGY.

As a result of the long upswing in the post World War Two world economy the period covered by this study was characterised by sustained full employment and periods of acute labour shortage. Between 1945 and 1970, unemployment in Britain stayed below 2.5%. [53] The effect of this, coupled with welfare building programmes was to cause labour shortages in the building industry. In Britain, for reasons which have yet to be accounted for, building wage rates remained low and job security and conditions of work inadequate compared with other industries. [54] Although the cheapness of British building labour was in itself no incentive to the introduction of new technology, it also meant that the ability of the industry to recruit labour was poor. The immediate postwar period found heavy building demands thrust upon an industry stripped of labour by conscription. Even after the building labour force had stabilised in the early 1950s, persistent labour shortages were experienced from then on and felt most acutely during periods when intense economic activity, and hence capital investment in building, coincided with peaks in social housing production. [55] As was often stated, the excess of building demand over building supply was a powerful stimulus to the use of system building in postwar social housing. [56] It is this theme which has dominated previous causal accounts of new technology.

Nevertheless, to base an explanation of system building purely on the demand for building created by the Welfare State, as historians such as R.B.White have done, [57] obscures the fact that Welfare policies caused significant changes in the character as well as the overall dimensions of a major portion of the building market. The supply and demand model does not account for the fact that system building was ever present in social housing - between 1947 and 1977, according to official figures, it remained above 14%. [Tab.II] Although not measured consistently, and undoubtedly less successful than after the Second World War, attempts to launch system building in welfare housing were also frequently made during the interwar period. [Tab.II] The supply and demand model does not adequately account for the fact that system building in the sense described earlier in this chapter was, to the knowledge of this study, exclusively the preserve of the state sector. Some of the less conspicuous and captial intensive techniques used by system building sponsors, such as timber frame, are used in contemporary house contruction by speculative developers. [Ch.VII] However, although generally referred to as 'system building', this is not in the form found in postwar social housing. In speculative housebuilding the sponsor and client are the same and the relationship between the two, crucial to the development of system building as understood by this study, does not exist. It is the contention of this study that just as the the state emerged the major consumer of building in the postwar period it also emerged the exclusive consumer of system building.

The fact that certain forms of new technology in British housing were closely related to the Welfare State is something which has received little consideration in previous accounts of system building. R.B.White notes the role of government experts, and implicity of the state, in the development of 20th Century building, but does not link this to the larger framework within which they operated.

[58] Marion Bowley was certainly aware of the search for forms of building which it was hoped might be more appropriate to the character of welfare building. Her study of the technical development of the British building industry, The British Building Industry: Four Studies in Response and Resistance to Change (1966), was directed to this larger aim. Nevertheless, while a text much referred to in this study, her central concern is with the detailed political economy of innovation, rather than the social context within which it took place. Both of these works were written in the thick of the 1960s debate on new technology by involved and "progressive" authors - White's study was published by the Building Research Station. Both of these authors' closeness to the subject is reflected in an, albeit restrained, enthusiasm for the subject. More recently, R.McCutcheon's unpublished thesis, 'Modern Construction Techniques in Low-income Housing Policy: The Case of Industrialised Building' (1979), presents a rounded study of system building and housing policy, and, as well as providing a great deal of statistical evidence, compares the British experience with that of other countries. [59] B.Russell's book, Prefabrication, Systems and Industrialisation (1982) is a more recent addition to the literature. Through its conceptualisation of building systems as an intellectual approach to building, Russell does not attempt a historical analysis of technological development in postwar Britain, but does provide a retrospective critique of system building philosophies by an author committed to system building himself. Although not

primarily historical, an invaluable survey of the condition of the system building industry in the late 1960s is given in B.L.Gosschalk's unpublished thesis 'Industrialised Building: Concrete Systems in Great Britain' (1970). [60] None of these studies address the nature of the relationship between systems and the Welfare State.

The period covered by this study spans 1942 to 1976. The former date was chosen as the starting point because not only was it the year in which the War Cabinet Reconstruction Committee began to consider postwar welfare provision in earnest, but because it was also the year in which the Interdepartmental Committee on House Construction was charged with the examination of new methods of building. [61] The end date was harder to choose. The pressures on welfare provision, and the beginnings of its decline started in the mid 1960s. It was in 1967 that the National Plan's target of half a million houses/annum was abandoned and the first fall in housing completions for ten years took place. [Tab.I] Throughout the late 1960s and early 1970s, government policy was dominated by the balance of payments deficit. Throughout the 1970s the condition of the British economy worsened. Public expenditure came under increasing pressure and as social housing programmes fell so did the proportion of them carried out by system building. [Tab.I&II] However, this does not necessarily mean that the concept of a Welfare State had been abandoned, but rather it was compromised by other priorities as government pursued the restraint of demand as a means of dealing with economic decline. 1975 was chosen for the end date of this study as it was the year in which Edward Heath was unseated as leader of the Conservative Party by Margaret Thatcher. The demise of Heath represented the end of 'consensus' politics, and although it was three years until Thatcher took office, this was the year in which the Welfare State was jetisoned by the party that currently holds parliamentary power. From 1979 onwards the stimulation of demand by government expenditure and positive economic management were replaced by monetarist polices designed to reduce the money supply and restore the 'free market' as regulator of economic activity. [62] In January 1985, the Institute of Housing announced that it expected the coming year's state housing starts to fall below 20,000 dwellings - for the first time a smaller programme than that of 1919. [63]

This brief examination of the Welfare State has described the conditions under which system building arose and flourished. However, it has not described in any detail the policies which lay behind the decisions leading to the adoption of system building by the individual parties involved in the social housing process. Nor has it described the detailed character which this form of building assumed, of the buildings it produced and of the way in which new building technologies and its products were viewed by those involved in their development. These issues will be dealt with in successive chapters. These chapters are organised thematically for it is the contention of this study that there was no single piece of legislation from which system building arose, no single act upon which it depended and no resolution towards which events were leading. Rather it is suggested that system building was stimulated by a form of social policy that lasted throughout a historical epoch. The thematic structure of this study is intended to allow the many facets of system building to be described without having their continuity broken by the disciplines of a strictly chronological narrative.

The three chapters forming the first part of the study examine the adjustment of the major participants in the social housing process to the peculiarities of demand created by social housing, and the policy decisions which led them to adopt system building. Chapter One examines government policy and describes the role of system building within the rapid provision of subsidised housing at the same time as ensuring the stability of the building economy in the post World War Two transitionary period. In latter years, it is argued, system building in social housing represented a means of increasing the efficiency of the building industry as part of the state's effort to secure more rapid growth of the economy. The chapter also examines the attempt of government to establish a new relationship with the building industry in the hope that it would invest in capital intensive methods of building. Chapter Two looks at the motives underlying the investment in system building by commerce and argues that for non-building firms it represented the means by which they could enter the social housing market in order to utilise excess manufacturing capacity. Chapter Two also examines the remarkable propensity of building firms to over-invest in new technologies and suggests that this resulted from both an unwarranted optimism in the certainty of ever-increasing volumes of social housing, and the hope that system building would be the means by which the larger contracting firms could increase their monopolisation of this newly enlarged market. Chapter Three proposes that, while many of the larger housing authorities adopted system building as the best means of executing large public housing programmes, a wider reluctance on the part of local government to substantially modify its housing policies led to the under-utilisation of available system building capacity to the frustration of government and industry.

The second part of the study looks at the role of building technology in architectural and political ideology and its impact on operatives and architects. Chapter Four examines the notion of mass producing buildings. While this does not provide a causal explanation of system building, it does explain the tendency of architects, and housing policy makers to proselitise system building as the panacea to the production of social housing and as a means of giving weight to the building technology policy described in Chapter One. Chapter Five looks at the two largest areas of labour in the building process, operatives and architects, and describes the adjustment of their corporate organisations to new technology. It is suggested that the weakness of organised building labour forced it to assume a passive role in the introduction of new technology. Furthermore, system building's association with welfare housing provision caused organised building labour to sanction new technologies despite their deskilling effects. Through the adoption of a postwar ideology of social responsibility, the architectural profession both adapted to system building and through its promotion, unlike labour, was able to raise its status in the postwar building economy. Chapter Six looks in some detail at the role played in building technology by the government expert. The government building expert eschewed a philosophy of public service through the promotion of new building methods. The chapter describes how, in pursuing this, the expert attempted to guide the development of system building in a direction incompatible with commercial interests.

The final two chapters look in detail at the products of system building themselves. Chapter Seven will look at the various forms of building technology used by system building sponsors and describe the factors which led to their success at distinct times in the postwar period. The chapter also describes developments in traditional building and explains why new building methods found it so difficult to displace old. Furthermore, it will be suggested that the cost advantage eventually claimed for system building might in fact have been illusory. Chapter Eight concludes by discussing the design of system built dwellings. Rather than arguing that system building produced a visibly different type of dwelling to traditional methods, the chapter examines the attitudes to system building held by those involved in their design. It suggests that a wide divergence of opinion existed between architects involved in social housing, and that the eventual architectural forms which system building took were determined less by the technology of system building production itself than the attitudes of designers to this.

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CHAPTER ONE. GOVERNMENT POLICY: THE MANAGEMENT OF RESOURCES

An examination of the policies that led to government attempts to promote new building technologies suggests that they were concerned less with increasing housing supply for its own sake than with the effect that such increases would have on the economy as a whole. This chapter will argue that the government promotion of new building technologies thoughout the post World War Two period was more the result of broad economic considerations than of a narrow focus on housing and other areas of construction policy.

I. POSTWAR STABILISATION.

In November 1942, the Ministry of Health (M.O.H.) presented a paper, 'Long Term Housing Policy', to the War Cabinet Official Committee on Postwar Internal Economic Problems. The paper noted that the likely demand for housing would place an unprecedented pressure on the building industry. It pointed out that after the First World War the building industry had slowly been built up, eventually achieving four million completions between 1919 and 1939. However, in order to meet the anticipated need for three to four million houses to be constructed in the first postwar decade, the M.O.H. argued that a rate of production double that of the interwar period would be necessary, imposing a considerable strain on the traditional building industry. As one measure to ease this, the paper informed the Committee that consideration was being given and would continue to be given to "alternative" methods of construction including the prefabrication of houses on a large scale: "If practical methods are evolved which result in houses being provided quickly and at a reasonable cost they will have to be adopted". [1]. Indeed, earlier that year the Interdepartmental Committee on House Construction (Burt Committee) had been set up to review the benefits of alternative methods of construction. [2] As yet no conclusions had been reached.

In May 1943, the Internal Economic Problems Committee presented the results of its deliberations on housing policy to the War Cabinet. Its memorandum, 'Post War Housing Policy', was particularly vehement about not repeating the mistake of the Addison housing programme of the post First World War transitionary period:

> "The worst of all possible courses would be to attempt with high subsidies to force through a programme of new construction immediately after the armistice in excess of the capacity of the industry: this would lead to higher prices and wages in the Building Industry which would not only tend to defeat the end in view but in its wider reactions might well upset the whole stabilisation policy"[3]

It added that a lack of attention to this problem might lead to the suspension of the housing programme "as in 1921". In March 1944, the Subcommittee on Post War Building reported to the War Cabinet Reconstruction Committee on its investigation into the post war demands on the building industry and its proposals for their restraint through administrative controls. These controls were intended to ensure that the demand on building would not outstrip the ability of the industry to produce economically. By these means, the potentially inflationary situation referred to in earlier papers was to be avoided. [4] Control was eventually achieved through two measures. The licensing of building through Defence Regulation 56A was renewed by means of the Supplies and Services (Transitional) Act, 1945, which between 1945 and 1949 imposed limits on unauthorized building that were so low that practically all building had to be sanctioned by government. The Control of Engagement Order ensured that up to 1948 building labour was directed in persuance of government policy, and the consumption of individual building materials was controlled until well into the early 1950s. [5] While writers have questioned the success with which these controls operated, [6] an essential component of the preparation of postwar housing policy was that the implementation of a substantial housing programme would be carried out within the limitations of available building resources - primarily labour.

However, while licensing could keep demand and building capacity in balance and direct resources towards housing, the rate at which the building industry could expand was finite. As the Committee on Reconstruction Problems noted, industries such as building "will have been so contracted as to be quite unable to meet demands immediately forthcoming". [7] The government was taking steps to increase the labour force to 1,250,000 [8] but it was acknowledged that this would take between three to four years during which housing demand would be intense and building labour and materials short.

This interval, dubbed the "emergency" period, began to occupy the thoughts of the Reconstrucion Committee during the latter part of 1943 and a much vaunted solution was the provision of temporary accommodation using methods which departed dramatically from conventional building practice. In May 1943, both the Reconstruction Priorities Committee and Committee on Internal Economic Problems both recommended recourse to this expedient. [9] However, the real impetus for what eventually became the Temporary Housing Programme came from the War Cabinet, and in particular the Prime Minister. In the War Cabinet meeting of the 24th February, 1944, Winston Churchill announced that he "envisaged a large programme for the provision of emergency houses, to be undertaken by exceptional methods" to meet the immediate demand for houses on the part of returning soldiers. Churchill's intention was to manufacture half a million such homes from steel, the whole operation being treated "as a military operation handled by the Government, with private industry harnessed to its service". [10] The object of the programme was to provide a large number of houses which could be constructed without inflating the demand on conventional building resources and so jeopardise the progress of permanent housing. This role for new technology was explained to Parliament by the Minister of Health in August 1944:

"We felt that it was of the first importance that this project should not delay the building of permanent houses, and, consequently, that it should make the minimum demand upon the building industry. That consideration pointed to a type of building so far as possible, factory made... whereas it is usually reckoned that it takes 100,000 building operatives to build 100,000 houses in a year, the building labour force required for 100,000 of these bungalows is not much more that 8,000 to 10,000"[11]

Churchill's ambitious hope of a half million temporary prefabricated dwellings was dashed in September 1944, when the committee he had set up to plan the implementation of the programme reported that little more than 150,000 of these dwellings could be provided without competing significantly for resources needed for permanent houses, and it was with this reduced target in mind that the programme was implemented. [12]

As Churchill had commented, the programme was indeed carried out on the lines of a military operation, subverting the principles established for the provision of state housing. During the interwar period this had developed on the lines that, although subsidised by the state, local authorities designed, built and owned the houses themselves. Under the 1944 Housing (Temporary) Accommodation Act, which authorised the expenditure of 150 million pounds, provision was made for the manufacture of temporary houses on government account. [13] The production authority for the houses was the Ministry of Works (M.O.W) and the centrality of this ministry to the programme was indicated by the type of contract into which it entered with the manufacturers which it described:

> "as a management contract - with the firm which put forward the particular type of temporary bungalow, and that there should be a series of supply contracts for the supply of materials, prefabricated parts and components, and a series of erection contracts, all with the Ministry of Works"[14]

Local authorities were not involved in the production or procurement of the dwelling and their responsibility was limited to making a bid for an allocation on the basis of their needs, obtaining the necessary sites and preparing the off site services and roads. [15] The instruction manual, which advised local authorities on layouts, maintenance, selection of tenants, rents, and management, clearly set out the terms on which they received their allocation:

> "the houses will be provided and owned by the Government... The authority will choose the tenants, fix and receive the rents, manage the property and keep it in repair. The authority will make an annual payment to the Ministry of Health of an amount to be determined"[16]

In September 1944, a new urgency was added to the preparations for post war housing with a memorandum to the Reconstruction Committee from the Home Secretary urging the rapid implementation of the "agreed broad policy" on housing provision for fear of the social unrest that might be caused by housing shortages in the immediate postwar years. [17] In the Committee's meeting of the 8th August the Minister for Reconstruction, Lord Woolton, announced that the destruction of 25,000 houses and the serious damage to a further million by flying bomb attacks had falsified earlier assumptions of housing demand:

"In these circumstances I propose to re-examine... the means of harnessing to the problem of providing living accommodation every form of construction, however unconventional"[18]

Among these he made particular reference to the experiments being carried out into permanent prefabricated housing by the M.O.W. which had indicated considerable economies in skilled building labour. The immediate tasks, he suggested, were to approve alternative designs and to ensure that manufacturing capacity for fittings and components would be "given priority second only to essential war production" in order to ensure their availability by the end of the war. As well as suggesting the setting up of a Housing Sub Committee Woolton concluded by stating that "Of all the problems facing us on the Home Front, housing is the most urgent and one of the most important from the point of view of future stability and public contentment". [19]

While it might wish to produce housing in large numbers, the adopted policy of keeping demand within the ability of the industry to supply led the government to increasingly focus on towards alternative methods of construction in the latter months of the war. Further reference was made to the M.O.W.'s experiments at Northolt in the second meeting of the newly convened Sub Committee on Housing, on the 18th September 1944, during which Woolton was impressed by the prefabricated house which "he understood... required about half the number of manhours required on a house built by traditional methods."[20]

In January 1945 the War Cabinet Housing Committee absorbed the functions of the Reconstruction Committee Sub Committee on Housing and discussions on the implementation of a permanent prefabricated housing programme started in earnest. In March 1945 Duncan Sandys, Minister of Works, presented his case for the maximum use of permanent prefabricated houses. He argued that as building labour would be the limiting factor in the construction of new houses during the two year emergency period it was essential that prefabrication was used: "there was no doubt that novel methods would enable substantial economies of building labour to be effected". [21] Although both the Minister of Health and the Minister of Labour and National Service questioned the advisability of departing from traditional methods - the former through a scepticism that local authorities would accept the houses and the latter through a fear of the detrimental effect that prefabrication would have on recruitment to the building industry - Sandys' persuasive arguments on labour savings carried the meeting which resolved that "the aim should be to secure that in the emergency period as high a proportion as practicable of permanent houses were erected by new methods using the minimum of building labour". [22] In September 1945, Sandys quantified the contribution that new technology would make to the maximisation of house completions in the "emergency" period. A memorandum, 'Programme for Housing', detailed the results of a planning enquiry undertaken by the M.O.W. into the resources of building labour expected to be available "with a view to suggesting... a target of construction of permanent houses with separate figures for traditional brick houses and non brick prefabricated houses". The combined total of half a million to be completed in June 1947, was comprised of 200,000 brick houses and 150,000 prefabricated houses, the remainder being made up of 150,000 temporary houses. However, delays in reaching a decision had reduced the anticipated completion of prefabricated houses by 30,000 with only a "small increase" in brick houses. Any further delays in the implementation of the programme of prefabricated houses would jeopardise its contribution to the overall programme and

> "would be open to the objection that owing to the greater call of the traditional brick houses for building labour there would be a reduction in the aggregate number of houses that might be erected"[23]

In the implementation of the prefabricated component of the housing programme, as had been the case in temporary housing, government played a central role by both ensuring producers of a market and subsidising the product. By 1945 a number of commercially sponsored non traditional housing systems were available and the Housing Sub Committee began to give consideration to the means by which the programme could be launched. On the 22nd January 1945, the Committee approved a recommendation by the Minister of Works that:

> "manufacturers should be assured of a sufficient demand for these [prefabricated houses] to warrant their embarking on large scale production. To the

extent necessary to secure this, government bulk orders or production agreements would be used"[24]

Indeed, for fear of prejudice on the part of the building industry and local authorities, the M.O.W. prepared legislation "for the manufacture of permanent prefabricated houses on Government account". [25] In May 1945 these proposals were approved by the War Cabinet and were made statute later in the year as the Building Materials and Housing Act, 1945, which made financial provision for the M.O.W. to purchase building materials and equipment, including complete prefabricated houses, sell these to local authorities, and where necessary erect them on their behalf.[26]

However, although these powers existed, the eventual means of implementation relied on less direct measures. In September 1945, the M.O.W. prepared its final paper on the implementation of the programme. The Minister recommended that local authorities should be notified of the various types on offer with an indication of the dates when deliveries could be made and that they should be asked to place orders. These enquiries would then allow an assessment to be made of the extent to which:

"bulk ordering of components or of complete houses should be undertaken, production agreements made in order to stimulate production in advance of firm demands... or central negotiations undertaken to fix the price of components... In some cases no action by the Government will be necessary, but wherever substantial factory production is involved, either of complete houses or of steel frames or other steel or concrete units, action by the government in one or other of the directions indicated above will probably be found to be desirable in order to secure proper organisation of production and distribution and economy in costs"[27]

In the discussion accompanying this paper the Minister of Works urged out that "the experimental stage should now be regarded as over" and the local authorities approached as soon as possible. [28] This was done in October 1946 when Circular 182/45 asked local authorities to place orders for the steel framed houses "on the assumption that the cost will be comparable with the present cost of houses of traditional construction". [29]

In certain cases the M.O.W. intervened directly in the production of houses. For instance, a guaranteed order was given to the British Iron and Steel Federation (B.I.S.F.) for the "large scale production" of houses of its design [30] (31,320 were eventually built). [Tab.IV] The government used its powers under the Building Materials and Housing Act to order 20,000 sets of precast concrete components for the Airey system which were supplied to local authorities at cost price and also purchased 5,000 Swedish Timber House Hulls for sale to local authorities. In the case of one system, the Howard house, the full extent of the powers was used. In June 1945, the M.O.W. placed an order for 3,000 Howard houses (only 1,303 were eventually built) and supervised delivery and erection. [31&TAB.III]

However, the greatest support that the state gave to prefabricated houses was the financial aid made under Section 17 of the Housing (Financial and Miscellaneous Provisions) Act of 1946 which until December 1947 offset any increased costs of prefabricated houses through the payment of an additional capital grant to local authorities. [HLG/58] The optimism of the M.O.W. that these houses should compare in cost with traditional houses, stated to the Cabinet as late as September 1945, was ill founded. The first report of the Girdwood Committee in 1948 set out the average capital grant paid on each of the houses. 15 of the 19 systems which entered substantial production in the immediate postwar years received subsidies. The largest of these, 708 pounds, was that given to the permanent aluminium bungalow, followed by the B.I.S.F. house, 244 pounds, and the Airey house, 175 pounds. Eight other systems received subsidies of more than 90 pounds. [32] Given that the average cost of a three bedroomed local authority dwelling was estimated by the same committee as costing 1,242 pounds, these subsidies were substantial and it seems unlikely that they would have been offered had not the exchequer felt that they were essential to the success of the progamme.

The need to increase housing supply through the utilisation of labour saving housing systems in the immediate postwar period should be seen in the light of the government's overall stabilisation policy. This expressly forbade the imposition of an inflationary level of demand on the building industry for fears of its potentially destabilising effect on the economy as a whole. Building controls fixed the level of demand to be placed on available resources and in the event of these being expected to be inadequate to meet planned housing targets, recourse to new technology was made. The degree to which the Cabinet both planned the use of new technology and intervened in its implementation can be compared to the post First World War transitionary period. In 1919 the government turned to new methods only when the effects of its refusal to control private building demand caused inflationary pressures to undermine the Addison housing programme. The unwillingness of the government to intervene in production and distribution and subsidise the additional costs ensured that this hastily conceived recourse met with limited success. Less than 20,000 non-traditional houses were built under the Addison Act. [33] In the latter years of the Second World War government prepared its plans early and made sure that they would meet with success. In 1948, 30.8% of the 168,971 local authority houses were produced in non traditional building systems, and this outcome must in large meaure be seen as the result of the government's postwar stabilisation policy. [Tab.II]

II. PRODUCTIVITY AND THE BUILDING INDUSTRY.

With the prospect of a heavy demand on the building industry in the post war period the government's first aim was to expand the labour force as rapidly as possible. In February 1943 the government published a Command Paper, Training for the Building Industry, setting out measures to ensure a rapid increase of the labour force from its 1945 level of

500,000 [34] to 1,250,000, which it felt would correspond to construction demands for 10 to 12 years after the war. [35] By the end of 1946 Rosenburg estimates that, with the exception of certain of the materials producing industries (bricks, tiles, pipes and fire clay goods), the building industry, now with 953,000 operatives, had regained approximately 80% of its labour force. [36] In 1950 the Minister of Works reported to Parliament that the load on the building industry had been steady for the past three years, and the building industry labour force constant at one million operatives. [37]

During the latter part of the 1940s there was little discussion of new building methods as a means of increasing housing supply. In April 1950, the Labour Cabinet resolved to stabilise the national housing programme at 200,000 completions a year for 1950 to 1952, thereby presenting the industry with the prospect of a demand well within its capacity. [38] This prospect was modified by the Conservative's election pledge of 300,000 annual housing completions by 1953. The implications of this dramatically increased housing programme were discussed in the Cabinet meeting of the 28th December 1951, when the Chancellor of the Exchequer, R.A.Butler, stated the three conditions on which he was prepared to countenance such a programme. As well as demanding that no more steel should be used in house building unless supplies became more plentiful and that softwood consumption be subject to a level to be set by the Cabinet he insisted "that the labour force engaged on house building should not be increased above its present level".

[39] This stipulation was agreed by the Cabinet. In March 1952 MacMillan announced to Parliament that he was encouraging building by non-traditional labour saving building methods amongst housing authorities generally, [40] and in 1952 the M.H.L.G. instructed its Regional Production Officers to increase the use of systems "in areas of good as well as bad... [building]... labour supply". [41] Rather than expanding the building labour force, government policy was now directed towards limiting it and labour saving housing systems had become seen as a means of assisting this.

The late 1940s and 1950s saw considerable discussion of the role of building as an activity within the economy and in particular the alarming fall in productivity. In 1944 the M.O.W. found that on its experimental housing site at Northolt the cost of traditional construction had risen by as much as 70% for labour and 60% for materials. [42] Much of this increase was accounted for by the rise in wages throughout the war, but also by the decline in the productivity of the labour force: "it was inevitable that although the fully trained worker regained his skill, the average level of skill was lower than that of pre-war days". [43] In 1948 the Committee of Inquiry into the Cost of House Building (Girdwood Committee) published its first report. It found that the postwar house was three and a quarter times more expensive than its prewar counterpart. Aside from improvements in specification, inflated materials costs and increases in overheads and profits, the report stated that a major portion of the increase was the product of higher labour costs:

"The decline in productivity in the building industry since 1939 led to an increase of some 45% in the number of hours required to build a house in 1947, and a resultant extra cost of about 150 pounds in the case of the typical three bed house. This increase is manhours is equivalent to a 31% decline in output"[44]

Excepting the bad weather of 1947, the shortage of materials and the overloading of the industry during the transitional period, the causes of lowered productivity were twofold in the committee's view: the deskilling effect of the war on the quality of labour; and a "lack of individual effort" occasioned by full employment. The less coercive nature of the labour market under conditions of full employment was noted by G.C.Allen, who in 1970 still found that "adequate substitutes had not yet been found for the pressures, harsh but effective, that had existed before the war". [45]

The absorption of the nation's resources by the construction of dwellings was the subject of discussion by the cabinet on two occasions in the postwar Labour administration. In July 1948, The Lord President's Committee considered the problem of increasing productivity within the industry, [46] and in April 1950 the Ad Hoc Cabinet Committee on Future Policy Towards the Building Industry stated that "the economic future is largely dependent upon the ability of such a large and important industry to achieve a really high standard of efficiency and to reduce its costs". [47] The perceived lowering of productivity within the building industry brought forth two responses. On the one hand fierce criticisms of the British building worker were made, in particular by the Rt Hon. G.P.Stevens who, in 1950, berated those building workers who were not "pulling their weight... and are therefore depriving us of that marginal productivity which would not only build more houses, but would cheapen houses". [48] The second reaction was the retention by employers of the payment by results scheme introduced in 1941 under the Essential Work (Building and Civil Engineering) Order. [49] The extent to which the scheme operated and its contribution to lower labour costs is difficult to measure. In 1959 the M.O.W. acknowledged that less than half the labour force was working to payment by results. [50]

Despite the frequency with which government and industry was reminded that efficient building was essential to national economic performance, [51&52] the productivity of the building industry improved only slowly. In 1952 the third report of the Girdwood Committee found that little more than one hundred hours had been saved in the labour required to construct a house between 1949 and 1951. Productivity was still 20% below the prewar figure. [53] In its sympathetic review of the building industry of 1954 the British Productivity Council admitted that progressive techniques such as preplanning, standardisation and teamwork were "beginning" to be adopted by progressive sections of the industry but for true progress these needed to be widely imitated. [54]

While there was a general awareness that the industry's low productivity was potentially harmful to the economy, state intervention to rectify this problem during the 1950s, in terms of the promotion of investment in labour saving building systems, was minimal. Under Conservative housing policies of the mid and late 1950s housing programmes fell and no longer exerted the intensity of pressure on the building industry that they had in the immediate postwar period and in the early 1950s. While concerned with building efficiency, the need to take action was not pressed upon government - it could afford to take a less direct interest in the way in which dwellings were made. Furthermore, the bulk of production gradually reverted to private producers and the established postwar avenue of intervention in housing production methods - system building in association with large social housing programmes - was no longer present on the scale of the late 1940s and early 1950s. [Tab.I]

When the state did start to promote technical change within the building industry in the early 1960s, it seems to have done so for two reasons: an awareness that labour shortages within the industry would hamper the expansion of building programmes and a dramatic shift in the government's whole economic policy. Anxiety about the shortages of labour and bricks first appeared in the Report of the Ministry of Housing and Government 1961 which noted the effect of labour shortages on house construction over the year: "this disappointing turn-out was the result of a further slowing in the pace of construction, due mainly to the shortage of craftsmen", [55] although it also commented that the situation had eased with government economic restraints imposed later in the year. The value of new building work that the industry had carried out had risen in money terms by 42% between 1955 and 1962 [56] and it had become apparent that the increases in building output associated with the high rates of postwar economic growth and welfare expenditure were straining the capacity of the construction industry.

The second factor was the change in government policy in favour of planning as a means of achieving increased economic growth. R.Opie cites four reasons for this shift in emphasis away from the stop-go policies of restraint favoured during the 1950s towards economic planning: firstly, a popular interpretation of the French "economic miracle" as the outcome of the planning policies exercised by the French state; secondly, a growing preoccupation with the discipline of planning amongst the managerial establishment of British industry and government; thirdly, a shift in this direction amongst the leaders of the major political parties; and fourthly, the balance of payments crisis in the summer of 1961, the outcome of which was yet another stringent and disruptive economic squeeze exercised through a rise in the bank rate and public expenditure cuts: "It seemed obvious that there must be a better way of managing the economy than this. One such way, it seemed to many, was to plan the growth of the UK economy". [57] This new policy was described to the Commons in July 1961, by Selwyn Lloyd, the Conservative Chancellor of the Exchequer who outlined the principles of what became known as "indicative planning":

"I envisage a joint examination of the economic prospects of the country stretching five or more years into the future. It would cover the growth of national production and distribution of our resources between the main uses... and would try to establish what are the essential conditions for realising potential growth"[58]

The outcome of this proposal for the joint examination of the economy was the National Economic Development Council (N.E.D.C.). [59] The Council, comprising representatives from government, industry and organised labour, was formally constituted in March 1962 and began to "consider together what are the obstacles to quicker growth, what can be done to improve efficiency, and whether the best use is being made of our resources", [60] with the intention of increasing "the rate of sound growth". In February 1963 the N.E.D.C. authorised the publication of the Growth of the UK Economy to 1966 which set out optimised forecasts of growth and the conditions that would have to be met for their fulfillment by individual industries. A general factor within this growth was the contribution of technical change:

"A key factor in achieving a 4% growth rate will be the degree to which new investment embodies the results of up-to-date technical advance. Its effects will be seen both in improvement in the product and in a reduction in man-hours, materials, space, machine time, and fuel and power per unit of ouput"[61]

In the section on construction the report saw manpower as the major problem inhibiting the anticipated rapid rise in output. To achieve this an increased rate of recruitment was necessary allied to a faster rise in productivity through increased investment in technologically sophisticated building methods. The Paper urged that increased building output could only happen "if the... [technological]... changes under way proceed at a faster rate than in the past". [62] These changes included those being promoted by the M.O.W. in persuance of the findings of the 1962 Emmerson report into the obstacles to improved efficiency in building. These included greater co-operation between clients and producers, new contracting procedures and the rapid acceptance of standardisation and promotion of new building technlogy. [63]

Concern for the future performance of the building industry was not confined to the effect which poor performance might have on the production of buildings, but to a wider concern at the distribution of real resources, primarily labour, within the economy and the effect on overall growth that the building industry was seen to exert. In September 1963, the Minister of Works, Geoffrey Rippon, pointed out that the nation's workers were "our most precious national asset" and one which must be "fairly shared among all our activities". [64] Later in the year the Government White Paper, A National Building Agency pointed out that construction demands would rise by 50% in the next decade and stated that "This will have to be done without any great increase in the demand on the Nation's limited labour resources". [65] The solution, the Paper continued, was higher productivity, which would be gained through the "industrialisation" of the industry's methods, in particular by investment in labour saving system building techniques for housing. In 1964 the N.E.D.C. published its report The Construction Industry which, looking in detail at the role of building within the economy, forecast a regressive effect on the economy as a whole were demand to exceed the capacity of the industry to produce:

> "Looked at in the light of its ability to meet the level of demand forcast for the years ahead to 1966, it is clear that drastic changes will have to be made... What is clear is that there is no certainty, in present conditions, that the industry will be able to meet the demands upon it. And the possibility cannot be ruled out that by falling short it may hold back the expansion of the economy as a whole"[66]

Commenting more directly on building systems the report acknowledged that current experiments provided "little conclusive quantitive evidence on their advantages", but in view of the labour shortage in general "the reason why increased industrialisation is essential for the construction industry is the saving of labour and the replacement of scarce skills by other skills". [67]

1964 saw the return of the Labour Party to power for the first time since 1951. One of the first tasks to which the new government addressed itself was the establishment of the Department of Economic Affairs (D.E.A.), on the 26th October 1964. This new government department, described by its head, George Brown, as "the greatest contribution of the Labour Party to the recasting of the machinery of government to meet the needs of the twentieth century", [68] published its plan for the growth of the British economy, The National Plan, in September 1965. [69] While proposing a rate of growth in the gross national product of less than the N.E.D.C. plan of 1963 (3.8% per annum until 1970 as opposed to 4%) this, according to J.A.Hackett, was nevertheless an ambitious target, bearing in mind the constrained labour market, and relied heavily on increasing the efficiency of British industries. [70] According to the National Plan a 4.6% increase in the output of the economy was to be achieved with a 0.9% rise in employment. With the exception of mining and quarrying the Plan cited building as having, in 1964, less fixed capital investment relative to output than any other industry. The 1960-4 period had seen capital investment by the industry rise at the sixth highest rate in comparison to other industries. However, Labour's plans for the economy envisaged an annual rate of increase in capital investment on the part of the building industry second to no other. [71] The main form which increased capital investment in building was to take was system building applied to housing. In the section on housing the plan proposed an annual house building programme of half a million dwellings by 1970. The role of industrialised building systems within such a programme was clearly stated:

> 'with large scale production of a few selected systems, houses built by industrialised systems should become competitive in cost and in design with those built by traditional methods. The number of industrialised dwellings in tenders approved is likely to be 38,000 in 1965 rising to about 100,000 in 1970.

The use of industrialised systems should enable the larger building programme envisaged to be carried out with a relatively small addition to the labour force"[72]

By the mid 1960s it had become apparent that the sources of new labour upon which the construction industry had previously drawn were becoming increasingly restricted. By 1965 the prospects for securing a further growth of the building labour force were declining. In 1965 the Ministry of Labour's Manpower Studies No.3: The Construciton Industry, referred to the 12% rise in the number of males in employment in the industry since 1959, and predicted that such a rate could not continue for the next five year period:

"Towards the end of the period the numbers of young persons entering employment will decline: construction may not continue to receive a net gain through transfers between it and other industries and it may be that in the future the industry will gain fewer workers than in the past through migration"[73]

Associated with this, what new workers there were were expected to be absorbed by the enlarged stock of existing buildings to be repaired and maintained. This area of building work, which absorbed up to 40% of the construction labour force, became a major source of concern. In March 1965, P.A.Stone drew attention to the effect of this on the building economy as a whole: "there seems to be little doubt that expenditure on maintenance work will rise in the future...if the relative efficiency of this work does decline... [which he suggested was inevitable due to the inherent difficulty of effecting technological change in this area]... other things being equal, a growing proportion of labour will need to be devoted to it". [74] In June 1966 the Director of the National Building Agency, A.W.Cleeve Barr, forecasted that the labour force engaged on new building might actually decline in future years. [75]

Nevertheless, the government's concern to improve productivity within building was not primarily a response to envisaged building labour shortages. Indeed, from 1966 onwards it pursued a policy of actively hindering recruitment to building. In 1966 the Labour Government introduced Selective Employment Tax (S.E.T.) which was designed to constrain the building workforce in order to prevent construction from taking labour away from manufacturing industry. In 1965 C.A.R.Crosland described the need for a labour market policy designed to have a redistributive effect on employment in different sectors of industry:

> "It follows that unless we can make the fullest and most efficient use of the manpower available, and ensure that its distribution between industries makes the maximum contribution to growth, the shortage of labour will be more severe... it is clear that the Government will have to pursue an active and vigorous labour market policy"[76]

The following year the Chancellor of the Exchequer announced his proposals for a Selective Employment Tax as part of the Budget Statement. Lamenting that between June 1960 and June

1965 employment in service industries had risen by one million while in manufacturing it had only risen by 142,000 he proposed a system of taxation which would raise the costs of labour within certain industries. The distinction was made between service industries, which would be penalised, and manufacturing industry, which would not. Indeed, certain of the latter would receive a premium paid for from the taxes of the others. The anomaly to the broad classification of "service" and "non-service" industry was building which was also to be taxed "in the same way as services so as to encourage the industry to scrutinise its use of labour more closely". Co-incidentally, the pill was sweetened by bringing the industry within the government's investment grants scheme "thus encouraging it to make use of more up to date equipment". [77] The effect of this tax levied on site labour, but not off-site construction labour (such as that working in system building component manufacturing plants), added, according to the National Builder, 80 million pounds per year to the cost of building, raising the cost of a traditional home by 70 pounds [78] and in 1969 costing six pounds "to get an operative on site before he even does a stroke of work". [79] The degree to which this measure increased productivity within building cannot be established (although P.Hillibrandt cites it as a contributory factor [80]). However, it does indicate clearly the government's intention to contract the building labour force in the face of competing demands from manufacturing industry.

The government's desire to restrict recruitment of labour to the building industry extended beyond the boom in construction output of the mid 1960s. Demands that the government should address its policies to relieve the 10.2% unemployment within the industry, in February 1970, were rebuffed in the following terms by the Parliamentary Secretary to the Minister of Public Buildings and Works: "with increased productivity, redeployment in the industry can often be difficult... The industry will need a highly skilled and compact labour force, well abreast of new techniques". [81] Indeed, it was not until 1978 that the Secretary of State for the Environment, Peter Shore stated that:

> "My major concern... is with the efficiency of the construction industry... it is also with maintaining as high a level of employment in the industry as we possibly can. We shall always be prepared to consider measures which promote these ends"[82]

By this time 15% of jobs under job creation schemes were in building. [83] In contrast to the building policy of previous years, government was by this time seeking to increase employment in construction rather than reduce it. The wheel had turned full circle.

III. THE STATE AND INDUSTRY IN PARTNERSHIP

The previous section argued that industrialised building systems were a recognised part of government economic policy both during the early 1950s and more dramatically during the 1960s. This section will examine the degree to which the government implemented that policy in terms of the active encouragement of new building technology. During the transitional period (1945-47) the promotion of systems for housing relied heavily on direct government intervention, which in the case of the Temporary Housing Programme, and a number of the permanent prefabricated houses, resulted in the government assuming direct responsibility for manufacture and distribution. Furthermore, the government, by offsetting any costs above traditional construction, assured sponsors of a market. However, during the 1960s, government intervention operated in a very different way. Industrialised building policy was not implemented through fiscal provision, nor direct intervention in production. Rather, a new type of relationship with the building industry was developed by the government which, during the 1960s, did its best to modify state housing policy in a way which suited the sponsors of capital intensive building systems. An important aspect of government policy, the coercion of local authorities, is discussed in Chapter Three.

The desire for government to promote policies favourable to system building sponsors can be observed as early as 1948 when the M.O.H. was debating what position to adopt now that the 1946 Act subsidies no longer applied. Circular 6/48 noted that a number of systems, through the facilities offered during the past two years, had developed on economic lines to a point whereby they could compete with traditional construction. As these promised to form a supplement to traditional resources a policy was advised to enable sponsors "to plan their production ahead on the basis of estimates of the probable demand". Local Authorities were therefore advised to give early intimation to the M.O.H. of the systems they wished to use and their numbers in advance of the approval of their overall housing programme: "The information supplied in this way would then be collated and transmitted to the firms concerned". [84]

When, in January 1952, the Ministry of Housing and Local Government (M.H.L.G.) again considered the means of expanding non-traditional housing production, the course of action adopted included an extensive series of interviews with producers. They were asked to state "their maximum possible expansion", and where they would find it easiest to build. [85] Government enthusiasm to assist producers in the production of non-traditional houses even prompted it to approach the single largest building firm without a system, Costains, with a suggestion that they should introduce one and build a factory in the Stoke-on-Trent area "to build - say 50% of the miner's houses... Mr Costain felt they might well do that if they had some assurance of, say, two years output being taken up and they've now gone away to think about this". [86] Costain's response to this overture seems to have been favourable for, in December 1953, the firm was erecting 1,000 dwellings for the Coal Industry Housing Association in the West Midlands, having adopted the Swiss Schindler Goehner system. [87]

Further active intervention by the government in housing technology followed the economic planning revolution of the early 1960s and in particular the publication of the Emmerson Report, commissioned in Autumn 1961 and published the following year. [88] This report, in the words of the Ministry of Public Buildings and Works' (M.P.B.W.) representative at the United Nations 1965 conference on industrialised building, was "the starting point of a major change of policy". [89] The central message of the report was that there was no specific remedy to the malaise of the industry, rather the need was for a new sort of relationship between it and its major client:

> "the government needs to exercise a more powerful influence on the general efficiency of the industry. This is not a question of imposing controls, but simply of creating a new relationship between government departments and the industries, and of trying to establish conditions in which all of those engaged in construction can themselves increase their efficiency"[90]

Some of the measures by which the state could encourage the introduction of new technology anticipated the Emmerson report. In June 1961, Keith Joseph, Parliamentary Secretary to the Minister of Housing and Local Government, announced the replacement of the building bye-laws by a national system of building regulations in the 1961 Public Health Act, which superseded the 1933 Act. The bye-laws, he maintained, acted as an inhibiting factor on new techniques: "Even if the developer of a new technique may persuade my Right Hon. friend to vary his model bye-laws, it may be years before all the 1,400 local authorities are equally persuaded" [91] The influence of bye-laws on system building had been noted in 1946 when local authorities were informed that those which inhibited the use of non traditional housing were to be waived by the Minister of Health. [92] In reporting on the principles to be adopted for a revised system of national building regulations, in 1964, the Building Regulations Advisory Committee advocated a system of requirements which did not prescribe new techniques but "should be tailored to the circumstances - the state of design practice, the level of technology... and the economic importance of preserving flexibility or an incentive to new methods". [93] Commenting on the imminent introduction of the new regulations later in 1964, Geoffrey Rippon, Minister of Public Buildings and Works, described them as making "it possible to approve once and for all for use anywhere in England and Wales a new building method or design". [94]

A further inhibiting factor on new technology, and one which had been a source of contention within the building industry prior to Emmerson's report, was the government's tendency to make public building, and housing programmes in particular, subject to short term economic policy. Between 1945 and the end of licensing in 1954 programmes were approved on an annual basis. After licensing was abolished in 1954 local authorities were free to build as many houses as they wished within the subsidy system but the economic crisis of 1957 prompted the government to return to the requirement that yearly programmes were once again subject to ministerial approval. [95] The effects of such a policy were that, on the one hand, programmes were, at the most, determined only one year in advance, and further, that they were always subject to cuts imposed as a result of government economic policy. The stop-go policy exercised by the government in the late 1950s caused a series of credit squeezes which imposed drastic cuts on public building programmes. [96&97] The outcome of such policies was to create uncertainty within the industry which, in the absence of stable and foreseeable demand, produced a general reluctance to invest in technologies which might take years of full utilisation to provide an adequate return on the capital expended. [98]

Following the mini budget of 1961, the N.F.B.T.E. met the Minister of Works to express concern at the loss of confidence occasioned by the latest credit squeeze, and when the Federation met Emmerson, in the course of preparing his report, they again emphasised the detrimental effects of short term economic planning on the industry. [99] This view was to form a significant part of Emmerson's report

> "No industry can be fully efficient when there are alternating spells of overloading and under-employment... There is real substance in the view that greater efficiency will result if the Government can adopt as a main feature in its policies a steady and expanding construction programme"[100]

As we have seen, one of the crucial elements of the economic planning revolution of the early 1960s was the replacement of short term policies of restraint by planned steady growth. This was the central impetus behind the creation of the N.E.D.C. in 1962 and the Department of Economic Affairs in 1964. In a speech to the National Federation of Building Trades Employers, in August 1962, the Minister of Works extended this philosophy to the building industry: "the main task is to increase the application to building of large scale industrial organisation. What the government can do is help by securing a balanced long term construction programme". [101] This help was to take the form of assurances of steady growth in overall building programmes and also in the approvals policy of the M.H.L.G.. Later in the year the Minister of Housing and Local Government announced to the Conservative Annual Conference that following discussions with local authorities during the course of the year he was about to "agree firm forward programmes for several years ahead". [102] By May 1963 the M.H.L.G. reported that it was encouraging authorities with large housing programmes to plan their housing five years in advance in order to allow them to "let big forward programmes", [103] and had even given approval for a four to six year programme by the northern authorities faced with large building programmes. [104] The most definite advice on this initiative came in Circular 21/65 when the local authorities were instructed to submit, to the Ministry, housing programme forecasts for the years 1965 to 1968 inclusive, after which "it is intended to repeat this request for four year programmes each year". [105] In 1965 the M.H.L.G. guaranteed the four year programme of the 34 London authorities, which together produced 20% of overall housing output and in 1966 this system was extended to cover another 106, with the effect that 60% of the state housing programme was guaranteed for four years ahead. [106] While the direct impact that such measures had on the proliferation of systems cannot be measured, there is no doubt that such a policy promised a secure market in social housing, for producers wishing to invest in sophisticated production techniques. At the least it must have alleviated the concerns expressed by the industry to Emmerson in 1962.

Shortly after the Emmerson Report, the M.O.W. was reorganised and given a new mame, the Ministry of Public Buildings and Works (M.P.B.W.). One of the first points Emmerson had made was that "there is a vast store of experience within the works directorates of Government Departments, particularly those responsible for direct government building". In particular Emmerson recommended that greater publicity should be given to the specialist development groups in government departments working on new technologies, the lessons of whose work, he felt, needed to be more widely known. [Ch.VI] One of the larger aims of the reorganisation of the M.O.W., in which all the government building departments were eventually brought within the one ministry, was to provide an example to the building industry by demonstrating the benefits of modern technology and practice. This policy was described by Rippon himself:

> "I am not going to spend my time exhorting the construction industries to accept the best modern practices and techniques. Now that my ministry is responsible for almost the whole of the Government's direct building programme, I intend to give a lead which will set the pace in new methods of contracting, site management, and development. It is my purpose that the results of Government action will serve as a

practical guide to all engaged in the construction industries and that any benefit which may flow from research and development in the public sector will be available to every builder"[107]

From this policy flowed a stream of advice to the building industry, in the form of analytical studies and information resulting from practical building projects - in particular the extensive barrack rebuilding programme which was undertaken during the 1960s almost entirely through industrialised building systems.

One area in which government offered advice both to building firms and local authorities was in new methods of contracting. As Emmerson pointed out, there had been no official examination of contracting methods in public housing programmes since the Simon Committee report of 1944. [108] Emmerson's opinion was that such a review was long ovrdue and that new contracting methods, by securing a closer relationship between building design and methods of construction, might do much to improve technical efficiency in building. [109] This suggestion was taken up in the appointment of a Committee headed by Harold Banwell, in 1962, which reported on <u>The Placing and Management of Contracts for Building and Civil Engineering</u> in 1964. In particular the Committee recommended the wider adoption of the negotiated contract which introduced the contractor at an early stage in the design process, thereby incorporating system building methods into the design process. Serial tendering, in which a number of contracts were awarded to one contractor was also advised to aid the introduction of new technology. [110] The M.O.W. itself published reports of its own experiments on new techniques advising public sector clients on the methods of selecting contractors most suited to system building. [111] Specific advice urging local authorities to adopt new contracting methods was given twice by the M.H.L.G. in official circulars; once in 1965, as part of its industrialised building drive, [112] and again in 1967. [113]

A further element of government policy designed to create a social housing market suited to new building technology was the extension and promotion of the consortia movement to housing authorities. Consortia, the amalgamation of local authorities to form larger purchasing organisations originated in educational building during the mid 1950s. [Ch.V] By combining their building programmes, local authorities were able to provide a market large enough to enable them to design and operate their own systems. However, another feature of consortia was that the smaller housing authorities, who by themselves presented insufficiently large programmes to utilise system building economically, could, through combination, provide much larger programmes. This feature was of considerable attraction to the government and, although it did not originate them, the M.H.L.G. and the N.B.A. were very active in promoting consortia. Indeed, in October 1963, Keith Joseph announced consortia to be the panacea to promoting system building in social housing: "The secret is to group authorities into consortia so that they can place orders large enough to make invesment in labour saving systems economical". [114] Government promotion of consortia was noted both by <u>The Builder</u> magazine [115] and the <u>Economist</u> which noted that:

> "On the wall of Dave Embling's office at the housing ministry is a map of Britain with the housing authorities coloured in many shades. It is his progress chart on the job of talking them into consortia"[116]

By 1965 Embling was able to announce that the past 18 months had seen the grouping of over 200 authorities into 22 consortia, and although, as Chapter Three describes, consortia were not the panacea that was envisaged, this aspect of government policy played its part in the promotion of new technology in social housing.

Perhaps the most conspicuous result of Emmerson's plea for a new relationship between government and industry was the creation of the National Building Agency (N.B.A.). While much of Emmerson's report emphasised the need to modify existing channels of communication between state departments and the industry, or the reinforcement and extension of processes already underway, one suggestion was that for a new type of agency "a focal point where those matters which are common to all forms of building can be brought under examination and discussed". [117] In May 1963, Geoffrey Rippon indicated the lines upon which government thought on this matter was developing:

> "What is needed is a method of bringing together the building requirements of a large number of public agencies and even private building owners so that they

may be collated into programmes for industrialised building extending to one, two or even three years ahead... One possibility would be the establishment of clearing houses of some sort for building orders which would also give advice to prospective clients about the potentialities of industrialised building"[118]

In December the government published its White Paper on the subject, A National Building Agency, which proposed a new quango which would provide the advice and information necessary to allow building clients to make use of the latest developments in building technology:

"Most clients, public and private also, need help in the choice and use of industrialised building methods. Those local authorities which lack whole-time highly qualified professional staffs cannot be expected to evaluate and employ the new methods unless they have access to expert objective advice... A new source of independent advice drawn from the available pool of specialised professional expertise appears to be essential"[119]

The services which the Agency offered were many and various but were all related to the purpose of assisting clients to modify their building policies and procedures in order to facilitate the use of new technology, and in particular, system building. The Agency's services included: assistance to clients to group their building requirements together and collate them into phased programmes (on the consortia principle); advice to clients on administrative procedures and the necessary professional services in order that they may use new technologies and, if necessary, supply a full design and planning service; advice on the suitability of individual methods of building; assistance to clients to form "sound working relationships" with the firms who control the individual systems; the encouragement of training in the use of new techniques; the appraisal and approval of specific systems for local authority use; and advice to contractors and manufacturers of systems on the best way to pursue their development. The actual form that the Agency was to take was, in line with current thought, "a partnership" between the government, clients and the building industry, through the form of a limited company, governed by a board of directors appointed by the M.P.B.W.. The intention was that the Agency should be staffed by highly trained experts transferred to the agency for a limited period subsequently resuming their normal work, "in this way increasing numbers of professional officers could gain knowledge of the new techniques". [120] Initially the Agency was to be funded by a government grant, although the eventual aim was that it should fund part of its income through fees charged for its services.

Two years after its creation, in 1964, I.B.S.A.C. carried out a profile of the N.B.A. and found:

> "three well organised divisions - administrative, architectural and operational - with multiprofessional teams serving local authorities and a wide variety of other building clients, a consultancy service, close links with government departments and professional and trade associations, a first class library and

information centre, a London headquarters housed in a new office block, regional offices in Edinburgh, Newcastle and Manchester"[121]

In 1968 the M.P.B.W. reported that the Agency employed 208 staff engaged, in the words of D.Turin, in stimulating "a rationalised market for industrialised products". [122] In 1967 the N.B.A. received 157,772 pounds in fees and expended 704,110 pounds, the balance being made up by public funds. [123] In November Official Architecture reported that the original intention of securing a high turnover of staff had succeeded and that the Agency was engaged in a number of demonstration projects; developing brick construction techniques for Crawley New Town, providing design services for a 1,750 dwelling development in Sunderland, developing the Surebuilt system for a 316 dwelling scheme for Harlow New Town, and developing three systems on a housing estate at Glenrothes. [124] Published information on the number of interventions that the N.B.A. made into the building programmes of local authorities are not available, however, in 1965 it was called in by Liverpool to review its ailing housing programme and advised the clearance of larger sites in order to extend the use of industrialised systems, advice which was duly heeded by the Council. [125]

By the time that the Labour Government replaced that of the Conservatives in 1964, the essential groundwork for the boom in industrialised building techniques that took place between 1965 and 1969 had been laid. [TAB.II] Reporting on the impending growth of system housing The Economist commented in May 1965, that:

"We are on the verge of a great explosion in the use of these methods. But if Mr Crossman will be able to say that he set it off, he ought also to recognise that the laying of the powder and the trailing of the fuses was the energetic work of two Tory ministers fortunate in their civil servants: Mr Geoffrey Rippon and Sir Keith Joseph"(1964)[126]

By this time the industry was marketing 400 building systems and had carried out the investment necessary to fulfill the Labour pledge of half a million housing completions by 1970. The unleasing of capital already invested was emphasised by Crossman in the Cabinet discussions leading up to the implementation of the enlarged programme:

"I had also stressed that the whole increase in the housing programme could be put through by expanding our industrialised building. This would not put a strain on our resources but simply employ unused capital resources in which millions had been invested, and production could now take place"[127]

Crossman's drive began in earnest in April 1965, with the distribution of Circular 21/65 which instructed local authorities to begin planning their housing programmes with particular reference to the use of industrialised building. [128] Seven months later this was followed by Circular 76/65. The first part of this second circular dwelt on the advantages that would accrue to local authorities if they utilised new technologies in terms of larger, faster and, even, qualitatively better programmes, while the second outlined the procedure to be adopted for the immediate drive "aimed at giving the industrialised building programme the best possible conditions to get on its feet". [129] The larger local authorities, on whom the drive was to be concentrated, were required to discuss their proposed programmes with the Ministry's regional officers who would then be able to assess the magnitude of the industrialised component, the individual sites to be used, the density range, the general form of development and the family sizes to be housed. The N.B.A. would then make its contribution by recommending the systems most suited to the programme, and ensuring "a satisfactory flow of work" for each of these. In order to allay any doubts that authorities might have, the N.B.A. was also to issue appraisal certificates for systems "considered by them to be suitable for local authority use". A further measure adopted by the Ministry was the negotiation with sponsors of national prices for a range of systems so as to allow local authorities to select a scheme "in the confidence that the resulting contract sum is likely to be acceptable for loan sanction when application is made to the ministry". [130] This gave local authorities and producers a degree of certainty denied to the purveyors of traditional building technology.

The new relationship between government and industry was undoubtedly cemented by informal contacts between industry and government officials and politicians. A.Friend provides a list of high level politicians with interests in system building companies which included Keith Joseph (Bovis), Reginald Maudling (Open Systems Building), Geoffrey

Rippon (Cubitts Construction Systems). [131] R.McCutcheon adds the Permanent Secretary to the M.H.L.G., Dame Evelyn Sharp, to this. [132] However, the view that the sectional interests of a particular class of capital played a significant part in the development of policy towards new building technology implies a more passive position on the part of government than was the case. If anything, the initiative was taken by the state which took considerable interest in guiding the industry. In 1962 the M.H.L.G. convened a meeting to which it invited 60 to 70 representatives of the largest building firms, and by July 1964 had held over 700 interviews with various contractors during which it discussed its building policies. [133] It was a department of government that appointed an ex director of W.M.Thorntons, T.V.Prosser, as the first Chair of the N.B.A. [134] and Crossman who consumated the new relationship between the government and industry by persuading Peter Lederer, a director of Costains to Join his ministry and be responsible "for pushing and shoving and getting industrialised building off the launching pad". [135] When Crossman met Maurice Laing, McAlpine and others at "the club" in December 1964, he found them apprehensive rather than bullish about the prospects for system building. This apprehension was founded on a suspicion that the stated intention of the government to secure steady and expanding housing programmes would not be carried through, a suspicion later acknowledged by Crossman to have been well founded. [136]

IV.

The view that central government played a significant part in the development of local authority housing policy during the postwar period is not shared by all. J.B.Cullingworth describes the M.H.L.G.'s role in policy formulation as "remarkably weak". [137] The absence of fiscal subsidies during the 1960s, such as were offered during the post World War Two transitional period, does not necessarily diminish the role of government policy as a potent force in the promotion of system building. If anything the emphasis was on promoting confidence within the building industry that the adoption of advanced technology would be accompanied by the orders essential to commercial success. Coercion of the building industry as a means of forcing it to utilise technological developments would have been neither appropriate to the type of relationship that the state was trying to establish nor the political climate within which postwar government operated. Indeed, this had been discussed in relation to public building contracts by the Lord President's Committee as far back as 1948 but dimissed as impracticable. [138] Despite the absence of direct measures it is evident that government played a large part in the promotion of system building: as the Court of Inquiry into the Collapse of Flats at Ronan Point observed in 1968, system building "naturally blossoms under such Government policy". [139] Without the promise of a market, which only the government could provide, industrialised building would have had little future. It is to government policy, where building technology in housing was part of a larger economic strategy, that we should look for much of an explanation for the use of system building in social housing. There can be little doubt that governments of the post war period undoubtedly gave effect, as indeed they intended, to substantial changes in building methods.

CHAPTER TWO. SPONSORS.

This chapter will discuss two themes which stand out in the history of the commercial production of building systems. The first of these, examined in Section I, was the tendency for housing systems to be sponsored by firms outside the building industry - in particular engineering and steel firms. The second theme, examined in Section II, was the adoption of systems by large building contractors. These two groups by no means represent the full range of producers. The connection between system building and the development of the concrete precasting industry and the adoption of timber frame by smaller contractors will be examined in Chapter Seven. A further group often singled out in connection with system building are civil engineering contractors. [1] However, many of these, including the two firms looked at in detail in this study, John Laing and Taylor Woodrow, undertook both building and civil engineering work, and, indeed, had established themselves through housebuilding before diversifying into the latter in the post Second World War period. For this reason, the sponsorship of systems by civil engineering firms is encompassed within the broader heading of large building contractors.

I. DIVERSIFICATION

The desire of some engineering and steel firms to enter the mass housing market through the development of new building technologies may be observed as early as 1905. The Cheap Cottages Exhibition of that year - intended to demonstrate the potential of new methods to provide cheaper forms of accommodation for the working classes - featured designs from a number of companies hoping to find new outlets for their metal products, either as cladding materials or as the structural framing. [2] There is no evidence to indicate that these initiatives were successful in terms of the production of a significant volume of houses and it was not until after the First World War that engineering firms were able to realise their ambitions of 1905. The most successful producer of a system based on steel products was Dorman Long, a steel manufacturing firm which built some 10,000 houses during the 1920s. [3&Fig.1] A number of other attempts to enter social housing with engineering based technologies were made in the depression years of the mid-1920s and 1930s, during which steel and engineering industries were particularly affected. As well the house promoted by Lord Weir (Weir House), [4&Fig.2] models were sponored by Atholl Steel Houses Ltd., (Atholl House), Braithwaite & Co.Ltd. (Telford House), Denis Poulton, Cowieson, Walter McFarland & Co and Thorncliffe, all of which embodied substantial amounts of steel in their manufacture. [5] R.B.White estimates that less than 3,000 dwellings were built using these systems, [6] the reason being that they were more expensive than traditional construction.

The government's intention to utilise non traditional technology in its post World War Two housing plans brought a vociferous response from a steel and engineering industry inflated by six years of war production. The wartime expansion of munitions manufacture, heavily dependent on engineering products, was considerable. In November 1941 the War Cabinet estimated the employment of workers in the manufacture of armaments to have risen by 2.5 million since 1939. [7] In February 1941 the British Iron and Steel Federation (B.I.S.F.) wrote to the Cabinet Reconstruction Committee expressing its member's fears of a collapse of markets in the immediate postwar period:

> "Many industries have extended beyond any possibility of having a postwar demand equal to present capacity, and unless the surplus capacity is liquidated and the policy controlled, unrestricted competition might result in a slump with serious unemployment"[8]

In order to avoid the consequences of this collapse, many engineering firms, including the authors of this plea, hoped to enter the state housing market. Of the 12 systems of construction being considered in detail by the newly constituted Burt Committee in September 1943, seven featured techniques involving the substantial use of steel products. [9] In the Committee's final listing of approved schemes no less than 29 of the 78 post war proposals involved steel frames. [10]

One group of manufacturers who made a successful diversification into housing was the Arcon group which consisted of an amalgamation of engineering firms and materials producers serviced with designs by a firm of architects. The group's first project was a two storey house using the products of Stewart and Lloyds, a steelwork firm based in Corby. This system was one of the first to be produced in preparation for postwar housing policy. The most remarkable feature of its construction was the use of a welded tubular steel frame - tubular steel was the main product of the firm and one for which they wished to find a post war market. With the M.O.W.'s decision broadening the number of designs to be used in its Temporary Housing Programme the Arcon Group eventually became producers of 41,000 steel frame bungalows. [11] The production of the Arcon house was a collaborative effort involving a whole group of industries, each individually assigned a portion of the manufacture according to their industrial antecedance. The roof trusses were manufactured by Stewart and Lloyds at Corby where "the complete cycle, from digging the ore to making the tube, is carried out practically under one roof". [12] The significance of this diversification was considerable for the steel industry as it was the first substantial application of steel tubes in building structures - their use previously being confined to service piping and scaffolding. [Fig.4] Another steel firm, Williams & Williams, manufactured the framework for the walls, and the production of the asbestos cement roof covering was secured by Turners Asbestos Cement Ltd. Joinery was distributed between 60 Joinery firms under the aegis of Taylor Woodrow who joined the group as production agents for the bungalow in 1945. By 1946 the Arcon group consisted of the following producers: Imperial Chemical Industries (industrially manufactured boards and plastics), Stewart &

Lloyds (steel), Taylor Woodrow Construction (erection agents), Turners Asbestos Cement (asbestos), The United Steel Co (steel) and Williams & Williams (steel). [13]

In terms of permanent steel framed house construction the B.I.S.F. was the most successful producer. By 1945 it had established a Housing Committee [14] and was promoting three systems of steel house construction each of which involved substantial quantities of steel. The variant finally chosen had a steel frame, steel floor beams and roof trusses, sheet steel cladding to the roof and upper floor, and a sheet steel backing for the sprayed render to the ground floor walls. [15&Fig.7] By 1950 over 38,000 local authority dwellings had been built in steel systems of construction, comprising 29% of non-traditional completions. Of these 31,320 were accounted for by the B.I.S.F. which, by 1950, was the largest single producer. [Tab.IV]

The late 1940s brought a hasty end to the engineering industry's extensive diversification into housing. In 1947, the government withdrew subsidies to non traditional housing systems in general, thereby disadvantaging the more expensive steel systems. In 1948 this was followed by restrictions on the use of steel in housing construction in order to conserve supplies for manufacturing industry. Between 1951 and 1955 completions by steel systems fell to 3,736. [16&Tab.IV]

The curtailment of steel systems prompted an export drive by a number of prefabricated housing sponsors which was also joined by firms promoting timber based systems (the use of timber in housing was also strictly limited during the immediate postwar period). This drive was also encouraged by state building policies at home which restricted private building through the licensing system. [17] By November 1950 prefabricators had supplied exhibition houses to 34 nations, in an attempt to promote overseas sales. [18] In 1949 exports in prefabricated buildings stood at 80,000 pounds and by 1952 this had risen to 7 million, with 4.6 million of this being sold to the Australian Continent. [19]

Arcon was a major contributor to this export drive. The group's movement overseas followed two unsuccessful attempts to exploit the state building market at home. The first of these consisted of a steel frame and copper clad system for highrise construction developed for the L.C.C. However, the system eventually proved too expensive to enter production. [20] The group then turned its attention to school design and in January 1949, published a system in the press which was based on the products used in the temporary bungalow. The structural frame consisted of cold rolled rectangular stanchions and tubular welded steel trusses and the external wall units were steel spandrel panels and windows within steel frames. Asbestos cement sheeting was used for the roof and fascias with timber framed internal partitions. [21] Again the group were unsuccessful, for the design, based on the outmoded 'finger plan' principle, did not conform to current educational design practice. A prototype was built in Hertfordshire, and later purchased by the county. [22&23]

The technical direction which Arcon's overseas development took was based upon an analysis of the difficulties being faced by developing Commonwealth nations in the development of indigenous building production:

> "In almost all countries there are generally available satisfactory local materials for walls and partitions, but there is often no means of making a permanent roof for anything but the smallest spans"[24]

This difficulty was exploited by the Arcon Tropical Roof, designed in 1948. The design used the by now familiar welded tubular steel frame and consisted of a minimal structure, spanning 30 feet, for supporting a roof covering of asbestos or aluminium sheet. [Fig.5] The system sold well for five years but was restricted by the fixed bay width and span. This limitation was remedied by a new design, the Arcon Roof, which was offered in three alternative spans and two alternative bay widths. These frames were sold until 1958. One of the many clients was the Anglo Iranian Oil Company. As well as the roofs, Arcon developed designs for other export markets. An order was signed with the New South Wales Government for 5,000 houses, a prototype and the jigs for which were assembled before the cancellation of the order in the early 1950s. A circular aluminium roof, to replace the thatch in native huts, was developed, and an entire prefabricated town was designed to accommodate the government's ill-fated ground nuts scheme at Noli, Tanganika. Although in advanced stages of preparation, both these projects failed. [25] Nevertheless, these abortive schemes were more than compensated for by the success of the roofing systems, which were sold in over 100 different countries. In July, 1954 Interbuild reported that Arcon was

Britain's major exporter of prefabricated buildings. [26]

The export of whole buildings was by no means an easy undertaking and a whole science of design, packaging and marketing was rapidly worked out to enable it. [27] As well as being supported by Prefabrication, a journal dedicated to furthering new building methods, exporters were given help by the M.O.W. who provided advice and assistance in marketing, [28] and allowed the use of controlled materials such as imported timbers and aluminium. [29] Problems for exporters included the resistance of local builders, satisfying a variety of national statutory requirements and entrusting erection of the often complex designs to non specialist indigenous builders. [30] Nevertheless, expectations were high and in 1952 David Eccles, the Minister of Works, estimated that by the 1960s "these exports would be running at an annual rate of 50 million pounds to 100 million pounds and that they would eventually surpass motorcars as a source of overseas earnings". [31] However, rather than rising, exports began to fall from 1952 due to the loss of the Australian market which shrunk from 4.7 million pounds in 1952 to 1.7 million in 1953. Not only had Australia's housing shortage eased, but stringent import restrictions were introduced by the government in 1952 in response to a balance of payments crisis. [32] In 1954 Britain exported only 2.4 million pounds worth of prefabricated buildings, and Prefabrication reported that firms were attempting to re-enter the British private housing market, although this was not helped by the reluctance of building societies to provide mortgages for non traditional forms of construction. [33]

By no means all of the engineering firms that proposed systems based on steel frames found a market in social housing. Hills Patent Glazing Co., who made an unsuccessful attempt to market a steel framed house eventually manufactured frames for the prefabricated schools system developed by Hertfordshire County Council. [34&Fig.14] Eventually the firm marketed its own system of school construction which, by September 1953, had been used in 30 million pounds worth of educational building. [35] The firm eventually expanded its manufacturing facilities to include the precast concrete slabs with which the frame was clad. [36] In 1961 the company became the nominated contractors for the Second Consortium of Local Authorities (S.C.O.L.A.), and had completed the design of the frame when, for reasons yet to be discovered, the firm was liquidated in the following year. [37] Other firms involved in system built schools were the Brockhouse Engineering Co., the Bristol Aircraft Company - which, by 1954, could boast that it had completed over 500 school buildings in Britain alone before returning to the more lucrative area of aviation work in 1956 - and Sanders and Forsters. [38]

By the early 1960s steel was being reconsidered for use in housing. Indeed the ailing fortunes of the British steel industry prompted the government to once again promote its use in building. [39] As with the immediate postwar period there was no shortage of firms interested in extending their production to include housing. In May 1963 the Minister of Works reported that he and the Minister of Housing and Local Government "were receiving a flood of enquiries about industrialised building, not only from local authorities but from building firms, building component manufacturers and many other industries which would like to diversify". [40] In 1963 the government published a report, Production of Building Components in Shipyards which considered both the practicalities of the shipbuildng industry diversifying into building and the means by which it could do so. [41] The M.O.W. assisted this by setting up a number of enquiry centres to encourage shipbuilding firms to enter housing. [42] A number of shipbuilders sponsored housing systems such as Blyth Dry Dock & Shipbuilding Ltd. and The Duxford & Sunderland Shipbuilding & Engineering Group. [Tab.V]

The early 1960s saw an attempt by the Arcon Group to exploit the expanding social housing market. In August, 1962, their architectural consultants produced a report, 'The Housing Programme and the Arcon Group', examining the possibilities which it saw as potentially considerable:

> "There seems to be little doubt that the Arcon Group should be involved in the Housing Programme as it has been in the past. Housing accounts for about one third of the total output of our building... this rate of output is likely go on for at least 20 years"[43]

In order to realise this potential the group's architectural consultants suggested that two-thirds of the research budget up to 1964 should be devoted to the development of housing systems, even though this would involve dropping work on the current programme. However, the consultants also pointed out that the group was not well placed to provide low cost housing systems as the basis of system built housing technology had shifted in favour of cheaper materials and techniques than those which the group were accustomed to using in their systems:

> "The question of manufacturers and materials is as much a question of Group Policy as is marketing. The cheapest or local authority kind of 'system' house usually relies a good deal on timber, concrete and brick to keep the cost down. Group members are more interested in steel, aluminium, gypsum, plastics, asbestos, etc. This needs very careful consideration and could affect the selection of the most suitable market"[44]

Consideration of this problem indeed affected the selection of a market and resulted in the consultants proposing a single storey courtyard housing system aimed very much at the private market. In contrast to this, the Executive Committee of the Group decided that its best interests lay in the direction of social housing and instructed the consultants to produce a scheme on this basis in 1963. In the meantime, the most significant member, Taylor Woodrow, was negotiating the purchase of a licence to use the Larsen Nielsen system in Britain, having decided to base its system built housing approach on the import of a foreign precast concrete system in line with most of the other large building firms. The deliberations of the Executive Committee were clarified with the membership of Hawthorne Leslie

(Buildings), a diversifying shipbuilder who was already marketing a two storey steel frame system for local authority housing. It was on the adaption of this, to a low-rise flatted system, that the architectural consultants were instructed to concentrate their efforts. [45] No sooner had this been achieved than Hawthorne Leslie withdrew from the system building market, [46] leaving the Group without any means of continuing in the housing field. Following this the Arcon group was dissolved in 1967.

Other engineering firms which produced housing were British Ropes Ltd. (manufacturers of steel reinforcement rods), which completed 310 houses; Redpath Brown, which developed a steel hospital system; [47] and Williams and Williams, a member of the British Steel Corporation and formerly a member of Arcon, which erected 601 houses in its Roften system. [Tab.V]

The most ambitious project was mounted by two steel firms, Richard Thomas & Baldwin and the Pressed Steel Company, who, in 1963, unveiled plans to manufacture the I.B.I.S. house. [48] This system was intended to be manufactured in such quantities that it would justify flowline production of the components. Steel sheet was to be used for the beams, columns, internal and external wall panels, doors, windows, floor and roof decks, staircases, and bathroom and kitchen units -- a degree of utilisation of one material precedented only by the aluminium bungalow. [49] By 1967 two prototype houses had been erected and the company was confident that I.B.I.S. would be produced in such quantities that it would compete easily with traditional construction. However, this confidence did not endure to the stage of production and development was eventually dropped. [50]

Although this study has not identified all of the engineering firms that diversified into system housing in the 1960s, this latter movement does not seem to have been as successful as that following the war. The reason for this must be that government support, in offsetting the costs of using an expensive material in bulk for house production by the provision of financial subsidies, was not forthcoming. At the peak of steel framed systems production during the 1960s, (1967), only 3,759 dwellings were completed: rather less than 1% of all industrialised housing. [Tab.VI]

II. OVEROPTIMISM AND OVERINVESTMENT

This section will explore the building industry's adoption of system building. It will suggest that in providing large housing programmes tailored to new technology, welfare policy encouraged an optimistic building industry to invest in system building. This optimism led to overinvestment and severe financial losses by a number of sponsors hoping to monopolise the local authority housing market with technologically sophisticated housing systems.

The building of houses during the interwar period was dominated by the private developer building for sale. After 1933 the state relinquished building for general needs, and the task of producing housing was left to the speculative builder who achieved the unprecedented rate of 341,000 completions in 1938. [51] The bulk of this housing output was undertaken by small and medium sized builders producing for local markets. However, the period also witnessed the rapid growth of a number of large housing developers, such as Laing, Wates and Taylor Woodrow, building in and around the larger southern towns and in particular London. [52] Despite the outstanding success of these firms the majority of housing developers remained of moderate size. [53] According to Richardson and Aldcroft this arose from the fact that, in the absence of major technological developments in domestic construction, there were few benefits to be gained from large scale housebuilding. [54] Although the interwar period witnessed the adoption by large contractors of a range of new technologies, embracing reinforced concrete and steel construction, [55] their use was confined mainly to the construction of commercial and industrial buildings, offices and some flats, having little impact on the process of house building which remained much the same as it had been in the 19th Century; a craft based labour intensive operation.

By early 1944 the government's plans for the introduction of new technology to housebuilding were well known and had prompted responses from the established, and apprehensive, organs of the traditional house building industry. On the 26th April 1944, the Minister of Reconstruction received a memo from the National Federation of Registered House Builders criticising the government's plans. As well as pointing out the advantages of brick for dwelling construction it poured scorn on the intention to introduce new industries to house construction. [56] The argument presented by the building industry not only centered on the inability of new methods to produce constructionally sound dwellings but also that, were the building industry decontrolled, it could readily produce half a million houses each year. [57] This proposal was considered by Sir Hugh Beaver, at the time Controller General of the M.O.W., as "unrealistic". [58] Writing in 1950 in the National Builder, Beaver remembered "how few were the builders who supported the intensive efforts of the Ministry to develop alternative methods" although adding that "those who did support did so with a will" [59]

Indeed, although excluded from temporary house production (except in the capacity of erection agents as in the case of Taylor Woodrow and the Arcon house), a number of large building firms made a substantial contribution to the provision of permanent non traditional housing despite the opposition of the National Federation of Registered Housebuilders. The Second World War had changed both the building industry and market, giving considerable impetus to large firms and restricting the building of speculative housing. The mushrooming of firms such as Laing and Taylor Woodrow are told in their house histories. [60&61] Indeed, John Laing and Frank Taylor, their principals, became significant figures in the prosecution of the war effort which relied heavily on massive construction programmes suited to firms with large organisational capabilities and the capital to invest in the technologies necesary to carry them out. [62] In the case of Wates, a prewar speculative house builder which also grew to large contractor proportions during the war, the Mulberry project - the construction of massive precast concrete cassions for use as a floating dock in the Normandy landings - furnished it with an expertise both in a new technology and large scale project organisation which it harnessed directly in the development of a housing system. [63] Thus, the Second World War saw the emergence, largely through their involvement with the state war machine, of a new breed of contractor, unprecedented in size and the scale of projects it could undertake and familiar with and able to invest in the level of advanced technology that is the province of large commercial organisations.

On coming into power in 1945 the Labour Government continued the restrictions on private house construction of the Defence Regulation 56(A) under the Statutory Rule and Order of 1945. The effect of this was that throughout the period between 1945 to 1950 the construction of private dwellings was limited to a quarter of the numbers of local authority housing, although, at one stage in 1947 private construction was totally suspended. While the building industry could not complain that there was a shortage of work in the immediate postwar years, government policy was dramatically affecting the housebuilding industry, making it for the first time primarily bespoke builders for government departments and local authorities until it was finally decontrolled in 1956. [64] Marian Bowley noted that of the five most prolific builders of housing systems to the end of 1950, three - Smiths Building Systems, the Unit Construction

Co. and Woolaway - were previously "moderate or small builders based on local markets". [65] The other building firms, who produced the largest proportion of non traditional housing were, she maintains, large contractors previously constructing speculative estates during the interwar period. In her opinion they were attracted to system building because:

> "At a time when normal building was expected to be limited by a lack of traditional resources, it offered the prospect of a market. It is, for instance, noticeable that all of the really big builders who came in, or tried to come in, Costain, Laing, Wimpey, Wates and Henry Boot had been estate developers and house builders on a large scale in the interwar period; in particular it is relevant that they had not confined themselves to single localities. Such operations were impossible in the immediate postwar years. Thus non-traditional houses seemed more likely to offer a nation-wide market than did traditional ones, for local authorities are naturally inclined to employ local contractors for straightforward traditional housing work"[66]

A firm which proved successful in marketing a building system in the immediate postwar period was John Laing & Co. Laing's involvement in system building had started soon after the First World War when it introduced the Easiform method of construction, an insitu system of poured concrete, claimed by Coad to be "one of Britain's first major methods of system building". [67] Towards the end of the Second

World War the system was resurrected as one of the few prewar systems to be reused, a feature which conveyed considerable benefits. Laing were first into the market with a system competitive in cost with traditional construction, fully developed and tested, and supported by the plant necessary for large scale production: by December 1946, the house magazine Team Spirit was able to report that one third of the dwellings constructed for housing authorities in England and Wales were Easiform. [68] Such was demand that the company licensed the system to eight other large contractors, including John Mowlems & Co. and Gilbert Ash. [69] The role of the government was crucial in this success, as the house magazine makes clear:

> "When our present programme of Easiform houses was started... the business of getting people interested was comparatively uphill"[70]

Vigorous promotion of the system and the erection of demonstration houses helped, but:

> "the trickle turned into a flood when the Ministry of Health "blessed" Easiform in a circular to local authorities... [Circular 56/46]... Then came the "National price" and the Government Subsidy, just at a time when we could be proud of our progress, and the river became a flood"[71]

Between 1948 and 1951 the system accounted for well over 4,000 completions each year, more than any other system, a lead it held until 1953 when it was overtaken by Wimpey's No-Fines. [Tab.IV] Although losing its lead to No-Fines, Easiform provided Laing, reputed to have built 1/20 of private dwellings in London during the 1930s, with the market in housing that the curtailment of speculative house construction denied it. [72] In 1947 half the company's labour force of 7,000 were engaged in Easiform construction [73] and by December 1950, this figure had risen to 5,267. [74] In 1950 the company erected 4,394 Easiform houses, rising in 1954 at the peak of MacMillan's housing drive, to 8,300, [Tab.IV] and although figures for the proportion of the company's labour force that this number represented are not available, they suggest an increasing commitment of resources to Easiform construction throughout the housing drives of the late 1940's and early 1950's. This degree of commitment to Easiform together with the company's involvement in the erection and production of the B.I.S.F. house illustrates the centrality of system building to the immediate postwar fortunes of a company whose pre-war development had been mainly concerned with traditionally constructed speculative housing. Even though the mid 1950s saw a change of direction in Laing's application of technology to social housing, Easiform production continued until 1971, and although it never rose to the levels of 1956 the system did better than many. Therefore, the proud boast of 100,000 Easiform houses completed between its reintroduction in 1945 and 1968 [75] should be borne in mind when considering the commercial failure of the company's later initiatives in system housing.

The commitment to system building technology of large contractors as a means of constructing social housing continued throughout the 1950s. Although social housing output fell, a consistent proportion of between 20 and 14.2% of local authority dwellings were completed by housing systems between 1955 and 1960 [Tabs.I&II]. The 1950s also saw building firms adopting foreign systems for the newly expanding high-rise housing market. Compared to the level of commitment to be seen in the mid 1960s the industry's involvement was still tentative and concentrated on methods which involved moderate investment. One building firm, Robert M.Douglas, bought a licence to use the American Lift Slab system, which it marketed through a specially formed subsidiary, British Lift Slab Ltd. By 1960 this company was working on a nine storey block of flats for the Birmingham Corporation. [76] At a similar time W.M.Thorntons, a Liverpool building firm was using the Swedish Prometo sliding shutter system for high-rise blocks at the Birkenhead docks. [77] In addition to these low investment insitu systems two other large contractors, Wates and Laing, were marketing systems developed by themselves for high-rise construction, both of which embodied a large degree of concrete precasting. [78] In addition to these initiatives Wimpey was also adapting its No-Fines system to flatted construction at the Tile Hill estate for Coventry City Council. [79]

In common with other firms, Laing continued to apply new techniques to housing construction during the 1950s. In 1951 J.M.Laing reported that "Work was going ahead on other forms of construction in addition to Easiform... [and]... prophesied interesting developments in the next few months". [80] In the same year <u>Team Spirit</u> reported that extensive development was being carried out on precast concrete units for housing. [81] However, neither of these initiatives produced an alternative system to Easiform for several years. In 1956 Laing experimented with the applicaton of Easiform shuttering to the crosswalls of an estate of 6 storey flats at Duddleston for the Birmingham Corporation, [82] and in 1957 introduced the Storiform system for multi-storey flat construction. [83] Current with developments in high-rise construction, such as W.M.Thornton's use of the Prometo system of sliding shutters, Storiform utilised insitu shuttering techniques, and could be considered as the application of Easiform to flatted housing.

Laing's departure from insitu construction to precast concrete was made in the Picton Street scheme for the L.C.C. [Fig.21] The initiative behind this experiment in new building technology for multi-storey housing came from the L.C.C. Architects' Department. However, Laings took a financial risk in entering into an agreement which included in its terms that any financial gains or losses (by comparison with traditional construction) would be shared equally between the council and the company. Picton Street was an experiment in the application of precast concrete and the tower crane to high-rise housing, and involved the collaboration of the producer and the architect within a novel form of contract, in order that the most suitable building form was generated. The experiment was considered successful by both the council and Laing who entered into continuation contracts for further identical buildings. [84]

In 1957 the company was marketing the design as the system High Structure. However, the degree of precasting in High Structure was partial and confined to the cladding panels, balconies, party floor planks and horizontal beams. The main structural element of the design, the cross walls, were of insitu construction, and in this sense the design lagged behind precasting developments on the continent.

The early 1960s saw a a major drive by the building industry to adopt technologically sophisticated overseas housing systems. There can be little doubt that this was linked to the government's expressed intention of securing a planned and ambitious increase in social housing supply. Government policy was warmly welcomed by the N.F.B.T.E. in its annual report of 1962 [82] and again in 1963 when the Federation's President referred to his understanding of government policies in relation to the building industry:

> "They cannot fail to have important repercussions on the contracting side of the industry... let me say here that this new-found government participation in the affairs of industry generally and of the building industry in particular is not resented"[86]

Following the Cement and Concrete Association's 1962 conference, "Housing From the Factory", during which a multitude of central and local government politicians, architects and building scientists spoke favourably on system building, [87] Interbuild noted that a frenzy of activity was taking place in which contractors were rushing to license foreign systems, or bringing their older ones up to date. [88]

By the latter part of 1963 system builders were beginning to distinguish themselves from the mainstream of the British building industry. In September the General Council of the N.F.B.T.E. approved a proposal for the formation of a System Builders' Section of the Federation. [89] This was organised into two classes of membership; the first for members of the Federation who produced their own or marketed a foreign system, and a second for non Federation members who were also involved in system building. One of the first tasks to which the new system building industry addressed itself was the promotion of industrialised building. The theme of the 1963 International Building Exhibition was 'Industrialised Building' [90] and this was followed a year later by the staging of a one million square feet exhibition devoted entirely to the subject by I.B.S.A.C. Ltd, a firm formed by the N.F.B.T.E. in association with Industrial and Trade Fairs Ltd specifically for the event. [91] As well as producing exhibitions, 1964 saw the industry launch a vigorous advertising campaign, discussed in some detail by P.Dunleavy, aimed at persuading local authorities that system building was the apposite solution to modern day building. [92]

Laing were one of the many firms to embark on an ambitious programme of acquiring new technology. In January 1960 the <u>Team Spirit</u> review of 1959 announced that the economic gloom of the past few years had lifted, and that the company stood at the edge of an unprecedented period of building activity. [93] In September 1962 the magazine announced, as the outcome of extensive studies, the acquisition by Laing of the sole rights to M.Lucien Quentin's Sectra system, designed for up to 25 storeys of construction. [94] Sectra, a more sophisticated version of Storiform, was the first and lesser of Laing's investments in foreign systems, and represented the first prong of a strategy for making an early and successful entry into the systems housing market, as they had done with Easiform 17 years before. The system was insitu and therefore did not depend on the proximity of precasting factories to the construction site, making it suitable for widely dispersed smaller contracts. According to Team Spirit, the largest contract for which it was used was 188 flats. [95]

The second prong of Laing's strategy, the purchase from A.Jesperson & Sons of Copenhagen of the sole United Kingdom rights for the Jespersen system, was announced in April 1963. [96] The subsequent development of this system for use in Britain was carried out in collaboration with the government who, together with Laing and Ove Arups, intended that the system should represent the ultimate in the state of-the-art of system building: "it is a highly mechanised process in which a variety of precast concrete components are produced under highly controlled conditions in a semi-automated factory". [97] The production characteristics of the Jespersen system represented the other extreme to Sectra in that it was a high volume, completely precast system suited to large contracts situated close to the casting factories: "We have come to the conclusion that, where large numbers of dwellings need to be built in a limited area... our company is prepared to erect factories in those areas to produce component parts under this system". [98]

In the first few years of production Jespersen was used on a number of prestigious contracts. However, on closer examination it is evident that considerable support was being provided by government departments. The first major contract was for 977 dwellings for Livingstone New Town, in which the Scottish Development Department played a major role in the choice of the system. [99] The second contract was for a development project in Oldham designed by the M.H.L.G. Development Group, the organisation with which Laings were co-operating in the development of the system. [100] However, the third and largest contract was that awarded by the M.P.B.W. for a large slice of its barrack rebuilding programme. In fact, out of a total of 8,643 dwellings which Jesperson eventually built in England and Wales, over 3,000 were for contracts in which central government agencies were directly involved in the choice of contractor. By January 1966, Laing had won 15 million pounds worth of contracts for Jespersen [101] and in 1967 this was followed by a 1,957 dwelling contract for the London Borough of Southwark. [102]

The size of some of these contracts was matched by the scale of investment which Laing made into their newest and most sophisticated housing system. According to the <u>National Builder</u> the first plant at Livingstone, near Edinburgh, cost the company half a million pounds, [103] although <u>I.B.S.A.C.</u> estimated the cost of this and the two subsequent factories at Andover and Heywood, near Manchester, at between 600,000 and 750,000 pounds each. [104] In January 1967, I.B.S.A.C. estimated Laing's investment in Jespersen to be two million pounds in permanent casting factories, a further one million in research and development "and they back this up with a continuing investment of a quarter of a million pounds each year". [105]

Laing were only one of many firms to make a substantial investment in high capacity production technologies. In a leader titled "Slightly Ridiculous" the January 1965 edition of I.B.S.A.C., commented that:

> "No other country in the world possessed such a variety of systems from so many building firms...with so few dwellings in production... A superabundance of systems, too many of which are inefficient and hastily designed, all confusedly jostling and crowding each other in the market, could well hoist industrialised building on the petard of its own success"[106]

An indication of the motivation behind the willingness of firms to enter this overcrowded market is provided in a later issue of I.B.S.A.C. which commented on the concentration of systems in the public housing market even though this sector could accommodate no more than a fraction of those available. The journal went on to speculate that the building industry was playing a waiting game:

> "This does not imply that those techniques due to go to the wall will be technically, qualitatively or aesthetically inferior to those which survive, indeed endurance and stamina in the form of capital and the

capacity to operate initially at a loss may well be the deciding factors in this building Armageddon, for the harvest to be reaped in the field of local authority housing is worth a long-term policy of financial outlay"[107]

It would appear that a policy of accepting initial losses to achieve an eventual monopoly of social housing was being pursued by Laing in their adoption of a system capable of producing 12,000 dwellings per annum (nearly 10% of the state housing market in any one year of the 1960s). Such a policy was certainly suggested by a comment of Maurice Laing's in 1972, on the British Building industry:

"The top ten contractors carry out less than 20% of new work, and not one contractor carries out as much as 4%. By comparison it is quite normal in other major industries for one firm to have over 40% of the market!"[108]

Indeed, two firms were already reaping the harvest that could be gained with a successful high capacity housing system; Wimpey with No-Fines and, less dramatically, Kirby Laing's own firm with Easiform. It may well have been the success of these systems that inspired other firms chasing too few contracts with too many systems to persevere. [Tab.V]

In an analysis of trends in industrialised building, in 1967, L.M.Madden noted that the proportion of system built state housing was increasing and that, within this, two storey housing was eclipsing high-rise as the major market for systems. However, looking in more detail at the figures for contracts gained by low-rise systems in the first quarter of the year he pointed out that more than one third of the orders were accounted for by Easiform and No-Fines. Leaving these aside he found that the 33 remaining listed firms were sharing orders for 10,145 dwellings with six having orders for less than 40 houses and three for less than 20. [109] In a similar exercise carried out later in the year he found that the situation had changed little and that much the same was true of the high-rise systems [110] with two firms, Wates and Concrete Ltd., capturing the bulk of the market. [Tab.V]

By 1966 changes in government policy were also damaging the prospects of the system building industry:

> "By 1965, the first results were beginning to appear from the considerable capital sums invested by these building firms... No sooner had the programme got into its stride than the cancellation of the first national plan, followed by the economic squeeze in 1966, induced major doubts about the government's intention to persist with the programme"[111]

With reduced building programmes a major factor in system building's favour, the shortage of construction labour began to subside. This was noted by the 1965 Annual Report of the N.F.B.T.E. which reported growing uncertainty within the industry and a steady improvement in the availability of bricklayers, although shortages of plumbers and carpenters remained. [112] The Annual Report for the following year stated that in some parts of the country "a reasonable balance between supply and demand" had developed in the availability of skilled labour. [113] 1968 saw this situation develop to one where "the availability of labour has generally been adequate" [114] and in 1970:

> "Architects' new commissions, contractors' new orders, housing starts, brick production, and the results of enquiries conducted by the industry itself have all suggested an appreciable decline in activity, with housing, which has in the past accounted for abut 40% of the total construction programme, the worst hit... the first drop in output for over 10 years"[115]

In 1967 a spate of reports appeared in The Builder illustrating the difficulties being experienced by system building firms. Larger building firms with system building subsidiaries, such as Bryants, The Fram Group and Trollop & Colls, announced losses in profits directly attributable to system building and a number of smaller specialists, Dorrans and Hawthorne Leslie (Buildings) Ltd., were closing down.[116]

The combination of too many systems and cutbacks in social housing programmes caused Jespersen to become an expensive liability to Laing. In January 1967 Jespersen contracts stood at 30 million pounds. Large though this sum might have been it only involved Laing's Jespersen plants working at less than half capacity. [117] In March 1967, Building reported that Laing were in severe difficulties "in the industrialised building field" [118] and indeed the completions of Jespersen dwellings for that year - four years after the introduction of the system - were only 765.

This figure rose to 1,588 in the next year but fell again to 702 in 1969. In 1970 Jespersen reached its peak of 1,893 completions therafter dwindling to zero in 1975 (these figures for completions do not include Scotland where Jespersen had one of its four plants). The company was having even less success with Sectra, which in the nine years of its production completed little more than 2,500 dwellings, representing an average of 281 completions per year. [Tab.V] In 1963 company profits stood at 1.1 million pounds, [119] and this rose to two and a half million in 1965. However, by 1966 profits had fallen to 64,000 pounds and the relative loss which these figures represented was attributed by the company to its problems in the industrialised building. By 1969 the Scottish factory had been turned over to the production of various non-system precast concrete units. [120] In 1975 the Heywood factory closed, followed a year later by the Andover plant which was being turned into an industrial estate. The same year found the Princess Risborough factory producing the last few panels for the final stages of the huge Aylesbury estate in Southwark. [121]

III.

It would be untrue to say that all builders who adopted systems found their expectations unfulfilled. Considerable success was enjoyed by a number of sponsors, particularly Wimpey with No-Fines and Laing with their Easiform system. [Tabs.IV&V] In addition, Concrete Ltd and Wates with their precast concrete systems also enjoyed commercial success over an extended period. Furthermore, prefabrication offered opportunities for diversification to a number of firms in the immediate postwar years - in particular the B.I.S.F. and Arcon.

Nevertheless, during the 1960s completions by the majority of sponsors were considerably less than anticipated. If the case of Laing is taken as an example it could be suggested that overinvestment in system building arose from a belief that it was the best way to win a large portion of the social housing market. The firm certainly made its substantial investment with the expectation of a profit, as Maurice Laing pointed out a few months after the introduction of Jespersen:

> "Capital expenditure in the factory, in transport, and on site, as well as on stocks, on starting an "industrialised" system of building was generally extremely heavy, and the speed of turning over the capital very slow... when compared with traditional building... No manufacturer would spend the large amount of capital involved unless he was reasonably certain that his end product was likely to be acceptable, competitive in price and that over a period of years he would receive an adequate return on the capital employed"[122]

What is significant in this degree of investment is the extent to which the building industry was influenced by the government's forecasts of steady increases in housing programmes and an optimism that they would be ensured of markets. According to Peter Trench, ex Director of the

N.F.B.T.E., member of the Board of Directors of the N.B.A. and a director of a system building firm himself, it is unlikely that such a scale of investment in system building would have taken place without confidence in government policy:

> "It could be said that anyone who puts hundreds of thousands into a system without some guarantee of continuity of orders or the ability to write off the cost on a guaranteed first contract needs his head examined. It could equally be said that there was indeed a promise of a market implied by those in high places" [123]

CHAPTER THREE. LOCAL AUTHORITIES: A BRAKE ON PROGRESS?

In all cases but a few, local authorities were the agencies which built the housing funded by the Welfare State: they employed and controlled the professional services that bought the land, implemented design policies and chose the methods of construction. This chapter will demonstrate that the attitudes of local authorities were crucial to the use of system building in social housing. The chapter will argue that the response of local government to new building technology was varied. On the one hand a number of large housing authorities adopted system building wholeheartedly for their extensive housing programmes. However, many authorities limited their use of housing systems to the minimum and displayed a marked resistance to the government's intention of effecting a radical change in building methods.

I. ADOPTION.

This section describes the broad consensus existing within the larger authorities that an alliance with national building firms, using new methods of construction, was the best means by which welfare housing programmes could be realised. The section begins with a brief general account of the adoption of system building by local authorities followed by case studies of two councils who were particularly large users, Coventry and the L.C.C.

The impact of the Second World War on British industry had a major effect on the distribution of non traditional housing in the late 1940s and early 1950s. The prewar building industry had been distributed in accordance with the centres of prewar industry. By the end of the war these centres had shifted, in particular to the Southern and Midland towns which grew at the centre of the munitions industries. Within these areas of rapid growth there were few incentives for workers to take jobs in building in preference to other industries. As early as 1946 the M.O.H. noted that "we are losing labour which is badly needed because men are being attracted away from the building industry to other industries where they can earn more". [1] In 1951 the M.H.L.G. Regional Production Officer for the Southwest region, C.H.H.Smith, described the benefits that he felt non traditional housing offered local authorities in the area. The principal of these was their ability to correct recent changes in the distribution of industry:

> "In this region there is a general shortage of bricklayers. Moreover in certain areas (of which Gloucester and Cheltenham are extreme examples), the building labour situation is much less satisfactory than before the war. The retention of new factories, established for armament production, has not only tempted many of the skilled craftsmen to leave the building industry for better paid and more congenial work in modern factories, but factory maintenance and extension work have thrown heavy burdens on the depleted building industry. At the same time, an influx of population has created exceptionally heavy

demands for new houses"[2]

The concentration of non traditional housing from the end of the war to December 1955 in the Midlands and the South, areas of most rapid industrial growth, supports Smith's view. The highest was in the Southwest Region, which completed 46.7% of its housing programmes in non traditional systems; the Southwest Region was followed by Wales with 32.2% with the North Midlands and the Midlands coming third and fourth with 24.8% and 23.5% respectivley. The four lowest users, each using non traditional methods for less than 15% of their output, were Eastern, Northern, the South East and London. [Tab.III] In addition to the redistribution of industry Bowley cites the availability of brickworks as a significant factor accounting for the low usage in London, the South East, and Eastern regions. Furthermore, the lack of a developed building industry in rural areas influenced the exceptionally high usage in the South West, Scotland and Wales. [3]

From the mid 1950s onwards Britain's social housing output was increasingly focussed on slum clearance programmes in the larger urban areas. By 1954 Birmingham was building on its Duddleston, Netchells, Ladywood and Bath Row redevelopment sites, [4] and in March 1957 Glasgow gained Ministerial approval for its 16,000 dwelling clearance plan, the largest yet, for the Hutchesontown and Gorbals redevelopment area. [5] The use of industrialised systems by urban authorities with large clearance programmes began early in the 1960s well before system building became an important feature of government economic policy. By the time of the "Housing From the Factory" conference in 1962, at which Keith Joseph announced his Ministry's wholehearted support for system building, Glasgow Corporation had already decided to use prefabricated components in place of brickwork for the Pollokshaws redevelopment area. [6] In June 1962 Liverpool adopted a similar course and sent a delegation to Paris to inspect the factories of three rival systems before placing a contract with the Unit Construction Co. for 2,500 dwellings in the Camus system. [7] A trend was being set in which large urban authorities were looking to new building methods for the execution of their redevelopment programmes. In March 1963 the Civic Trust Industrialised Building conference paper noted that:

> "It is only towns of 50,000 or more which have housing programmes of sufficient size for industrialised building, and have sufficient technical staff to handle necessary design, negotiation and research. The first 12 system constructed schemes in Great Britain are all in cities of more than 300,000"[8]

The geographical distribution of system built housing between 1965 and 1972 displays a more even regional pattern than between 1945 and 1955. With the exception of East Anglia and the North - predominantly rural areas with few urban concentrations - the starts in systems by local authorities in England and Wales varied between 27% and 44% of total housing. Again, two of the three largest users were the East and West Midlands, with the North West industrial region the second largest. [Tab.III] However, an analysis of the housing starts in industrialised systems between 1966 and 1971 by the different types of local government administrative unit reveals considerable variations. By far the largest users were the County Boroughs and the New Towns (with averages of 44% and 43% of completions); Greater London proved to be the third largest user (34%) with Urban Districts coming third (28.7%) and the Rural Districts the smallest users at 15%. Whereas between 1945 and 1955 the use of housing systems was focussed on specific regional areas - primarily the Midlands and Southwest - during the 1960s the focus was on the larger administrative units and new towns and bore less relation to their geographical location. [9] By 1967 Manchester, Liverpool, Leeds and Swansea were all using systems for over 60% of their municipal housing. [10]

The larger local authorities were motivated to use system building for a range of reasons each connected with the practical problems of implementing housebuilding programmes of an unprecedented scale. In 1968 the Association of Metropolitan Authorities claimed only one advantage for system building: "the benefits are in terms of improved and increased production". [11] In signing a contract for 2,500 flats in the Camus system Liverpool felt that it had assured itself of the steady supply of ten flats a week for five years over and above that which it felt could be provided by traditional methods of construction. According to the Director of Housing, a study of the resources of the local building industry had been carried out in which it had been found:

"reasonable to suppose that a figure of 3,200 dwellings is the maximum which can be achieved by the

Corporation by traditional methods and it follows that, if the City is to achieve its target of 5,000 dwellings per year, it must bring in some other methods of construction. The City Council, therefore, decided that a bold step in the introduction of an industrialised housing system was the only course to take" (1964) [12]

Liverpool was but one city to turn a large portion of its housing programme over to system building. In 1964 Birmingham completed 2,506 dwellings. By 1967 this had risen to 9,034, 83% of which were built in industrialised systems. According to the City Architect in 1968: "There is no doubt that without it... [I.B.]... last year's figures would have been impossible". [13] By 1967 the city was concentrating on three systems: No-Fines (1,660 completions in 1967) and Bryant (1,044 completions in 1966) for its low-rise housing and Bison for its highrise flats (1,530 completions in 1967). In addition to these 1,030 houses had been completed in 1967 by four rationalised traditional systems. The reason for awarding large numbers of contracts to such a small number of selected firms using system building was provided by the Chief Quantity Surveyor for the City:

> "they should all have efficiency as the common denominator of their organisations and they should be rewarded with continuity of production by one of the many methods of negotiation now open to us... So the pattern emerges: a section of the programme set aside for competitive tenders invited from firms selected from the authority's lists and thus providing a means

of testing the market and giving an opportunity for firms to show their worth; and at the same time a trickle of schemes running through the programme set aside for negotiated continuity for the efficient: a trickle that could become a steady river of productivity for the authority"(1968)[14]

By the mid 1960s it had become easier for the smaller urban authorities to use industrialised systems. The N.B.A. offered a wide range of advice and assistance to facilitate the use of systems, including a full architectural service in the case of authorities lacking the necessary expertise and staff to implement system building programmes. [15] This ease was increased by the tendency for firms to offer a "package deal", whereby the sponsors of the system, many of whom employed their own architectural staff or used consultants, would design the building and undertake all the professional duties in addition to construction for a fixed price. The approvals of "package deals" increased to 39% of industrialised building contracts by 1970. [16] Building systems promised a solution to the problems facing local authorities during the redevelopment boom of the mid 1960s; shortages of building labour, shortages of professional staff - compounded by the additional technical complexity of dealing with high rise construction - and large housing programmes. Furthermore, in the light of Ministerial policy, dealings with central government were eased in the case of authorities prepared to tackle their programmes through the use of large contractors exploiting new building techniques. A pleased Town Clerk of a modestly sized Midland town found these advantages in the Bison blocks that it had bought "the tender for the three blocks at Kidderminster by Concrete Ltd., and Bryant & Co. was the lowest, completion date offered was the earliest, approval by the Ministry was automatic". (1964) [17]

CASE STUDY: COVENTRY.

A visit to Coventry's municipal estates reveals a monotonous prospect: wide vistas of housing dominated by the grey concrete finish to No-Fines construction. This case study will examine the social housing production policy of this large Midland city and describe the factors leading it to devote a major part of its general needs housing programme to one large national contractor, Geo. Wimpey and Co. and their No-Fines system of construction. By 1958 this system had accounted for the construction of 6,000 municipal dwellings. [18]

Coventry emerged from the Second World War with two claims to fame, an intensively bombed city core and a burgeoning engineering industry which established the city at the centre of British automobile manufacture. The first of these did not contribute greatly to the city's housing problem as the damage was mainly confined to the commercial centre; furthermore, the city was relatively free of slum and blighted property. [19] It was the second of these claims that placed a massive strain on the city's ability to keep pace with housing demands. The type of growth that had typified the older industrial areas of Britain in the 19th Century occurred in Coventry in the latter half of the 20th.

In 1951 Councillor W.Callow stated that the population of a city the size of Canterbury had been added to Coventry in the past six years and had generated a 14,000 long housing list. [20] The success of Coventry's engineering industry placed a double burden on housing supply. Not only did it increase the numbers to be housed but also the high wages to be earned in the factories inhibited the growth of the local building industry. In 1959 a breakdown of the city's employment showed 66.1% in engineering and vehicle manufacture, with 6.2% in building compared to national averages of 16.8% and 8.9% respectively. [21]

Coventry Council turned its attention to non traditional building methods during the early years of the war when, in September 1941, the Housing Committee approved in principle the construction of experimental houses. [22] As a result, three years later, the City Architect constructed an experimental house of tubular steel and precast concrete in association with Messrs Gyproc. [23] As well as pursuing its own non traditional system, the Committee discussed a number of others, none of which were found to be satisfactory. In 1946, with the failure of the City Architect's own system, the Housing Committee directed its attention to the B.I.S.F. house, 2,000 of which it ordered in March. [24] Despite the government's subsidy, the B.I.S.F. house proved more expensive than traditional construction due to the cost of providing travelling expenses and subsistance allowances to the labour imported by the erection contractors. In the face of government refusal to bear these extra costs the Council reduced its allocation to the 506 already in contract. [25] By 1948, due to the diversion of building labour to the rebuilding of the city centre and war damage repairs, the problems encountered with the B.I.S.F. house and the Labour Government's deflationary measures of the late 1940s, only 380 permanent houses had been completed by the Council. [26]

In April 1949, the Housing Committee again considered the augmentation of its ailing housing programme through the use of new technology. A proposal to order a further 500 of the ill-fated B.I.S.F. houses faltered, for, with the government subsidy withdrawn, the cost of these was now 1,548 pounds each. The Committee approved a suggestion to enter negotiations with Unity Structures for 100 houses at the verbally agreed price of 1,360 pounds. However, realisation of this proposal was dependent on the sponsors finding a contractor willing to erect the houses. The third system under consideration was that offered by Wimpey. A firm price of 1,310 pounds/house had been agreed with the firm who offered to bear the cost of importing the labour necessary to complete the 100 No-Fines houses in 11 months. The offer was accepted. [27] In January 1950, the Architect reported good progress on the No-Fines contract and the Committee approved the negotiation of an additional 252 flats. [28] Six months later the Architect reported on difficulties being experienced with the negotiation of a contract for 1,400 dwellings on the Tile Hill North Estate with traditional contractors busy with other work and presented an offer made by Wimpey. The firm would undertake to provide the 1,636 houses in accordance with the

Architect's site layout providing the full range of dwelling types envisaged. [Fig.12] In September, with a reassurance that Wimpey's price would entail rents below those charged to the tenants of equivalent traditional houses recently completed, the Committee accepted the price of 1,149,576 pounds for the development. [29] In June 1952, at the same time that progress on the city's traditionally built estates was found to be less than that hoped for, progress on Tile Hill North was ahead of the programme. As a result the Housing Committee considered the award of further contracts to Wimpey:

> "if their labour force is to be retained... it will be necessary to allocate to them a further contract on another estate, to which their labour force can be transferred without interuption in house building progress"[30]

By this time the Council had become aware that its housing programme was dependent on the commitment of the resources of a major national contractor to the city and that to ensure the continuation of this a succession of contracts would have to be provided. In September 1952, the Housing Committee approved a proposal by the Architect to reserve a portion of each of the Willenhall, Tile Hill, Bell Green and Stoke Aldermore Neighbourhood Units for non traditional construction in order to maintain the housing programme at a satisfactory level. [31] Eventually the Council agreed a five year programme of 5,000 non traditional houses for the city, the first installment of which was to be 848 dwellings in No-Fines at Tile Hill North and Bell Green. [32]

The growing dependence of Coventry on one system of building was not occasioned through a neglect to consider other systems. In February 1951, the Architect opened discussions with Wates on the use of their system [33] and three months later the Housing Committee invited Mr Costain, of R.Costain Ltd., to its June meeting to discuss a programme of housing using the Schindler Goehner system. [34] At a similar time the Committee also considered a system by Redifice and were pursuing Unity. [35] However, with the exception of Unity, which was used for a contract of 126 dwellings at Bell Green, discussions fell through due to difficulties in negotiating satisafactory prices and specifications. [36] The site set aside for Costain's system went to No-Fines, and although the Committee eventually built in the Unity system it took five years from the opening of negotiations in 1949 to the approval of the project in 1954. [37] In contrast to the other systems, No-Fines was tried and tested, competitive in price and readily available from a large building firm which already had resources committed to the area.

A further fillip to the use of No-Fines in Coventry came with the delicensing of speculative housebuilding in 1953 which placed a further strain on the city's inadequate traditional building industry and prompted a further increase in the non traditional programme. [38] In mid 1955, by which time private completions had outstripped public housing in the city, the Council had 2,791 No-Fines houses in contract, with 909 by other contractors using traditional methods. Two years later, towards the end of Coventry's general needs programme, these figures were 2,142 and 235 respectively. [39]

The late 1950s saw a redirection of Coventry's housing policy from general needs to redevelopment. This was associated both with a change towards high-rise and a sharp fall in the output of council housing. [40] This fall in public housing was also accompanied by a reduced rate of private housebuilding in the city. Between 1961 and 1965 total housing completions in Coventry remained below 2,000 per annum in contrast to over 3,500 in both 1955 and 1956. [41] Nevertheless, although redevelopment began in a context of lessened demand on the local building industry, the Architect's Department framed its redevelopment programme with the intention of continuing the use of large national contractors, as these were the most experienced in multi-storey construction and promised the speediest progress with the programme. As the Architect explained:

> "if local firms were to be seriously considered it would mean that full tender drawings, together with bills of quantities, would have to be prepared in this department, which would mean that the start of work on the ground would be delayed. On the other hand were authority given for the negotiation with a national contractor, experienced in this form of development, advantage could be taken of his technical design services and a start could be made earlier"[42]

By mid 1966, four national contractors were building 71% of the Council's 2,368 houses in contract. Three of these were system building specialists, Truscon, Vic Hallam and British

Lift Slab, and the fourth was Wimpey using No-Fines on two contracts totalling 560 units. The Direct Works Department and the Midland Housing Consortium, of which the city was a member, were building 16% leaving only 13% under construction by local builders using traditional methods. [43] The Council's policy of letting large contracts (the 87% of contracts to non local firms varied between 100 and 250 units, while the remainder averaged 39) assisted in the exclusion of local builders and prompted the Coventry & District Association of Building Trades Employers to form a grouping of small contractors hoping to negotiate some large housing contracts in order to "heal the rift" that it felt had arisen between the itself and the Council. In response to this overture the Architect pointed out that future years' programmes had been planned on the basis of negotiating contracts with a series of national firms using proprietary systems. Of the sites unaccounted for in the 1966/8 programme the majority were earmarked as continuity contracts for the system builders already committed to the city. In support of their case the local builders also suggested that they would be easier to deal with than national contractors with remotely situated headquarters. To this the Architect responded that "There is no reason to believe that out of town firms are difficult to contact or negotiate with; it is common practice for any contractor dealing with say 400 dwellings... to establish... [locally]... an efficient management team". [44] Furthermore, the architect considered that communication with a loose association of small builders might prove very difficult, and referred to the last time, shortly after the war, when large contracts had been negotiated with a number of small builders: "this particular arrangement was not found to be particularly efficient and as other building work became available the negotiated schemes tended to become 'hospital jobs'". [45]

In the 25 years of intensive house building following the Second World War Coventry Council increasingly substituted national contractors able to produce large volumes of housing through the use of their own special techniques for the local builder relying on traditional construction methods. By far the most successful of these was Wimpey whose ability to produce housing in volume was unrivalled by the other commercial interests available to the City. The appreciation of the Council for its favoured contractor was indicated by the ceremony held to mark the opening of the 6,000th No-Fines house in Coventry in 1958. At this the Mayoress celebrated the partnership between the city and the building firm that had played a crucial role in Coventry's housing programme by presenting a bouquet of flowers to the management of George Wimpey & Co. [46]

CASE STUDY: THE LONDON COUNTY COUNCIL

This case study will concentrate on the 15 years leading up to 1965 during which the London County Council (L.C.C.), in partnership with national contracting firms, attempted to develop a technology of construction suited to its large redevelopment programmes. In 1953 the Municipal Journal estimated the L.C.C. to be the largest producer of housing in the world, with an annual output of 10,000 homes. [47] The L.C.C. was a pathfinder in the application of industrialised building to redevelopment programmes and its influence spread far and wide, both through the practical example of its building projects - Coventry Council visited its schemes at Roehampton and Picton Street. when it was formulating its policy toward redevelopment [48] - and through the web formed by its architects who took senior posts elsewhere in the public service. McCutcheon lists three L.C.C. architects; J.Foreshaw, H.J.Whitfield Lewis and A.W.Cleeve Barr who became Chief Architects of the M.H.L.G. and four who became city architects or planners for other large cities; A.Ling (Coventry), D.Jenkins (Hull), J.A.Maudsley (Birmingham), W.Bor (Liverpool). [49] Because of its influence the experience of this authority in industrialised building provides an understanding of the developments that took place within local authority building in postwar Britain.

Like many authorities with large housing programmes the L.C.C.'s involvement with new building technology began in the closing years of the Second World War with the allocation of 3,000 temporary bungalows in November 1944, [50] and the consideration of reports from the Architect on which systems of permanent construction would best suit the council's needs. [51] Between 1946 and 1953 the Council built 12,000 of its 54,000 general needs houses in non traditional systems. According to the Director of Housing in 1953, the use of new methods had allowed the Council to maintain its housing programme through times of shortages in materials and labour. [52]

With the shift in emphasis towards redevelopment during the 1950s the L.C.C. turned its attentions increasingly to the development of methods of multi-storey construction. A feature of this was the formation of close relationships with large contractors. This manifested itself as early early as 1947 in the Minerva Street scheme which witnessed the "close collaboration" between the L.C.C. architects and Holland Hannen and Cubitts, through the standardisation of detailing to maximise the use of mechanical aids and facilitate the re-use of standardised shuttering. [53] In 1953 the Architect to the Council, R.H.Mathew, prepared a report for the Housing Committee proposing an experiment to be carried out with a major contractor into high-rise construction. Bearing in mind the Committee's concern with economy Mathew was convinced:

> "that scope exists for savings in cost and, more particularly, for more rapid construction of flats at no extra cost, if the design, erection and engineering aspects of a scheme could be planned together from the outset by the architect, structural engineer, quantity surveyor and a contractor working together"[54]

In July 1952 the Committee had authorized a structural engineer, Ove Arup, to carry out an investigation of new constructional techniques, but, in order to experiment with these on a practical building project, Mathew proposed to introduce a contractor before the design had been completed, thereby circumventing the normal tendering procedure. The contractor, chosen 14 months before the site start of what eventually became known as the Picton Street experiment, was Laing. [55] In December 1956, Mathew's successor, H.Bennett, reported the findings of the experiment. Although the first phase had exceeded both the target costs and the time schedule, phase two was expected to reveal considerable economies in time while costing no more than traditional construction. To follow up what, in his opinion, had been a successful experiment, Bennett made two proposals for the Housing Committee's approval; firstly, a complete scheme would be designed on the Picton Street lines to be let by competitive tender to a number of contractors, and secondly, another scheme would be prepared exclusively for the Laing system developed in the original experiment. [56]

As well as carrying out this experiment with Laing the L.C.C. also built an experimental project in order to adapt the Reema system, previously confined to two storey housing, to its multi-storey designs. The first block of the Aegis Grove scheme, in Battersea, was completed in 1962, and as a result Reema also began to market the design to other local authorities. [57] As with the Picton Street scheme savings in cost were marginal, due, in Bennett's opinion, to the fact that only a small part of the building, the basic structure, had been prefabricated. [58]

In the early 1960s the L.C.C.'s use of new technology took on a new character. Rather than conducting experiments in which the Architect's Department and contractors developed and tested new designs and methods of construction, increased housing programmes and the overloading of the building industry forced the L.C.C. to turn to foreign systems operated by national contracting firms. In November 1961, Bennett reported to the Housing Committee on a recent visit by officers from the Architect's Department and the Deputy Director of Housing to view the "large scale" prefabrication methods currently in use on the continent but little studied in Britain. As a result of the group's findings Bennett informed the Committee that:

> "the possibilities in terms of increased housing output appear on the information available to be so promising that I propose to make a thorough investigation with the object of submitting detailed proposals for supplementing the present output by large scale industrialised prefabrication"[59]

In 1962 the increasing workload on the building industry added a note of urgency to the Council's consideration of foreign systems. Before having a chance to report further on the use of continental systems, and in the same month that the Council announced its intention to clear 10,303 unfit houses in the next five years, [60] Bennett prepared a report for the Council on the serious staff shortage in the Architect's Department which was threatening the execution of the housing programme. Between 1959 and 1961 the workload on the department had grown 11% while the numbers of architectural staff had fallen by 13%. In the Architect's view this was the result of the increased workload of the industry inflating the salaries to be gained in private offices above those offered by the Council. As well as improving recruitment and reducing turnover, in order to keep abreast of the building programmes, the report stated, the architectural department would have to "increase productivity per man". [61]

Five days later Bennett unveiled his proposal to introduce the Danish Larsen Nielsen system into Britain. Preliminary discussions with the sponsoring firm had revealed that the system could be adapted to a number of the Council's approved dwelling plans allowing its speedy introduction to London. Furthermore, Larsen & Nielsen were prepared to grant a manufacturing license to Taylor Woodrow Anglian, a company established to operate the system by the fusion of a subsidiary of Taylor Woodrow, Myton, with the precast concrete specialists, Anglian Building Products. [62] With these necessary preliminaries under way Bennett reported that he was investigating the development of a number of sites on the basis of placing a contract for 1,000 dwellings in the system. [63] In August a delegation from the Housing Committee visited the parent Larsen Nielsen plant in Copenhagen and a number of completed projects and:

> "In general... considered that the use of this system of industrialised building was capable of being used in London to make an effective contribution to the Housing effort of the L.C.C."[64]

The Morris Walk development at Greenwich, at which 562 dwellings were built, was the first scheme chosen for the Larsen Nielsen system. In the event of a satisfactory performance from Taylor Woodrow Anglian the Council intended to enter into continuation contracts for the remainder of the 1,000 dwellings, in which case 50% of the cost of the moulds would be discounted by the sponsors. [65] In September 1962, Bennett notified the Council that its building programme was being held up due to labour shortages, particularly in the finishing trades, and that that year's programme would be underfulfilled. [66] In April 1963, the Housing Committee considered, and accepted, an offer of 2,179,086 pounds for the Morris Walk scheme [67] although the Valuer pointed out that this would exceed traditional construction by 3-3.5%. However, as the Valuer also pointed out, the great saving would be in time, for even with the construction of the precasting factory in Norwich the contract was expected to take only 27 months, bringing it to completion nine months faster than traditional methods would allow. [68]

In the event the contract at Morris Walk was completed to the Committee's satisfaction and followed not only by the continuity contracts envisaged by the contractors and the Architect (eventually built in Brixton, Fulham and Peckham) but also a futher 850 dwellings by January 1968. [69] In all, 182 blocks were built for the Council in the Larsen Nielsen system. Although Taylor Woodrow Anglian completed many dwellings for the L.C.C. it was not the Council's policy to concentrate on one system. By this time the L.C.C. was using a number of systems to produce its large housing programme for, as Bennett pointed out, "It... would be unwise to assign the whole programme to a single manufacturer; there must be some diversity". [70] Between 1959 and 1965 the Council had let 15 industrialised housing contracts using seven systems (including a low-rise system which it developed in association with Taylor Woodrow Anglian to complement the Larsen Nielsen high-rise system) [71] totalling 3,192 dwellings, 2,050 of which were let in 1965. [72] Therefore, at the outset of Crossman's housing drive, the L.C.C. had already committed a major part of its housing programme to system building and, furthermore, could boast that it had played a developmental role in the design of a number of the systems it was using.

In the cases of Coventry and the L.C.C., alliances were formed with contracting firms capable of bringing organisational expertise, large labour forces and new technologies to bear on local authority housing programmes. System building was adopted for various reasons ranging from shortages of building labour, shortages of architectural staff, a desire to increase the rate of housebuilding or the desire to ensure the continued commitment of the resources of large contracting firms. In each case system building offered a solution to the difficulties of carrying out large housing programmes at a time of shortages in traditional building resources. However, it could also be suggested that system building in the hands of national contractors became seen by many local authority clients as the most appropriate method of dealing with postwar housing. Coventry, having embarked on the course of using a limited number of national firms, was reluctant to return to the small builder using traditional methods during its redevelopment programmes of the 1960s, even though the evidence suggests that the local building industry was eager to take the work on. Indeed, and important feature of some of the larger local authorities committed to system building was that their interest preceded government policy supporting industrialised building during the 1960s. Thus, when early in 1966 the L.C.C. Housing Committee considered the M.H.L.G. Circular 76/65 on the government industrialised building drive the Committee's response was to note the contents but regard it as little more than an affirmation of its present policy.

> "Because of the early start made by the L.C.C. in the application of such methods, the G.L.C.... [as it became in April 1965]... is already well advanced in the knowledge and use of the points contained in the circular, in some ways indeed, it has progressed somewhat further"73]

II. RESISTANCE

Although the use of industrialised housing systems by local authorities was considerable, it persistantly fell below the expectations of government and industry. As well as describing why system building was resisted by many local authorities this section will describe the state's efforts to overcome the refusal of many authorities to make the maximum use of new methods.

An exchange of memorandum between C.H.H.Smith and his superiors in London described the difficulties that the M.H.L.G. had in encouraging the use of non traditional housing systems by local authorities during the late 1940s and early 1950s. By 1951 the larger authorities in the South

West Region for which Smith was responsible, such as Bristol, Plymouth, Cheltenham, Gloucester and Swindon, had come to the view that system building was essential to the implementation of their housing programmes. However, according to Smith, impressing this need upon these authorities had not been easy:

> "The methods of encouragement have been various, and have covered a period of several years. In the early post war period, every opportunity was taken of inviting local authorities, at individual interviews, zonal conferences and group meetings, to examine the labour situation and to assess the output potential... This process of general education was long and difficult: and it was pursued in the face of strong opposition and prejudice which, even today, has by no means been overcome" [74]

Although emphasising that local authorities had not been forced to use non traditional housing he admitted that "we may sometimes go rather near the line" by refusing applications for loan sanction for traditional methods on the grounds that the necessary skilled labour was unavailable whereas, he added, care was taken never to penalise an authority if it included non traditional houses in its programme. [75] Other measures included exploiting the desire of many councils to maximise their allocations of licences for private housing development in which case the Regional Office had "dangled extra licences before their eyes, with non traditional allocations attached to the other ends of the strings". [76] In conclusion, Smith considered the use of coercion to have been pardonned by circumstance:

> "This all seems a little underhanded but the justification is that local authorities refuse to face the facts unless they are led to them, and that we have maintained a well balanced programme with more or less even progress in relation to comparative needs, throughout the region" [HLG/79]

Despite his best efforts Smith was finding it increasingly difficult to ensure that non traditional systems of construction were exploited as widely as he thought necessary to maintain the Region's housing programme. According to Smith local authority resistance was focussed on the expense of building and maintaining non traditional houses, their unattractive and monotonous appearance [Ch.VIII], the unsatisfactory performance of some contractors and "constant pressure from interested parties" such as councillors with building interests. The job of ensuring the use of new methods had been made all the more difficult with the abandonment of the government subsidy in 1947. Summing up, Smith feared "a severe risk of non traditional houses fading from the picture". [78] If the new Conservative administration were to realise the increase in non traditional methods that they envisaged, Smith urged that "special measures" would have to be adopted. After discussion at the M.O.H. the following course of action was agreed in order to influence local authorities in their choice of building methods. The Ministry intended to write at once to local authorities stating the "merits" of non traditional systems - that they offered a 30-to-50% saving in labour and allowed much faster construction – and would offer authorities a 50% increase in approvals on any part of their housing programme which included non traditional houses. Councils were to be instructed to encourage private building of housing systems through the issue of block licences to speculative developers prepared to use such methods, and Regional Officers were to be instructed to push alternative methods and "increase their popularity and remove prejudice". Although the general policy would be to achieve willing acceptance, the possibility was not ruled out that in areas of acute labour shortage specific quotas might have to be allocated. [79] Despite these preparations, in February 1952, Smith once again contributed to the development of Ministry policy by suggesting that a circular should be sent to local authorities emphasising that the policy to be pursued had emanated from the Minister. Furthermore, he considered, a circular "will recieve publicity, and be regarded as an issue of real importance". [80] Such a circular (Circular 28/52) was indeed produced which, as well as stressing the advantages to be gained by using new methods, stated quite baldly that:

> "the Minister feels quite justified in offering increased programme instalments to those authorities who employ in their current or future programmes the new methods of building for some or all of the houses they had intended to build by traditional methods. Authorities will thus be able to get more houses under contract" [81]

During the early 1960s the M.H.L.G. relied on two measures to increase the use of system building by local authorities. The first of these was advice in the form of government reports on the benefits of system building and the creation of the N.B.A. as an agency to actively assist local authorities to overcome any technical problems associated with system building. The second measure was the encouragement of the consortia movement. [Chs.I&V] Despite the fact that, by 1968, 482 authorities combined to form 40 consortia, this did not have the impact on system building completions hoped for by the government. [82] In January 1969, D.Llewellyn, a Director of the N.B.A., pointed out that while authorities producing 70% of housing belonged to consortia, only 8% of housing was carried out by such means: "In other words... the authorities which are nominally supporting the consortia have, in total, put less than one eighth of their output through joint machinery for design or programme". [83] Furthermore, half of the 16,334 dwellings in contract by consortia in mid-1968 were accounted for by two untypically prolific organisations, the Yorkshire Development Group (Y.D.G.) and the Midland Housing Consortium (M.H.C.) - both using their own systems. [Ch.V] 1968 was the peak year for consortia housing: the number of dwellings in consortia contracts fell to 12,274 in the next year and 5,441 by 1972. [84] According to Llewellyn, in his experience, the poor performance of consortia resulted from the inability of authorities to find common agreement on building policies:

"Where consortia programmes were led centrally, there was a tendency for authorities either to withdraw from the programme if they did not like what they saw as a result of the joint negotiations, or, alternativley, they tried to adjust what had been done by the group organisation to their own whims. Thus a firm successfully tendering for what it thought was a consortium programme of identical types finds it is building specials for individual authorities"[85]

The effect of such disputes was to increase the cost of contracts thereby defeating the intended aim of consortia which was to make system building cheaper. Llewellyn also provided three other reasons for the apparent failure of consortia: firstly, the desire of lay committee members to make a personal contribution to housing programmes refusing to accept centralised solutions; secondly, a concern by authorities that they would lose control over their building programmes if they placed too large a portion of their programmes in the hands of an organisation over which they had only joint control; and thirdly, the fact that the internal administration involved in letting a contract in conjunction with the consortia machinery was often greater than for one handled entirely within the authority.

The reluctance of many local authorities to adopt system building for a major part of their housing programmes prompted frequent rebukes from government ministers and eventually the adoption of a more coercive policy by the M.H.L.G. In February 1965 Charlie Pannel, Minister of Public Buildings and Works, addressed a Council Meeting of the Association of Municipal Corporations (A.M.C.) on the subject of system building, complaining that too many councils "leave their neighbours to make use of industrialised systems of building while they proceed with traditional methods". [86] By July 1965 the capacity of the industrialised building industry was estimated to be 50,000 units per year while the government's forecasts expected only two-thirds of this to be used. As Pannel stated in Parliament, in response to a demand for the government to set up system building factories of its own, "the principal obstacle to greater use of industrialised building is the need to organise the demand, not to supplement the supply". [87] In April 1965, Circular 21/65 departed from the Ministerial policy pursued hitherto of seeking to increase the use of systems through consensus and introduced a coercive measure reminiscent of that used in 1952: "In deciding what programmes to approve the Minister will be influenced by the extent of the proposed use of industrialised methods". [88] This intention was restated in <u>The Housing Programme 1965-7</u> White Paper published later in the year. [89] While this advice did not amount to a specific instruction to local authorities its implications were readily seen by one local politician, the Lord Mayor of Norwich, who felt that "the threat is there that unless we use these industrialised systems our subsidies will be affected". [90]

While many authorities were prepared to use building systems few were prepared to offer contracts of a size that compensated for the investment of capital and organisational expertise on the part of the sponsors. As Cleeve Barr pointed out to local authorities in the <u>Municipal Review</u>:

"They cannot be run economically on the basis of one order for 300 houses here, 30 different houses in another part of the country, 20 elsewhere and infinitly protracted negotiations for a few dozen again-different types elsewhere". [91] Circular 76/65, published in December 1965, advised authorities that contracts for industrialised building systems should be for at least 100 dwellings and that a string of different systems should be not be used. [92] Although the letting of contracts for over 100 dwellings increased from 39.5% in 1960 to 66% in 1966, [93] the bulk of contracts for system building remained below 100 dwellings despite ministerial advice. In late 1966 The N.F.B.T.E. found that out of 87 current industrialised building contracts 51 were for less than 100 units. [94] As regards Circular 76/65's advice that only a few systems should be used, Crossman, in May 1966, described, as one of his department's greatest problems in extending the use of industrialised systems, the tendency for councils to "flit from one building system to another according to the whim of fashion". [95] Local authorities were unwilling to adjust their policies to embrace system building to the point of ignoring ministerial advice.

A further source of frustration for the promoters of system building was the reluctance of local authorities to exert a discipline on their building policies in accordance with the accepted tenets of industrialisation. In the Oldham development, near Manchester, on which the Jespersen system was used, the Council insisted on having 13 different types of housing unit which, linked with the undulating site, prevented the standardisation of the concrete units and slowed erection. At the Hulme No.2 development, where Jespersen was used by the Manchester Corporation, the Council insisted on implementing its favoured 8'9" floor to floor height, instead of the 8'4" dimension to which the system was designed, again increasing the number of non-standard components. The effect of such deviations was to render system building even less competitive in comparison to traditional building. [96] In 1964 Interbuild cited as a prime case of the irrationality and reluctance of local authorities to accept the implications of technological change the withdrawal from a 700,000 pound system building contract by a council only a fortnight after it had initially approved the contract. [97] In 1965 a specialist with a "carefully designed" housing system, Housing Development and Construction Ltd, withdrew from system building. The reason offered by the Chair of the firm for his early departure from system building was the difficulty in dealing with local authorities:

> "In the municipal housing market one is dealing with laymen... I have been appalled and shocked at some of the questions... all we get from the biggest potential market is procrastination and a lot of waste of time"[98]

The opinion of one particularly heavy investor in system building, Maurice Laing, was that government policy towards local authorities was too weak: "despite all that it has appeared to say to the contrary, the Government is not prepared to bring the building owner, in the shape of the various local authorities, into line". [99]

While government and industry continually expressed dissatisfaction with local authorities, an equal discontent was felt by many of the authorities being pressured into using system building. Such complaints were conspicuously absent from the building industry and professional journals of the time, but occasionally surfaced in conference reports on industrialised building carried by the Municipal Journal. A group which proved particularly resistant to industrialised building systems was the rural district councils. In 1951 a deputation from three Cotswolds R.D.C.'s visited the Minister of Housing and Local Government with a request that they should be allowed to build in traditional methods using the local stone. [100] Throughout the 1960s an often stated opinion by such authorities was that, in the words of the representative of the Thingo (W.Sussex) R.D.C. "it was the duty of councils in places like Liverpool and Manchester to Break away from traditional building". [101] According to the Engineer, Surveyor and Architect for Warmly R.D.C., A.Chubb, the:

> "problems of planning for dense urban areas should be separated from planning for rural areas... this division would save rural districts endless talk on industrialised building and housing consortia"[102]

The Housing Centre Trust conference in July 1964 found a number of delegates from both urban and rural councils sceptical of the benefits of the large system building contracts that were being let by the "pioneering" large urban councils such as Liverpool and the L.C.C. [103]

At the 1966 Annual Conference of the Association of Municipal Corporations (A.M.C.) the most sustained public criticism of system building by lay members took place. Many of those present, by now, had actually had experience of system building. The controversy was undoubtedly fuelled by a paper delivered by the Managing Director of a system building firm, W.S.Jones, which criticised local authorities for not rationalising their building policies in order to make the fullest and most efficient use of housing systems and, in a particularly partisan manner, attacked direct labour organisations. [104] The "counter attack" was led by a Wigan Alderman, H.R.Hancock, who stated that, as an authority which had used systems, Wigan had found them to be neither the panacea for the evils of building that Jones had described them to be, nor cheaper than traditional methods. [105] The representative from Reading pointed out that councils had a "justifiable" fear of the possible future maintenance costs of industrialised housing which was not allayed by the apparent refusal of private speculators to depart from traditional methods. [106] However it was left to the Lord Mayor of Norwich, H.Derry, to ask when the building industry intended to rationalise itself and reduce the 240 systems available to a reasonable number which were proven and economic:

> "How can we evaluate all 240 systems and know which is the most economic... it is not in this year 1966 economical at all to go in for industrialised systems. In my authority we can build traditional homes and traditional flats in very nearly the same time as it

takes to put up industrialised buildings at something of the order of 600 or 700 pounds cheaper for two bedroomed accommodation... I am suggesting to the building industry it ought to rationalise itself and it ought to decide which are the best systems... because until costs are reduced considerably my authority is prepared to fight the Ministry in relation to the threat in the White Paper"[107]

Local authority fears cannot have been allayed by the A.M.C. which, in July 1965, six months before Crossman launched his drive, reported that it had approached the M.H.L.G. for the provision of financial assistance to local authorities who found their first attempts with building systems had not provided the savings that they had been led to expect. [108]

III.

The response of local authorities to system building was varied. Authorities with large building programmes, and the necessary technical resources, relied heavily on system building and provided the market which enabled sponsors to establish their products in Britain. The partial monopolization housing programmes by a single sponsor took place in cities other than Coventry. By May 1960, Laing had built 59% of Carlisle's 4,935 municipal dwellings and two years later completed the 8,000th Easiform house for Leicester. [109] For five years, between 1963 and 1968, the Unit Construction Co. produced 10 flats each week for Liverpool Council in the Camus system. [110] Indeed, the forging of close alliances between individual cities and system building firms is cited by Gosschalk as a major factor behind the profitability of those systems that were commercially successful. [111]

However, an opposing tendency was local authority resistance to government and industry efforts to achieve a permanent change in housebuilding methods. While many consortia were set up they achieved very little in the way of providing large building programmes for system builders. The reasons for which local authorities rejected system building were various and included a reluctance to alter building policies to conform to the disciplines of system building, a fear of eventual maintenance problems, a distaste for its visual monotony, and a distrust of the system building market which they felt to be disorganised and overpopulated with untried building methods.

In particular, local authorities complained of the greater expense of system building. At the height of the 1965 industrialised building drive the architect to the G.L.C., an authority committed to, and very experienced in system building, admitted that although it had hoped for cost savings through system building, "The results of tenders received to date do not bear this out". [112] For some authorities, with massive building programmes and shortages of labour, the absence of a cost advantage did not seem to be sufficient discouragment from using system building while to others, with perhaps a lesser burden on their building resources, it was presented as a major objection. The cheapening of system building in the mid-1970s (according to official figures in Table VII) did not prevent an accompanying abandonment of new metheds as overall housing programmes fell. Indeed, the conclusion which might be drawn from this is that, so far as the use of new building technology by the bulk of housing authorities was concerned, its usefulness as a means of discharging unprecedentedly large housing programmes was of equal importance to marginal cost comparisons.

CHAPTER FOUR. THE RHETORIC OF MASS PRODUCTION.

In 1945 the Minister of Health, Aneurin Bevan, informed an audience in Birmingham that:

> "I have been looking eagerly, ever since I took office, for some system of prefabrication which would enable us to build houses in the same way as cars and aeroplanes. So far my search has been in vain, but I do not despair"[1]

Bevan was but one of a number of housing ministers and experts to see mass production as the solution to the 'housing problem'. This chapter will attempt to explain why a link was repeatedly made between methods of production used by manufacturing industry and the provision of social housing and why this link proved so attractive to 20th Century politicians and housing experts.

I. STANDARDISATION AND THE HOUSING PROBLEM.

The notion of applying mass production to building seems to have been peculiar to the 20th Century. The solution to 'the housing question' was discussed by Frederick Engels in 1872. Although Engels argued that the development of manufacturing technique and the subsequent urbanisation of society had created the slum, he did not propose a similar revolution in building technique to be its remedy. [2] Indeed, 19th Century attempts to remedy the inability of capitalism to provide adequate housing for all members of society seem to have concentrated on securing cheap methods of finance. Over

100,000 rooms were built by the 5% philanthropy movement between 1841 and 1914 which provided housing at modest rents by borrowing capital at low interest rates. [3] A similar solution was proposed by the Garden City Movement which sought to finance housing for the labouring classes by using the capital created by increases in land values consequent on developing a garden city. By this means 11,000 houses were built prior to the Great War. [4] The inability of these methods to solve 'the housing problem' was demonstrated by eventual state intervention in housing provision during the latter years of the 19th Century. Like previous initiatives, this intervention took the form of low interest loans, on this occasion by the state to local authorities. [5]

The 19th Century lack of interest in adapting the principles of large scale manufacture to dwelling construction probably arose from the general level of tecnological development in manufacturing industry. The application of machinery to manufacture had been a feature of industrial development for many centuries and the moving line and mass production were techniques used throughout the 19th century. As early as 1829 Thomas Carlisle desribed his times as "the Age of Machinery, in every outward and inward sense of that word". [6] Nevertheless, despite Carlisle's awareness of the technological transformation in industry wrought by the industrial revolution, the application of large scale production methods to complex artefacts for mass consumption came only in the latter years of the 19th Century with a second phase of industrial development.

According to Hobsbawm, this was characterised by the growth of a new generation of science based industries, the systematic extension of the factory system, an increase in the scale of economic enterprise and the discovery that the "largest potential market was to be found in the rising incomes of the mass of the working citizens in economically developed countries". [7]

The technology of working class housing received increased attention in the early years of the 20th Century largely as a result of the identification of 'the housing problem' and early attempts to solve it. Between 1905 and 1908 three exhibitions were held in Britain to "demonstrate the cost-reducing potential of new methods for cottage building", [8] at which many novel and patent methods of construction were demonstrated. In 1905 J.Cornes described technological changes that were taking place to cheapen cottage construction in order to "erect healthy, sanitary, well-lighted and attractive homes which will pay interest and return the capital... at such rentals as the class of people for whom they are intended can pay". [9] These changes consisted of reductions in the costs of traditional techniques by using thinner walls, smaller roof timbers and, where stringent bye-laws allowed, the increased use of fireproof timber construction. A further experiment which took place in 1905 was the construction of a block of apartments in Liverpool by the City Engineer, J.A.Brodie, in a steel framework clothed in precast concrete panels. [10] The first decade of the 20th Century also saw the continual urging by W.Thomson, author of <u>The Housing</u>

Handbook Up-To-Date (1907) "that the cost of production of the dwelling, like that of other manufactured articles, ought to be capable of reduction as a result of experiment and production on a large scale". [11]

Subsequent discussion on the application of manufacturing techniques to housing seems to have been considerably influenced by two early 20th century developments in methods of business organisation and manufacture: Scientific Management and the assembly line. The study of the rationalisation of operations within the workplace developed in America during the latter decades of the 19th Century and in 1895 F.W.Taylor began lecturing and publishing his theories on Scientific Management. [12] The basis of Taylor's theory was that the productivity of each worker would be maximised by management prescribing, as a result of exact measurement and detailed study, the most efficient way of carrying out any working operation. [13] Taylor's ideas gained considerable prominence in the American efficiency craze of the decade following 1910, making a fundamental impact on industrial methods and popular consciousness. [14] The innovation in industrial methods, the assembly line, took place in the automobile industry, itself a product of the late 19th Century phase of industrialisation. The success of the Ford Motor Co. was initially based on the identification of a mass market for cheap motor cars. This market was exploited by designing a standard model which could be produced in large volumes. By 1913 this strategy had proved successful enough to allow Henry Ford to begin the application of moving line techniques to the manufacture of standardised components. The assembly line brought the task to the worker, thereby eliminating fetching and carrying. With the aid of "scientific study", the worker's task was reduced to the simplest and most repetitive operation: "He does as nearly as possible only one thing with only one movement". [15] Both the conveyance of the task to a stationary point and the rationalisation of its execution to one repeated movement allowed the introduction of machinery. Ford's motor operation combined the three prerequisites essential to the mass production of complex artefacts: the identification of a market large enough to support volume production, the standardisation of components to the minimum number of variations and the accumulation of sufficient capital to invest in expensive, but eventually cost reducing mechanised production plant.

The wider dissemination of these products of American industrial development was fostered by the destabilisation of Europe following the First World War. The 1917 Russian revolution was followed in 1918 by revolution in Germany and widespread social unrest in the majority of the beligerent nations. [16] In Britain, a victor of the war, industrial unrest followed the armistice culminating in major disputes in the power and transport industries. The severity of this unrest was the cause of renewed commitment to social housing by the state. [17] A feature of this crisis was the promotion of advanced methods of industrial organisation as the means of providing the wealth required to satisfy the demands of labour without fundamentally altering the social and economic system. As J.Merkel pointed out, the ideas promoted by Taylor and Ford possessed considerable attractions to politicians:

> "The Scientific Management doctrine of technocratic control, central planning, and high productivity, leading to a golden age of mass-production in which high levels of material consumption would banish class emnity and create permanent social harmony, had a core of truth that made it a powerful doctrine in the political sphere" (1980)[18]

If standardisation and the assembly line had cheapened the motorcar to the point of enabling it to become an article of mass consumption, then, in the view of a number of politicians and housing experts, it could do the same for housing. By 1916 the architect S.D.Adshead, a member of the Liverpool Group of architects had come to the opinion that "The cost of producing a simple article of commerce depends very largely upon the number of similar articles produced... this holds good with standard cottages". [19] In 'The Standard Cottage' (1916), Adshead proposed a method of lightweight wall construction combining brick, concrete and a light steel frame "which would be extremely economical" if allied with standardised cottage design and "if a big repetition could be ensured". A more direct reference to the social benefits to be gained by the application of Ford's production methods to housing was made by Pemberton Billing M.P. in a speech to the House of Commons in 1919:

> "As regards motorcars Mr Ford, the American, has taught what can be done by standardising them, and I

submit it would be possible to standardise every door and every window frame, to make them by the hundreds and thousands in Government factories and thus get rid of a good many difficulties... if next winter finds us where last winter found us, the social state of this country will be far more serious than it is today"[20]

The post First World War re-evaluation of housing production was also prompted by increased state intervention in housing provision. The state now had a direct interest in the means by which housing was produced. In the 1917 Tudor Walters report, which examined the implications of mounting a large publicly funded housing programme, building technology formed a significant element. The section on "Economy in Construction" stated of the 19th Century that: "while science and skill were devoted in ever-increasing measure to the development of industrial processes, no such attention was paid to housebuilding". [21] In the opinion of the Committee, housebuilding should be the product of up-to-date methods of "business organisation, scientific costing, standardisation, etc., which have been found effective in other industries". [22] While the Tudor Walters Committee did not consider the degree of standardisation found in automobile manufacture to be appropriate to good dwelling design, it nevertheless recommended the adoption of a range of standardised plans, window and door opening sizes, and fixtures and fittings. The postwar interest of government in housing technology also gave rise to the appointment of the Building Materials Research Board (B.R.M.B.) by the Department of Scientific and Industrial

Research, (D.S.I.R.) itself a result of the state's wartime interest in promoting technological advance in industry. [23] In 1920 the B.R.M.B. was replaced by the Building Research Board (B.R.B.) at the behest of the Standardisation and New Methods of Construction Committee formed to examine methods of circumventing acute shortages in skilled building labour, and consider the benefits to be gained by standardising building components. The B.R.B. was created as a permanent state body to carry out research into building materials and experiment in new methods of construction. In 1921 a modest research station was set up at Acton which later became the Building Research Station (B.R.S.). [24] The state maintained its keen interest in housing technology thoughout the interwar period, partly because of recurrent shortages in skilled building labour, and partly because of its continued involvement in low cost housing provision. In 1924, a government committee on Methods of House Construction (1924) reported on the steel clad housing system being promoted by Lord Weir and noted with interest the fact that it had been designed with "a view to adopting such methods of standardisation as will lead to cheapness in large scale production and to rapidity of building". [25] In its report on the industrial dispute following the introduction of the house, [Ch.IV] the government court of enquiry found against the unions stating that:

> "In the ordinary course of the progressive evolution of industry changes are made, as a means of increasing the volume of production and lowering the cost, which have the effect of substituting standardisation and

mechanical processes for the individual effort of the skilled craftsman. The whole history of modern industrial development in this country and elsewhere shows that this is true"(1925)[26]

II. HOUSING PRODUCTION THEORY AND THE MODERN MOVEMENT.

The prolonged depression of the 1930s saw an intensified interest in the concept of mass producing houses. From 1921 onwards unemployment remained high. However, in 1929 the Wall Street Crash precipitated the longest and most severe slump hitherto experienced by industrially developed economies. [27] By 1931 world trade had fallen below that of 1913. [28] Within a scenario of world economic stagnation Britain fared particularly badly. According to A.Madison it experienced the highest levels of unemployment in Europe. [29] Nevertheless, despite the severity of the interwar depression in staple industries, such as heavy engineering and textiles, more recently established areas of the British economy, such as synthetic yarns, cars, and electrical goods, thrived. The combination of new forms of employment and a reduction in the cost of living which accompanied falling world commodity prices created new areas of affluence in the Midlands and South East able to enjoy the mass products of new manufacturing industries. [30] Typical of these was the growth in the annual output of the British automobile industry from 34,000 cars and trucks in 1913, to nearly half a million in 1937. [31] While not able to provide for all, the more technologically advanced aspects of the industrial system were providing in unprecedented and very evident abundance for many. Rather than proposing fundamental changes in the structure of society, the solution which an increasing number of politicians, scientists and housing experts proposed to alleviate inequities in provision was the wider distribution of the fruits of new technology. Nowhere was this proposed more vigorously than in housing production. Typical of this interest in the relationship between technology and social progress was the Social Relations of Science Movement which "seemed to dominate the British scientific world between 1932 and 1945" and advocated scientific rationality as the means towards creating a utopian society of abundant provision and the erosion of social conflict. [32]

The consideration of housing production during the 1930s was encouraged, and its tenor influenced, by the dissemination of the European Modern Movement in Britain. The rapid industrial expansion of Germany following unification in 1871 and its tradition of planned state industrial development and scientifically biased education system provided strong encouragement to industrial innovation. [33] Indeed, German industry took a world lead in many of the new late 19th Century science based industries, such as electrical and chemical manufacture. The principles of standardisation and industrial efficiency promoted by Taylor and Ford were adopted by areas of German and French engineering industry during the early years of the 20th Century. [34] By 1910 the German architect, Walter Gropius, was advocating the mass production of housing through the standardisation of products as had been achieved in automobile and machinery manufacture. [35] The years which followed the end of the First World War intensified the relationship between architectural theory and models of industrial production. Architects such as Charles-Edouard Jeanneret (later Le Corbusier) advocated Taylorisation as the means of physical reconstruction in France. [36] The imperative for the new Weimar Republic to rebuild its economy and prevent a recurrance of the social instability which had followed the war caused it to become the most technologically innovative nation in Europe. In 1921, a grouping of German state officials, industrialists, engineers and academics formed the National Board for Efficiency, with the aim of aiding a major reform of German industry in accordance with the latest principles of American management theory. [37] This movement, known as German Rationalisation, contributed greatly to the formation of architectural theory during the 1920s. The outcome of the interelation between Rationalisation and architectural design was the Neues Bauen, a movement which adopted models of industrial organisation for a series of low cost state housing developments in the larger industrial cities of the Weimar Republic. [38] With the political ascendancy of the National Socialist Party after 1933, under which architectural theories associated with Bolshevism were outlawed, a number of Neues Bauen architects sought refuge in Britain and America. This group of architects and theorists assiduously propagandised what since the late 1920s was known as the Modern Movement. [39]

Throughout the 1930s a number of British architects and housing experts discussed building production technology integrating technical theories with a political programme intended to ensure adequate housing provision to all classes of society. A characteristic of the models of production proposed was that they anticipated the pattern of housing production adopted by the postwar Welfare State, calling for the central organisation of building to provide markets large enough for mass production. In 1934, F.R.S.Yorke stated that he was confident that the solution to 'the housing problem' lay in factory production of standardised building components:

> "It seems that the provision of the economical house of good quality can only be made possible through rigid standardisation and prefabrication... The low cost house will be manufactured as a whole, or in parts, in central factories and assembled on the site. Production will be similar to that of the automobile. Design will be dictated not only by convenience and efficiency but by economical machine production, handling and distribution"[40]

Writing five years later, Yorke acknowledged that the realisation of his vision was not practicable within the current pattern of demand for new building. The tendency for buildings to be commissioned singly from the architect "leaving to posterity a series of little monuments that are scarcely seen in the chaos", [41] and the domination of production by individual commercial producers made the scale of production required by mass production unrealisable. However, a role was identified by Yorke for both the architect and the state which he felt pointed to the way forward. For the architect, able to unite industrial technique with design, "it is the common people who now most need his services", and for the state, a willingness to involve itself in the production of buildings: "The job is too big for the individual, and a government cannot undertake the work while it is reluctant to compete with him". [42]

During the Second World War a group of experts purported to devote itself to a concentrated programme of research into the benefits and implications of the proper application of scientific methods to house production. The conclusion to which the Committee for the Industrial and Scientific Provision of Housing (C.I.S.P.H.) came was that under advanced industrial conditions of production housing would no longer be an expensive capital investment but an artefact of everyday consumption available in superabundance. C.I.S.P.H. originated with the consideration by Raymond Perry, an industrial economist and administrator, "of the social importance of a rapid housebuilding programme" [43] to follow the Second World War. Perry then embarked on the research for a thesis on the application of machinery to "the enclosure of space for human consumption", [44] leading eventually to the formation of the Committee in November 1941. Perry, and an early architect collaborator, Dennis Clarke Hall, then approached Harry Weston, who, as well as being the owner of a machine tools business, was the chair of Coventry's Housing Committee, thereby providing Perry and Hall with an influential connection in the field of social housing:

"So they came to tell me all about it and I was rather proud. And I can remember when they asked me if I'd take the chair at the first meeting, which I did... Well now that meeting was a real sensation. All those clever men with only the thought of the country at heart, comparing notes, giving their suggestions. It would have cost millions of pounds to have set up a committee like that. This was free"[45]

C.I.S.P.H.'s premise was that the basis of traditional construction in craft technique, involving as it did the putting together of building parts and pieces with a large degree of cutting and fashioning, all by hand, "sets by itself a certain limit to the rationalisation" of building operations. [46] What it proposed was a revolutionary approach to housing provision. In October 1943, Perry submitted a memorandum to the M.O.H. on 'The Limitation of Life of Houses: its Industrial and Economic Implications' which, current with the Ministry's consideration of a temporary housing programme, presented the Committee's views on housing production. As with most informed discussion on the subject C.I.S.P.H. acknowledged that a secure and large market must be obtained prior to production in order to amortize the capital costs of development and manufacturing plant, "after which production becomes unbelievably cheap". Using the example of the light bulb, the cost of which through mass production had been lowered to a two/hundredth of its original price, the memorandum stated that house production would follow the "common curve" of price reduction. The cost of a 1,000 sq.ft. house "with a hitherto undreamed-of amenity standard" would cost between only 300 and 350 pounds at prewar prices. The revolutionary implication of such a cheapening of the dwelling on the property market was also noted by Perry;

> "by a small capital payment and continued income payments a man becomes a consumer of motor cars. This position has been brought about entirely by the application of quantity production... If the idea of permanence in a house be once abandoned and particularly its permanent association with the land upon which it is built, similar conditions begin to apply, and if the quantity production element can be brought in as well the analogy is complete"[47]

In its first report, published in January, 1943, the Committee gave considerable space to the discussion of ways in which the work of firms involved in the production of house parts could be "co-ordinated both technically and in terms of production schedules". [48] The solution to this problem, the Committee felt, lay in the establishment of a Housing Production Council, relying on the donations of industry and operated by a full time staff. In 1944, with the publication of its second report, an extensive analysis of existing systems of construction, the Committee dissolved itself and founded in its own place the Housing Production Society comprising 15 members, many of whom were on the original committee. [49] However, this initiative seems to have petered out and Weston explains that soon after the war the architect members of the Society left to begin their work on practical rebuilding projects. [50]

The rebuilding programme following the Second World War provided the opportunity for Modern Movement architects to apply their ideas in practice. Maxwell Fry, writing towards the end of the Second World War, considered the marketing problem described by Yorke more optimistically. In Fine Building (1944), which looked forward to the contribution which modern architecture could make to the era of reconstruction, Fry, like Yorke, pointed out the significance of marketing to the success of mass production through reference to the example of Henry Ford:

> "When Henry Ford built his first 'T' model Ford, the beloved old boneshaker... he assumed a demand... he assumed that the need was widespread and varied only within narrow limits: that was the standard need. On this he based his production"[51]

The extent of the market identified by Ford, Fry suggested, had now been forced onto the nation by the Second World War: four years without "serious" town building and four years of bomb destruction concentrated in major cities. The demand that the war had created was so great and the social imperative for rebuilding such that standardisation and mass production would have to be extended to all parts of the building. Taking as his hypothetical case a standardised bathroom and kitchen Fry insisted that there was not:

> "a first class industrialist in the country who would not agree that if we could standardise five such models - five and no more - and get them adopted by

five big cities for use in their rebuilding over a term of ten years, that a kitchen better than the best in the Ideal Home could not be brought within the means of all who need them. It was by such means that Ford made his 'T' model universal"[52]

A review of C.I.S.P.H.'s pedigree suggests that the philosophy of scientific housing production was shared by a range of influential figures. For instance, the membership of C.I.S.P.H. included the following: Harry Weston, the Chair of a major Midland Housing Committee; Ove Arup and F.J.Samuely, both of whom practised successfully as structural engineers during the war; Max Lock, who taught at the Architectural Association; Lewis Silkin, a member of the Central Housing Advisory Committee to the M.O.H.; D.E.E.Gibson, City Architect to Coventry; Edric Neel, who upon leaving C.I.S.P.H. initiated the Arcon group, and Elizabeth Denby, author of Europe Rehoused, a widely read survey of social housing programmes in interwar Europe. [53] Furthermore, Weston describes Lord Portal, the Minister of Works responsible for the production of the Temporary Housing Programme, as a frequent and "valuable" attender of the Committee's meetings and refers to a visit he made to London to explain C.I.S.P.H.'s ideas to a special meeting of the House of Commons. [54] The Second World War saw a wide range of architects and influential figures participating in discussions on standardisation and prefabrication. If the membership of C.I.S.P.H. is any indication, the ideal of compensating for inequities in housing provision through mass production was upheld by a number of individuals able to exert a considerable influence on the formation of state housing production theories.

III. THE PREFABRICATION MOVEMENT.

During the Second World War prefabrication became a popular issue in discussions on the physical reconstruction of the nation. As the Royal Institute of Architects of Ireland commented in 1945: "Unquestionably prefabrication, more than any other aspect of building has excited public interest in recent years". [55] Indeed the subject of prefabrication was even raised by the Workers' Education Council as a topic of conversation in the 'Houses and Towns We Live In' series. [56] The catalyst which pushed prefabrication to the forefront of discussion was the Second World War, which focussed opinion on housing issues and the role of technology in economic development.

The model of technocratic success focussed upon during the war was provided by Britain's ally, America. Whereas the Continent, in particular Germany and France, had served as the prewar focus of modern architectural theory, interest shifted to the contribution to housing technology made by the U.S.A. This interest was to colour developments in Britain and was encouraged as a matter of policy by the War Cabinet. In a report, 'British Ignorance of America', prepared by the Committee on Reconstruction Problems, it was pointed out that the lack of knowledge of American achievements - bred by the popular press concentrating on Vaudeville and prohibition gangsters - fostered "mutual misunderstanding and suspicions which tend to hamper a co-operative war effort". [57] A programme of propaganda was then proposed, utilising all the avenues of popular communication including radio, the press, films and school education, to concentrate attention on American contributions to cultural, scientific and industrial progress. The intentions of the government were fulfilled by journalists such as Alistair Cooke who began his highly successful career in broadcasting the "passions, the manners, the flavour" of the American way of life to an eager British audience by taking up the position of Special Correspondent to the B.B.C. on American affairs in 1938 and launching his 'Letters from America' in 1946. [58]

One American development seized upon by the British architectural press was the use of prefabricated timber housing in the welfare programmes of the Tennessee Valley Authority (T.V.A.). One of the first of many articles on this subject appeared in <u>Architectural Design</u> in September 1941, which reported on the "cottages" produced in the T.V.A.'s workshops assembled from four prefabricated sections and taken to site on standard trucks. [59] Indeed, if a precedent is to be sought for the Temporary Housing Programme then this was it. The aluminium bungalow, produced by the aircraft industry as part of the Temporary Housing Programme, used an identical concept of construction, albeit translated into aluminium: it was manufactured in four complete sections in the factory and transported to site on derequisitioned aircraft trailers. [60] In 1942, <u>The Builder</u> concluded that the "panel and caravan" types of temporary prefabricated house, produced under the American government's Defense Housing Programme "will most probably be the prototypes for any adopted over here". [61]

The interest excited by American building techniques prompted the dispatch of two missions to observe their methods at first hand. The first of these reported directly to the Minister of Works in 1944, [62] and the second was sent in 1949 by the Anglo American Productivity Council, itself a product of British interest in American industrial organisation. [63] Indeed, the first years of peace saw the establishment of the Urwick Committee, (headed by Lyndale Urwick the propagandist of Taylorism in Britain and eventually Chair of the British Institute of Management), which established a national syllabus for the teaching of management theory in 1947. [64] While Urwick had complained that there was little real understanding and adoption of Scientific Management by industry in Britain during the interwar years, the late 1940s saw the beginning of a process whereby American Business theory began to permeate management techniques at every level of British industry and public administration. [65&66]

The contribution which transatlantic industrial technique made to the war effort was noted by Alfred Bosson M.P. in 1944, who claimed that prefabrication had reduced the assembly time of the Liberty Ship to three to four days, and proposed that such methods should be used to tackle the postwar housing problem in Britain. [67] The methods adopted for the Liberty ships were also used in Britain and the technique of prefabrication became a familiar feature of the war effort. Belman demountable hangers and transportable

Bailey Bridges all relied on the use of structural units individually manufactured and coupled together insitu. In an attempt to increase the anti-submarine fleet, 110 frigates and 200 tugs were "mass produced" by 76 firms contributing large prefabricated parts. [68] By the end of the war, Ford's assembly line had invaded vastly expanded industries, many of which experienced a phase of accelerated development. Typical of these was aircraft manufacture. Whereas prewar aircraft production methods were crude by comparison with the American automobile industry, the war's end saw aeroplanes rolling off assembly lines in vast numbers - a product of industrial co-operation relying on the production of standard components by numerous subcontractors. [69] The words "standardisation", "mass production" and "prefabrication" became everyday terms in the prosecution of the war effort and in the vocabulary of those, including architects, who looked on. Such was the interest aroused in this subject that the formation of C.I.S.P.H. was welcomed by the Architectural Review as a possible means of translating the "ceaseless talk, talk, talk" on prefabrication into positive action. [70] Small wonder that by June 1943, the Architects Journal couched its remedy for reconstruction in singular terms: "There is one solution only to the problems of post-war housing. It can be expressed in three words - use the machine". [71]

By 1948 the Interdepartmental Committee on New Methods of House Construction had vetted 101 of the non traditional housing systems which the government hoped would expand housing supply. While all of these departed from conventional construction, very few utilised prefabrication extensively, [72] and many were of insitu poured concrete. Prefabrication was used to a greater degree in the Temporary Housing Programme, but only one model, the A.I.R.O.H. bungalow, actually consisted of large factory made units. Nevertheless the majority of non traditional dwellings used new materials (such as concrete, steel and laminates) and familiar materials (such as timber) in new ways to replace labour intensive craft processes. While the houses themselves were not prefabricated, prefabrication was used to a larger extent in the preparation of the parts and materials of which they were built. More important than the real extent of the application of mechanised techniques was the innovative nature of the materials and methods of construction used. The fact that the houses were sponsored by commercial concerns - often from engineering industry - and appeared as standard models in the manner of automobiles made them very distinct from traditional construction.

Although not mass produced, these new methods of construction were promoted by the advocates of scientific methods of housing production as the beginnings of the major change in building technique forecast by the Modern Movement. In 1946 a spate of publications appeared all devoted to prefabrication. The content of these publications was characterised by two features; a conviction that factory made houses had arrived and an optimism that this tendency could only continue in the future. In a survey of the systems produced both in America and latterly in Britain - Prefabrication in Building - Richard Sheppard, later to become a noted postwar architect, introduced the reader to the subject by pointing out that the book did not consider the merits of the argument for prefabrication as this was no longer necessary:

> "It does not question the feasibility of prefabrication and such a discussion is now largely academic, for it has been amply demonstrated that efficient buildings can be constructed from mass produced factory units. Prefabrication is no longer a possibility but a fact"[73]

J.Madge, editor of a "practical book written for practical men", commented of the A.I.R.O.H. bungalow, constructed by a consortium of aircraft firms, that although it did not have the beauty of the Spitfire,

> "the minds which have created the modern aircraft have turned their attention to the solution of an almost equally urgent problem. In so doing they have produced a design which is more completely prefabricated than any which has so far appeared... the substance of the method may equally well be applied in the future to the provision of permanent homes"[74]

The interest excited by the revolutionary aspects of the Temporary Housing Programme prompted the Women's Group on Public Welfare, an organisation committed to the alleviation of domestic labour, to carry out a study of the temporary bungalow's effects on domestic labour for the Ninth Scientific Management Congress held in Brussels in 1951.[75]

The tendency to make a firm distinction between the new and the old in building technology, and by implication, the new and the old in social policy, was seized upon by the state. On many occasions politicians demonstrated an enthusiasm for new building methods, which can only have served to aid the acceptance of new housing methods by reluctanct local authorities and a possibly apprehensive working class. In 1944, Winston Churchill described the proposed temporary bungalow as "far superior to the ordinary cottage". [76] The suggestion that new ways of building were at least as good, if not superior to old, was repeated in Parliament by the Secretary of State for Scotland who said this of the M.O.W. prototype bungalow exhibited outside the Tate "I have been inside the house which struck me as splendid. The gadgets, the health conditions - everything splendid". (1944) [77] The Temporary Bungalow was particularly focussed on by politicians as the embodiment of the state's ideal of scientific progress applied to the "tasks of peace". As Dr.R.Stradling M.P., formerly the Director of the B.R.S., pointed out to Parliament, "this bungalow has had more attention in matters of detail than any house or bungalow has ever had before. It is probably more scientifically correct than any house has ever been". [78] When describing the progress made in house design since the war at the Ideal Home Exhibition at Olympia in 1948 the M.O.H. described the Temporary Bungalow in the following terms: "really they are luxury flats on the ground", and proudly announced that "in prefabrication Britain now leads the world". [79]

While the affection of politicians for new housing technology could be understood as expediency, it was undoubtedly fuelled by the government's wartime recognition of the role of scientific research. According to N.Vig, it was the Second World War which constituted "the great turning point in government-science relations". [80] Wartime scientific and technical developments had been seen to make a crucial contribution to the outcome of the war, and scientists and engineers came to play a significant part in operational strategy and tactics. In 1945, Herbert Morrison, Lord President of the Council, proclaimed that:

> "The Government attach the very greatest importance to science. We recognise the contribution which science made to the prosecution of the war and the achievement of victory, and we are no less desirous that science shall play its part in the constructive tasks of peace and of economic advancement and progress"[81]

The war firmly placed scientific invention and technological advance in the minds of politicians as the means of ensuring a continuation of economic growth. It could be said that while the formation of the Welfare State guaranteed a more equal distribution of wealth without fundamental social change, it could not of itself guarantee the continually rising levels of consumption essential to maintain unity in a stratified society. If technological innovation had ensured the survival of the state in war then, allied to welfarism, it might ensure the survival of the state in peace. A sure belief in the benefits which scientific advance could bring to the embryonic Welfare State prompted Aneurin Bevan, on taking office as Minister of Health in

1945, to embark upon his search for a method of mass producing housing. Soon after he was forced to admit that he was as yet unsuccessful, but he reassured those among the electorate unconvinced that welfarism would prove capable of satisfying their housing needs:

"The age we live in will surely be known as the age of invention... the skill and ingenuity of our technicians can revolutionise housing as they have revolutionised so many other undertakings"[82]

IV. THE MODERNISATION OF BRITAIN.

During the 1950s popular discussion on prefabrication and mass production subsided. Like the enthusiasts who had formed C.I.S.P.H., architects were preoccupied with designing the buildings with which Britain was reconstructed. Throughout the 1950s the further application of the philosophy of prefabrication was concentrated on educational schoolbuilding programmes and it was in this field that many of the advocates of new methods of building worked. Nevertheless, despite a lessened prominence, prefabrication continued to arouse interest. In 1951, the Building Research Congress was held on the subject of The Influence of Mechanisation and Prefabrication on Techniques and Costs of Building. [83] The rationality of prefabrication also had a particular appeal to the postwar generation of newly trained architects. As the Principal of the Architectural Association, M.Pattric, pointed out in 1956, "Generally speaking, the idea of prefabricated building appeals to students and they find it difficult to understand how a system of construction which is so obviously cheaper in theory is not more used". [84]

While the 1950s saw a lessening of the rhetoric of mass production in relation to building methods in the speeches of politicians, it is evident that state interest in science and technology grew. Indeed, according to A.King, this took place on an international scale as a result of the relatively recent appraisal of the role of science in economic development and a tendency to make international comparisons of research expenditure which "provided an international ranking order somewhat like a football league table... the United States, at the top, was the pacemaker". [85] The culmination of the 1950s embodiment of science and technology into state policy was the appointment of Quentin Hogg (Lord Hailsham) as Minister for Science, a new ministerial post created by the Macmillan Government in 1959. In Science and Politics Hogg described the process by which:

> "This expansion of Government provision, this development of the political interest in the scientific, has rested upon the clear demonstration that a nation's power to prosper in peace, survive in war, and command the respect of its neighbours, depends very largely on its degree of scientific and technological advance"[86]

The 1960s saw the identification of a new role for technology by the state in 'The Modernisation of Britain'. The aims of this programme of rapid techological change were to accelerate economic growth to levels enjoyed by Britain's neighbours on the Continent and halt the nation's relative decline as a world economic power. Indeed, the government's Indicative Planning policies of the 1960s, previousy discussed in Chapter One, were an aspect of what was intended as a larger reform of the British economy. As M. Shanks pointed out, by 1963, the year in which the N.E.D.C. was formed, the need to effect technological reform had become urgent - the existing system was simply not producing the goods fast enough:

"if existing productivity trends in the various countries were to continue, by the early 1970s the average Briton would find himself worse off than almost all his Continental cousins, and on a roughly comparable level with the average Russian, Venezuelan or Israeli"[87]

A response of the state to this latter crisis of capitalism was to focus attention on the benefits to be gained by dramatic advances in technology. The intention to pursue 'The Modernisation of Britain' programme was announced by the Conservative Government at the opening of the 1963 session of Parliament. [88] While writers, such as N.Vig, have characterised this policy as little more than an electoral manoeuvre, "an element of style rather than substance", [89] it is evident that it reflected a broader movement towards regarding technology as the panacea to economic and social problems among the political and intellectual establishment. As H.&S.Rose point out, the 1960s saw the birth of science policy journals, such as Minerva and the formation of the Science of Science group on the lines of the Social Relations of Science movement of the 1930s. [90]

The idea that a 'revolution' in building techniques would accompany the 'Modernisation of Britain' was advocated first by Conservative politicians and began with the introduction of their industrialised building policy. In this, it is significant that system building was identified as 'revolutionary' - in a manner similar to that during the 1940s, rather than as a trend in the construction of social housing which had developed since the Second World War. Politicians such as Geoffrey Rippon, Minister of Works, displayed a degree of enthusiasm in system building which was more the product of faith in techniques as yet unproven than a realistic assessment of a quickening in the development of housebuilding technology. Nevertheless, by focussing on the "miraculous" qualities of system building Rippon at once validated current beliefs in the role of technology and gained support for measures designed to reform the production methods of social housing. Furthermore he drew the nation's attention to the progressiveness of Conservative technical policy. Thus, in 1963, Rippon enthusiastically announced to Parliament that the gradual evolution of traditional technology would no longer satisfy the pace of change demanded by Conservative policy:

> "progress in increasing output which has been made so far has been achieved without any major change in the characteristic methods of work of the construction industries. If these methods of work could be transformed, we might get increases of output which at

this moment would appear to be almost miraculous. What is needed is something of the nature of an industrial revolution in building"[91]

The rhetoric of 'revolutionary' advance in building technique was no less vigorously promoted by the Labour Party. As Harold Wilson pointed out of Britain's relative industrial decline in 1964, "Without a quickening of innovation and productivity in Britain, the very basis of our social fabric would be endangered". [92] The role of technology in the postwar Labour Party's interpretation of socialism was indicated in Harold Wilson's equation of socialism with science:

"In a recent newspaper interview I was asked what, above all, I associated with socialism in this modern age. I answered that if there was one word I would use to identify modern socialism it was 'science'"[93]

Indeed, Wilson's biographer, Paul Foot, has noted the way in which 'technologism' gradually removed overtly socialist policies from Labour Party policy in the early 1960s: "Perhaps the main change in Labour's home and economic policies between 1959 and 1964 was a shift in emphasis away from traditional welfare demands towards economic growth, efficiency and technocracy". [94] Technology played a major role in Labour's election campaign, minimising the party's identification with sectional working class interests and broadening its appeal to all classes concerned with economic reform. Wilson claimed that "the cities of the future, cities worthy of our people" were to be constructed by "a great breakthrough in science and technology" [95] rather than through the fundamental restructuring of the social and economic system as had been the orthodoxy of Labour Party socialism in previous years and was still demanded by more radical sections of the Party.

When speaking in public, politicians tended to hedge their sometimes dramatic statements of intent regarding the building industry by pointing out that future construction demands would provide more than enough work to keep traditional builders fully occupied. [96] However, senior architects in the public service were less cautious. As K.J.Campbell, housing architect to the L.C.C., pointed out, the "real" reason why industrialised housing systems were being introduced was that traditional building had "run its course" and as a method of housebuilding was now obsolete. [97] Cleeve Barr, Chief Architect to the M.H.L.G., saw changes in social housing technique as having implications beyond this immediate sector of the building market. He hoped that advances in housing technology would eventually serve as an example for the whole industry:

> "There are unique opportunities in housing, which if matched with good design and good quality in building, could act as a catalyst for transforming the industry generally, from its present low state to a highly mechanized level in a comparatively few years"[98]

Given that state housing in 1967 comprised 20% of new building, [99] the pathfinding role identified by Cleeve Barr carries with it some credibility.

Having persuaded itself of the inevitability of technological revolution in building, the state set out to promote this idea among the population at large, and in particular the local authority client. Rather than as a mere substitute for traditional methods of housing supply, system building was urged as an inevitable feature of progress and the contribution that modern science and technology would make to the era of welfare architecture. The means by which these ideas were promoted ranged from conferences which were openly attended to lectures aimed at specific groups. The fervour with which this was mounted was noted by <u>Interbuild</u> in July 1964:

> "A widespread propaganda campaign has been carried out in which the national press, television and even the glossy women's magazines have played their part. The aim was to get the concept of industrialised building accepted by potential clients and the general public and to encourage the building industry to participate joyfully in the increase in industrialised building"[100]

The first major event in this process of persuasion in which government, industry and the architectural profession co-operated was the Cement & Concrete Association conference, 'Houses From the Factory' held at the R.I.B.A. in October 1962. Such was the interest in new building technologies among the building professions and industry that the main lecture theatre was filled and an overflow gathering watched the proceedings on closed circuit television. [101] Addressing the conference, Cleeve Barr presented a highly reduced, but persuasive argument, which tended to ignore the practical complexities of system building and concentrate on the theoretical rationality of prefabrication, setting a style of argument which pervaded lectures and conferences for the remainder of the decade. Rather than being promoted as a means of compensating for shortages in building labour, Cleeve Barr promoted system building as the means by which extra space could be provided in social housing in conformity with the Homes For Today and Tomorrow report published by the M.H.L.G. in 1961. [102] Underlying this was the proposition that, due to the supposedly small labour content in manufacturing prefabricated components, larger wall and floor panels would only incur extra costs in terms of materials, and as concrete was relatively cheap up to 10% more space could be provided by industrialised building at possibly a third to a half of the cost of provision by traditional methods. [103] In later lectures Cleeve Barr simplified this proposition by stating simply that "standardisation can give greater space for very little extra money". Pointing out that concrete panels came in 23 varieties of finish and 57 different colours Cleeve Barr also claimed that it would not be difficult to improve on the quality of traditional building. Furthermore the contribution of the machine would automatically ensure a higher quality of finish:

> "You only have to think for a moment about the quality of factory made goods, which are standardised and produced in large numbers, particularly the standard of finish, to realise this - television sets, motorcars, furniture, office equipment and so on"[104]

By 1963 both Keith Joseph and Geoffrey Rippon were contributing optimistic articles to national newspapers on the forthcoming breakthrough in house building technology, [105] and the next year saw the Deputy Chief Architect of the M.H.L.G., O.J.Cox, delivering lectures throughout the country including one to the South Yorkshire and District Society of Architects titled simply, 'The Revolution in Building', which, according to fashion, drew the attention of the audience to the 'revolutionary' changes in housebuilding technique being enjoyed in social housing.[106]

The conviction that system building was at least as good, if not better than traditional construction was also promoted in speeches of housing politicians and official advice given in ministerial circulars. Circular 28/52, published at the outset of MacMillan's housing drive in 1952, claimed, in the face of the conflicting example of the many reluctant authorities, that non traditional methods "provide thoroughly satisfactory houses at prices fully competitive with traditional methods, and, given judicious and careful lay-out, not less satisfactory appearance". [107] When Brigadier Barraclough, Chair of the Regional (Midland) Housing Production Board, acknowledged that there were "admitted disadvantages" in non-traditional building he received a curt response from Whitehall: "we do not admit any disadvantages in the current models other than the prejudice we have to wear down!". [108]

Such was official policy's enthusiasm for new housing methods that systems were promoted as the means to the fine era of welfare building anticipated by Maxwell Fry in 1944.

In 1963 Rippon extolled system building with an evocation of 18th Century neo-classical town planning:

"industrialised building is perfectly capable of making a proper contribution to the beauty of our towns and villages... you have only to look at a terrace of Georgian or Regency houses to see that uniformity of design and architectural merit can go together. What we have done before we can do again. We are a rich country. We must afford to bring a new deal to those who still live in conditions of dreary squalor; and we can afford good design"[109]

At the very least, as the M.H.L.G. Circular 59/63 impressed upon local authorities, system building would allow current design standards to be maintained: "There is, in fact, no reason why houses built by industrialised building methods need be more standardised than houses built by traditional methods... the use of these components... opens up new opportunities for skilled and imaginative design". (1963) [110] By 1965, the proposition that system building would provide an environment worthy of the Welfare State had been elaborated to suggest that it would allow local authorites to achieve a higher standard of design than if they relied on traditional construction. The logic of this argument was described in Circular 76/65 which proposed, as had Cleeve Barr, that a better quality of finish would be achieved but also that:

"the use of carefully prepared standard designs will release scarce professional time to concentrate on raising the quality of layouts both for industrialised and traditional building... the aim of all authorities should be by careful attention to groupings, layouts and landscaping to use industrialised building to improve the environment"[111]

Furthermore, the same circular gave an incentive for authorities to persevere with the drive, despite any reservations that they might have as to the quality and cost of system building, by suggesting that they would reap the benefits of an eventual transformation in building processes. Circular 76/65 pointed out that "there is a continuing need for industrialisation but the immediate drive is a short term effort aimed at giving the industrialised building programme the best possible conditions to get on its feet". [112] Once on its feet, the Ministry suggested, industrialised building would eventually become cheaper, in the manner of general industrial advance, as larger quantities of increasingly standardised components were produced. As Cleeve Barr had advocated in 1964, initially production of building components would be by the batch, but the ultimate aim was to secure "'flow' production in order to gain the full benefits of industrialisation". [113] Authorities were assured that the Ministry and the N.B.A. were working on improved techniques, although it was also pointed out that their realisation was "not the kind of development in which quick solutions can be expected". [114]. The message was clear. If authorities ignored their reservations and played their part they would be the eventual beneficiaries of the revolution in building methods.

To argue that the notion of inexorable change in building methods was the invention solely of politicians and official architects as the means of implementing their industrialised building policy denies the wider influence which such expectations had among those involved in construction. The developments that were taking place in social housing technique inspired architectural journalists to envisage an Orwellian building scene of future years in which unproductive traditional builders were "swallowed up" by giant building corporations utilising the full benefits of automated production. [115] J.Carter, journalist and Architectural Advisor to the R.I.B.A.Journal, described a future building site devoid of mud and of such clinical precision that it would fully merit a place in the era that lay ahead of a modernised Britain. In years to come Carter envisaged a technocratic society of abundant provision for all classes where "worker and architect, builder and occupant then go back to their ample comfortable homes, to their ample culture-filled, well organized leisure time". The contribution to this scenario of wealth and contentment focussed on by Carter was building technology:

> "a group of (almost) white coated, well paid workers, slotting and dipping standard components into place in rhythmic sequence on an orderly, networked and mechanized site to a faultless programme without mud, mess, sweat or swearing"[116]

1967 was the heyday of industrialised building. The housing programme was still aimed at producing half a million dwellings each year by 1970 and the difficulties of promoting system building were not yet seen as insurmountable. However, the years following Carter's vision saw the inevitability of a revolution in building technology grow less certain and the frustrations of sponsors more acute as the balance of payments crisis prompted cuts in housing expenditure and dispelled optimism that technology was the means to uninhibited economic growth. Significantly, science and technology were relegated to a minor role in Labour's re-election programme of 1966 as the difficulties of achieving the 'Modernisation of Britain' subdued optimistic statements of a scientific revolution. [117] Despite the support which the government still professed towards system building, popular discussion of the subject waned. Between 1967 and 1969 the two journals devoted to the propagation of system building, Interbuild and I.B.S.A.C., ceased publication without a word of explanation to their readership. 1967 saw the highest proportion of new housing tenders approved in system building and 1970 the highest completions. [Tab.II] Thereafter, despite a brief resurgence in the early 1970s, [118] discussion of industrialised building, which had dominated editions for the four years between the creation of the N.B.A. in 1963 and the economic crisis in 1967, is scarcely to be found in the architectural press. Six years later a rare mention in Building Design declared the completion of the last stages of the Thamesmeade Development to be industrialised building's "death rattle". [119]

V.

Despite the currency of theories of mass production in housing, there were many experts who pointed out that expectations of this type were unrealistic. As early as 1919 The Builder pointed out that "The economy to be attained by repetition in building is limited, and cannot be compared to that which can be effected in turning out machines or domestic implements". [120] A similar view was held by the Tudor Walters Report. [121] The point that unwarranted optimism was being invested in prefabrication was made at regular intervals in the subsequent development of new building technology by expert bodies and individual writers. The 1945 report by the Royal Institute of Architects of Ireland which noted the popularity of prefabrication was also sceptical of the benefits claimed, [122] and in 1965 the L.C.C., an authority particularly committed to the use of new methods of housebuilding, admitted that no economic advantages were to be gained from increasing the scale of production in the systems they were using. [123] Indeed, as late as 1965 it was noted by C.Pratten and R.M.Dean that:

> "Economists have long written about economies of large-scale production, and every economics textbook has a section on the subject. Very few, however, give any particular quantitive notion of how important these economies are in any particular industry"[124]

Nevertheless, architects and politicians displayed a recurrent tendency to proselitise the benefits of applying the principles of mass production to housing, forecasting miraculous gains in output and reductions in cost. Developments in manufacturing technique applied to the manufacture of complex artefacts such as cars and aeroplanes served as an example which housing experts found impossible to ignore. It is also significant that the application of these methods to housing production gained particular prominance at times when the political establishment felt the existing social structure to be under pressure. Technology appeared the solution to many 20th Century crises in production, for it offered a solution to insufficiencies in the supply of wealth and inequities in its provision without major changes in the social structure. Where housing formed an important element of policy, prefabrication was proposed as the means of its provision.

By the mid 1960s, politicians such as Geoffrey Rippon and Keith Joseph shared a belief in 'progressive' housing production theory. By adopting the rhetoric of the Modern Movement, politicians involved in housing reinforced their belief in technology and at the same time were able to give weight to their policies concerning the building industry described by Chapter One as central to a government building industry strategy that had developed over many years. Indeed, the argument that a fundamental change in methods of construction would be both beneficial to the client and an inevitable fact of the future building economy was a powerful one with which to press new methods onto local authorities and the public. It is evident that central government made full use of the persausive power of 'progressive' housing production theory for these ideas were presented repeatedly at forums which included local authorities, such as the Cement and Concrete Association conference of 1962 and the official circulars advising local government on state policy. By reiterating the inevitability of change the framers of policy were at the same time promoting the changes they sought. This must be born in mind when considering the enthusiasm with which ministerial policy embodied the most progressive theories of housing production.

CHAPTER FIVE. WORKERS BY HAND AND BRAIN

Visiting a factory making aluminium temporary houses in 1947, a contributor to the New Statesman observed a radically different way of making buildings to that which had existed before the advent of prefabrication:

> "The whole process of making prefabricated houses goes on here. The raw material comes in - aluminium, wood, glass and various complementary knicknacks; completed houses go out"[1]

Instead of craft workers, assisted by labourers, fashioning and placing materials on site in accordance with detailed drawings provided by the architect, he found automatons standing "on one spot for eight hours a day putting strips of metal into the guilotine, pressing the lever and taking them out again". [2] Production of the aluminium house represented perhaps the most mechanised of the postwar building systems, but, in light of current architectural theory, many thought it to be the shape of things to come. In the manufacture of the bungalows considerable changes were affected on two of the largest areas of labour in the building process; operatives and architects. In the case of operatives, craft skills were dispensed with: any worker might walk off the street and stand before the guillotine without ever having held a saw or trowel. Prefabrication threatened to upset the whole craft structure of the industry and therefore the basis of its trade union structure. In the case of the architect, accustomed to a position at the head of the building process, design ended with assisting the engineers in the preparation of the prototype and a single set of drawings furnished the production of 50,000 houses. In addition to this, one of the architect's largest areas of work, supervising construction, was obviated by the factory production of prefinished units assembled with minimal and unskilled site labour. As one architect pointed out:

> "If one's house was produced as a motor car was produced, and one received with it a book of words showing the spare parts that could be bought, where was the need of the architect?"[3]

As a result of a perception of the deskilling implications of prefabrication both the the craft unions and the architectural profession developed strategies to safeguard their positions in the context of radical departures in building technology. This chapter will discuss the response to system building technology of both the National Federation of Building Trades Operatives and the Royal Institute of British Architects.

I. OPERATIVES.

This section will explain why, throughout the entire postwar period, organised building labour did not attempt to thwart the use of system building even though the assembly on site of factory finished building components could not but have a significant effect on the work of skilled craft labour.

The postwar acceptance of system building by building labour was in direct contrast to prewar precedent. During the 1920s a serious dispute took place over the Weir House. There was little that was revolutionary in the design of Lord Weir's system for it was "essentially a timber-framed house faced externally with steel sheeting". [4] What was significant about Weir's proposal, from the point of view of building labour, was that its economic viability was based on the use of engineering workers and engineering rates of pay which were lower than those for building. In its manufacture and, more significantly, in its site erection the nationally agreed flat rates for building were circumvented. In response to this the National Federation of Building Trades Operatives (N.F.B.T.O.) warned local authorities that the erection of Weir houses with labour paid under other than building trade rates would result in the withdrawal of Federation labour on municipal construction sites. Although the Court of Enquiry, appointed by the Minister of Labour to review the dispute, found against the N.F.B.T.O., the fear of disputes on the part of local authorities helped to undermine the market for the house which was later withdrawn. A precedent had been established: while the Unions had not sought to control the rates of pay within factories, the site erection of prefabricated systems was to be the work of building labour paid under the established rates. Both Telford and Braithwaite, also promoting steel based systems before the war, observed this practice. [5]

The government was careful to involve the building unions in its wartime deliberations on future building policy. As well as being approached to sit on C.I.S.P.H. -

an offer which he declined - Richard Coppock, Secretary of the N.F.B.T.O., sat on both the subcommittee of the Central Housing Advisory Committee considering temporary house construction and the Burt Committee. But Coppock harboured few illusions on what prefabrication meant for building labour. In a memorandum prepared for his Federation in 1944, Coppock concluded that, as well as introducing non building labour controlled by other unions, prefabrication threatened to undermine the craft structure of the building industry:

> "unless we are prepared boldly to face up to the questions we may find our craft processes broken down to small units of such simplicity and specialisation, that the entire fabric of our organisation... [the N.F.B.T.O.]... and our economic position is placed in jeopardy"[6]

However, as Coppock pointed out, any initiative by government to expand housing supply would receive the acclamation and support of the nation, and the hinderance of this through a clash between the Federation and the government over prefabrication would attract the "most caustic criticism". A more productive approach, reasoned Coppock, would be to seek to influence the development of prefabrication in order that any new processes and classes of labour involved would be brought within the "control" of the N.F.B.T.O. In 1945, the Federation's annual conference passed a motion accepting non traditional methods of construction on the basis that "whatever type of prefabricated house may be invented, it should be regarded as normal building trade practice, and that building trade rates and conditions should apply". [7]

While the unions saw prefabrication, both within and without the factory, as building work deserving the proper demarcation of skills and rates of pay, sponsors did not. For instance, when Weir launched a postwar housing system he acceded to the Almalgamated Society of Woodworker's demand that that the site labour should consist of gangs containing a high proportion of skilled labour paid at current rates. However, within the workshops the company insisted on the use of unskilled labour in tasks such as pipe-bending, paint spraying and preparation of wall and floor units, claiming that "scientific methods of efficient industrial production" obviated the need for craft skills. The Federation was disturbed to hear that trade work was being carried out by "girls" and men, all on a labourers rate of 1s/8d per hour. [8] The lack of a dispute over this breach of N.F.B.T.O. policy indicated that, as in the case of Weir's earlier house, the unions were prepared to insist on a high degree of control on the building site but not in the factories.

In March 1946, the Minister of Labour and National Service and the Permanent Secretaries from the M.O.W and M.O.H. visited the General Council of the N.F.B.T.O. to discuss future building policy. Pointing out that building demands over the next decade would more than absorb the planned increase in the labour force and that prefabrication was a temporary expedient only they found a Council very sympathetic to the Labour Government's housing policy:

> "The meeting pledged itself to support all the Ministers in all steps necessary to expand the housing

programme... and appreciated the vital importance of supporting the present government in such a way that there should be no failure of the housing programme"[9]

By 1946, organised building labour chose neither to jeopardise the survival of a Labour Government pledged to social reform nor the welfare policies that it was pursuing. A year later, the M.O.W. was able to report that, with the careful consultation of the workforce on the non traditional building sites for which they had been responsible, "The co-operation of the workmen has been as wholehearted as could have been wished". [10]

By 1950 non traditional methods had not proved as transient as the government had claimed. At the N.F.B.T.O. Conference that year the Midland Counties Region (an area relying heavily on system building) proposed a motion opposing new methods which it felt were causing not only a "deterioration of craftsmanship" but also unecessary expense and a reduction in housing quality for the working class. As the delegate from the plasterers union pointed out: "it is the people of our class who have to pay for all the experiments and all the stunts that have been introduced in the name of housing since 1945". [11] In the ensuing debate, opinions ranged between support for the motion and fear that the Federation might be branded as "people not prepared to face up to new developments in the industry". [12] No vote was taken and the motion was referred to the Executive Committee for further consideration.

The subsequent development of union policy in relation to system building was heavily influenced by two postwar developments; full employment (although this varied in different regions), and a weakening of organised building labour. The first of these had a crucial effect on the acceptance of new technologies and, as was noted by Coppock, reduced the potential for conflict. [13] Workers made redundant by labour saving, or skill eliminating technologies were able to find employment elsewhere. The second tendency also minimised industrial confrontation. The weakening of organised labour began with the introduction of payment by results under emergency legislation to improve productivity in wartime building. [14] The scheme, one of the first examples of state intervention to improve efficiency in building, was retained after the war by employers eager to introduce piecework to building operations. According to L.W.Wood, the opportunity to negotiate wage payments locally opened the door to labour only subcontracting ('the lump'). The seemingly generous premium (untaxed wage) offered under 'the lump' reduced the incentive for workers to join the unions which negotiated the hitherto universally applied national flat rates. [15] From 1947 building union membership began to fall, and by the late 1960s a number of the craft unions were experiencing financial difficulties and considering amalgamation. [16] This was eventually carried out in 1968, when the individual craft unions, previously federated under the N.F.B.T.O., combined to form the Union of Construction and Allied Trades Technicians. The eventual combination of the unions into a stronger whole and a greater militancy provoked by declining building wage rates and increasing use of 'the lump' culminated in the first ever national building strike in 1972. This brought an end to the period of relative tranquility covered by this account.

The introduction of continental large panel systems in the early 1960s was thought by the unions to herald the greatest change in building methods so far. On this occasion there was no suggestion by government or the industry that this latest departure from traditional building methods was temporary. One delegate at the 1962 N.F.B.T.O. conference described his visit to a system building factory in East Germany and the threat that large panel systems held for skilled building labour:

> "Here were complete wall units manufactured in a factory without one skilled operative having to touch that work. They were transported to site and joined together like a pack of cards... This is what we are going to face, this is industrialised building"[17]

Not prepared to resist new methods which severely diminished the labour content of building operations in principle, the Federation, in 1963, reiterated its 1945 position by demanding that not only should it be informed of government intentions on the extent to which industrialised building was to be used but also that "The labour engaged in the production and erection of new materials should be that trained within the construction industry and controlled by the unions affiliated to the N.F.B.T.O.". [18] This was also endorsed by the National Joint Council (N.J.C.) for the Building Industry, on which representatives of the Unions and Employers sat (the N.J.C. for the Precast Concrete Industry, under which many precasting firms worked, did not accept the agreement). [19] Thus, the building firms promoting systems had, for the first time as a body, formally agreed to observe the application of building rates of pay and conditions both within the factories in which components were manufactured and on the sites on which they were erected.

In order to avoid friction with the unions over new techniques, large building firms displayed a meticulous desire to involve the Federation in early negotiations. In 1962 Laing approached the Executive Committee of the N.F.B.T.O. with an invitation to view the Sectra system that it about to import from France. Eventually, in consultation with the Federation, it devised an erection gang made up of a mix of skilled and unskilled labour. [20] A similar process was undertaken by the Unit Construction Co. over the introduction of the Camus system, who agreed an erection team comprising of 7 trade operatives, three steel fixers and 16 labourers. [21] In April 1964, the National Federation of Building Trades Employers agreed to the setting up of a committee, comprising members of both the employers' and operatives' federations to settle any disputes that arose on the composition of gangs for specific systems. [22] One conspicuous exception to this conciliatory process was Taylor Woodrow, who, "unlike most of the other firms", introduced the Larsen Nielsen system without consulting the Federation, intending that building rates of pay and conditions would not be extended to their factory workforce. In response to this, the Federation "told the firm quite frankly" that if they did not observe the national agreement in the manufacture of their panels "it was quite likely there would be considerable difficulty in getting them erected". [23] Next March, the Federation noted that not only were the facilities and working conditions of the factory excellent, but that the firm was also employing a large number of craft operatives who were to be paid under the conditions of the national agreement.

In attempting to examine the impact of system building on craft skills, and the degree to which the unions were successful in realising their aim of controlling all the labour involved in industrialised building, it is essential to realise that developments in this field were also accompanied by wider changes in methods of building during the postwar period. In 1958, the N.F.B.T.O. Conference noted that a recent one and a half million pound contract in Swindon had been completed in 10 months by only 40-50 labourers and 14 craft operatives. In a conference called in the following year to examine new technologies, Coppock reviewed the changes that had taken place:

> "The modern structure of today is a suspended one, mainly of concrete beams and roofs and floors carrying a light covering of bricks... the artistic development of the industry has been assimilated to straight lines... Architects today have rarely demonstrated what is known as Victorian or Edwardian architecture... until we can get a different format in the structure that is being erected, our industry is

bound to become more simplified and part of the craftsmanship may be eliminated"[24]

One of the most significant effects of new trends in building was the increased use of the semi-skilled worker. Where new materials and techniques were introduced, rather than being assigned to an existing craft they were often carried out by quickly trained unskilled labour paid at a higher rate for the time spent on the new job. [25] This tendency was particularly evident in the use of precast concrete. For instance, of the 26 operatives in the Unit gang the 12 workers responsible for erecting and sealing the concrete panels were plus-rated labourers, with the number of bricklayers used in the system reduced to two. This tendency brought the complaint that "this prefabrication work is being based on the labourer, and not on the craftsman". [26] As H.J.O.Weaver noted in 1964, so far "the big problem had been the desire of most of the firms to use as high a ratio as possible of non-craft labour in the balanced gangs erecting the systems". [27] The figure aimed at by the Federation was a 50% mix, which corresponded to traditional construction. The feeling that this was not generally achieved was the cause of the Conference on New Techniques convened by the Federation in 1964 in which the problem was discussed.

The effect of system building on operative's skills was discussed by the B.R.S. in a study on the skill structure of the building industry in 1966. The study noted that system building had indeed influenced the work of skilled trades and labourers affecting the proportion of work carried out by each. Of the five main trades it found that bricklayer's work had been reduced both in quantity and complexity, and noted that on some sites it had been dispensed with altogether. However, in the case of carpenters and joiners, the study found that, although simplified to the erection and assembly of prefabricated panels and components, the proportion of work had increased. [28] Unlike bricklayers, carpenter's work had adapted to system building and their skills were utilised to a larger degree. Indeed, the discrepancy between the fortunes of the two largest trades involved in building was the source of a marked division of interests which manifested itself in both the N.F.B.T.O. conferences on new technology held in 1959 and 1964. The bricklayers, represented by the Amalgamated Union of Building Trades Workers (A.U.B.T.W.), finding themselves vulnerable to modern technology, advocated the amalgamation of all building unions and the centralised negotiation of rates of pay for all trades. [29] While the carpenters, represented by the powerful Amalgamated Society of Woodworkers, were sympathetic to the difficulties of the A.U.B.T.W. they "were not prepared to proceed on a basis of sharing out the available work" or contenance any federal negotiation of rates. [30] However, the fact that this dispute manifested itself as early as 1959, suggests that it was as much a symptom of the wider changes in building technology that were taking place as the product solely of system building. The B.R.S. also found that system building brought changes to two other trades. In the case of plasterers, half the sites had dispensed with the trade altogether and where the trade was present it comprised only half the proportion of the labour force that it did on a traditional site. However, with the widespread use of plasterboard in both traditional and system building, the numbers employed in this trade had been falling overall since the late 1950s. Like bricklaying, the erosion of the plastering trade was not peculiar to system building. [31] Painters and decorators also comprised a larger proportion of the labour force than they did in traditional construction.

As well as debating the degree to which they might control the labour involved in system building, the unions also contemplated the "wider" issues involved in the relationship between social housing and new building methods. The outcome of this discussion can only have lessened the potential for conflict over the introduction of new technologies. In 1963 a delegate at the Annual Conference of the A.U.B.T.W. pointed out that the building unions could not condemn the government for building too few homes at the same time as opposing the new methods of construction which it was thought would make them possible. Furthermore,

> "they could not condemn the lack of high investment in the industry and the lack of scientific planning without some responsibility in participation in methods of building"[32]

This sentiment was heightened with the return of the Labour Government in 1964. At the N.F.B.T.O. conference of that year Coppock urged support for the new government in its housebuilding programme with another speaker suggesting that sectional interests in relation to new building technologies should be abandoned "in the wider interests of the economy of the country". [33] Indeed, the eventual culmination of a consideration of "wider" issues was the adoption by the 1966 N.F.B.T.O. Conference of a motion proposed by the Northwest Counties Regional Council calling for the setting up of state owned factories to manufacture prefabricated components for "houses, multi-storied flats, schools and hospitals" to be supplied to local authorities at cost price on long term loans. [34] Since 1945, the erstwhile opponents of industrialised building had become one of its many advocates.

II. ARCHITECTS.

In 1939 F.R.S.Yorke wrote of "the oldest and most powerful body in the profession", the Royal Institute of British Arhitects (R.I.B.A.) that:

> "The bulk of its members, as of the profession as a whole are academic practitioners of one form or another of revivalism... The Architect's Department of His Majesty's Office of Works.. appears wedded to a staid neo-classical style. The same is true of the big banks and many of the local government authorities"[35]

Criticism of the stylistic and technological conservatism of the R.I.B.A. was nowhere more severely expressed than by the Chief Scientific Advisor to the Minister of Works in 1940.

Reginald Stradling described the tendency of the architectural profession to "live in the the past" and ignore the technological developments of recent years. At its worst Stradling thought the architectural profession about to descend into "parasitism" which only a radical reappraisal of its training and outlook could arrest. [36] The view that the R.I.B.A. was technologically backward can only have been confirmed by the actions of its Reconstruction Committee in August 1942. In a 'First General Statement of Conclusions' the Committee recommended the "greatest practicable proportion of factory production to site works, so that factories and factory workers formerly employed on munitions may relieve the pressure" on traditional resources, but, contrary to Modernist beliefs, did not advocate prefabrication as a long term solution to housing. [37] Indeed, in its representation to the sub committee of the Central Housing Advisory Committee considering temporary housing the R.I.B.A. stated that it "would regard with regret the creation of a body of labour unskilled in any craft but the assembly of ready made houses by means of the spanner". [38] The antagonism of the official wartime committees of the R.I.B.A. towards permanent changes in housing tecnology caused it to stigmatise the factory production of housing in 'House Construction of a Definite Limited Life', as fit only for temporary construction. This was greeted with severe criticism by Architectural Design on behalf of "the more active and forward looking members of the profession". [39]

Although not as rapid as many advocates of new methods would have liked, it is evident that the latter years of the Second World War saw areas of the architectural profession attempting to adapt to changes in technology and identify a new role in society. P.Malpass locates this as originating before the war and identifies two themes; the notion of the architect as the purveyor of a broad range of distinct technological skills, and the belief that they could be of "quintessential value to society". [40] The association between the social role of the architectural profession and their technical expertise as a means to this end was a dominant motif of the profession's adjustment to the postwar Welfare State and may be seen as a major aspect of its eventual policy towards system building. In 1936, the President of the R.I.B.A., Percy Thomas, set out this new view of the profession:

> "Most thinking persons in this country realise only too well the many ills from which our civilisation suffers. Architects know that the cure for many of them lies in ordered replanning and the rebuilding of our congested towns and cities... it is on the technical ability of architects that the success or otherwise of rebuilding our towns and cities will depend... we exist solely to serve the community and we must bend our utmost power to that end"[41]

Elements of the profession also saw in a mastery of new techniques the means by which it might enhance its status in the postwar world. Already, by 1942, the R.I.B.A. had established in the Architectural Science Board a body designed to discuss, and disseminate among the profession, the impact of technological developments on building practice. [42] A major purpose of the education of the profession in new technologies was undoubtedly to maintain the architects position as the central figure in the design of buildings. As an Architectural Design leader pointed out in 1944, postwar design had become a multidisciplinary effort involving a number of technical specialists:

> "Science has contributed much to practically every aspect of building and building organisation during the war years, and the professional standing of architects can be proportionately enhanced, provided they grasp the situation in a realistic spirit"[43]

The identification of a social role for architects and the introduction of science to building was accompanied by both a growth in the profession and the assimilation of a major portion of architectural practice within the state machine. Whereas before the war the norm was for architects to work in private practice the balance had changed and the large increase in the profession was finding employment in the state sector. [44] This tendency continued for, by 1967, 40% of all architects were employed by local or central government; furthermore, the 50% remaining in private practice found that, by then, more than half their work was awarded by the public sector. As Martin Pawley put it in 1971: "Thus within 50 years, the involvement of the architectural profession with the state has become almost as complete as that of the doctors or the teachers". [45]

The state direction of building resources to social housing and educational programmes through the licensing system of the 1940s and early 1950s relegated private practice to a subsidiary role in the development of postwar architecture. As the Economist noted, it was the public architect who was getting the interesting work, and the private architect who was carrying out the overflow of work from public offices. Indeed, it could be suggested that the synthesis of the profession's interest in new technology and its belief in a social role for architecture was the public sector office where many of the new systems of construction were being developed:

> "Thus the Hertfordshire County Council first showed in its school building what could be done by pre-planning, modern technology and cost planning... [furthermore the Ministry of Education architects]... have not only reduced the cost/schoolplace by 45% since 1949... but have demonstrated a variety of non traditional methods and materials - and even invented some - within a genre of architectural comeliness which has brought foreign architects flocking to these shores. A bitter pill this for the old school, whose efforts in the interwar years hardly raised a flicker of interest among their questing overseas colleagues"[46]

Even the R.I.B.A. Journal admitted, in 1960, that, while the ideal of most professional architects might still be to become the principal of a private practice, the opportunity to open up new fields of technical development offered by public service had done much to counter this. [47]

From the 1950s onwards the official architects who had been promoting prefabrication began to assume an exalted position within their profession. With pride the Chair of the Hertfordshire County Council pointed out the success which the use of new technology had brought to two members of his professional staff: "up to 1945, we had no architect... our first County Architect is now your President, and our first Deputy is now the Chief Architect at the Ministry of Education" (1954). [48] However, it was D.E.E.Gibson who personified the "public service" architect with a sucessful career based on the furtherance of new technology in welfare building. In 1938 Coventry City Council appointed Gibson as their first City Architect. [49] Gibson's commitment to new technology was expressed during the war with his membership of C.I.S.P.H. [Ch.IV] In 1941 he attempted to set up a committee to discuss the use of aircraft factories for housing production and, as well as designing an experimental prefabricated house for his corporation, Gibson's department eventually designed a house for the Bristol Aircraft Company (B.A.C.). [50] Indeed, it was Gibson who wrote the reports advising Coventry Council to concentrate their housing programme on No-Fines construction. While the leader of the Council, George Hodgkinson, displayed some anxiety over this "step into the dark",[51] Gibson's philosophy was more confident: "I find one ought to assume full responsibility for one's ideas" and if lay committees resist "do the job and take what comes". [52] Gibson's proclivity to boldly assign entire building programmes to firms promoting new methods of construction applied also to schools. In 1951 he proposed that the City's educational building programme for the next five years should be awarded to B.A.C. for construction in their prefabricated aluminium system. [53] Although the city eventually used four systems, the bulk of this programme was eventually carried out in aluminium as Gibson intended. [54] In 1957 Gibson moved to Nottinghamshire where he became County Architect and supervised the design and establishment of the Consortium of Local Authorities Special Project (C.L.A.S.P.), [discussed in the following section] an undertaking which was to have great significance for the subsequent development of prefabrication. In 1963 Gibson was appointed head of the Directorate of Research and Development of the Ministry of Public Buildings and Works. In 1964, Gibson became President of the R.I.B.A.

Perhaps the most singular public success for both prefabrication and the architectural profession was the award of a special prize to a C.L.A.S.P. prefabricated school at an Italian design fair in 1960 - the significance of which was eloquently noted by Raynor Banham in 'A Gong For the Welfare State':

> 'In July, if you had taken a poll of the 18,000-odd registered architects in Britain on the subject 'who is Dan Lacey?' barely a couple of hundred could have told you he was county architect for Notts, but by the end of the month every thinking architect in Europe could have told you he was the titular designer of the <u>Schola Inglese</u> at the Triennale di Milano, which so far outdid all other exhibits that an unprecedented class of award - Grand Premo con Menzione Speziale -

had to be created for it"[55]

With the wholehearted support the R.I.B.A. gave to government efforts to improve productivity within the construction industry during the 1960s, the bond between the architectural profession and industrialised building was cemented. In an attempt to set its own house in order the Institute commissioned a survey on working practices in architects' offices, The Architect and Productivity, which it published in 1962. A characteristic of the report, indicating the flavour of opinion within the profession, was the distinction between the "good" and the "bad" offices. The former tended to be the larger, more highly organised and efficient practices, while the latter were smaller, less profitable and less inclined to make use of modern organisational techniques. Both types of office were aware of the increasing trend toward industrialised building. While the "bad" offices "did not understand the effect it would have on the practice of architecture" and felt it a threat to their professional position, not suprisingly, the "good" offices "welcomed the inevitability of increasing industrialisation in the building industry as an aid to higher productivity" and felt that the profession should become more involved in order to strengthen the architect's position. [56] In 1963, the R.I.B.A.'s annual conference was held on the subject of Architects and Productivity and in his opening speech the President, Robert Mathew, illuminated the social need to execute rapid building programmes. The foremost responsibility of architects to their clients, whether individual or collective, was clearly to increase the output of buildings:

"As architects we have to think first of our responsibility to our clients, and to the public at large, all of whom want a vast output of new buildings, and can't afford, or aren't prepared, to wait very long for them. The word 'affluence' will continue to have a rather hollow ring until we have provided society with the buildings it requires. The building programme is indeed at the centre of all our social and industrial problems"[57]

Two years later the R.I.B.A. published its definitive statement on system building, <u>The Industrialisation of Building</u>, pointing out the benefits of system building to both the architect and the client. If the system was properly designed, the report stated, architects would maintain high standards while at the same time handling up to 60% more work. Referring to the benefits which industrialisation conferred on the client, whether collective or individual, the report left architects in little doubt where their professional responsibility lay:

"Many forms of industrialisation enable the architect to give him... [the client]... a better professional service, the manufacturer to produce better quality components at a more favourable price, and the contractor to maintain a more uniform and high standard of construction"[58]

As Cleeve Barr commented the following year, "the architectural profession is adapting itself to the needs of the day".[59]

III. THE CONTROL OF DESIGN.

This section will discuss a form of organisation, the local authority consortium, by which architects, through the agency of local government, became both the designers and sponsors of systems. Consortia represented the only means by which architects were able to wrest the absolute control of system building design and production from commercial interests. As such, consortia can be seen as the architectural profession's attempt to resist the tendency for system building to take design responsibility away from the architect and place it with the manufacturer.

It was in Hertfordshire's schoolbuilding programme that the architect's hand first came to the fore in the design and successful sponsorship of a building system. The vital difference between Hertfordshire's system and those marketed by commercial interests was described by the County Architect, C.H.Aslin, in 1950. Up to this time, Aslin pointed out, the design of system building components had generally been dictated by manufacturers, but, in the case of Hertfordshire's schools, a vital difference was that "the various parts of the structure... have been designed by architects". [60] However, the conditions under which Hertfordshire were able to design and operate their system were not enjoyed by other authorities whose building programmes were simply not large enough to support a system of their own design. [61] By the late 1940s, Hertfordshire, whose boundaries encompassed the new towns of Stevenage (designated 1946), Hemel Hempstead (d.1947), Hatfield (d.1948) and Welwyn Garden City (d.1948), [62] was building up to 20 schools a year. Although other local authorities had educational building programmes large enough to exploit proprietary systems of standardised construction designed by manufacturers, programmes were generally too small to operate systems of their own.

The solution to this impasse was found through an innovation in local authority building policy which originated in Nottinghamshire. In common with a number of other education authorities experiencing shortages in traditional building supply, Nottinghamshire turned its attention towards system building for its primary schools early in the 1950s. [63] In 1955 a new County Architect was appointed, D.E.E.Gibson, and a number of staff changes occurred including "the importation of new blood which had been subjected to the Hertfordshire experience". [64] The policy which the authority then pursued was to place the 1956/7 schoolbuilding programme with outside architects using commercially available systems while Gibson's department developed one of their own. [65] However, it was the solution to the difficulty of providing a market sufficiently large to support a system designed by themselves that was the most significant feature of Nottinghamshire's contribution to the development of system building. Through the amalgamation of a number of neighbouring authorities under the umbrella of the Consortium of Local Authorities Special Project (C.L.A.S.P.) a vastly larger programme was offered to the firms selected to manufacture the parts than any one of the member authorities itself could provide. Furthermore, the member authorities were not forced to commit the whole of their schools programmes to new methods to enjoy a system designed and managed by their own architects. The 1957/8 programme included 11 schools with a total programme worth 900,000 pounds, in 1958/9 this rose to 2.8 million and by 1959/60 stood at 3.4 million pounds. [66]

It is important to emphasise that C.L.A.S.P. did not represent a significant development in system building technology. The basic principles of the structure had been developed ten years previously by Hertfordshire. [67] What technical innovation there was was confined to the development of a flexible joint in the steel framework to accommodate ground movement found in the coal mining counties that comprised the membership. Nor was the association of local authorities into larger buying units the invention of the Nottinghamshire Architect's Department. In 1935, the M.O.H. Committee on the Standardization and Simplification of the Requirements of Local Authorities urged firstly the standardisation of "the innumerable articles" bought by local authorities and secondly that in order for smaller authorities to "obtain for themselves the full benefits of bulk purchase... [they]... should combine for purposes of buying either with other local authorities similarly situated or with larger local authorities". [68] Indeed, a major benefit which C.L.A.S.P. and its advocates consistently pointed out, was the apparent savings made through bulk purchase - it was on this basis that consortia were promoted by the Ministry of Education. Through the principle of combining a number of building markets, C.L.A.S.P. proved the model by which architects could be both designers and sponsors of building systems. As one of the C.L.A.S.P. design team, Henry Swain, pointed out:

> "The inherent limitation of prefabrication was that it was always liable to be directed by commercial rather than architectural considerations. The manufacturer of the system would generally control its development and it would tend to appear on the market for architects to take it or leave it. Many of them would take it, but somewhat reluctantly... The consortium formed by a number of public authorities was devised to overcome this disadvantage. Its architects, by accepting the responsibility of co-ordinating many factories and sites and by carrying out continuous technical development are able to reconcile architectural control with the need to standardise components for quantity production"[69]

The architectural profession described its attempts to control the design of building systems through consortia as a part of its newly identified social role. The suggestion that the control of prefabrication should be taken by the profession as a part of its social duty was made by the Architects Journal as early as 1941. The journal urged that, unless the profession resolved to dominate "shop made buildings... in the interests of the community" there would be "chaos" after the war". [70] In 1964 the Architectural Review explained consortia as the outcome of architect's "strong conviction... that user needs and not the exigencies of production should be the deciding factor" in design. [71] Indeed, in sponsoring proprietary systems industry was "in fact usurping the function of the architect" which was to interpret the client's needs and protect the architectural quality of the environment on behalf of the community. Being aware that buildings designed by the production engineer provided an environment lacking in "human quality and convenience" the journal described the formation of consortia as a strategy arising from this concern:

> "The next conclusion in the furtherance of this idea was that the architect could only obtain sufficient control over industrialised production through the medium of the large clients in the public sector... resort has been had to the building authority consortium"[72]

The desire for architects to gain control of new technology on behalf of the building client, rather than in their professional interests, formed a powerful thread in the profession's promotion of its social role.

One of the first application of consorting to housing was initiated by Coventry - one of the early members of C.L.A.S.P. In December 1961, the Coventry City Housing Committee considered a suggestion by their Architect, now Arthur Ling, to join together with neighbouring Midland authorities in order that they might:

> "exchange information on designs, methods of construction and building costs and confer on the possibilities of standardising fittings and components

and bulk purchase of such items for authorities in the group as a whole, which apart from effecting savings in costs could also speed up production"[73]

With the Committee's approval for the architect to make the necessary approaches, the establishment of the first housing consortium began. In July 1962, representatives from 12 neighbouring borough councils met to discuss the "obvious advantage from the point of view of client design and control" of joining together to form a consortium. [74] In February 1963, Municipal Journal announced that the 12 Midland authorities, with a combined population of two million and housing capital expenditure of 6.5 million pounds, had joined together to form the Midland Housing Consortium (M.H.C.). [75]

The first job which the M.H.C.'s joint development group tackled was the organisation of a bulk tendering programme for commonly used items such as ironmongery, doorsets, and rainwater goods. By the end of December, 1963, the Board of Chief Officers of the consortium was able to report to the Coventry Housing Committee that, whereas it would contribute 2,134 pounds toward development costs in 1964/5, it would save 4,204 pounds through bulk purchasing agreements. [76] However, as the Principal Architect to the Consortium pointed out, this had been only a preliminary step, for, "The real work of the Development Group... began with its first development project... resulting in production of the M.H.C. building system". [77] By mid-1964 M.H.C. had completed its first project of 129 houses at Woodway Lane, Coventry, in its Mk.I system which combined blockwork crosswalls with timber infill panels. Like C.L.A.S.P., M.H.C. made little in the way of a technical contribution to housing, the novelty was in the promotion and control of a housing system by architects. [78]

By the early 1960s consortia had produced systems capable of building schools and low-rise housing. However, one field of system building technology which consortia, as yet, had left untouched was that of large panel concrete construction. Intervention in this latter area of system building technology was considerably harder as it required more organisational and technical resources than the types of building with which consortia were familiar. For this reason, high-rise precast concrete construction had remained the exclusive preserve of large building contractors and specialist precasting firms.

Nevertheless, by 1964 a further consortium had begun to take on this as yet untouched area of system building technology. The Yorkshire Development Group (Y.D.G.), comprising Leeds, Sheffield, Nottingham and Hull, had been formed in late 1961 and in December 1964, it unveiled plans to develop a large concrete panel system for an initial programme of 4,500 dwellings. [79] The first step consisted of the rationalisation of members' house plans on the basis of a standardised superstructure four to seven stories high. This was then developed to a stage where it was suited to construction in precast concrete panels and "could be built in a variety of systems of manufacture and erection... capable of using a limited range of large simple components". [80] However, the key to Y.D.G.'s appropriation of precast concrete construction from commercial interests lay in a tendering procedure based on the two-stage method developed by the Ministry of Public Buildings and Works. [81] Rather than purchasing an existing system, two stage tendering was designed to allow contractors to compete for the manufacture and erection of a system designed by outside architects. As the first stage of the procedure, Y.D.G. considered the manufacturing techniques and organisational capabilities of 24 firms in relation to its outline proposals. As a result of this examination four competitors proceeded to 'stage two' and were required to submit tenders on the basis of detailed performance specifications and scale plans and elevations of typical blocks. The Shepherd Building Group won the initial contract to manufacture and erect the Y.D.G. system for the first 440 dwellings in the programme at Leak Street, Leeds, and eventually constructed the remainder of the programme. [82] Through the use of a modified contract procedure developed by the government, local authority architects, through the consortia system, had gained control of the design and production of the complex and sophisticated precast concrete systems. A firm which would otherwise have been a system building sponsor, had become merely the supplier of components to the client architect's design.

By the mid 1960s, the control of systems had divided into two camps: commercial producers and consortia, with the latter growing rapidly in number and size. This bipartisan division was reflected in the alignment of the building journals: R.I.B.A.Journal and Architects Journal gave considerable coverage to consortia, while those representing building interests, such as _Interbuild_ and _The Builder_ were conspicuous for the lack of space afforded to such important developments in the building world. In 1965 Concrete Ltd, the most successful of the precast concrete system sponsors, published _The Function of I.B._ which argued against the design of systems by client organisatons in favour of the greater efficiency of commercially sponsored systems which embodied the best expertise of the commerial specialist. [83] A dispute was developing over who should control the design and production of system building; industry or the architectural profession. So far as the large contractors were concerned, consortia were a threat to their attempts, described in Chapter Two, to monopolise the social building market. The publication of the White Paper on the proposed N.B.A. in 1963, and the government's intention to use its new organisation to promote consortia provoked the most notable attack by _The Builder_. The Journal enlisted the services of a firm of Industrial Consultants, O.W.Roskill, in the hope that its prejudice against consortia would be justified by an expert examination. This report, published in 1964, makes interesting reading for it presents a sustained counter argument against consortia which is difficult to dismiss as entirely partisan - despite the hail of indignation with which it was greeted from an affronted architectural profession. [84]

The report confirmed that the building industry had indeed much to fear from the growth of the consortia movement:

"If a significant number of powerful consortia are established, they are likely eventually to have a big impact on the building industry. Large contractors think that consortia may lead to the elimination of medium sized contractors some of whom are already seeking to avoid this fate by having themselves nominated as approved contractors for proprietary systems"[85]

Looking in more detail at the claims made by C.L.A.S.P., the report made a number of criticisms suggesting that a myth had been created by member architects to gain credence for their system. The points made included the allegations that low initial capital costs had been achieved at the expense of higher eventual maintenance costs; that, by not including development costs in published statistics, local authority architects were concealing the real costs of the schools produced by their system; that although costs might be lower than the national average, other authorities were building schools for less than C.L.A.S.P. in traditional construction; that manufacturers were now able to produce standard products as cheaply as the special items provided in bulk to C.L.A.S.P.; and that the monopolistic position of some of the consortium's specialist manufacturers, particularly the steel frame suppliers, was contrary to cost efficiency. Nevertheless, perhaps the most substantial criticism was that no systematic statistical basis existed to support the many claims made on C.L.A.S.P.'s behalf:

"Members of C.L.A.S.P., as would be expected, are loyal to their organisation. Those who were interviewed made very similar claims for its usefulness though in all cases they admitted that no detailed investigation had ever been carried out to prove that their claims for C.L.A.S.P. designs could be firmly substantiated by figures"[86]

Having been created, the report suggested that overlapping membership and the continuous interchange of staff had transmitted the myth widely throughout the public architectural service, and that the sudden recent growth of the movement resulted from its support by government policy - to a large extent framed by previous consortia members now in senior positions. Indeed, the role of the continuous interchange of staff and ideas within the state architectural sector was noted by other writers as a significant factor in the growth of consortia. [87] Turning to the M.H.C. the report drew attention to the "impressive" anticipated 35,000 pound saving through bulk purchase in the 1964/5 programme which it felt

"has clearly been used tactically to reinforce the acceptability of the idea of the consortium with the elected representatives of the member authorities... [however] ...in two of the four cases there has been a change in the specification... there is a strong temptation to build up these advantages in the eyes of the elected representatives"[88]

Indeed, as a local authority architect working within a member authority was later to maintain of the M.A.C.E. consortia: "all the information is in the hands of the authorities and can be manipulated at will. The whole costing of schools is so fluid and obscure that statistics can be made to prove almost anything". [89]

Roskill's general conclusion was that the case for consortia designed systems had yet to be proved. However, the one respect in which the report did opprove of consortia was as a means of rationalising local authority programmes into larger units for the more effective use of proprietary systems. Indeed, while criticising government support for consortia, The Builder overlooked the fact that it was as a means of rationalising the social housing market on behalf of the large contractor sponsored systems that government and the N.B.A. gave consortia their support. [Ch.I] The M.H.L.G. were as concerned as the industry that the numerous systems already existing should not be added to by the many consortia they were fostering. [90]

In the field of education, consortia did indeed displace the proprietary system. In 1969 the National Federation of Building Trades Employers complained that three quarters of system built schools were constructed by consortia, [91] and by 1971 30% of the national schoolbuilding programmes was being carried out by the three largest; C.L.A.S.P., South Eastern Authorities Consortium (S.E.A.C.) and the Second Consortium of Local Authorities (S.C.O.L.A.). [92] However, their impact on housing was considerably less than anticipated as Chapter Three pointed out. Y.D.G., in the event the only consortia concrete panel system, built no more than 4,500 homes in its Mk.I, and by 1970 differences between the membership had brought about its demise. [93] The M.H.C., the most prolific housing consortia sponsoring a system of its own design, rarely built more than 1,000 houses a year, and by 1979 had completed barely 11,000. [Tab.V] Many of the consortia which were established, such as the London Housing Consortia - which provided the largest of all the combined programmes - [94] used proprietary systems in conformity with government policy rather than devise their own.

Consortia were not the only attempt by the architectural profession to maintain its status within the building industry in the face of system building. In November 1963, the R.I.B.A. conference on 'The Architect and Productivity' resolved to take further action on two proposals designed to allow the profession to exercise a greater control over system building. Firstly, it might attempt to operate, on behalf of the government, the central building agency (eventually the N.B.A.) recently proposed by Geoffry Rippon; and secondly it might allow architects to become directors of "building and manufacturing firms, but not development firms" in order to have a greater impact on the design of components and materials. [95] As events demonstrated, neither of these proposals came to any effect. Of more success was the G.L.C.'s operation of the value cost contract in its Thamesmeade development of the late 1960s through which the authority gained control of its largest system building contract yet. Frustrated by ignorance of the "true costs" of system building, and convinced that this would continue "so long as the manufacture of I.B. components remains completely in the hands of the contractors concerned", [96] the authority used a modified contract procedure under which it owned the factory in which the Balency components were made. Nevertheless, this initiative remained unique in the history of system building and the desire for architecture departments, without the capital resources of the G.L.C., to design and control the systems they used was realised through the consortia movement.

IV.

System building did not provide the basis for a major confrontation between organised labour and sponsoring industries during the postwar period. The changes that it effected on working practices were consistent with general developments in postwar building technology lessening the opportunity for system building to be isolated as a specific issue. The conciliatory attitude of sponsors, and their willingness to negotiate over the balance of skills in erection teams - according to F.Knox and J.Hennessy, the only skilled labour theoretically needed to erect prefabricated structures was a crane operator and lorry driver - served also to reduce the opportunity for conflict. [97] The fears that prefabrication aroused in the speculations of Richard Coppock in 1945 were not realised in its eventual development. It was not system building which initiated a narrower specialisation of skills and the weakening of the craft union structure but general developments in building technology and 'the lump'. Rather than choosing to oppose a potentially injurious form of building technology, the building unions sought to influence the labour policies of the sponsoring companies hoping to bring as much of the new types of work as possible within their control. Furthermore, building labour supported the system building policies of both the Atlee and Wilson governments. In calling, in 1965, for the establishment of state operated component producing plants organised labour embraced building methods which held few immediate benefits promoting what it perceived to be the larger aims of its class. Building unions were committed to the goals to which system building was seen as the means - increased state housing provision and a strengthened Welfare State economy - making a concerted resistance to new methods all the more difficult to justify.

The resistance of the architectural profession to system building was also shortlived. The vigorous activities of its members ideologically committed to prefabrication, and the success with which they realised their ideas in postwar social building programmes presented a powerful influence on a profession attempting to find a place in the much changed postwar building economy. Up to the mid-1950s many of its most progressive members influenced the development of prefabrication and, through consortia, eventually found a model by which to control the design of building systems. In the light of architects' concern to be of service to society, involve themselves in the development of new technology, and maintain their professional status as leaders of the building team, C.L.A.S.P. and the other consortia were paradigms of the postwar profession. Although successful in schoolbuilding, where consortia eventually dominated the market, the profession was less so in housing. Nevertheless, the speed with which the profession adapted to the advent of new technology, in attempting to maintain its professional status and develop an ideology which embraced the industrialisation of building, dispelled any tendency for it to remain wedded to the outmoded architectural philosophies described by F.R.S. Yorke in 1939.

CHAPTER SIX. INNOVATION IN THE STATE SECTOR: THE EXPERTS.

Despite their often revolutionary statements, one feature which typified the various post war ministers responsible for housing was that they generally had little technical knowledge of building. Foot's detailed biography of Bevan discloses no interest by the Minister in building prior to his appointment [1] and Nigel Birch, Minister of Works in 1954, made a virtue of ignorance when he announced to the assembled architectural profession that he was "entirely unburdoned by the slightest technical knowledge of this subject". [2] The ignorance of the political masters of the M.O.W. seems to have presented few problems for the Permanent Secretary, Harold Emmerson, who found that party political changes tended to affect the scale of work done by the Ministry rather than the "way in which it is done". Pointing out that a Minister usually stayed with the Ministry for less than two years, Emmerson found it understandable that he had "difficulty in getting to know the full extent of his responsibilities". [3] The conclusion which might be drawn from this is that Ministers, whether responsible for housing or building, took their technical advice from the departmental experts to whom they had access when in office.

Evidence suggests that state departments reponsible for housing and the building industry provided a strong undercurrent to government policy. This does not necessarily imply ineptitude or carelessness on the part of government for, while retaining the reins of overall economic and social policy, Ministers drew enthusiastically on the expertise of the scientists and technologists under their employ in matters of building science and technology. The common pursuit of welfare policy, and in particular housing provision, by the major political parties created the context in which the expert played a significant role. For as long as there was agreement on goals, the expert was needed to advise on the means by which these might be achieved. Postwar government embraced and elevated the building expert, raising to high office a generation of architects committed to the promotion of prefabrication and mass production in building. This chapter will describe the process by which the central state itself became the designer and, in some cases, the sponsor of building systems, and the attempts of state experts to guide system building in the direction they felt most beneficial to society.

I. THE M.O.W. AND PREFABRICATION.

As Chapter Four described, the state took an increasing interest in building technology from the point at which it first became a significant producer of housing in the immediate post First World War period. This interest was maintained during the interwar period largely through the Building Research Station (B.R.S.). While the state financed a permanent research station and periodically set up committees to consider specific issues, as yet there was no department charged specifically with overall responsibility for the organisation and efficiency of the building industry. The Second World War, and with it the reorganisation and extension of the state machine, precipitated a more concerted examination of the building process. The Office of Works, as the government department responsible for crown buildings had been known for many centuries, was inadequate for the task of assimilating the building industry into the 'total war machine' and in 1940 the Office was transformed into the Ministry of Works and Buildings in order to control the competing demands for building resources of government departments. Whereas the staff of the Office of Works had stood at 6,000 in 1939 the staff of the Ministry of Works (M.O.W., as it became in 1945) stood at 22,000. [4] As well as taking responsibility for the administration of building resources the M.O.W. was originally made responsible for the postwar reconstruction of "towns and country" and in the latter years of the war it played a major role in housing policy. However, housing and town planning functions were taken away from the fledgling department with the creation of the Ministry of Town and Country Planning in 1943 [5] and the reversion of all matters concerned with housing design and policy to the M.O.H. in 1945. By 1945 the M.O.W.'s role had been narrowed to the technical aspects of postwar construction. Nevertheless, whereas previously the Office of Works was concerned purely with government buildings, 1945 saw the creation of a ministry with, in the words of the Prime Minister, "a general responsibility for the organisation and efficiency of the building industry as a whole". [6]

The first Chief Scientific Adviser to the Minister of Works was in fact the former Director of the B.R.S., R.Stradling, and in 1940 he described the extent of the work ahead of the Ministry and made clear the lack of technological sophistication within the industry for which he was now responsible:

> "The building industry has not yet adjusted itself to modern conditions. Its personnel is largely ignorant of the basic priciples of science upon which modern industry, and life itself has now come to depend.... a new type of world has happened which has largely killed the possibility of still using the traditional methods"[7]

In Stradling's view radical change was needed, and needed fast if the nation's reconstruction plans were to be put into effect. As well as transforming the industry through basic research and education, Stradling suggested that the government itself should lead by the example of its own works: "Nothing will be so effective in this education as the realisation that government can produce better, cheaper and quicker construction than anyone outside". [8] In his paper Stradling set out two of the basic principles on which government building research policy was to rest: education through the publication of research findings, and education through the example of government building projects.

Together the M.O.W. and the B.R.S. pursued the application of the scientific method to all aspects of construction. In 1946, J.D.Bernal, Chair of the Minister's Scientific Advisory Council, described the division of research work within the Ministry into requirements, materials, structures and construction. Of these, construction was "both the largest and the most immediate". Under this heading, attention was being given to human efficiency - "the first time that any attempt has been made scientifically to deal with the question of human productive effort"; the mechanical and organisational means by which building technique could be improved; and structures and calculation. Research also included the wider economics of building in which the application of expensive plant and larger organisational units were being compared against "the individual attention that the small man can give to the job". [9] It could be said that the principles of Ford and Taylor were now being applied to the building industry through the latest addition to the state machine. Characteristically, one of the Ministry's first publications was a time and motion study of the expenditure of man and machine hours in the execution of building and civil engineering. [10]

Despite the eagerness of the M.O.W. to effect rapid changes in building methods, the formation of the Interdepartmental Committee on New Methods of House Construction (Burt Committee) in September 1942, did not contribute significantly towards this end. As has been pointed out by R.B.White, this Committee was not intended to further the application of prefabrication to house construction but to assess the alternative methods with which traditional construction could be supplemented. [11] Indeed in its first report the Committee refused to "express an opinion on prefabrication except in so far as it is already advantageously applied in the building industry". [12] Nevertheless, the Burt Committee's three reports on contemporary housing systems provided both the M.O.W. and the M.O.H. with a wealth of technical information on the systems they were considering. [13]

Current with the Burt Committee's deliberations, the Minister of Works appointed a controller of Experimental Building in 1943, to assist "private enterprise and local authorities to develop new methods". [14] The extent of the M.O.W.'s supervision of the introduction of new systems was considerable. If the Ministry felt a system to be of value it assisted promoters in the development of the system and issued licences for the erection of prototypes. [15] These prototypes were then reported by the Burt Committee and the B.R.S. and the more promising selected for further development. In the final stage the M.O.H. found sites for a development group of up to 150 houses with a local authority willing to purchase the dwellings on completion. This last stage was monitored closely by the M.O.W. which, by observing factory manufacture and erection on site, calculated a "definite figure" for the labour content. Such was the detail of this study that the Deputy Chief Scientific Adviser estimated that one million cards were passed through a Hollerith machine. [16] However, as well as studying and analysing the products of industry, a conclusion to which government experts in the B.R.S. and M.O.W came was that they should involve themselves more actively in development.

The effect of this interest was the promotion of a number of steel frame systems using the resources and latest techniques of the diversifying engineering firms described in Chapter Two. In view of the concentration of the M.O.W. on this particular approach to system building it is worth looking at the development of the steel frame in more detail. Steel frames had been exploited in system building before the war, most notably in the Dorlonco and Weir systems. These houses relied on labour intensive methods of bolting and rivetting steel members together, [Figs.1&2] and used considerable amounts of steel in their structures and claddings. The subsequent development of steel frame systems was guided by the introduction of welding and new steel fabricating techniques. The use of welding in engineering and building became increasingly common during the 1930s and was greatly stimulated by the Second World War which caused the necessary plant to be installed and labour to be trained. [17] The cold rolling of thin steel sheet, stimulated in particular by the introduction of pressed car body shells, also developed during the interwar period. [18] The combination of lightweight steel sheet and welding allowed the manufacture of more efficient structural members. Lightweight steel sheets could be shaped into complex sections and a number welded together into composite members, enabling the full tensile properties of steel to be exploited. Furthermore, the production of lightweight steel sheet provided an external cladding. Lightweight steel engineering technique formed the basis for a tradition of prefabricated building systems promoted by government architects in which it was hoped that prefabrication and mass production could be applied to housing.

A lightweight steel frame manufactured by the Hills Patent Glazing Co., formed the basis of the first prefabricated housing system designed by the M.O.W. at Northolt in 1944. The M.O.W. found their steel-frame house not only to have taken less than one half the labour hours of the traditionally constructed 'control' house, but also to have been the only system of those tested to have been cheaper. Encouraged by results so favourable to the steel frame, the M.O.W. claimed a whole range of "considerable" advantages for this type of construction. Firstly, the components for the frame could be standardised, facilitating mass production. In addition to this, the cladding could be varied according to the availability of suitable materials - in the case of the Northolt House precast concrete was used. Furthermore, as had been found with the Dorlonco house, the rapid erection of the frame and its roofing protected the remainder of the works from the weather. It was noted that this early provision of the structure allowed the other trades to work simultaneously, greatly speeding the construction process. [19] Such was the success of the first state promoted system that the Minister of Works, Lord Portal, advised the Cabinet Reconstruction Committee that the M.O.H. should recommend the Northolt House to local authorities. [20]

Although nothing came of this initiative, Portal was soon at work on a new project which promised to be the Ministry's first large-scale intervention in housing design and production; the Pressed Steel Bungalow. Commonly referred to as the Portal House, this design was conceived by the M.O.W. in response to the Cabinet's intention to produce a large number of temporary bungalows. Portal's scheme was "based on mass production by the government of a single type of house" [21] and was intended to directly apply engineering industry methods to housing. The Portal House embodied the latest in lightweight steel technology. The name of the manufacturer chosen for its production, Briggs Motor Bodies, indicates the source of inspiration for its design. The basic structure of the Portal House consisted of ribbed pressed steel panels fixed to steel columns by a system of spotwelded cleats. Joints in the external cladding were protected by pressed metal 'snap-on' cover pieces. The sheet steel roof covering was supported on pressed steel lattice trusses and the rectalinear shell was further subdivided by sheet steel partitions and pressed metal storage cupboards. [Fig.3] In May 1944, a prototype manufactured by Briggs Motor Bodies was exhibited at the Tate Gallery. Reviewing the bungalow for Architectural Design, Edric Neel, one of Portal's acquaintances on C.I.S.P.H., saw in it the most sophisticated application yet of engineering technique to housing:

> "Lest any reader of the above critique should have lost sight of the wood for the trees, let it be said once again that this official solution to the problem of postwar emergency housing stands head and shoulders above anything yet attempted in this country or abroad"[22]

Portal's bold initiative in the application of steel engineering to the emergency housing programme was frustrated by the the prolongation of the European war. The extension of the conflict prevented the diversion of engineering industry from war production soon enough to produce the bungalow in accordance with the Cabinet's emergency housing plans. [23] Eventually the order placed with the Ministry of Supply for the manufacture of 50,000 bungalows was cancelled and contracts awarded to seven manufacturers who, unlike the Portal House which was made wholly of steel, utilised a wide range of materials which included asbestos, aluminium and timber. [24]

Although the Portal bungalow was scrapped, a proposal to convert it to a permanent two-storey design capable of "real mass production" was greeted enthusiastically by a M.O.W. Committee, chaired by J.D.Bernal. This committee, charged to review current systems and "consider the practicality of designing an ideal type" concluded of Portal's design that:

> "We are strongly impressed with its great potentialities and recommend that its development should be prosecuted in an energetic manner so as to permit a decision to be taken as soon as possible"[25]

In August 1945, the new Minister of Works, Duncan Sandys, reported to the War Cabinet Housing Committee that he wished to place an order, again with Briggs Motor Bodies, for 25,000 Pressed Steel houses. While authorising Sandys to enter negotiations, the Committee refused to place an order in the absence of detailed cost data and moved that the issue should be re-presented when this was available. [26] The production of the Pressed Steel House was not brought before the Cabinet Housing Committee again and it may be inferred that the eventual costs were such as to cause the scheme to be abandonned.

The steel framed house eventually chosen by the government for production was that sponsored by the British Iron and Steel Federation (B.I.S.F.). By the end of the war the B.I.S.F. had designed three models in which were displayed the full range of new and old steel frame technologies. The frame of the first B.I.S.F. prototype, Type 'A', departed little from the principles of the Dorlonco House, comprising short lengths of hot rolled steel bolted together on site. The Type 'B' house accorded more with the general trend in applying cold formed composite members to provide a structural frame, while Type 'C', the most highly prefabricated, was akin to the Portal bungalow in its assemblage of two-storey pressed steel prefabricated wall panels. [27&Fig.7] In the event, Type 'A' was selected for the government grant, and despite the adoption of methods of construction using less steel by other producers, such as Hills Patent Glazing Co., far more B.I.S.F. houses were built than any of the alternative steel frame systems. [Tab.IV] The reasons for the eventual selection of the Type 'A' by the B.I.S.F. and its subsequent support by the government are not clear but may have resulted from an insufficiency, within the Federation, of the expertise and capacity needed to provide the volume of components in the newer technologies used in the Types 'B' & 'C': therefore it chose the least sophisticated design in order to involve the maximum number of its member firms. Alternatively, it could be argued that the very object of Federation policy was indeed to use the maximum amount of steel, thus automatically excluding the more efficient designs. One way or the other, the B.I.S.F. house indicates that commercial policy and the most technologically innovative methods supported by the state building experts did not necessarily coincide.

The last attempt by the M.O.W. to develope a prefabricated house was the proposal to blend the Arcon temporary bungalow and the Coventry House - designed by D.E.E.Gibson under the aegis of C.I.S.P.H. - to produce a hybrid design which might be offered to local authorities. The closest this latter project came to fruition was the allocation to Coventry of 2,000 of the blended houses. Production of these was to commence by the Arcon Group late in 1945. However, this project failed due to the inability of the Arcon group to produce components before 1947. [28]

The latter years of the war saw a concerted effort by architects in the state sector to sponsor technologically sophisticated building systems. Although none of their models entered production an important precedent had been established: the state had become a designer of building systems.

With the non traditional housing programme underway and the disbanding of "the brilliant team of scientists and technologists brought together during the war" [29] the M.O.W. and the B.R.S. abandoned the design of systems and turned their attention towards the measurement of the costs and labour savings of new methods of construction. The need to measure new methods in comparison with old was realised by the B.R.S. as early as August 1943, when it pointed out to the Burt Committee that the "remarkable dearth of systematic data" produced widely differing opinions even amongst those who had had actual experience of new methods. Referring to its development of building physics in the interwar period the B.R.S. remarked that:

> "There seems no reason why the methods of scientific research which have been applied to problems of heating and so on should not be equally successfully applied to practical problems of construction... it is of the highest degree of importance nationally, that an effort should now be made to collect a body of systematic data on the subject, and develop the necessary experimental technique"[30]

The first application of the new experimental technique was made at Northolt where four types of alternative system, including the M.O.W.'s steel framed design, were constructed. In line with orthodox scientific method a brick house was constructed as "A standard, or control... to measure the relative costs of these less familiar methods as compared with traditional brick building". [31] The results of this experiment were remarkable in the light of subsequent experience for it found that the M.O.W.'s house made a 50% saving in labour and a marginal saving in cost over the control house. Despite their avowed objectivity, it could be suggested that the Ministry were partial to their own design particularly as it exploited the principles of prefabrication most thoroughly. According to the B.R.S., the less prefabricated types showed no saving in labour and were considered to have been more expensive than traditional construction. Thus, the results of the first 'measured' experiment confirmed the views of many progressive building experts that the route to cost savings lay in the maximum use of prefabrication. In April 1944, Portal informed the War Cabinet Housing Committee, currently deliberating on the use of new methods, that he hoped that "the costs of prefabricated houses will not exceed that of houses of normal construction". [32]

In the event, non traditional houses proved more expensive that traditional - the level of government subsidy offered to local authorities to offset the greater cost reflected this disparity. Indeed, the most prefabricated types, such as the B.I.S.F., Airey and Cussins houses, required the greatest subsidies of between 244 and 147 pounds. [33] The results of the first large scale postwar measured experiment in new methods were published in 1948. The results contradicted the findings of the Northolt experiment and showed that prefabrication and building economy were by no means automatically connected. In this experiment ten types of house were built in groups of not less than 50. With the exception of a timber system and the brick control group, the systems were all based on concrete. It is significant that the more prefabricated steel framed types were excluded from the experiment for by this time they were realised to be both more expensive and in conflict with government policy designed to reduce the use of steel in building. The factory and site operations were measured by Ministry officers to ascertain the precise labour content and costs. Compared to earlier expectations this experiment showed a more complex situation. The report stated confidently that new methods of construction showed appreciable manpower savings, but was less certain on the question of costs.

> "From first principles it seems reasonably certain that the economy actually achieved in man-power must be reflected in a lowering of costs, but from the information obtained from production on a pilot scale it has not been possible to reach a final conclusion as to the level at which costs can be expected to settle when the houses are in normal production"[34]

Furthermore, the experiment disclosed wide disparities between the construction of similar types by different contractors, suggesting that problems of organisation and materials availability were more crucial to eventual performance than the technological principles of the systems themselves. At its most specific the report was unable to say more than that at their best new methods both saved up to 20% in labour and that - when working at an economic tempo and assuming sufficient continuity of operation - they were capable of being cheaper. [35]

With this experiment completed, and a lessened interest in new methods on the part of the M.O.W., [36] the only further significant contribution that the Ministry made to prefabrication in housing was a large measured experiment carried out during the latter 1950s. [37] The results of this were published in 1959 and confirmed the disappointing results of earlier research. Indeed, such was the poor performance of the systems tested that the Deputy Chief Scientific Officer to the B.R.S. suggested that:

> "it seems for house building at least, economy is more to be sought in the evolution of traditional processes rather than by the introduction of radically different methods of construction"[38]

II. RESEARCH AND DEVELOPMENT GROUPS.

Following the work carried out by the M.O.W. during the war, the development of building systems by the state was taken up by the Ministry of Education (M.O.E.). Whereas plans for the use of new methods in housing had been laid and most of the models designed by 1946, little work had been done on preparations for the school building programme. Nevertheless, events that took place in the M.O.E. during the 1950s had a considerable impact on the administration of housing research and development policy during the 1960s and therefore require examination in some detail.

In 1944 the Wood Committee, convened by the Minister of Works and comprising architects promoting standardised construction such as C.G.Stillman (W.Sussex County Architect) and Dennis Clarke Hall, published Standard Construction for Schools. [39] The report concluded that "there is no reason in principle why the same plan should not serve for two or more schools of the same type and size" and examined various methods of standardising and prefabricating school construction in order to speed the considerably enlarged educational building programme. The apparent success with which authorities such as Hertfordshire supplemented limited building labour resources with system building prompted the M.O.E. to take a more active role in promoting new methods of building in the late 1940s. [40] In December 1948, the Minister of Education informed local authorities, by circular, that he had "for some time encouraged the development of various new methods of building and their application to educational needs", [41] and that in order to carry this work further he intended to establish a small Development Group in the Architects and Building Branch. The duty of this group was to interpret new building technologies in terms of educational needs, and the choice of head architect was Stirrat Johnson Marshall, the Deputy Architect for Hertfordshire County Council. Marshall's purpose was to increase the use of prefabrication in school building beyond the tendency of local authorities to regard it as no more than a short term expedient. [42] The way in which the M.O.E. Development Group achieved this was to embark on an ambitious programme of building projects. In these, the combination of standardised steel frames and prefabricated claddings, used in house construction and subsequently developed by Hertfordshire, were applied to the development of a range of schoolbuilding systems. [Fig.14] Five systems of this type were developed by the M.O.E. between 1950 and 1953. [43] As well as developing the systems, the group also intended to "stimulate demand... for what we know already to be good and available". [44] The means by which this was done was twofold, a series of meetings was held with authorities to persuade them to adopt the group's systems in their advanced programmes, and Building Bulletins were issued publicising the success of the M.O.E.'s developments in prefabrication. [45] In the event the Group was successful - each of the systems it developed entered production - partly because the systems were considered to have real architectural merit, but also because of the enlarged educational building programmes of the mid-1950s. As the Development Group commented, "it has been our working hypothesis that two factors will ensure their widespread adoption by authorities; the pressure of circumstances and the quality of the systems". [46]

The success with which the Research and Development Group introduced prefabricated systems was accompanied by two developments in the administration of school building programmes. The first, resulting from the slow start to educational building, was the requirement that programmes should be planned in advance, and by 1947 authorities were asked to submit proposals for two years ahead: "It enables Authorities to group projects together from the point of view of development work, planning and bulk ordering". [47] The second development was the adoption of a new approvals procedure in 1949. Rather than submitting each project to the M.O.E. for individual approval of the overall cost, a cost limit per child place system was devised. If an authority demonstrated that the schools it designed met the

Ministry regulations on minimum areas and did not exceed the cost/place limit, approval was automatic. [48] The use of a standardised system of construction by an authority greatly facilitated this prediction of costs and aided the advanced programming policy. Allied with these administrative changes the M.O.E. made a concerted attempt to reduce the costs of school construction through more compact planning. These changes were made in school design by means of a steady reduction in the cost/place limits: in 1949 they were set at 200 and 320 pounds for primary and secondary schools respectively; between 1950 and 1951 they were twice reduced by 12.5%. [49] The planning of schools radically changed from a distended finger plan, with long corridors, to a highly compact form with minimum circulation areas and the dual use of spaces (such as combined dining rooms and assembly halls). [Fig.17] Between 1949 and 1954 the British school became 40% smaller in plan area. [50] Significantly, the very building projects in which the Development Group tried new systems were also the vehicles for the development of space saving plans. Thus, the M.O.E. Research and Development Group of the Architects and Building Branch had been seen to combine new and rapid building technologies with a dramatic space, and hence, cost saving to the Exchequer. The point was not lost on policy makers observing these developments.

Addressing the closing of the 1951 Building Research Congress Sir Ben Lockspeiser urged the application of Operational Research techniques to construction whereby the building scientist would leave the laboratory and take the "powerful techniques" of the scientific method to the building site. Describing the work of the education architects Lockspeiser concluded that "because such a scientific attack has been made successfully in one corner of the building world... I believe we could all profit from a study of what has been done". [51] Indeed, in May 1952 an economy conscious Cabinet Building Committee report examined educational building policies and concluded that M.O.E. building policies were "conducive to economy" and that this was largely due to the Architects and Building Branch. [52] Like Lockspeiser the report advocated the extension of the principles of the M.O.E. to other government departments.

In 1961, Roger Walters, Chief Architect to the War Office Development Group, noted that nine state departments currently operated development groups. Describing the purpose and organisation of these he stated that as a prerequisite the parent organisation should be one which was financially responsible for a large volume of building work. Turning to the group itself, it must not only be aware of the current state of technology but in its practical building projects "should be sensitive to future developments and should be ready to pioneer". [53] The architects working in such groups, Walters felt, must have quite specific qualities. In a statement which reflects the degree to which Modernist architectural values had been adopted by the architectural establishment, he described these qualities, stating that the architects must be:

> "intelligent and... all share a basically similar attitude of mind. They should I think care more about

architecture as a social service than as a means of personal expression... They should be architects who will ask the user not what he wants, but what he wants to do, and how often he wants to do it: who believe that there is always a better answer to be found"[54]

Speaking for a parent department, and demonstrating the willingness with which policy makers accommodated the architectural theories of their professional experts, W.D.Pile, administrative head of the M.O.E. Architects and Building Branch, saw the ideal "pioneering" architect as one with:

"The ability to make as well as to follow policy. There is no place in this dynamic organisation that the state needs for the slave... a perpetual discontent with the <u>status quo</u>, a revolutionary desire... to change the order of things... that revolutionary feeling must be guided by some systematic and scientific methodology... he has to be a business like character, I don't want any prima donnas or little Corbs"[55]

Put less vehemently, another top administrator, A.Part, Permanent Secretary to the Ministry of Public Buildings and Works, felt his duty was to "understand the vision and the hopes and fears of architects, and to help create the conditions in which they can do their best work". [56]

The changes that took place in the public architectural service during the late 1950s and early 1960s were noted by Evelyn Sharp, Permanent Secretary to the M.H.L.G.. Between 1951 and 1969 the numbers of professional and technical staff in her ministry rose from 570 to 900. One of the largest contributory factors to this was the much greater amount of research, development and promotional work carried out. Indeed, as she pointed out, the growth of industrialised building had enormously increased the contribution which the Ministry's architects made to the work of the housing division. Rather than performing a regulatory role, as previously, Ministry architects became increasing involved in the "formulation and dissemination among local authorities of new ideas and new techniques". [57] Furthermore, during the staffing difficulties of the mid-1960s, when the state had been unable to offer salaries equivalent to the private sector and had found it difficult to recruit staff, the opportunity for architects to "try out their ideas on the ground" had been an important fillip to recruitment.

The elevation of architects to senior administrative posts in the early 1960s was greatly aided by organisational modifications in the M.O.W. and M.O.H. In 1958, the War Office became a civilian department and D.E.E.Gibson, previously noted for his work with new technology at Coventry and Nottinghamshire, was appointed head architect. On the 1st April 1963, the War Office was amalgamated with the M.O.W. which was restructured to become the Ministry of Public Buildings and Works (M.P.B.W.). A major part of this reorganisation consisted of the creation of the Directorate of Research and Development with Gibson at its head. The authority and status which Gibson was given in this new post, which according to his Minister was intended "to further the development and application of industrialised building techniques", [58] was considerable. Gibson was answerable only to the Permanent Secretary and received a salary of 7,000 pounds, larger than that of the Controller General for the entire Crown building programme and second only to that of the Permanent Secretary. [59] Gibson was not the only proponent of prefabrication to gain promotion in the early 1960s reorganisation of the public architectural service. In 1959, Municipal Journal reported that important changes were taking place at the M.H.L.G.: the Ministry was forming a Development Group with a former Hertfordshire architect, Oliver Cox, at its head. In addition, J.H.Forshaw, Chief Architect of the Ministry since 1945, was stepping down in the belief that "a younger man should take charge of the developments". [60] The new Chief Architect, Cleeve Barr, had, like Gibson, spent his life in the public service, previously with Hertfordshire and then the L.C.C. Prefabrication had made an early impression on Cleeve Barr; as a boy during the early 1920s he remembered "watching, fascinated [by] the erection of the first steel houses in my village", [61] and in 1958 he spoke of his time at the L.C.C. where he had "tried on a number of occasions... to evolve, for housing, systems of lightweight steel construction and of precast concrete construction, comparable to those which have made possible such notable advances in the field of school design". [62]

As Gibson pointed out in 1961, "There is now a well-established (although small) cadre of architects with the 'know-how' of development work and its history and its possibilities". [63] More importantly, however, this cadre had become firmly lodged in the upper levels of the state building machine.

III. COMPONENT BUILDING.

To understand official research and development policy during the 1960s it is necessary to return to the development of prefabrication theory during the 1930s. The proposal that prefabricated building components should be designed to a common dimensional framework - modular co-ordination - was promoted by a number of prefabrication experts including Gropius, Corbusier and Albert Farwell Bemis. [64&65]

The standardisation of building components was first initiated by the British Government in 1920 when the M.O.H. Standardisation and New Methods of Construction Committee proposed standardising domestic fittings such as baths, water fittings, gutters and ironmongery. [66] The application of standardisation to building elements was continued by the first Minister of Works, Lord Portal, who appointed the Standards Committee in 1942, with the following terms of reference: "To study the application in building of standard plan elements, standard specifications and building components, and methods of prefabrication". [67] The salient feature of this committee is that it failed to fulfill Portal's ambitious terms. The committee's discussion concentrated on the ability of standardisation to facilitate the interchanging of fittings, thereby allowing manufacturers to stockpile prior to the onset of the postwar housing programme, and made no comment on the relationship between the standardisation of dimensions and specifications to facilitate the production and use of prefabricated building components. [68] In the event the Committee made 260 recommendations to the British Standards Institute (B.S.I.) on fittings ranging from metal sinks to floor tiles and was able to note that these changes, minor as they were, had been happily taken up by industry.

The timidity of the Standards Committee did not satisfy the B.R.S. and the M.O.W.. Writing to the Burt Committee, the B.R.S. urged that it should compile an encyclopedia of standard interchangeable components which could be manufactured in far greater numbers than components for individual systems and selected freely by housing architects: "If a mass production system is adopted it is vital to ensure that the advantages of mass production are not thrown away". [69] However, as with the Standards Committee, the Burt Committee showed little desire to take such an ambitious approach to new methods of construction. In 1945, D.Dex Harrison, an architect working for the M.O.W. described the implications on prefabrication of the refusal of Government Committees to promote dimensional co-ordination:

> "5-10,000 off is [not] mass production as we know it today. Entrepreneurs tend to think rather in terms of 100,000 and we have to face the chance that the market may be collared by a few big scale producers who have broken into the market, achieved economy and gained

control of the field. The alternative, equally disastrous, occurs if too many big interests try to participate in a programme too small to enable them all to mass produce on the requisite scale, for then the cost of housing will not fall and prefabrication will languish... we need to establish a common basis of dimensions to which sponsors of individual products can adhere and so that we get a range of standardised products that will fit together in different ways in the building, but, above all, that <u>will</u> fit together"[70]

In noting the divergence between the interests of commercial producers, which were to monopolise the system building market and limit the interchange of components, and the most 'rational' way of organising mass production in building, which called for the establishment of a common dimensional framework, Harrison identified the conflict that subsequent official research policy sought to overcome. The way to achieve a common dimensional basis, according to Harrison, was through a "<u>central body</u>" which could itself instigate standards both in the dimensional basis of buildings and in the specification of components. By 1947, with the work of the Burt and Standards committees completed, Harrison felt that Britain had missed its chance and that government had failed the cause of mass produced housing. [71]

The concept of assembling buildings from parts that could be combined into varying building forms underlay the initiatives in standardised schools construction during the 1950s. In 1948 the M.O.E. advocated that prefabrication in schoolbuilding should not entail the factory production of standard schools, "in a sense comparable with totally prefabricated houses", [72] but the production of standard ranges of components. Although educational systems did not consist of components that could be interchanged between different systems on a national scale, the design of frame systems which would allow flexible planning and the insertion of different types of wall panel - albeit all exclusive to an individual system - provided a far greater degree of variation in the form of the buildings than was achieved in system built housing. [Figs.14,15&16]

As Harrison had predicted, the initiative in formulating a modular system moved to an international forum. In 1954 the European Productivity Agency (E.P.A.) of the Organisation of European Economic Co-operation initiated research on modular co-ordination with the involvement of 11 European countries of which Britain, represented by the B.S.I., was one. In 1956 it published a report on the subject but many of the countries dissented from the basic module proposed for components. In 1961 the E.P.A. produced a second report based on further negotiations and research which reccommended a 10cm. module for metric countries and 4" for imperial countries. This latter proposal was accepted and approved by the International Organisation for Standards (I.S.O.). [73] With a plea in 1962 in the Emmerson Report that the state should finally adopt a modular framework [74] a consistant policy was initiated on dimensional co-ordination by government departments. In May 1962 an Interdepartmental Committee was set up among building ministries with the object of agreeing a set of standard dimensions. [75] Between 1963 and 1968 the M.P.B.W. published seven documents advocating a non mandatory series of both horizontal and vertical dimensions that covered commercial, housing, educational, industrial and public buildings. [76] In 1963 the Minister of Public Buildings and Works reported to Parliament that from then on all government buildings would be designed to these standards. [77]

The renewed promotion of modular co-ordination in housing during the 1960s can be seen in the development of the 5M system by the M.H.L.G. in 1962. The stated object of the Ministry in developing 5M was to provide a much needed flexible low-rise system for small sites capable of being used by small builders. However, it is evident that the design of 5M was determined by the intention of official architects to implement recent agreements in modular planning and hence move toward the goal of open systems. The system represented the direct application of the modular steel frame systems used in educational building. The designation '5M' referred to its planning grid which was derived from five times the size of the I.S.O. 4" module. The initial market for the system was provided by the Crown barrack re-building programme when it was awarded a 370 house contract at Catterick. This project, undertaken by the M.P.B.W. Research and Development Group, was intended to establish the production of 5M components by individual manufacturers and represented a form of co-operation that was to endure between the development groups of the two ministries. [78] By 1966, 5M, the first government designed housing system to enter production, was in use by 14 authorities, and, true to its original intention, 20 different house types had been conceived. [79]

The extension of modular principles was also made through the Nenk system. Designed by the M.P.B.W. Research and Development Group in 1963 as an all-purpose building system, the Nenk was also based on the flexible frame and infill panel technique developed in educational building. Like 5M, the barrack building programme of the early 1960s was used as a development and production vehicle; the system was first used for a half million pound programme of communal buildings at Invicta Park, Maidstone. [80] Although specifically conceived for Crown use, Nenk, like 5M, was intended to further a national system of interchangeable components:

> "In Nenk an effort has been made not only to devise a method of building which would allow the designer greater flexibility in planning... but it was also hoped that as it evolved, it might evolve in a more open manner. A key point for the future development of Nenk would be to ensure that new components could be introduced into it more readily than was possible with the existing systems"[81]

Indeed, the Research and Development Group intended that the use of the system should not be restricted to the Ministry but hoped that "in the national interest" it would be adopted by local authorities and "any architect public or private, who wants to use it". [82]

The most ambitious state designed system was Jespersen 12M, developed in 1963 in association with John Laing & Co. [Ch.II] The first practical application of the 12M was in the M.H.L.G. Research and Development project at Oldham, in which the group based its modifications to the system on a 12 times 4" module (12M). The choice of Jespersen for Ministerial support was quite deliberate: it was the only heavy precast concrete system whose panels sizes were based on a dimensional module rather than a limited range of standard designs. [83] Furthermore, the cladding panels to the front and rear did not form part of the system: panels made by other manufacturers of varying design could be introduced in accordance with the policy of "opening" commercial systems. [84] The condition that the Ministry attached to carrying out development work on behalf of Laing was that the company should make the components available to outside contractors (this was duly done in November 1967). Like Nenk, the ministry was attempting to spread the use of its systems as widely as possible. As Chapter Two describes, considerable state support was given to Jespersen in the form of a contract for 2,252 barrack dwellings in the Home Counties and 1,000 houses at Livingston New Town. [85]

By 1965 the notion of component building had become commonly accepted as the next phase in industrialised building technique. In the same year Interbuild opened a monthly section on the subject listing any form of new component that came onto the market, [86] and by early 1966 the Ministry of Health had developed a range of standard components for use in hospital building that included complete door sets, partitions, storage units, and window assemblies. [87] Indeed the words "component" and "open" became fashionable among commercial firms. In 1966, Hawthorne Leslie named their modified low-rise system "the flexible component" system [88] and in the same year Cosmos launched an "open" housing system claiming that its components could be bought individually and if wished could be used in traditional construction or with other systems. [89]

While industry acknowledged this trend the fortunes of the three systems designed by the state were failing. Although sophisticated and attractive to experts in "open" system building they were unsuccessful with potential purchasers. The complexity of ordering the 5M components from a large number of individual manufacturers made it uneconomical in comparison with commercially sponsored and more highly standardised systems and required a large programme to make the effort worthwhile. [90] Eventually only 3,468 houses were built. [Tab.V] For Jespersen to be economical it needed vast contracts and a rationality in design which belied its apparent flexibility; [Ch.VIII] the sponsoring company eventually lost heavily on the project. Nenk, conceived to be openly available was used only on Crown projects, and did not survive the completion of the barrack rebuilding programme. [91]

The design of these three systems comprised the first phase of government building research and development policy during the 1960s. The second was to prove even more ambitious: an attempt to bring into being the national system of interchangeable prefabricated components envisaged by D.Dex Harrison. In 1966 the government announced that it was halting the development of further systems and concentrating on the development of standard components. [92] The way in which this was to be done was explained to Parliament by the Minister of Public Buildings and Works in July. Departmental professional staff, working in the Interdepartmental Component Co-ordination Group (I.C.C.G), would provide potential producers with dimensional standards and performance specifications. When components satisfactory in performance, design and price had been developed with industry it was intended that they should initially be used in public building programmes to stimulate large scale production. [93]

The first component to be promoted by the state was the I.B.I.S. partition for schools. Describing educational research and development policy, in 1966, the Assistant Chief Architect to the Department of Education and Science (D.E.S.) explained that his department was hoping to promote the use of standard components in a number of the systems being sponsored by local authority consortia. Indeed, a number of educational consortia were currently considering sharing window units devised by S.E.A.C. However, the building element first chosen for development was an internal prefabricated classroom partition; a complex component - needing to be soundproof, lightweight and durable - which, it was hoped, would be the first to be interchangeable and nationally used within a variety of systems. [94]

By July 1967, the D.E.S. had prepared the performance and dimensional specifications upon which the partition was to be based and advertised for willing manufacturers in the press. Some suppliers dropped out in the early stages and of the remainder, two designs, I.B.I.S. and the Expanded Metal Partition System, were considered to have met the D.E.S.'s design specifications. The manufacturers of the former, Richard Thomas & Baldwin, were prepared to have a mock-up ready in six weeks and, were this to prove acceptable, the Second Consortium of Local Authorities (S.C.O.L.A.) undertook to enter negotiations with the firm for the inclusion of its partition in their schools programme. However, it was not until 15 months later that it was reported that I.B.I.S. was satisfactory in terms of appearance, technical performance and - if half the consortium's programme was guaranteed to it - price also. In the ensuing discussion of the adoption of the partition by the Board of Chief Architects of S.C.O.L.A., it was pointed out that the work involved in its immediate inclusion into the Mk.II would prevent development work from taking place on the next system. Furthermore, as the Chief Architect from Leeds pointed out, the trend towards open plan schools threatened to reduce the use of partitioning by 80%. Already, the extensive lead in period of the product threatened to make it obsolete before production could begin. The argument for adopting the system concentrated on "the wider question of moral commitment" to support the attempt to develop open components. The D.E.S. were prepared to offer a guaranteed programme to the consortia large enough to cover any commitment they made to the partition. In the vote that followed I.B.I.S. was accepted by a narrow majority. Nevertheless, the adoption of the first centrally designed open component had become a contentious issue and prompted a special meeting of the Board in which the previous decision was overturned by the representatives of five authorities who refused to guarantee the use of the untried partition in their share of the programme. By March 1969, S.C.O.L.A., S.E.A.C. and the Consortium for Method Building (C.M.B.) had all withdrawn from the I.B.I.S. project due to a price rise resulting from refusals to guarantee a sufficiently large programme. [95] In October 1969, with the design of a further, cheaper, version of I.B.I.S. by the D.E.S. Research and Development Group, Dan Lacey, the Department's Architect, asked S.C.O.L.A.:

> "to consider the adverse reaction non-use of the partition in the next programme year might have on the industry as a whole... a modest use of the partition in 1970/71 may give a good impression"[96]

The resolution, that the use of I.B.I.S. should be left "to individual members to decide", seems to have sealed the fate of the partition for it was the last reference to the subject in S.C.O.L.A.'s minutes.

Early in 1969, Patricia Tindale, Principal Architect to the M.H.L.G. announced that her Ministry was abandoning 5M and putting all its resources into practical experiments into the B.S.I.'s programme of dimensional co-ordination in building components. [97] Despite the intention to carry out research on component co-ordination and the formation of a working party of architects from local authorities to prepare performance specifications for standard housing components, there is no evidence that the M.H.L.G.'s new policy bore fruit in development projects. In the latter years of the 1960s the initiative in housing development work was taken up by the N.B.A., headed by Cleeve Barr since its inclusion into the M.H.L.G. in 1966.

In 1966 the N.B.A. carried out an exercise in the application of "standardisation, dimensional co-ordination, serial contracting and a rationalisation of the design and building processes" for the North Eastern Major Authorities (N.E.M.A.) consortium. As it made clear, the N.B.A. had "not produced yet another 'system'" but a "rational approach to repetitive building". [98] Essentially the Agency developed a range of house types each of which shared a common dimensional basis. The object of the "basic shell approach" was to allow the use of a standard external wall component, which could be constructed in a variety of techniques by different manufacturers. In April 1968, the Agency published Metric House Shells in which it proposed that the design of the nation's housing should be rationalised to a set of external shell sizes each of which bore a common dimensional relationship to each other. [99] As I.B.S.A.C. pointed out, the proposals "would provide the greatest single impetus to date for developing industrialised building methods". [100] In the next year the adoption of the shell plans, in association with the metrication of housing dimensions, became official ministerial policy. Circular 69/69 pointed out to local authorities that:

"During the next three years local authorities will be changing the design of their dwellings to metric dimensions... This provides an opportunity which may never recur, for bringing about a significant reduction in the great variety of two storey house plans used by local authorities"[101]

In the Minister's view the application of the disciplines described in the N.B.A.'s <u>Metric House Shells</u> "provides the best means of securing this objective". According to the Circular, house shells conferred many advantages on the local authority and comprised a major initiative in the wider use of industrialised methods. Primarily, the use of shells would enforce reductions in dimensional variety and hence the greater use of standard components in system building. From the 31st December 1969, the adoption of N.B.A. dimensions by local authorities was made a condition of loan sanction by the Ministry. At a stroke the M.H.L.G. had enforced a national system of dimensional co-ordination for public sector housing, and had it not coincided with the rapidly declining use of systems and resurgence of traditional construction, [Tab.II] might have made a significant impact on the development of postwar building technology. As it was, the flurry of excitement caused by the introduction of the house shells policy soon subsided, and shells became little more than a source of complaint by architects about the increasingly centralised direction of housing design. [Ch.VIII]

IV.

The systems developed by research and development experts displayed a conspicuous feature: in every case they were the most technologically sophisticated available and represented an "advance" on those promoted by industry. The systems sponsored by the state were intended to lead the development of prefabrication in the direction favoured by the government expert. However, equally as conspicuously, these attempts failed.

Three reasons may be offered to explain this. Firstly, despite the status given to this elite within the state architectural service, and their innovative zeal, it is evident that, while they were given the resources to promote system building, they were not provided with the means to determine the basis upon which it was to develop. For instance, the I.C.C.G., responsible for co-ordinating the dimensions and performance specifications for the entire public sector building requirement was staffed by only 17, [102] and the B.S.I., with whom they worked in the laying down of standards was a voluntary body quite inadequate to the volume of work involved. [103] Secondly, the 'rationality' of the state expert demanded a degree of technological sophistication inappropriate to the postwar building market. Thus, the pressed steel systems of the later years of the Second World War failed. Where dimensions and performance specifications were agreed during the 1960s, the latter were often set too high for manufacturers to meet within cost limits. [104] As the I.B.I.S. project demonstrated, the more sophisticated the product, the longer the lead in time and the less the chance of securing a sufficiently large market to justify production.

Thirdly, and perhaps most significantly, manufacturing industry had little incentive to conform to government research policy. Indeed it had good reasons to frustrate it. As the M.O.E. pointed out in 1952, "An attempt, therefore, to co-ordinate several different elements is liable to involve considerable changes in factory plant", [105] increasing the capital costs to the producer and placing at a disadvantage any manufacturer prepared to put the philosophies of expert opinion into practice. The incentive for manufacturers to change their ways was further reduced when, in times of peak demand, a market was ensured for their existing products. With increasing economic instability in the late 1960s the expectation that manufacturers would invest capital in mass production techniques was even more misplaced. The reluctance of industry to follow the lead of science and rationality in building production was discernable as early as the Burt Committee's cool reception to prefabrication. This committee was chaired by Sir George Mowlem Burt (Mowlem), and included John Laing (Laing) and G.W.Mitchell (Wimpey). [106] Dominated by such building interests as these, the Committee could hardly be expected to espouse philosophies such as those which C.I.S.P.H. thought might change the basis of the property market at a stroke or threaten to introduce firms to building such as Briggs' Motor Bodies and the subsidiary of British Steel, Richard Thomas & Baldwin. While each of these firms launched building systems at one time or another their designs owed nothing to mass production theory, but, rather, were based on the hard facts of current building economics. [Ch.VII] Furthermore, the motivation, suggested in Chapter Two, behind the promotion of systems by large contractors was to monopolise the state housing market. Allowing the interchange of components between different systems could only conflict with this policy by making the market available to a larger number of producers. Far from establishing a common dimensional basis, commerical firms jealously guarded the technical details of their systems. With reluctance, and in strict confidence, they provided the information required by the N.B.A. to assess their systems in order to advise local authorities on those best suited to their housing programmes. Indeed, a fear expressed by some builders, in the mid-1960s, was that component co-ordination, allied to what was expected to be a wider growth of consortia, would provide a basis from which government could nationalise the building industry. [107] The demand by Rene Short M.P. in 1965, [108] and that by N.F.B.T.O. in 1967, [Ch.V] that the state should set up its own component producing factories can only have fuelled these fears. Paranoia was excited among system builders, already known for their secretiveness [109] by the N.B.A.'s development work for N.E.M.A. in 1966. This led to accusations that the Agency was exploiting technical information provided by commercial producers in the development of its own system. [110] In 1967 the N.F.B.T.E. insisted on a reduction in the information its system builder members provided to the N.B.A. [111]

The experts, promoting science, rationality and the common good, were, for the most part, in conflict with the economic rationale of the building market they sought to change. While able to influence government technical policy and disseminate their ideas within the architectural profession, they were unable to achieve their primary aim - a major structural change in the organisation of the building market through the mass production of interchangeable prefabricated building components. As the Deputy Director of the B.R.S. pointed out in 1972, shortly after S.C.O.L.A.'s final rejection of I.B.I.S., "component building in the sense of catalogues of generally available components which can be readily assembled in a wide variety of ways seems a remote possibility". [112]

CHAPTER SEVEN. THE DYNAMICS OF POSTWAR BUILDING ECONOMICS.

As the previous chapter described, housing systems sponsored by the state met with little success. In contrast, a number of the systems developed by commercial interests met with considerably greater success. In the years covered by this study commercial producers, using a range of technologies, were able to provide alternatives to traditional construction in social housing. However, with the decline of large social housing programmes it is apparent that system building proved incapable of supplanting traditional housebuilding methods. This chapter will review the approaches to system building of commercial sponsors and suggest that their success resulted from the conditions created by postwar social and economic policies. The final section of the chapter will attempt to explain why, in the absence of the conditions created by the Welfare State, house construction in Britain has consistently favoured traditional methods in place of capital intensive technologically sophisticated building systems.

I. PRECAST CONCRETE.

The savings to be gained by dispensing with costly shuttering and reducing site labour through the off-site casting of concrete floor elements were exploited both before, and more conspicuously during, the Great War. In the Cheap Cottages Exhibition of 1905, Cubitts demonstrated a polygonal single storey cottage made up of a small number of reinforced concrete slabs, with the claim that it facilitated rapid erection. [1] The subsequent development of a distinct precasting industry was signified by the formation of the British Cast Concrete Federation in 1928. Further attempts were made between the World Wars to apply precasting, primarily in the form of large blocks, to wall construction but, according to Bowley, labour savings were insufficient to provide a cost advantage over masonry and production concentrated on the further development of flooring units and non stuctural components such as paving slabs and fence posts. [2] As well as being used in Frankfurt's municipal housing schemes of the late 1920s, precast concrete slabs formed the cladding for the Mopin system used in the construction of the Quarry Hill Flats (Leeds, 1938). [3] Although the building industry submitted a number of designs to the M.O.H. Committee considering methods of constructing flats for the working classes in 1937, none featured the extensive use of precast concrete.[4]

The precasting of large structural elements for the wartime construction of concrete barges and floating harbours gave rise to a serious consideration by the building industry of a conceptual scheme by Professor A.L.L.Baker and V.G.Hatherly. Their proposal featured the construction of multi-storey buildings with large panels, weighing from 3 to 5 tons, hoisted into position by crane. In August 1945, the National Builder reported that contractors familiar with engineering methods were investigating the scheme "from the point of view of the amount of site labour involved and the probable total cost of the building". [5]

The first post World War Two applications of precast concrete to housing avoided the use of the latest technologies. Both the Cornish Unit and Airey houses used small precast components which bore little relation to the techniques being considered by the building industry for multi-storey construction. The basis of the Airey system had been developed as early as 1925 and, as in the case of Cornish Unit, was manufactured by a precasting specialist rather than by a large building firm with engineering experience, such as those who were later to exploit large panel technology. These houses were intended to be erected by small builders often in rural areas which precluded the use of large elements erected with heavy lifting gear.[6&Fig.8]

The use of concrete in small units seems to have been uneconomic. The Airey house received a capital grant of 175 pounds, second only to the Aluminium and B.I.S.F. houses. [7] In 1948 the M.O.W. found that, of the non traditional houses it had tested, the model featuring large precast units (although not mentioned specifically, most certainly the Wates system) proved to be most competitive with traditional construction. [8] Wates, a large building firm involved in the wartime Mulberry precast concrete harbour project, was the first British building firm to market a system with room-size precast concrete panels. [Fig.10] The economy of this method, in the hands of a large building firm with the requisite experience and organisational capacity, enabled Wates to increase its production after the withdrawal of government subsidies to non traditional houses. [Tab.IV] In 1948, Reed and Mallick built their first large panel precast concrete panel house. Unlike the Wates system which required a self supporting internal lining, the Reema panel was cast with an internal surface which could simply be given a half inch plaster coat, meaning a further element of wall construction had been incorporated into an increasingly complex panel, [Fig.11] and whereas the Wates house required 1,500 labour hrs, the Reema required only 1,280. [9] By 1962, as well as over 300 village halls, Reema had constructed 20,000 houses using its hollow panels. [10]

By 1950, a tradition of using large precast concrete panels for house construction had emerged. However, the wider exploitation of this technique and its increasing sophistication was stimulated by three factors: a change of government policy in favour of high-rise building, the introduction of the towercrane and the improvement of external wall finishes. In November 1955, the M.H.L.G. changed the subsidy system to encourage the greater use of multi-storey flats. Due to the greater cost of building high, local authorities had concentrated their flats in three to five storey blocks resulting in lower densities than the government wished to achieve in redevelopment projects. [11] The eventual operation of the new progressive storey height subsidy positively favoured high-rise construction. This may be judged from tender approvals for dwellings over five stories in height which rose from 8,044 in 1955 to a peak of over 44,000 in 1966. [12&13] In 1964, P.A.Stone calculated the cost of building a 775 square foot dwelling in London to be 2,737 pounds for two stories and 3,936 pounds for 15 (for the North the figures were 1,916 and 3,473 pounds respectively). [14] The government subsidy system had created a market for a very expensive type of building. The implications of high-rise housing were to prove considerable to precast concrete construction for a major part of the increased cost was accounted for by the introduction of a steel or concrete structural frame, unecessary in low-rise housing, but required in traditionally constructed flats over five stories. The need for this expensive item was eventually eliminated in large concrete panel systems by simply supporting loadbearing panels on one another thus securing for precast concrete a major cost advantage over traditional construction in this housing type. [15]

The lifting technique which was essential to exploit the newly created high-rise housing market, whether with precast panels or framed construction, was provided by the rail mounted towercrane. Developed in Europe between the wars, the first models were introduced to Britain in 1951 and vigorously promoted by the M.O.W. [16] Although essentially an efficient means of lifting heavy components to considerable heights, the tower crane itself exercised a powerful influence on building operations. Calling for detailed preplanning and the systematisation of erection processes, the wide application of tower cranes played its part in encouraging the adoption of sophisticated methods by industry. [17] If a firm possessed the expertise to use a tower crane it had encompassed much of the skill needed to operate system building. By 1952, four different continental makes were available in England and home produced models were rapidly being developed. [18]

In 1947 the range of finishes for concrete included painting, rendering, the application of special facing mixes and stone facings. However, a newcomer was the use of aggregate for facing precast units. [19] As precast panels were cast face down in horizontal moulds, aggregate, or crushed stone, could be applied by placing a layer over the bottom of the mould (prior to pouring) which would set into the face of the panel as the mix dried. An early application of this technique was to the facing slabs to the Quarry Hill flats where Derbyshire Spar and brown gravel were used. Whereas painting and rendering required maintenance, aggregate facing formed a permanent and (due to its irregular relief) self cleaning finish. In 1954 <u>Prefabrication</u> pointed out that early postwar precast concrete houses: "well built and otherwise satisfactory... show within a few years a sad picture of deterioration in colours, streaking patterns of stains and chipped corners". [20] In 1956 Reema dispensed with its stippled and painted finish and adopted Cotswold Stone aggregate. [21] By the early 1960s precast concrete was able to present a finish equivalent to brickwork in durability and low maintenance.

In April 1962, W.J.Reiners and Donald Bishop, both of the B.R.S., published a theoretical cost study of different methods of multi-storey construction. Using Operational Research techniques the study compared the use of large panels and conventional construction in a theoretical project of "800 maisonettes built to a single design in 20 nine storey blocks on four different sites in outer London". [22] The study was of necessity theoretical for at this time fully industrialised large panel systems had not been used in Britain. The large panel system showed a 3.5% saving over conventional construction, representing "a gross return of about 30% per annum on the additional capital investment of about 100,000 pounds" for purchase of the factory plant and a transport fleet. Were the transport hired, capital investment would be reduced to 65,000 pounds and the return correspondingly higher at 35% per annum. Apart from the elimination of the frame, a major factor in this saving was the reduction of plasterer's work due to the smooth internal surfaces obtained in precast concrete. Were plastering dispensed with altogether, as was current on the Continent, a further saving could be expected. Provided the investor could be assured of a 800 dwelling contract (or a series of continuity contracts amounting to the same total):

> "At present it appears that large panel construction can be undertaken with prospects of saving in cost representing an acceptable return on investment and with little danger of appreciable loss"[23]

By 1964, according to government statistics, tender prices for system built flats above four floors, in which large panel construction dominated, were over 2% cheaper than for conventional construction. Indeed, in two consecutive years, 1967 and 1968, high-rise system built tenders actually fell. [Tab.VII]

The first and most successful British firm to introduce a large panel system into the high-rise housing market was Concrete Ltd., the largest of the precasting specialists. Although the systems it manufactured were erected by subcontracted building firms, Concrete Ltd. may be considered one of the most successful entries of a non building firm into housing production. Concrete Ltd. was founded in 1919 and began by manufacturing precast floor beams. Rather than enter the housing market in the immediate post Second World War period the firm concentrated on developing pre-stressed concrete for flooring panels. [24] With the introduction of tower cranes in 1952 the company designed the Bison Wide Slab, a large pre-stressed flooring unit up to 7'6" wide. This was incorporated into a system with the introduction of precast beams and columns and a nine storey block of flats was built in 1957 for Barking Council. In 1961, in a further development for Barking the frame was replaced by load bearing wall panels and in July of the following year the introduction of the Bison Wall Frame was announced, with Birmingham Corporation as the first takers. [25] The essence of the system was a collection of precast concrete panels (integrating completed internal and external finishes, wiring, and plumbing) forming the entire structure of the dwelling, with stairs and bathrooms cast as complete units. [Fig.19] By the time that it introduced Wall Frame the company had increased its total output of precast products from half a million pounds, in 1945, to five million pounds and had established five casting factories in various parts of the country. [26] The first large panel system was introduced by a major manufacturer with a regional system of manufacturing plants. [27] Between 1964 and 1979 Concrete Ltd. constructed 31,668 dwellings in Wall Frame. [Tab.V] Three years after it was introduced, the system had captured 20% of the high-rise market. [28]

While it is evident that British manufacturers were adapting their production techniques to the economic characteristics of high-rise construction it is also true that British development owed much to continental practice which had advanced further by the early 1960s. France, Scandinavia and the Low Countries had been applying new techniques to flat construction continuously since the Second World War. By 1949, the French engineer, R.Camus, had patented his system and by 1962 it had completed 40,000 flats with factories in France (5), Russia (2), Algeria (2), Germany (1), South America (2) and Italy (3). The standard practice was for Camus to jointly own the factories in partnership with indigenous contractors and industrialists. [29] Rather than develop their own systems three British firms, Unit Construction Co., Mitchell, and Fram, Higgs & Hill, all became joint owners of British factories producing panels under the Camus patent. [30] Four other firms also licensed continental panel systems for production in Britain. [Tab.V]

Those systems that were developed in Britain owed much to foreign developments. Indeed, in the crucial years in which Concrete Ltd. converted their frame system to loadbearing wall panels they seconded a senior engineer to the Danish offices of P.E.Malstrom, consulting engineers to Jespersen and Larsen Nielsen. Rather than pay a royalty on a continental design, Concrete Ltd. were able to study at first hand continental practices and apply them to their system in return for a consultancy fee. [31] A central element in the design of panel systems was that of the joint between the panels, the principles of which were established by continental engineers. Where an internal wall met the external wall eight panels abutted and the junction had both to transmit the loads from one to another and be weatherproof. In framed construction the structural members are monolithically connected: in large panel construction it was crucial that they could be rapidly stacked, one above the other, with the minimum amount of site work to make the connection. Accurate casting of the panels in moulds obviated the need for laborious aligning processes on site. Any discrepancies in the alignment of the wall panels was accommodated by adjusting a bolt cast into the top of the panel below. The Larsen Nielsen joint, upon which the Bison and many other joints were based reduced the insitu work needed to join the wall and floor elements to a minimum. The panels abutted each other directly and the residual voids were either dry packed or filled with grout. The weather was excluded by a grooved channel holding a flexible tongue in the vertical plane, and, in the horizontal plane, by a down-stand in the face of the outer leaf of the panel. The dry joint was crucial to the production of large panel systems whose profitablility required minimal site work: the bold orthogonal grid imposed on elevations is their hallmark. [32&Fig.24]

The sponsorship of a large panel system was a considerable undertaking. The most expensive element in the production process was the concrete casting plant. The factory built by Taylor Woodrow Anglian at Lenwade, in 1963, to produce components under the Larsen Nielsen patent was estimated to have cost 250,000 pounds by I.B.S.A.C.. The factory consisted of four 330' long casting shops each making different types of component which were transported about the works by two 10ton overhead cranes. The stockyards included custom built racks for the storage of panels, and sidings were constructed to connect the works to the rail network (eventually the firm purchased a road transport fleet to avoid the vicissitudes of rail transport). Concrete was mixed and conveyed from a central batching plant by a system of conveyors. 90 5ton steel casting moulds were imported from Germany and Denmark at a cost of between 1,000 and 1,700 pounds each. Capital costs also included training the 120 strong workforce in precasting techniques. [33] Larsen Nielsen represented a norm for precast panel investment. The four, rather more sophisticated, plants built by Laing for the production of Jespersen components were estimated to have cost between 600,000 and 750,000 pounds each. As well as a steam curing shed, Laing's plants featured a conveyor belt system to transport the units and a travelling hopper and vibrating machine. Only 14 workers were required to operate the highly mechanised wall and floor manufacturing shops. [34]

Not all firms invested in this level of technology. The cost of a "crude but effective" Reema plant with an output of 500 dwellings per annum was no more than 150,000 pounds. By using a greater amount of labour in the production and erection process, investment costs could be substantially reduced and greater flexibility built into the design. [35] A further means of reducing the investment needed in a permanent factory was the setting up of temporary casting works on site. Although Wates had had considerable experience in precasting by the early 1960s and had studied foreign factory produced systems, it dissented from the fashion for centralised factories and developed a "mobile manufacturing unit" which was resident on site for the duration of the contract. The logic behind this decision is described by Wates' Managing Director:

> "a central factory will cost between half a million and three quarters of million pounds: it will produce 2,000 dwellings per year... A mobile factory costing 125,000 will produce 750 dwellings per year. The first must be amortised over at least ten years... The mobile factory can be amortized over three" [36]

Furthermore, while central factories built up considerable overheads which could be justified when operating at full capacity, they were an expensive liability when production was slack. Site factories avoided much of this expense and could cope more easily with the climate of uncertain demand which eventually characterised system building. Between 1964 and 1979, Wates built 17,782 dwellings in their precast concrete system, and their success was second only to Concrete Ltd. [Tab.V]

The enthusiasm of British building firms for importing expensive high capacity foreign systems was not shared by the B.R.S. which took an early and active part in panel production technology. In 1963 the Station developed the Battery Casting technique for use by smaller building firms and Direct Works Departments. This project was consistent with official policy designed to spread the benefits of industrialisation beyond the larger building firms to the industry in general and break down the autonomy of the closed system. [37&Ch.VI] This ingenious and cheap technique of casting panels vertically in multiple moulds was intended to be suitable for contracts as low as 100-200 dwellings. [38] Contrary to the Station's expectation the system was little used by Direct Works Departments, and a Midland Housing Consortium scheme to develop a panel system of its own using Battery Casting also foundered in 1968. [39] Nevertheless, the technique was willingly taken up by a number of larger contractors and was incorporated into the systems marketed by Wates, The Fram Group and Gleeson Industrialised Building Ltd. The Station's last contribution was a concrete panel pressing machine, which applied the techniques of hydraulically pressing kerb stones to large panel proportions. Launched in 1969, the 1,000 ton press, costing a quarter of a million pounds, could produce panels sufficient for 4,500 flats per year, and could be packed into 12, 13 ton sections. Impressive though this was, there were few producers by this time able to utilise this order of capacity. [40]

High-rise housing was a short lived phenomena. As early as 1962, Cleeve Barr pointed out that for industrialised building to make a real breakthrough it must be applied to low-rise housing. [41] Embling and Marlow, of the M.H.L.G., re-emphasised this in 1964, when they noted that 80% of local authority housing was built in two stories. Furthermore, ministerial design policy was moving towards the concept of two storey, high density housing interspersed with low blocks of flats or maisonettes. [42] Conspicuously, the West Ham housing development, intended to implement Parker Morris recommendations for more flexibly designed living accommodation, used a load bearing brick and timber frame "to give the flexibility and variation of first floor plan shape in relation to the ground [floor]". [43]

Changing design policy was crucial to large panel sponsors. Norman Wates pointed out in 1964 that it was doubtful if precast concrete could be successfully applied to low-rise housing. This fear may indeed have been an important factor in his firms decision to use a site-based system which could be amortised quickly. [44] Concrete panels could compete with frame and cladding construction in multi-storey building but, as simple walling materials were more expensive than brickwork and could not compete with the loadbearing brickwall in low-rise construction. [45] In December 1965, the government announced that it intended to reduce the quantity of high-rise flatbuilding and withdrew the progressive storey height subsidy over six floors. [46] This policy change produced a rash of local authority housing at six stories, at which point it was generally understood that precast concrete still maintained a positive, but lessened, cost advantage over conventional construction. In April 1967, the 1965 measure was followed by a cost yardstick system which prescribed limits for local authority housing costs and reframed subsidies in favour of low-rise high density development. [47] The effect of these policy changes was dramatic: between 1966 and 1974, tender approvals for housing over four floors fell from 44,306 to 2,390. [48] With the decimation of high-rise building came the demise of large panel systems. Between 1970 and 1976 housing completions in precast concrete fell from 25,566 to 1,766, or, from 45% of system built housing to 7%. [Tab.VI]

A number of two-storey housing systems were in fact marketed, although often to supplement a sponsor's high blocks in mixed development projects. [49] The general trend was to reduce the amount of precast concrete, often only to the structural crosswalls, as the system took on lower building heights. In 1966 Concrete Ltd. modified their system to accommodate the six storey heights favoured by the 1965 modification to the subsidy system. Featuring a prestressed floor slab which could span between the precast party walls, the system used timber frame panels for internal walls, and a single leaf non structural concrete spandrel panel for the front and rear cladding. [50] C.Bryant & Co. produced a low-rise precast concrete crosswall system using a substantial amount of timber frame components which completed over 12,674 dwellings. However the success of this firm must be considered in the light of the corrupt relationship into which it entered with its major client, Birmingham Corporation. [51] The tendency of systems such as Jespersen and Yorkshire Development Group to be used for medium rise developments also slowed the eventual decline in precast concrete systems. [Tab.V]

Associated as it was with a particularly conspicuous aspect of state housing policy - the high-rise boom - the rise and fall of precast concrete systems constitutes one of the most dramatic aspects of the development of system built housing. Nevertheless, this surge coupled with the importation of continental designs and techniques should not obscure the fact that a tradition of precasting concrete panels for social housing had developed in Britain, and that successful systems had been marketed for low-rise building by the end of the 1940s. The acute concentration on high-rise in the early 1960s undoubtedly informed the need to hastily exploit methods developed elsewhere. Had these not existed, it is evident that the British building industry would have developed its own precasting technologies for high-rise construction. Indeed, had large contractors not flooded the market with high capacity factory based continental systems, it is likely that more flexible techniques requiring less investment would have been utilised, such as Battery Casting. The inability of large panels to re-enter the low-rise market during the 1970s most probably arose from the fact that, not only had design trends changed in the direction of greater flexibility in layouts and houseforms, favouring more complex high density arrangements than the tight disciplines of precasting could achieve, but that traditional building had itself become more efficient than in the years of dislocation, materials and labour shortages that typified both the early postwar years and the heights of the 1960s building boom. Furthermore, a new type of system building technology, timber frame, had entered the market.

II. TIMBER FRAME.

Despite the fact that timber is well suited to prefabrication, its use in system building did not reach a peak until the mid 1970s - right at the end of the period considered by this study. This section will explain why the development and widespread use of prefabricated timber technology took so long to become established in Britain and why, when it had, it eventually dominated system building technology: in 1976 it accounted for more than half of system built housing. [Tab.VI]

The use of timber for housing construction has a long tradition in Britain particularly for the construction of temporary and emergency accommodation during the World Wars. [52] The introduction of plywood in the 1930s, and its subsequent postwar development, gave a considerable impetus to the use of timber in prefabricated construction. Industrially manufactured, light and strong, plywood provided the basis for eventual timber frame technology. When stiffened with timber battens, plywood forms rigid, easily handled units of considerable lightness and strength which can be made up in small workshops without expensive machinery. Between 1941 and 1944, Uni-Seco Structures claimed to have built five million square feet of accommodation in their plywood and timber system for government hutted programmes with 30 factories supplying timber components to 200 contractors. [53] The firm eventually constructed 29,000 bungalows under the Temporary Housing Programme in a timber and asbestos system.

However, at the end of the war stringent controls were imposed on the use of timber. Not only had the war disrupted the world timber supply, but government policy reduced the import of timber through the licensing system until 1953 in an attempt to improve the balance of payments. Whereas the prewar consumption of timber was 2.5 standards/dwelling, the allowance in 1947 was 1.6. [54] Although the import of 2,444 Swedish timber houses was allowed by the government in an attempt to boost housing output in the immediate postwar years, [Tab.IV] timber was limited in non traditional construction. In 1945 the Interdepartmental Committee on House Construction turned down British Power Boat Co.'s design for a prefabricated house as it required large amounts of timber despite the fact that it seemed an otherwise economic method of construction. [55] In common with Uni-Seco, many timber prefabricators turned to overseas markets, in which case timber was made available. The systems which this firm marketed in Britain - for schools, hospital buildings and offices - featured a gradual reduction in timber content throughout the late 1940s. [56] Before the war, Britain's consumption of timber was the highest per capita of any predominantly importing country. By 1953, with the exception of Ireland and Hungary, it had the lowest. Furthermore, timber had become an expensive material: since 1945 it had risen in price by 378%, whereas the average inflation of building materials was 216%. [57]

Following the decontrol of timber in 1953, the M.H.L.G., in conjunction with Canterbury City Council, commenced an experiment in crosswall construction on 24 maisonettes. [58] In this experiment, the loadbearing brickwork was confined to the structural crosswalls of the houses. The cladding was made up of prefabricated timber frame panels and the use of plasterboard on the internal partitions reduced the wet plastering work to a minimum. In 1957, the results of a cost analysis of this experiment in partial prefabrication showed a 142 pound saving per dwelling over the cost of all brick construction. [59] In December 1957, Unity, a firm which had previously sponsored a composite concrete and steel frame housing system, began marketing a two-storey system using brick cross walls, prefabricated non structural timber wall panels and prefabricated roof trusses. [60] Thereafter, this method of construction, referred to as rationalised traditional or crosswall, remained a popular one for housing construction, [Fig.23B] and a number of system were marketed on these principles during the 1960s. [Tab.V]

The increase in housing programmes of the early 1960s saw a rise in the use of timber frame. An additional fillip came with the replacement of local building bye-laws with the national system of Building Regulations in 1964. Although waivers could be obtained in "specific cases" the model bye-laws effectively prohibited the use of timber for external cladding and party wall construction in housing.

[61] With the National Building Regulation's emphasis on easing the introduction of new techniques, "deemed to satisfy" provisions were replaced with performance standards (thus a method of construction would be required to have a specific performance rather than be of a specific composition). External timber claddings could now be accommodated within the new performance standards and the construction of a fireproof timber party wall, of satisfactory performance, was pioneered by the M.H.L.G. Research and Development Group in the 5M system. [62]

The technique that predominated timber frame technology during the postwar period was the 'platform frame'. Originally developed in America and Canada, platform frame differed considerably from the traditional timber house eliminating a large part of its skilled labour content. Rather than embodying a skeleton timber frame constructed insitu, prefabricated wall panels were brought to site and, in conjuntion with the floor and roof construction, rapidly nailed together to form a rigid box structure. [Fig.27] Like steel frames, this allowed the simultaneous working of finishing and roofing trades. The standardised wall panels were made up in workshops using large table jigs on which the timber studs, ply sheathing, windows and door frames, vapour barriers and insulation were assembled with unskilled labour. [63] The adoption of prefabricated timber construction was assisted by the introduction of craft eliminating jointing techniques such as plate connectors which could be driven home by hydraulic presses. [64] Traditional carpentry required either the skilled and labour intensive processes of cutting away considerable amounts of wood and the connection of members by hand nailing. Platform frame replaced traditional jointing techniques, such as halving and morticing, with the universally applied buttjoint, whereby machine cut lengths were butted against each other in the jig and mechanically plate nailed.

The cost savings which the use of these techniques provided cannot be calculated precisely as reliable data on the cost of specific types of system building is not available. In 1965 the Timber Research and Development Association claimed that, when used efficiently, timber frame required one third to a half of the labour required in traditional housing, [65] and was capable of a cost saving of 5-10%. Official statistics on tender costs for low-rise system built and traditional housing also suggests that timber frame was competitive with other systems and traditional construction. By 1969, by which time timber frame was a popular form of system built two-storey housing, Table VII shows system building tenders to be cheapening in relation to traditional construction. During the mid-1970s, by which time timber frame was the predominant form of system built low-rise housing, M.H.L.G. statistics indicate that this cost competitiveness had increased substantially. [Tabs.VI&VII]

While some specialists, such as Vic Hallam, both manufactured and supplied the components for large housing contracts, an alternative trend was for a sponsor to restrict its involvement solely to the distribution of the components. A system on these lines was Frameform, marketed by James Riley & Partners. If a client selected Frameform, its scheme designs would be sent to James Riley who would modify the drawings in the light of the system's design constraints. The components were then manufactured by subcontracted woodwork manufacturers, using their standard equipment, to James Riley's specifications. A licensed building firm, whose supervisory staff were quickly trained in the use of the system, would then erect the components, which could be handled without special lifting plant, on site. In this manner contracts as small as two houses could be handled, as in the case of a pair of dwellings for Bedford Council erected by a small local builder, William J.Bushy Ltd. [66] By this means of organisation James Riley estimated themselves to be capable of supplying up to 15,000 houses each year (although successful the firm never attained this figure) [Tab.V] without having to invest in any production plant. The capital required by the firm needed to be sufficient only to provide the accommodation and staff necessary to co-ordinate suppliers and contractors. Furthermore, supply could be rapidly expanded or contracted to suit the state of the market. Compared to other forms of system building, the level of investment, and hence the financial risks were modest, and more importantly, were within the reach of a much larger number of firms.

A further feature of timber frame, important to its success, was its ability to allow considerable design freedom in comparison with steel frame or concrete panel systems. The planning grid on which Frameform was based was a 16" external module - coinciding with the intervals at which the wall studs were placed - and a 4" internal module. However, as the manufacturers were at pains to point out, where desired these could be departed from without imposing high cost penalties. [67] This relative freedom in planning was accompanied by a wide choice of external finishings which included a single leaf of brickwork, render, tile hanging, asbestos sheet, concrete facing slabs and timber boarding. Frameform was capable of mimicking a wide range of traditional house types. [68&Fig.28] Indeed, so confident were James Riley of the ability of its system to be indistinguishable from traditional construction that it ran a competition in which participants were invited to select, from 16 photographs, four houses which were not built in Frameform. Organised at the 1968 Housing and Town Planning Exhibition, successful competitors stood to win 100 pounds. [69]

The combination of timber frame's ability to be indistinguishable from and competitive in cost with traditional construction most certainly enabled its application to the private housing market. Furthermore, the minimal investment required to operate the system enabled housing developers to easily incorporate the technique into their speculative operations. In the late 1960s, Wates were marketing a two storey timber frame housing system, concealed beneath a veneer of brickwork, for use in speculative housing. [70] By 1967 the firm had gained approval from the three major building societies. The adoption of timber frame by large speculative housing developers has been rapid. A. Cullen estimates that, whereas during the 1960s and 1970s no more than 1.5% of private housing was built using timber frame, in 1979 it had reached 15% with many developers making a complete switch in their techniques towards this form of construction. [71] Unlike other methods of system building which modified the character of the buildings they produced, timber frame appeared to be an almost perfect substitute for loadbearing masonry construction. With the exception of timber frame there are no indications that the other forms of system building were adopted on a significant scale by private housing developers.

III. NO-FINES.

Whereas previous sections have concentrated on particular categories of system building, this section will look at one particular system; No-Fines, sponsored by George Wimpey & Co. There were many systems which shared the principle of pouring concrete into reusable shutters, but none, with the exception of Easiform for a brief period immediately after the Second World War, which enjoyed the success of No-Fines. In June 1968, a Director of Wimpey, Philip Ainley, claimed that over three quarters of a million people were living in No-Fines houses built by his company. [72] This section will explain why the large scale exploitation of No-Fines was undertaken by one firm only, and why, in the hands of George Wimpey & Co. it was uniquely successful in terms of the volume built.

No-Fines was developed in Holland, which, like Britain, was affected by shortages in skilled building labour and traditional materials immediately following the First World War. The system was imported to Britain in the early 1920s and used by a number of firms, including Laing. [73] In comparison with its later success, only a relatively small number were built between the wars. This was explained by the M.O.H. in 1924, as the result of a dearth in plasterers. [74] By the end of the Second World War both Wimpey and Holland Hannen & Cubitt had also experimented with the system. [75] However, of the two, Wimpey were the only firm to pursue No-Fines construction in England immediately after the war, and by 1951 the firm had reached an annual production of 10,000 houses. [Tab.IV]

No-Fines was based on a concrete mix which omitted sand - hence "no-fines" - and was poured into reuseable shutters to form the external wall and internal partitions. [Fig.12] According to the M.H.L.G., No-Fines was not a particularly labour saving system, using on average 1,700 labour hours per house. [76] However, Gosschalk points out that the labour used was classed as unskilled, representing a considerable labour cost saving. [77] The erection of No-Fines shells, in one 'throw' at the rate of one a day, like steel and timber frame, speeded the remainder of the building work. The omission of sand, as well as lightening and cheapening the mix, allowed the use of lightweight reusable shutters which constituted the major element of investment in the system. The omission of sand also gave the wall a cellular composition providing thermal insulation and preventing the capilliary attraction of water. Due to the lack in tensile strength of the cement mix, openings were required to be of modest size and evenly distributed throughout the wall - very much in the manner of brickwork. This requirement, together with the rendered external finish, makes the greatest contribution to the character of the finished dwellings which are indistinguishable from rendered brick construction. The floors and roof to Wimpey No-Fines were constructed in timber. Of perhaps most interest to prospective clients was the design flexibility allowed by the system. According to the Director of Housing and Valuer to the London County Council, a large number of its general needs nontraditional housing of the 1940s and early 1950s was built in No-Fines because, as well as being competitive in price with traditional construction, it could mimic the Council's standard house plans. [78] By 1953, Wimpey were using 11 different house types on the Willenhall estate for Coventry City Council, including a special corner unit devised by the City Architect. [79&Fig.12]

The capital investment required to operate Wimpey No-Fines is not known but its magnitude can be roughly guessed by comparing it with a similar system: Easiform. In 1952 the M.H.L.G. estimated a kit capable of producing 34 Easiform houses per annum as costing 4,000 pounds. The pre-World War Two Easiform house was identical to No-Fines, but its postwar version differed in three respects; it incorporated a cavity in the wall construction, used an inner leaf of dense concrete and smaller shutters. To ensure the weatherproofness of the solid No-Fines walls the shutters were a full storey high, and, unlike Easiform's, could only be handled by cranes - this in turn conferred an additional capital expenditure and organisational burden on the No-Fines sponsor. Although a single shutter set represented a modest investment, the number required to produce a poured concrete system in substantial quantities was considerable. For instance, in 1952 the M.H.L.G. estimated the cost of a concrete precasting factory with a capacity of 1,000 houses a year to be 60,000 pounds. According to the M.H.L.G.'s figures for Easiform, in order to produce 1,000 houses a year, the shutter sets alone would cost 116,000 pounds. [80]

A further feature of No-Fines was that it required considerable organisational expertise on the part of the sponsor for its successful operation. In 1948 the M.O.W. noted a considerable discrepancy between the two firms who used No-Fines (by this time the Unit Construction Co. was also using No-Fines in small numbers [Tab.IV]) in their measured experiment of that year.

> "Because the "no-fines" concrete houses on a particular site proved outstanding, one might be tempted to say that "no-fines" concrete construction was in itself superior to traditional construction... [however]... The methods and organisation used by a different firm to build "no-fines" houses on another site produced very poor results"[81]

It would appear that Wimpey possessed both the organisational expertise to successfully build No-Fines, and the financial resources to expand production. As the use of the system increased, according to Peter Ainley, so did Wimpey's selling and contracting organisation:

"a developing network of area and regional organisations made it possible to offer No-Fines to local authorities throughout the United Kingdom. All the advantages of a local contractor with the service facilities of an international organisation are thus available as required by every local authority"[82]

As the case study of Coventry demonstrated, in the hands of a firm with the resources of Wimpey, not least of which was a large permanent and mobile workforce, No-Fines was capable of obtaining the partial monopoly of a local authority's housing programme. Once established, the type of relationship which the firm enjoyed with its municipal clients would have been difficult for a newcomer to dislodge. Furthermore, Wimpey's had no intention of sharing their expertise with other and possibly less proficient firms. In 1952 the M.H.L.G. approached the firm suggesting that it should license its No-Fines technique to smaller builders but received a curt response from the Managing Director: "he was quite definite that Wimpeys will not associate with other firms: they would not be prepared to risk their goodwill... it has been considered carefully in the past and definitely turned down". [83]

Having successfully introduced the system, the postwar years saw its refinement and adaptation to the high-rise market. In 1953, with the casting of a dense reinforced concrete frame into the walls, the system was developed for an estate of six storey flats at Birmingham, [84] and in 1956 a series of 11 storey blocks were built for Coventry. [85] While the principle of constructing the external shell remained the same, the 1960s saw the refinement of the internal work, with the increasing prefabrication of timber roof trusses, timber flooring, and internal partition units and service installations. [86] Indeed, the postwar development of No-Fines owes more to progress in timber technology than to any development in the basic principles of casting the No-Fines walls.

Although outstandingly successful, the peak of No-Fines production was passed in 1967. The overall decline in system building did not begin until three years later. Furthermore, the system was less vulnerable to the reduction in high-rise housing - it could be applied to all building heights. Therefore, it could be suggested that the use of No-Fines was declining in relation to other forms of construction during the late 1960s. [Tabs.II&V] With the demise of high-rise flats, and hence precast concrete systems, the two main competitors to No-Fines were timber frame, whose postwar development had been delayed, and traditional construction whose efficiency had improved considerably by the late 1960s. It is most likely that the development of both of these methods of construction was eroding the cost competitiveness of No-Fines. Remarkable though its successes were, No-Fines was as vulnerable as any other technology to the dynamics of postwar building economics.

IV. THE EVOLUTION OF TRADITIONAL BUILDING.

Previous sections have explored the alternatives to conventional construction provided by system building. This section will examine why they had such difficulty in competing with traditional methods of house construction.

In assessing productivity increases in traditional building, non technical factors must be considered. The 1948 M.H.L.G. Committee of Enquiry Into the Cost of Housebuilding noted the deleterious effect of postwar dislocation on housebuilding productivity. [Ch.I] As these were overcome in the succeeding years, traditional building could but become more efficient. However, the considerable strains imposed on the building industry in the 1960s once again exerted periodic influences on efficiency. [87] Official figures for productivity suggest that the efficiency of traditional building improved steadily from the end of the war onwards. [88] Some sources also suggest a dramatic rise in productivity during the 1960s, with the Under Secretary of State for the Environment announcing to Parliament in 1972 that over the past decade output/per worker had risen by between 4% and 8% per annum. [89] However, the optimism of these figures must be tempered by the N.B.A.'s more circumspect analysis in 1976 of "little improvement" in productivity in house building over the past ten years. [90]

Despite difficulties in measurement it is apparent that real developments in conventional house construction proceeded along a number of different paths. One of these was the introduction of mechanised plant to site operations. Many of the basic innovations were made before the Second World War: the portable electric drill, the powered concrete mixer and the towercrane, however, their wider application in building operations was a postwar phenomenon. [91]

Between 1948 and 1964, investment in mechanical plant by the building industry grew from 11 million to 50 million pounds annually. [92] Nevertheless, the application of mechanical plant to building is not as easy as in other types of industry. While ideal for tasks such as earthmoving and heavy materials and components handling, it is less easy to use mechanical plant in the construction of the fabric of the conventional house. Furthermore, its overall efficiency is impaired by the long periods for which plant lies idle awaiting the appropriate stages of the job to be reached.[93]

Of more significance to housebuilding have been advances made in materials manufacture. These have benefitted system building and traditional construction alike. The production of many basic materials - ie. bricks and concrete - were highly mechanised before the Second World War. [94] Indeed, one interwar innovation, plasterboard, and its mass production was acknowledged by R.B.White in 1965, as "perhaps the greatest single contribution to prefabrication of any period". [95] The postwar period saw the introduction of extensive ranges of industrially produced boards to building, and in 1957, L.L.Goodman cited the production of chipboard as an early example of fully automated manufacture. [96] The impact of such advances on house building were legion for nearly half the costs of construction are accounted for by basic materials. Indeed, as Donald Bishop pointed out in 1966, over the past decade the prices of building materials had in real terms fallen in common with other mass produced commodities: "To this extent - amounting to perhaps 40% of the cost of building - the industry is industrialised already". [97]

Also of great significance has been the introduction of limited prefabrication. Rather than attempting to prefabricate the entire structure, conventional builders have increasingly inserted prefabricated components into a structure built by conventional means. By the mid-19th Century Thomas Cubitt was serving his building sites with centralised workshops pre-manufacturing and finishing plasterwork, marbles, steel components and joinery. [98] The pre-manufacture of windows, doors and joinery fittings was common practice among interwar speculative housing developers, and, indeed, has been noted in existing histories of prefabrication. [99] Led by Crittalls, the interwar period also saw the marketing of standard ranges of windows and doors in both timber and steel. A more recent innovation has been the introduction of prefabricated roofing trusses during the 1960s. These have since come to dominate the housing market, both private and public, and a significant part of house construction - the basic roof structure - is now manufactured under industrially advanced conditions: in 1978 three million trusses were made on 250 machines by between 150-200 firms. Other components, such as metal lintols, are also manufactured by flowline production. [100]

A further area of advance has been in management techniques. A particularly active participant in this field was the state. One of the first time and motion studies of building operations was produced by the M.O.W. in 1945 to aid the application of the payment by results scheme introduced during the war. [101] As a means of increasing efficiency in state building contracts, the M.O.W. reported, in 1948, that it and most local authorities were insisting on the use of Time and Progress Schedules by government contractors. [102] In view of the fact that, at this time, the bulk of building work was carried out directly for the state, this measure must have brought such techniques to the attention of a large number of firms. Many firms, both large and medium, adopted management techniques in their building operation during the postwar period. According to G.MacLean, of John MacLean & Sons, the prospect of competition with non traditional producers was an important incentive towards this. [103] During the 1950s and 1960s Work Study and Network Analysis were imported from America and applied to building operations, both conventional and industrialised, by larger firms. [104] The degree of systematisation required by building systems was a factor in the introduction of computers to building. In this the M.P.B.W. also played a developmental role. [105]

Advances in traditional building were only one of the difficulties facing investors in capital intensive, labour saving technologies. The inhibiting effect of the cheapness of British building labour on attempts to industrialise the housebuilding industry was noted on a number of occasions during the 1960s. At the Housing From the Factory conference in 1962, Donald Bishop observed the need for building labour to become more highly paid in relation to other types of labour for the "potential" economies of system building to be realised. [106] In 1965, A.Tozer, Managing Director of Cubitts Construction Systems Ltd., anticipated that in "about two years time" building wage rates would rise sufficiently for a real cost advantage to be found in system building. [107] In 1967, D.V.Donnison repeated Tozer's forecast that "before long" there might be a structural change in the relationship between building and non building wage rates. However, this did not take place and building systems were forced to compete in a building market inherently unsuited to capital intensive labour saving building methods. As Gosschalk pointed out in 1970, the cheapness of British building labour can only have contributed to the commercial failure of firms exploiting capital intensive foreign systems by comparison with the cruder models developed in Britain by Concrete Ltd., Wates and Reema. [108]

Despite the considerable demand on building resources during the 1960s, the fact is that building in Britain remained relatively cheap. Referring, in 1966, to the latest figures produced by the Organisation for European Co-operation and Development (O.E.C.D.) the National Builder proudly noted that:

> "the British building industry had the best record of any in Europe for holding its prices down during the ten years, 1953 to 1963, and that during this period our housebuilding costs rose even less than that of other building works"[109]

Other sources support this boast. [110&111] The fact that this relative cheapening of housing costs took place before the major industrialised building drives of the 1960s does little to support the contention that postwar productivity increases in building generally were aided by system building.

Detailed studies of the effect which system building had on building operations suggests that the gains which system building made over traditional construction had less to do with the inherent labour saving advantages of new methods, than the effect they had on building operations and the type of contractor which they attracted. To use a building system successfully, sponsors had to introduce a considerable degree of organisation and rationalisation into their building operations. The dependence of system building on good management was noted by the M.O.W. in its measured experiment of 1948. The M.O.W.'s verdict was that, on average, non traditional methods of construction had indeed shown significant savings in labour content and that 3 had shown savings in cost. However, in achieving this, successful sponsors had developed a degree of managerial expertise uncharacteristic of the traditional builder:

> "to achieve useful results with new methods of construction it is necessary to have the appropriate organisation for the design of the house, for the production of the components, and for erection on site. It is probable that all three functions will need to be very closely integrated if success is to be assured, and that management of the "production engineer" type will yield the best returns"[112]

This aspect of system building was re-emphasised by the B.R.S. during the 1960s. According to Donald Bishop, the benefits of system building resulted from the rationalisation it forced upon the design and organisation of the building process rather than from the superiority of system building construction techniques: "the discipline imposed by large panels on the design makes operational control and high productivity more feasible than is the case with conventional construction". [113] Hence Bishop proposed that the "<u>average</u>" labour productivity of building systems was likely to be higher than the "<u>average</u>" labour productivity for conventional brick construction although the difference between the best exponent of each was not great. In 1968 Bishop suggested that the average labour content of a traditional house might vary from between 2,400 hours "when building is just allowed to happen" to 700 hours in the hands of a specialist. The latter figure competed easily with best results obtainable in system building. So far as raising the productivity of the industry as a whole, Bishop's analysis suggests that either system building removed the difficulty that the average contractor had in making traditional construction as efficient as it might be or attracted the type of sponsor amenable to improved management techniques. [114]

In 1970 the N.B.A. suggested that it was in terms of the latter thesis that the higher productivity of system building should be understood. So far as the Agency was concerned the technical merits of different types of building in two-storey house construction were the lesser factor in the efficiency with which they were built:

> "the productivity which is achieved by using industrialised building methods is less dependent on the construction techniques adopted than on the management of design and construction. Industrialised housing is operated by contractors who are generally larger and more efficient than the average contractor. The size of industrialised housing projects is also somewhat larger than the national average. In this situation, system builders have achieved markedly faster building times and higher site productivity"[115]

According to this view, official statistics which suggest significant cost savings in system building for two-storey housing after 1969 [Tab.VII] may well be describing an altogether different phenomenon: that of larger, more efficient firms taking on larger contracts. The fact that they were using building systems may not be the reason for their lower tender prices - the firms may well have achieved the same efficiency with conventional building methods.

The degree to which building methods could be made more efficient without introducing capital intensive building methods but by mimicking the close relationship between design, production and organisation found in system building was demonstrated by the N.B.A. in the late 1970s. The Pitcoudie I development project concentrated on the effects which the rationalisation of conventional construction could have on productivity. The 112 houses, completed in 1977, were funded by the Glenrothes Development Corporation, and designed by the Scottish Development Corporation using the N.B.A. as project management and productivity consultants. The layout, although consciously intended to avoid the extremities of design rationalisation often associated with system building, consisted of straignt terraces of simply designed houses in five types, varying from 1- to 3-storeys. Pitcoudie combined a productivity raising design strategy with the latest limited prefabrication techniques. Firstly, although the housetypes differed in layout and elevational treatment "they were designed in such a way that, as far as practicable, <u>the same building sequence</u> could be followed in each house" thereby allowing a more regular flow of work from one house to another. Secondly, the building sequence consisted of fewer and larger operations than was normal, reducing the number of return visits by individual trades and reducing their interdependance: the wiring harness was delivered complete and installed in one operation. Thirdly a high degree of standardisation was used in the construction details: there was only one bathroom layout. Fourthly, readily available materials and components were used, concentrating on reducing the 'learning curve' in their installation and application. Fifthly, the house plans were dimensionally co-ordinated using only two shell sizes to aid the use of standard components: there was only one size of joist and two roof truss spans. [116&Fig.29]

According to the N.B.A., this approach was an unqualified success. Whereas between 1974 and 1977 the average labour content of a Scottish dwelling was measured at 1,584 hours for traditional construction and 1,139 for system building, the Pitcoudie I houses measured in the same survey took an average of 1,016 hours. A second phase of 283 houses, Pitcoudie II, completed in 1980 achieved comparable productivity using similar techniques. [117] In the light of the possibility of obtaining such dramatic increases in productivity in conventional construction, it is no suprise that, with the benefit of hindsight, contemporary observers such as P.A.Stone (1976) and D.W.Cheetham (1976) tended to question the approach of marketing prefabricated and complete building systems as many sponsors continued to do. [118&119]

V.

The individual development of the types of system building described in this chapter proceeded along very different lines, each occupying a different position in the changing economics of postwar building technology. However, it is also true that they had much in common, not least of which was the fact that sponsors tended to borrow their technologies from elsewhere; either from developments in engineering technique, in the case of steel frames, or from abroad, in the case of large panel systems and No-Fines. So far as British system building sponsors are concerned, little real innovation took place. Usually they were extensions of, or modifications to, existing trends in the development of traditional building technology: large panel systems were based on the development of concrete precasting; and platform frame on a long tradition in the development of American timber technology. Nevertheless, in the case of the eight-way dry joint in large panel construction and the M.H.L.G.'s fireproof party wall in timber frame, there were instances where innovation was generated specifically by system building and not adapted from traditional construction.

The success with which timber frame has been exploited in private housing raises an interesting question on the distinction between developments in traditional construction, and system building. The fact that timber frame techniques were promoted in the form of systems for social housing by proprietary producers has earnt this method of construction the status of 'system building'. In this form it certainly conforms to the understanding of system building presented in this study. Nevertheless, it is significant that timber frame represented the least dramatic departure from traditional techniques of all the forms of system building noted in this study and required the least capital investment. The difference between timber frame and advanced methods of traditional house construction in the 1980s is little more than that the internal wall leaf is constructed of premanufactured timber wall panels in place of blockwork. It may equally be characterised as the recent introduction of a cost saving component to traditional speculative house construction. Indeed, were it not for the legacy of 'system building' in social housing - a concept involving more than just the technicalities of construction - the term 'system' would probably not be applied to a comparatively modest development in housebuilding technique.

In the view of contemporary commentators, new technologies in the hands of system building sponsors were generally faster to build. In specific instances, official statistics record them as being cheaper, however, these statistics are open to alternative interpretations. They also economised in site labour to varying degrees, even though, in the majority of cases, system building's relatively high costs would suggest that these savings were compromised by increased labour inputs at other stages of production. By supplementing building labour with factory labour, they represented a real addition to the building resources of the nation at times of peak demand. In this respect it is doubtful that they fulfilled government policies intended to reduce the overall labour content in building. While they seemed to possess merits in terms of executing large social housing programmes, one feature which the capital intensive alternatives to traditional construction all had in common was an inability to ultimately usurp conventional methods of house construction as they developed in post Second World War Britain.

CHAPTER EIGHT. THE RATIONALISATION OF DESIGN.

Compared to traditional forms of construction, system building imposed considerable limitations on the design freedom of the architect. To understand the response of the architect to these, and the building forms that resulted, it is necessary to consider what seems to have been the two dominant views on design in relation to system building. On the one hand, as C.I.S.P.H. maintained in 1943, it was thought that prefabrication, under the guiding hand of the architect, should be allowed to generate its own 'mass production' aesthetic. [1] On the other, as expressed by G.A.Gellicoe in 1944 following his visit to America, it was asserted that the architect should not simply stand back and allow mass production to generate its own aesthetic for:

> "it is surely the fundamental task of our profession, and of ours alone, to preserve the humanities... we must have good design and good planning; but the main thing is the maintenance of human qualities over machine quality"[2]

However, an issue on which both Gellicoe and C.I.S.P.H. agreed was that it was the architect alone who was invested with the responsibility for bringing about a successful resolution between architecture and prefabrication. It is with these different views on the architect's role, and the profession's attempts to reconcile architectural values with system building technology that this chapter is concerned.

I. THE DISCIPLINES OF IB.

In order to discuss the design of system built housing it is appropriate to establish whether system building forced the architect to produce a different type of building to that which could be provided by conventional means. The evidence of contemporary commentators and the buildings themselves suggest that systems did indeed modify the formal character of housing and enforce a degree of repetition uncharacteristic of conventional construction.

The influence which non traditional systems had on the design of housing was commented on by the M.O.H. in 1924, when the Committee on New Methods of House Construction pointed out of the Weir House that "From an architect's point of view the necessary sameness of the buildings in any extensive scheme is some disadvantage" [3] and advised "careful attention" to layout, colour schemes and grouping. A similar concern was voiced by the M.O.H. in the Housing Manual 1949 which pointed to two characteristics of post Second World War non traditional housing: the designs were made prior to the introduction of the architect concerned with the specific scheme and could not be altered, furthermore they were in nearly all cases semi-detached:

> "the uniform appearance of these houses creates special problems in regard to layout. Not only are the majority of these houses designed in pairs, but it is hardly practicable to make variations in detail as in traditional houses because the design is predetermined"[4]

To combat these drawbacks the Ministry advised "special" measures such as the preservation of trees and hedgerows and, more specifically, the intermingling of small groups of non traditional with traditional housing. [Fig.7E] Despite this advice, The City Architect for Bristol, J.Nelson Meredith, found the non traditional estates designed by his department monotonous by comparison to those which they had been able to design in conventional construction: "In the traditional houses a strong effort has been made to get away from the monotony of large areas of semi-detached housing, though this is inherent in the non traditional type". [5]

Many of the systems which were widely used during the 1960s were rarely marketed as standard dwellings and were capable of some variation from scheme-to-scheme. However, the rationalisation of the construction process into the assembly of large premanufactured components exerted a considerable influence on the design of the buildings they produced. In particular, the design of precast concrete systems was based on the production economics of the concrete panel. The disciplines of large panel building were described, in 1967, by the Deputy Chief Executive Architect to the N.B.A., I. Fraser. Basing his figures on those obtained from a Jespersen plant in Copenhagen operating at design capacity, the ideal standard panel was gauged to be room sized and square with the minimum of indentations. If the panel were halved in width, despite the fact that it would be half the size, only 20% of its cost would be saved. Furthermore a half sized panel with indented corners cost nearly as much an ideal panel twice the size. A standard variant (panels which although not standard were produced in larger quantities than one-offs) with large openings added between 75-85% to the cost, while specials with one-off aberrations might cost up to two and half times that of the ideal. Simply moving a power point from its standard location dictated the manufacture of a special, involving labour consuming work in redesigning and adjusting the moulds. Nevertheless, it should be pointed out that the extra costs involved in producing non standard panels were greater in the more highly mechanised systems such as Jespersen. In the case of low capacity off-site systems such as Reema and site cast sytems such as Wates, the additional costs of producing specials were not so great.

The implications of utilising efficient panel sizes and configurations were numerous. In order to use the standard panel at its most efficient span, both wide frontage and narrow frontage dwellings were excluded. Staggers in plan and section also increased costs to the detriment of the system's cost efficiency. Whereas placing dwellings back to back, as in the Bison Wall Frame, had little effect, handing the plan simply doubled the number of component types. A standard arrangement in articulating the layout of traditional housing was prohibited by the exigencies of large panel production. Balconies fixed to the face of the external wall were preferred to those which were recessed and the staggered section, which introduced a range of additional jointing problems over and above more regular forms, was anathema. While plans needed to be repeated on each floor so that panels could be simply supported one above each other, the superimposition of two panels with large openings might require the insertion of extra reinforcement. One dwelling type particularly unsuited to large panel construction was the maisonette; a building form which had become increasingly popular in redevelopment schemes during the 1950s. The requirement of this type for a bedroom floor to be superimposed on a living room floor prevented the repetition of identical floor plans. Furthermore the internal stairs required floor panels with large openings which concentrated stresses in a manner unsuited to panel construction. [6] The imperatives of producing large panels favoured a cellular building form, regular in outline and identical on each floor with modestly sized openings in its compartment walls. [7&Fig.20] Large panel system building modified the design process with a host of rules and constraints. As the Consultant Architect to Concrete Ltd., Clifford Culpin, pointed out in 1967:

> "Beware of those presenting systems who say that theirs can be readily adapted to suit any circumstances! If it can, then it hasn't been systematised... To mess about with a system is as illogical as building with bricks of odd sizes"[8]

The impact which system building was having on the design of L.C.C. housing (which by this time concentrated on the use of precast concrete, but also the steel frame, and insitu concrete) was described in a report by the Architect to the Council, Hubert Bennett, in February 1965. In terms of design, the impact was not felt on the individual dwellings - indeed Bennett claimed that so far the council had found no restriction placed on the layout of the units of accommodation "beyond what would be expected of any method of construction now in use". Furthermore, the quality of finish in industrialised building could be good or bad no matter which of the systems was used and did not appreciably differ from that in traditional building. The unavoidable effect of system building was stated as that of repetition both of the individual dwelling unit and of the dwelling block: "Investment in the capacity to repeat carries with it an obligation to accept a minimum level of repetition without any change in the design". [9]

However, the L.C.C., like a number of larger authorities, was in the fortunate position of being able to offer contracts of such a magnitude that it could determine, within the constraints of the production technology, the design of the systems it used. Where unable to offer large contracts, or where lacking in the professional resources to redesign a system, an authority would be obliged to accept, more or less unmodified, a proprietary model. Typical of this type was the Bison Wallframe. [Ch.VII] The purchaser of Bison dwellings was subject to a very tight series of design constraints. The core of the system was a standard bathroon unit, emerging in one piece from the factory and embodying the piped services. Against this the kitchen was placed. The basic Bison dwelling was a two-bedroom flat with the standard kitchen and bathroom configuration against the party wall. Structural crosswalls, which could be centred at 6" increments between 9' and 16', divided the bedrooms and living rooms. The standard practice was to join two flats back to back to form a wing. Two wings would then be connected by the lifts and stairs. While adjoining flats had to be identical the plan of each wing could be varied within the formulae. The layout could be further elaborated by separating the wings with additional flats placed back-to-back. By arranging the standard wings in a variety of configurations a limited set of block shapes could be derived, the most distinctive of which was a staggered block. [10&Fig.19]

II. ARCHITECTURE AS PRODUCTION.

The way in which the modification of design by system building was received by architects involved in social housing can only be understood in terms of attitudes to the design of this particular building type. Such an understanding is essential to comprehend the readiness with which the majority of achitects accepted, and in some cases warmly greeted, the limitations imposed on their creativity by system building. This acceptance may be explained by two factors: firstly, the disciplines of system building were quite consistent with the design orthodoxy established for social housing by the state; and secondly, Modernist housing architects - from the turn of the century onwards - insisted that a major source of architectural expression should be the process by which a building was produced.

Like its interest in building technology, the government's interest in design began with its involvement in housing provision. This interest extended beyond standards of accommodation and building construction, and included formal principles of composition. The design of social housing was discussed in detail by the Tudor Walters Committee in 1917. The main aim of the Report's advice on the matter was to secure the maximum economy in construction and maintenance consistent with close attention to internal planning and orientation. The ideal cottage would be "simple, straightforward" and rectangular in plan without outbuildings and back projections unless these were "justifiable and desirable" in a particular case. Rather than relying on ornamentation, the formal qualities of the dwellings were to be provided by "good proportion in the mass and in the openings, by careful grouping of the various parts of each cottage" [11] and by careful site layout. In considering the monotony that might arise from large areas of similarly design housing the Committee suggested that attempts to introduce variety for its own sake "can only result in effects which in their way would be as objectionable as the monotony to which reference has already been made". [12]

A more stringent model for social housing design was promoted by the 'Liverpool School' and displayed in the 1917 Dormanstown housing scheme by Adshead, Ramsey and Abercrombie. [Ch.IV] The Liverpool School's understanding of an industrial society, characterised by standardisation and collectivism, dictated a very distinct approach to mass housing design. At Dormanstown, a standard cottage, using the Dorlonco steel frame system and characterised by strikingly simple neo-Georgian styling, was used without variation. [13] The philosophy of design for mass housing pursued by S.D.Adshead relied not upon "its peculiarity or idiosyncrasy, nor in a word upon its individuality, but upon more general characteristics such as suitability to purpose and excellence of design". [14] The M.O.H. itself promoted the neo-Georgian style used at Dormanstown from 1919, partly in an attempt to wean local authorities away from a tendency to embody decoration and needless variety in the design of their state-aided housing schemes. [15] Indeed, the potency of the simplified neo-Georgian style as an appropriate imagery for municipal housing is demonstrated by its wholesale adoption by the L.C.C. and other urban authorities in their interwar redevelopment schemes. By 1927 Ministerial insistence that good design in social housing was the product of a rationalist design orthodoxy, where individual expression and idiosyncrasy were displaced by reason and order, was displayed in the <u>Housing Manual on the Design, Construction and Repair of Dwellings</u>:

> "irregularity, which is merely want of order, is always a negative and destructive quality. Regular order is a quality within the reach of most; it should only be abandoned by those who have a clear vision of the more subtle and pleasing relationship and order which they are to provide in its place"[16]

A relationship between the design and production of the small dwelling was a central feature of the Neues Bauen. [Ch.IV] As the exiled architect Walter Curt Behrendt described, the social housing projects of the Weimar Republic provided the architect with a unique opportunity: "Now, for the first time, it became his task to develop, in accordance with actual and clearly defined needs, and with all the aid of technical science, a new type of small dwelling". [17] The scientific consideration of mass housing by Neues Bauen architects produced the 'Zeilenbau' ('strip building method') used in E.May's Westhausen Siedlung at Frankfurt (1930). The Zeilenbau derived from "constant attempts to lower both the cost of layout and the proportion of land coverage". [18] Housing blocks were arranged on the site in parallel rows orientated according to maximum insolation regardless of the surrounding road pattern. The outcome of the Zeilenbau was the standard dwelling placed within a standard site plan: its implicit assumption was that the needs of social housing were best met through the replacement of formal architectural values with the scientifically derived, universally applicable method. Nevetheless, it would be untrue to suggest that Neues Bauen architects eradicated formal concerns from design. In 1932, H.R.Hitchcock and Philip Johnson refuted the claims of 'Functionalist' architects that their work was devoid of style and identified a language of composition which they termed 'The International Style'. [19] Nevertheless, the source of this language, claimed Neues Bauen architects, was a "strict attention to utility, economy and other purely practical considerations" in which the process of construction played a central role. [20] As Bruno Taut wrote in 1929: "If everything is founded on sound efficiency, this efficiency itself, or rather its utility will form its own aesthetic law". [21] Within Modernist architectural theory, the most efficient way of producing houses was through standardisation and mass production, and it was these methods of production which should dictate architectural form.

The dissemination of Modern Movement design theory in the mid 1930s, by architects such as F.R.S.Yorke and Maxwell Fry, added a new colour to the rationalist trend already established in British social housing design. To many, the effect of promoting the mass production model for social housing meant the acceptance of an inferior order of design. Rather than being seen as architecture the dwelling should more properly be regarded as a mass produced article. In 1944 it was noted by T.P.Bennett that if the manufacturing model of housing production were to be adopted in order to satisfy the need for housing, the first victim would be "the high and interesting qualities that arise from the work of the highly skilled workman". [22] However, given that society could no longer afford work of such "high grade" for its everyday products, Bennett suggested that it would have to attune itself to the inferior order of design which was the inevitable result of mass production. As Basil Honikman conceded in 1965, system built housing "must be reviewed with the same attitude that one regards any other mass produced article designed for mass consumption. To demand more is like asking the low priced motorcar to perform like a Rolls Royce". [23] One influential critic, Reynor Banham, considered the contribution that technology might make to the building programmes of the 1960s, and urged a critical judgement of architecture which departed from a concentration on form to an appreciation of the social context in which it was produced: "for a decade or so, it is not going to be safe to pass judgement simply on the grounds of what a building looks like".[24]

There were those who saw advantage in the restrictions which new technology imposed on the designer. According to proponents of the 'Modern Movement', such as Nicklaus Pevsner, the constraints imposed by new technology could bring only good to architectural design: as he pointed out in 1960 "they keep the architect to reason. They eliminate neo-irrationalism". [25] The positive benefits of system building were also described by the Housing Architect to the L.C.C., K.J.Campbell in 1966:

> "To work within such disciplines may be just what the profession, at the moment, needs more than anything else. It would probably be good for society at large also, individuality run riot is one of the banes of our age"[26]

Furthermore, there were those who happily exchanged the traditional pleasures of architecture for the excitement of system building - such as Miall Rhys Davis, another of Concrete Ltd.'s consultant architects who wrote in 1965:

> "let us stop and look at the piece of metal, or concrete, or plastic, or glass. It is pretty well the same whatever chunk of building grows from it... So where the excitement, the fireworks..? The quantity, the speed, efficient, neat, fast organisations, calculated and planned exactly. A new machine, a mechanised administration - this is the excitement... it lives on continuity, big investment, and requires

vast pipe lines of communication"[27]

As building programmes, and the pressure on the building industry mounted, the call on housing architects to fall into line increased in intensity. As the Civic Trust pointed out in 1963, the tendency for a wider variety of housing types to be used in British social housing compared with the Continent was delaying the introduction of systems to Britain. [28] At the Housing From the Factory Conference in 1962, Cleeve Barr lamented the multitude of British social housing types which had developed over the past century. Listing eleven of these he suggested that the consequence of this was that:

> "At best this variety has led to some fine examples of good architecture which are known throughout Europe. At worst it has resulted in a waste of professional and technical skills which has caused additional expense to local housing authorities and prevented both traditional and non-traditional builders from taking full economic advantage of repetitive building operations"[29]

Throughout the 1960s, an ongoing project within the M.H.L.G. Research and Development Group was the reduction of "needless variety" in housing design. A consideration of this issue formed a part of the advice given to local authorities in Circular 76/65 (December 1965) which stated specifically that, as well as providing continuous programmes and providing system builders with larger, more straightforward sites, it was advised that "the number of plan types in a scheme is kept down, and satisfactory types kept in use". [30]

Within this context, the universal opinion of Modernist architects seems to have been that the design of non traditional housing produced immediately after the Second World War was a grave disappointment. The source of this discontent, however, was not that designs were being imposed on the architect from without, nor even that the houses were monotonous. As D.Dex Harrison pointed out in 1945, the problem lay in the tendency of sponsors to ignore the production process as a source of imagery. According to Harrison, while interwar architects in Germany and France had taken new materials and "examining their design potential" produced revolutionary forms such as the open plan dwelling supported on 'pilotis':

> "the pioneer prefabricators were trying laboriously to adapt these materials to the traditional plan and box like concept of the small house... Here we have the origin of the deep seated mistrust of prefabrication as something which is 'substitute' and lacks its own inherent validity"[31]

In Harrison's view, architects such as Beaudouin and Lods (France), Neutra and Buckminster Fuller (America) and Gropius (Germany) had indeed already begun to develop an aesthetic for prefabrication, primarily by expressing the jointed structure between the prefabricated elements and abandoning traditional archetypes such as the pitched roof and small window opening. [32] According to Joseph Emberton, architectural consultant to the Bernal Committee (1945), were the design of prefabricated houses to evolve on the lines of the aeroplane, motorcar, tube train and bus, where "maximum efficiency was expressed in form" the development of prefabricated homes "will produce results equally satisfying besides providing more efficient homes". [33]

In the event few of the non traditional houses produced after the war made any attempt to depart from traditional forms. The Keyhouse Unibuilt house, designed by Grey Wornum and Richard Sheppard in the early 1940s, displayed a very thoroughgoing interpretation of Modernism in its flat roof, rectilinear form without traditional excresences such as bay windows, and minimalist porch structure. However, this particular model only reached prototype stage. [Fig.6] The B.I.S.F. house designed by Frederick Gibberd, while not adopting a traditional cottage imagery made little external display of new technology. Indeed contemporary opinion seems to have regarded it as an acceptable compromise between the old and new: it was neither praised for being forward looking, nor vilified for its backwardness. The roof was neither flat nor steeply pitched, the windows neither unusually large nor abnormally small, but generously proportioned with slender steel mullions. Furthermore, both the roof and upper floor were visibly clad in a material new to housing - profiled sheet steel. [Fig.7] The concessions which the steel frame Unity and B.I.S.F. houses made to Modernism were not shared by the popular precast concrete models such as Airey and Cornish Unit, the design of neither of which was accredited to a well known architect. Between them, approximately 50,000 dwellings were produced by 1955 in an architectural style which made no celebration of precast concrete construction. The Airey house was a bland exercise in traditional styling with small windows and a steeply pitched roof. Unless seen at close quarters, in which case the horizontal precast concrete slabs are recognizable as a non traditional walling material, the Airey house differs little from the typical austere postwar cottage. [Fig.8] The more distinctive Cornish Unit was dominated by a mansard roof which stylistically owed more to interwar eclecticism than postwar Modernism. [Fig.9] Furthermore, the tendency for all of non traditional houses to adhere to the semi-detached model evoked images of the interwar garden suburb arhitecture despised by Modernist architects. [34] Nevertheless, despite these shortcomings the non traditionl houses were consistent with the British tradition of social housing design. They were modest in their architectural treatment, without decoration or overtly historical references. Furthermore, by their very nature in being standard designs they avoided the worst of architectural sins described by the M.O.H. in 1927 - gratuitous variety in external form. As their sponsors no doubt intended, they fitted inconspicuously into the model of social housing which had developed between the wars.

By the time that a new generation of building systems arrived in the early 1960s, stylistic preferences had changed: Modernism had become the accepted style for social housing. Furthermore, the two storey cottage had been replaced for much of local authority housing by multi-storey housing, and in particular the towerblock. The aesthetic expression of high-rise housing developed very much in relation to the technology of its construction and was guided by an architectural movement which embodied Modernist ideals: the New Brutalism. This restatement of Modern Movement design theories pervaded British housing design from the mid-1950s to the mid-1970s and provided a major source of inspiration for architects concerned with the design of system built housing. The New Brutalism displaced the prevalent British interpretation of Modernism - dubbed 'The New Humanism' by the Architectural Review and described by Reyner Banham as "brickwork, segmental arches, pitched roofs, small windows (or small panes at any rate) - picturesque detailing without picturesque planning". [35] In its place Brutalism offered a style which drew its inspiration from the contemporary work of Le Corbusier and Mies Van de Rohe and concentrated on venerating the materials and techniques of construction that were emerging in the post war period. The picturesqueness of The New Humanism was replaced by a style which concentrated on the processes by which buildings were produced. Within this restatement of Modernism, the formal character of system building was readily accommodated. The material particularly favoured by Brutalism, and one which became increasingly popular after the war, was concrete, large expanses of which were displayed in the Park Hill housing development (1961) by the Leeds City Architect's Department. Indeed, it could be suggested that the attraction of Brutalism - particularly as far as architects involved in system built housing were concerned - was the result of it giving coherent expression to the techniques and materials being exploited in flatted construction. As in Alison and Peter Smithson's most influential projects (Golden Lane Housing competition entry, 1952, and the Sheffield University Extension, 1953), the type of building to which 'Brutalists' first addressed their interpretation of 'Modernism' was the large scale urban architecture of the Welfare State - [36] the very type of building which was exercising the minds of architects concerned with housing redevelopment.

One of the first authorities to make a clear union between new technology and Modernism (or 'Brutalism' as it had by then become) was the L.C.C. The early 1950s saw an increasing concentration by the L.C.C. on mixed development and new technology. [Ch.III] Furthermore, in 1950, responsibility for the design of housing was transferred from the Valuer's Department to the Housing Architect, bringing in a large number of new staff. Amongst these were a number of architects from the Hertfordshire Architects Department including Cleeve Barr (later Assistant Housing Architect), and architects described by K.Frampton as "sympathizers and colleagues" [37] of the Smithsons. According to Reynor Banham's interpretation, the early 1950s saw the L.C.C. Architect's Department as the veritable battlefield between the New Humanism and Brutalism, with the latter emerging victorious. [38] One of the most thoroughgoing early L.C.C. essays in Brutalism was the Roehampton, Alton West Estate, slab block (opened 1959). Based on a scaled down version of Corbusier's Unite d'Habitation (Marseille, France 1947-52) the L.C.C. architects used concrete, both insitu and precast, as the material for its construction and cladding. [Fig.23A] As K.J.Campbell, Housing Architect to the Council, pointed out in 1962: "Concrete is a serious material, it is the building material of this twentieth century... there are some places in Roehampton where ordinary Portland cement has weathered as beautifully as Portland stone". [39] Thus, at the time it was adopting large panel building systems, the L.C.C. was committed to a design theory which derived its aesthetic from modern methods of building production.

The Morris Walk housing scheme (contract awarded 1963) was the first of the Council's large concrete panel estates and displays a studied attempt to develop an architectural style derived from the production technology of system building. For this reason the estate will be examined in some detail. Morris Walk consisted of 562 dwellings in the Larsen Nielsen system. In describing the scheme to the Housing From the Factory Conference in 1962, the Assistant Housing Architect to the L.C.C., J.Whittle, pointed out that many of the schemes they had visited abroad had been "architecturally disappointing" and their layouts "monotonous". According to Whittle this resulted from architects seldom designing schemes specifically for a system but too often adapting a preconceived design. However, in designing the L.C.C.'s first large panel estate Whittle announced that the department had returned to first principles:

> "it is our experience that many promoters of these systems delight in their claim that they can build any block designed for traditional building. But this is

putting the cart before the horse; building by a special method should give rise to a recognisable architectural expression, which should develop from a rational use of the method by the architect"[40]

The basis of the Morris Walk design was the "day production unit", that is, the number of panels which the factory could produce in one day. Together, these components formed a wing which comprised the standard unit of design. Each wing (or day production unit) contained two living or bedsitting rooms, two kitchens, two bathrooms, two W.C.s, two stores and four bedrooms. By varying the position of the party wall within the wing, a variety of dwelling sizes, ranging from three bedrooms to bedsitters, could be provided. [Figs.24A&B] The degree of standardisation inherent in the scheme meant that all the living rooms and bed-sitting rooms were identical in size and layout as were the bedrooms. There were two types of kitchen and a standard bathroom/W.C. for the whole project. The ten storey blocks were formed by joining two wings back to back with a staircase and lift tower while the three storey linear blocks were comprised by joining wings end-on. The exploded block plan provided advantages both intellectual and avowedly practical. The accommodation and staircase elements were maintained as distinct physical units enabling "the complex lift, staircase and service core... to be considered separately from the dwelling units" leading to greater simplification in design and erection [41] but, importantly, also giving formal expression to the method of construction.

The standardisation of the panels, considered essential to efficient system building design, guided the external character of the blocks. Whittle boasted that only four basic sizes of external panel were used - although admitting that, taking the different window configurations into account, there were in fact 17. The elevations marked a significant departure from preceding L.C.C. designs not least in an absence of modelling and a lack of visual expression to the individual units of accommodation. [Fig.24C] A particular departure (although due to its expense to become more common in later L.C.C. housing) was the elimination of the balcony - the dominant motif in the Alton West slab blocks where it was used to articulate the broad facades and give expression to the individual dwellings. [Fig.23A] The balcony was a feature that had been maintained in the Council's earlier experiments in system building at Picton St., Camberwell, (Laing, finished 1957) and Aegis Grove, Battersea (Reema, finished 1962) [Fig.21&22] and seems to have been dropped specifically in this first rigorous interpretation of large panel construction.

Little was said of the Morris Walk site plan by Whittle, other than that it had to contend with a highly disordered site with varied levels and that "the design problem was to dispose standard units about a site which was most irregular in contour and produce an ordered scheme". [42] Morris Walk is unusual by comparison with other L.C.C. mixed development estates in having both its low and high blocks built to essentially identical designs with similar elevational treatments. [Fig.24B&D] The blocks, both high and low, were composed of identical wing units - which gave all of the three storey blocks the same aspect and the ten storey blocks one of two aspects. Therefore, there could have been no reason, within the L.C.C.'s rationalist design philosophy, for orientating the blocks differently. Indeed, despite the fact that it is divided into two unequally sized portions by a railway line, this mixed development estate is remarkable in having every block, both high and low, aligned uniformly. [Fig.24E] Such an arrangement was not the case with the majority of L.C.C. estates which hitherto had made some acknowledgement of the site topography in their layouts. This varied from picturesque site planning at Roehampton to the variagated arrangement and external treatment of row houses, maisonettes and flats on the Loughborough Estate, Lambeth. Whether or not the intention of the L.C.C. architects, the degree of rationalism which lay at the heart of the Morris Walk design brought it closer to the systematization of the Zilenbau arrangement than any of their mixed development schemes.

While the basis on which Morris Walk was designed was questioned later, not least by the L.C.C. itself, Whittle and his colleagues were undoubtedly proud of their first essay in large panel construction: "This design demonstrates that the dull and repetitive schemes so often associated with industrialised housing are not necessarily the fault of the system". [43] To the charge that the identical blocks and rigid site plan of Morris Walk were monotonous, Whittle's superior, K.J.Campbell might have replied with the words he used at the 1962 Housing From the Factory

Conference:

"There has been far too much - there is always far too much - talk about variety and monotony. These are practically meaningless terms... design begins in the bones of a building. It is in the total of the building that beauty lies... One can easily obtain variety, which is, too often, restlessness, even vulgarity, but what one has to achieve is an inner richness in one's buildings which comes from quite different things entirely... what counts... is how far the architect has grasped totally and absolutely the technique by which his building is produced"[44]

III. ARCHITECTURE AS FORM.

Morris Walk represented the outcome of an approach to designing social housing that was able to accommodate the effects of system building, and indeed fetishised them. Another trend was highly critical of system building largely because of the degree to which it compromised the contribution which the individual architect could make to architectural design. Responses within this tradition varied and included attempts to avoid system building and the design of a second generation of housing system which would offer greater design freedom - in which the M.H.L.G. figured largely. The challenge to system building grew stronger throughout the 1960s as architects, such as those within the L.C.C., revised their position on the relationship between design and technology.

It is evident that the aesthetic shortcomings of system building played a large part in the resistance of local authorities to new technology. A substantial body of opinion, including senior architects, regarded system building as inconsistent with high standards of architectural design. Objectors to system building received little prominence in the architectural press: the Luddite implications of such concerns were in direct opposition to a professional ideology concerned with the conspicuous promotion of new technology. However, these subdued voices represented a substantial body of opinion aggrieved at the effect of system building on the way in which they worked as architects and on the way in which it affected standards of design.

One of the first architects to raise his voice in protest at the effects of prefabrication was R.W.Brown, who, in May 1944, said of his wartime work for the government that he:

> "felt that prefabrication would make us stale. He had had experience of that in the Office of Works, where he had to go to cupboard no.1 for section B, and so on, and copy something. He completely lost interest in his work and felt hopeless"[45]

The effects of prefabrication on the enthusiasm of architects for their work was noted by the Department of Health For Scotland who, in 1951, found that "Architects take more care with buildings designed by themselves". [46] In his correspondence with the M.O.H. in 1951, the Regional Production Officer for the South West Region, C.H.H.Smith, referred frequently to official architects, both in the local authorities and in his own office, who were:

"not enamoured of systems which limit the scope for attractive lay-outs... [and]... who feel no responsibility for securing rapid housing progress and will always prefer to plod slowly, so long as they can express their individuality in housing schemes of limited extent"[47]

Of the various means by which such retrogressive elements of the profession chose to frustrate the use of non traditional houses Smith mentioned the misinformation of lay-committees - in which the faults of new methods were dwelt upon rather than their merits - and the use of systems on sloping sites in an attempt to increase their costs and put them into disrepute. [48] A similar reluctance to accept the disciplines imposed by proprietary schools systems was noted by L.F.Robinson. In correspondence with the M.O.E. in November 1945, he castigated the anarchy of the architect who combined two proprietary systems in one school "to the detriment of both" and the refusal of another to alter "by inches" the span of a building that had been designed causing "a complete series of special beams to be made at 50% extra cost". [49]

Despite the greater design flexibility of local authority sponsored schools systems, [Chs.V&VI] it is evident that many architects and critics held serious reservations on the quality of architecture achieved. Of the Hertfordshire schools that he had visited, J.V.H.Davis was "troubled with an uneasy feeling that something essential was missing. The architect seems to be so far away, his voice so very thin". [50] In May 1961, F.H.A.Crossley, the Derbyshire County Architect, summed up the contradiction facing many architects when he tentatively suggested to a meeting on The Purpose and Organisation of Development Groups that he was "proud" to be a member of C.L.A.S.P. and felt it "excellent for what it is trying to do, but nevertheless, I am left a little doubtful whether it is real architecture". [51]

A senior architect convinced that prefabrication was not real architecture was Fred Pooley, County Architect and Planner for Buckinghamshire. By March 1968 he was able to confess with "some pride in being the architect to the only county in the country not to be muddled in a consortium". [52] Although Buckinghamshire was not an urban authority faced with massive redevelopment programmes it was a thriving Home County with, according to Pooley, a programme of County building running in 1968 at three to four million pounds a year in an expensive building area short of building labour. Thus it enjoyed the same incentives to adopt prefabrication as the rest of the country. Furthermore, Pooley was not ignorant of the characteristics of system building - he was employed by the Coventry City Architect's Department in the early 1950s and wrote a review of the City's No-Fines estate at Tile Hill in 1953. [53] The reason for Pooley's reluctance was quite plain: so far as he was concerned, consortia and industrialised building were unsound economic and administrative developments which had an "unfortunate influence on design". This is not to say that the County had not even considered prefabricated schools systems, it had in the early 1950s, but found them "by their very nature" incapable of providing the same flexibility in planning as traditional construction and unproven in any substantial economic advantages. In Pooley's opinion, the designs produced by system building were inherently poor:

> "The trouble with the post and panel theme is that at its best it is a flimsy looking element with little civic quality about it: at its worst it is just plain and monotonous... concrete panels are not all that much better and by and large those that we can afford are uncivilised slabs of material, incapable of maturing in a satisfactory way"[54]

In preference to system building, Pooley concentrated on "using simple straightforward construction, with an emphasis on limited standardisation" and the use of brickwork wherever possible - as in the 11-storey block of loadbearing brick flats he built at Aylesbury in 1961. [55] Nevertheless, Pooley was not averse to using precasting techniques where he felt them appropriate, for instance a proprietary Bison precast concrete frame and floor was used at the Royal Grammar School, High Wycombe (1964). [56] As far as Pooley was concerned architecture which combined good quality design with economy could only be achieved:

> "if every building is designed for its site and built in a construction that is economical and sound and where the individual architect can use his skills to the full"[57]

Official policy was by no means deaf to the criticisms of prefabrication levelled by architects such as Pooley. Indeed, the two housing systems in which the M.H.L.G. participated, 5M and 12M, made a conspicuous attempt to introduce more design freedom to system building. The significance to government policy of design quality in prefabrication had been pointed out by the Bernal Committee. In 1945 it commented of the systems already proposed that, unless the low standard of design was raised, there was a danger of "unjustified prejudice" forming against the appearance of prefabricated houses which might delay "the acceptance of new and progressive methods of building". [58] 18 years later the government once again drew attention to the issue of architectural quality in system building. In May 1943, the M.H.L.G. pointed out that "The Government is concerned not to repeat the uniformity of some of the early postwar prefabricated houses". [59] As well as forming part of the M.P.B.W.'s modular building policy, it is in the light of an attempt to increase the design flexibility of system building over and above that of commercially sponsored systems that the development of 5M and 12M should be seen. However, the outcome of the Ministry's efforts was the development of two systems of dubious cost efficiency, which, far from alleviating the design difficulties of system building, served only to emphasise them.

The first of the state sponsored systems, 5M (developed 1962), was derived from C.L.A.S.P., the last in a line of flexible steel frame systems developed for education. [Chs.IV&VI] Like the educational systems, 5M was based on a standardised steel frame capable of providing any building form that conformed to a basic module. In the case of C.L.A.S.P. this was 3'4", whereas in 5M it was reduced to 1'8" to account for the finer planning required in domestic construction. Attached to the frame were a series of cladding panels ranging in finish from concrete to timber boarding and tile hanging. [60&Fig.18] Of its developmental application to a block of elderly person flatlets at Stevenage the Architects Journal pointed to "the success of the design in creating a small scale and intimate environment for old people". [61] However, as the Journal pointed out, the success of 5M was by no means total in eradicating the limitations of industrialised building: "As so often happens with system building, however, a limited range of ceiling heights combined with the inevitable flat roofs has resulted in the pavilion arrangement being blurred by the uniform eaves". [62] Furthermore, the Journal suggested that the expensive steel frame might have accounted for the poor quality of finish to the external and internal claddings. In its overall verdict, Architects Journal felt that "Looked at in the cold light of reason this first essay in 5M CLASP seems to raise as many problems as it solves". [63] Despite its achievement in having produced 20 different house types by 1966, the M.P.B.W. admitted of its 5M barracks at Catterick in 1968 that unfavourable comments "on the appearance of the finished quarters had come from some Army sources". [64] Flexibility in plan and cladding finishes did not ensure the success of the system either aesthetically or commercially. As Chapter

Six pointed out, only a small number were built.

12M Jespersen, a Danish system modified by the M.H.L.G. and sponsored by Laing, [Chs.II&VI] was even more remarkable in its departure from prevailing orthodoxy for it was the only large panel concrete system to depart from room size panels. The wall panels were of three widths, 4', 6' and 8', while the floor panels were 4' wide and variable in length by 1' increments. According to the designers, this feature made it uniquely flexible in design for the internal plan was not fixed by an established range of room sized panels, but could be derived within the variable enclosures formed by the modular panels. [Fig.25A] Furthermore, the narrow panels made it possible to introduce staggers in section without departing from standard panel dimensions - although these in turn required complicated flashings and additional insitu work to render the joints waterproof. Of 12M's use at Livingstone New Town, Architects Journal commented favourably on the range of dwelling types achieved and the richness of the staggered sections in comparison to the designs produced by the average building system. Indeed, Architects Journal suggested that any constructional complexities generated by the staggered forms counted for little against the planning problems dealt with by the system and the range of dwelling types it had provided. The journal's overall verdict was that "If the level of design apparent at Livingstone could be achieved in a large proportion of our public housing instead of in a pitifully small proportion, the national standards would begin to approach a desirable level". [65]

While it may have been thought that 12M Jespersen had solved the technical problem of allowing flexibility in large panel system building design, it was apparent that it had not solved the economic problem. In terms of the N.B.A.'s analysis of optimum panel sizes, the narrow (less than room width and hence not square) panels constituted an inherent dis-economy. To this was added the tendency of designers to exploit the capabilities of the system and design relatively complex forms which generated a host of expensive detailing problems. In 1967 Laing announced that they were unable to operate the system profitably. This news was received with dismay by one contributor to Architects Journal, J.Jordan, who like many architects "saw the project as the most hopeful of the efforts in the British industrialised building field". [66] A subsequent contributor, E.Ambrose, drew the following conclusion from these events:

> "I have visited the Laing scheme at Livingstone where the system has been used and my first reaction was that a lot of 'architecture' has been added... There were many breaks including those required to form roof gardens... [ie. terraces]... every time you make a break you provide not only a new junction to be protected, but a fresh untried problem... This is costly and time consuming... if you buy a system you must accept its shortcomings so far as exciting variations are concerned and concentrate on its advantages"[67]

Illustrating his point by referring to the massive and uniform housing blocks employed in Danish housing using the indigenous variant of the system, Ambrose pointed out that the real advantages of 12M were speed and that the architectural corollary to this was "a grandeur due to scale and effective siting" rather than a picturesqueness derived from intricate detailing. Southwark Council seem to have applied continental practice in the design of the 2,000 home Aylesbury Estate (contract awarded 1967) which rationalised the use of the system to only two types of block - four storey maisonettes and 12 storey slabs. [68&Figs.25C&D] The latter were identified by the R.I.B.A. Journal as the longest housing blocks in Europe. [69] While not true to the spirit in which 12M was conceived, in Ambrose's terms the Aylesbury estate constituted a more appropriate acknowledgement of the system's virtues.

The mid 1960s saw a significant change in the G.L.C.'s approach to system building (the L.C.C. became the G.L.C. in March 1965). This was signalled no sooner than the foundations of the Morris Walk Estate were laid. In March 1963, K.J.Campbell expressed misgivings on the degree to which his department's concern with production technology had controlled the design of the estate:

> "it was an example of architects falling over backwards to try to look at it through the eyes of the production engineer, and we rather gave up the wider viewpoint of the architect. In our 'Mk II' development this what we shall be doing"[70]

The "Mk II" housing development upon which the G.L.C. increasingly focussed its attention during the mid-1960s was

Thamesmeade. This project was one of the first products of the Council's extended role in planning the London conurbation and the largest scheme it had so far designed. Originally known as the Woolwich Erith scheme, the intention, announced in March 1966, was to reclaim 1,300 acres of marshland from the Thames flood-plane to house a population of 60,000. Two-thirds of the homes were to be built by the G.L.C., and a half of these by system building. [71] Planned to take place over 15 years, the first stage of the project was a system built 4,000 dwelling contract placed in 1966. [72]

A further indication that the design philosopy of Thamesmeade would be different to that of Morris Walk was given by H.Bennett in May 1966, when he suggested that the hitherto strictly observed disciplines of system building were no longer consistent with the Council's design policy. In future large low density developments, such as Thamesmeade, the G.L.C. intended to use irregular building forms with an emphasis, in line with the new subsidy system, on medium rise housing:

> "Designing in this way exposes the weakness of most industrialised building systems, whether for tall or low building, which is their inflexibility in the manner in which one dwelling can be related to another... the development of a system offering flexibility and the opportunity for strong modelling is urgently needed"[73]

Rather than continuing to subordinate the design of G.L.C. housing to production techniques, Bennett warned of an increasing emphasis within the G.L.C. on the environmental quality of system built estates:

"The demand for variety must be disciplined, but the large contracts with which the G.L.C. is likely to be associated will, for social as well as architectural considerations, need to be carried out by building techniques which, although making full use of modern means of production will also facilitate the creation of a first rate environment"[74]

Thamesmeade inverted the design approach of Morris Walk. Rather than selecting the system and then designing the scheme, Thamesmeade was designed first and the system chosen later. The design philosophy was described by A.Pike: "The design team decided that the correct approach would be to design a good project without reference to a specific industrialised building scheme and then apply the use of a system". [75] By the Spring of 1966, design work had progressed sufficiently for the G.L.C.'s quantity surveyors to provide cost plans on the basis of traditional construction. Following this, advice was then sought from the N.B.A. on which contractors and systems possessed suitable production and management capacity for the scheme. Three national system building contractors were invited to submit proposals for carrying out the work within the prescribed cost limits. The successful firm was Cubitts, with the Balency system and the contract for 4,000 dwellings, to be constructed over five years at a cost of 30 million pounds, was awarded in October 1966. [76]

Balency was a typical large panel system in all but two respects; it had a particularly sophisticated system for integrating piped services into the concrete panels (which like most systems fixed the kitchen/bathroom arrangement), but more importantly, rather than precast flooring panels the system usually embodied an insitu floor. This latter feature increased its design flexibility and may well have influenced its suitability for the Thamesmeade contract. Phase I consisted of 1,500 dwellings in three types: a highly modelled 2 to 5-storey linear maisonette block, 13-storey point blocks and 3-storey terraces. The most notable outcome of the G.L.C.'s new system building design policy was that a large part of the scheme was not in fact built in Balency. The half-a-mile long, intricately shaped 2-5-storey linear block (completed in 1969 and comprising 342 dwellings, 9 shops, 2 public houses and 250 garages) staggered both in plan and section had been found unsuitable for the system at the preliminary tender stage. However, rather than rationalise its form to bring it within the economic capabilities of the system, the block was built in traditional construction with insitu loadbearing crosswalls and brick panels. Non structural precast cladding panels were styled to match the rest of the system built contract and, where the design allowed, Balency units were incorporated adhoc. [77] The result is a formally complex, traditionally built housing block which forms the core and visually dominant element of the scheme. [Fig.26C]

The 3-storey terraces, in comparison to the Linear BLock, conformed more to the principles of system building design outlined by I.Fraser in 1967. However, in their alternating indentations and projections in plan and section they too flaunted the economics of system building in return for concessions to architectural formality. [Figs26B&E] The same is also true of the 13-storey point blocks. Although of a similar shape - two wings connected by an access bridge - these were given a richness of form, which contrasts starkly with the Morris Walk blocks. Two of the features which contribute to this are the incised corner balconies and wrap-around kitchen windows. Neither of these - involving cantilevered panels and arkward jointing problems more readily solved in monolithic framed construction - owe their inspiration to an acknowledgement of the constructional principles of precast concrete panels. [Figs.26A&D] The outcome of the G.L.C.'s rejection of their former rationalism was a highly mannered design of greater formal richness than had hitherto been achieved in system building. Within this the insitu blocks borrowed an imagery from system building, and the system built blocks an imagery from insitu construction. While this approach may be seen as lacking the intellectual ruthlessness of Morris Walk, it was adequate to gain Thamesmeade the highest international award for urban design. The Sir Patrick Abercrombie Award was given to the G.L.C. in 1969 with the following comment by the Adjudicators: "An indication of harmonious integration of human values, aesthetic expression and modern techniques is to be found in this project". [78]

IV. BUREAUCRACY AND SYSTEM BUILDING.

In December 1968, I.B.S.A.C reported Ove Arup's warning that society was in imminent danger of being taken over by technology. [79] A former member of C.I.S.P.H., Arup's recantation was part of a larger process. The precise nature of this shift in cultural values has yet to be explained but it seems to have been linked to a more critical recognition of the role of technology in achieving economic and social progress.

Within this reassessment of the role of technology came a re-evaluation of architectural principles. Rather than being seen as the panacea to the 'housing problem', system building was increasingly identified with bungling politicians and unfeeling bureaucrats. These sentiments are expressed with particular clarity in Malcom McEwan's Crisis in Architecture (1974). Rather than being seen as the means to gratify the nation's need for public housing, industrialised building became identified increasingly as the worst aspect of modern architecture. Furthermore, the central government architects and commercial enterprises promoting industrialised building became increasingly identified as a heartless bureaucracy, as Martin Pawley described in 1971, "deeply implicated in all kinds of plans for the destruction of old England". [80] At the R.I.B.A.'s 1967 Annual Conference, Fry mourned the shattering of an illusion, formed in the 1930s, of a fusion between architecture and industry which would provide "a renaissance of urbanism". Architects, he lamented, "are as much in the grip of the reproductive system as we are the agents of a bureaucracy, whether governmental or commercial and the buildings we design must reflect the character of both". [81] Indeed, according to Banham - another 'technologist' dismayed by 1971 at the course which modern architecture had taken - the most recent apotheosis of the architecture of the welfare bureaucrat was Thamesmead - "Bennett's Leviathan" as he described it:

> "a virtually self manufacturing city, erecting itself panel by room-sized panel out of a factory in its own entrails... My first reaction to the new environment being created there was a kind of numb disbelief... What I can't beleive is that we have really created a situation in which one man can ordain the environment of so many"[82]

1969 saw the publication of Metric House Shells, and the requirement of Circular 69/69 that it should be applied to all subsequent local authority housing. [Ch.VI] Rather than being remembered for bringing the building industry one step nearer industrialisation, the Metric House Shells policy should be remembered for the protest which it unleashed from an architectural profession aggrieved at yet more erosion of its design freedom by Ministerial edict and the enmeshing of architecture in a further layer of state control. In the November 1969 meeting of the R.I.B.A. Council, in which Metric House Shells was the major topic of discussion, Edward Hollamby, Borough Architect to Lambeth, protested that "The whole of the country's architecture was being removed from the field of creative design". [83]

Taking up the attack in <u>Municipal Journal</u> later in the month, Jane Drew launched an extended polemic against the N.B.A. describing a future environment of Orwellian dimensions:

> "there will be no curves, no minor refinements, no visual adjusments for heights, no connections at corners... Is it really all part of mechanisation taking command, of the Orwellian-cum-Giedion world of the future where feeling and imagination are blunted, convenience takes command and idealism is lost... it is noticeable that those who urge metric shells are not creators. Not being practising architects, they wish to control others"[84]

Defending the N.B.A., in the same issue, Cleeve Barr could do little more than reiterate the need for greater efficiency in building and point to the fact that most council housing was already rectangular, and that the N.B.A. was only rationalising the design of a product that was, in all but the finer dimensions, standardised anyway: "The trouble to date is that every architect, for every site, tends to use a different set of dimensions for simple rectangular houses of the same type". [85] The interchange between Drew and Cleeve Barr carried over into the next issue of <u>Municipal Journal</u>.

While the controversy over Metric House Shells led only to words, that over the M.A.C.E. schools system led to positive action on the part of a disaffected G.L.C. Architects Department. M.A.C.E. (Metropolitan Authorities Consortium for Education) was set up in 1966, and like other consortia immediately began to develop its own system of construction. Using a space frame based on a 1M planning grid, M.A.C.E. was intended to be unique in its degree of planning flexibility. [86] The adoption of M.A.C.E. by the I.L.E.A. also coincided with the G.L.C. Architects Department employing Louis Hellman, an architect who had moved from private to public practice in 1965 "in the hope of entering a more liberal environment". [87] His hopes dashed, he found a hierarchy "trained in the forties and early fifties... cast in the orthodox functionalist and technological mould... local authorities with their bureaucratic structures were ideal for them". [88] In January 1973, Hellman published an article in Built Environment, 'The Myth of the Machine Aesthetic', attacking the 'functionalist' aesthetic of the Modern Movement. The direct descendant of this, industrialised building, was in Hellman's view the quintessential outcome of a fusion between Modernist design theories and hierarchical bureaucracy:

> "This upper strata finds it hard for its part to cope with imaginative proposals or creativity. They have generally risen to high posts not through design ability or architectural merit but through political and administrative conformity - they generally go for the safe solution. For this new management class of non-architect I.B. is ideal. It allows them not only to control the career structure of those below them but also their architectural output. I.B. with its related codes, graphs, graphics, grids, manuals,

financial jugglings, programming and all the other paraphernalia of 'rationalism' fits in nicely with the self-perpetuating mystique of 'management' - it is a style for bureaucracy, tidy boxes to be labelled and administered"[89]

In August 1973, Dick Collins, the Mayor of Camden, on behalf of his Council, refused to accept responsibility for the Edith Neville Junior and Infants Mixed School at Kings Cross built in M.A.C.E. Among Camden's complaints was that there was too little stock room, corridor and teaching space. [90] Seizing the moment, Hellman published an attack on M.A.C.E. in the R.I.B.A.Journal. According to Hellman, even from the first M.A.C.E. prototypes it was evident that "far from being anonymous enclosures for teaching, they were assertively 'architectural' with a most unpleasant brutalist prefab aesthetic". [91] The introduction of M.A.C.E. was followed by a "growing wave of discontent" on the part of architects obliged to use the system. A result of this, claimed Hellman, was that "architects are so demoralised that they do not give sufficient care and attention to their work with it". Among its technological faults, he listed poor sound and thermal insulation; wall and roof leaks due to the impractical jointing system; and a lack of choice in finishes. However, as conspicuous as these was the system's high cost, which led to a reduction in teaching areas and standards in order to make it work. As Hellman pointed out, high costs allied with an inflexible planning grid had serious repercussions: "Reduce the area of a M.A.C.E. school? How can you reduce area on a 1M planning module without chopping off valuable teaching space? How can you decrease the height of external walls when only a 2.4M high component is available?". [92] Following a further unsatisfactory report on the system by the Schools Division Participation Movement and in view of cuts in its capital spending programme, the I.L.E.A. announced, in April 1974, that it was withdrawing from M.A.C.E. In all, by this time, the G.L.C. had built nine schools, had seven under construction and three more due to start in the system. [93] In its response to this decision, the M.A.C.E. Development Group ascribed the revolt of the G.L.C. architects to "an inability to work within the discipline of a standard idiom... and a romantic desire for self-expression". [94]

V.

Post war social housing was designed in the context of a debate on whether or not design should be inspired by the production process or by a broader range of architectural values. The need for economy to be achieved by an avoidance of gratuitous variety had been stated frequently throughout the interwar and postwar period. The belief that an appropriate idiom for mass housing was to be found through the standardisation of the individual unit had manifested itself as early as the 1918 Dormanstown project. The notion that design was purely a process of finding the most scientific solution to the problems of production and building use became a central part of the European Modern Movement and formed an ever present motif in post World War Two design theory. The allegiance between, on the one hand, design theories based on models of massproduction and, on the other, new techniques of construction based on industrial processes, provided a context in which the design of system building was considered carefully, and commented on by Modernist architects. In the case of Morris Walk, the two came together in a tour de force of design rationality.

The dominance of rationalist design theories, and an anticipation of the benefits that might accrue from an exploitation of new building methods, does much to explain the architectural profession's tolerance to forms of building which considerably modified the design process. However, it is evident that the history of system building, in both education and housing, was characterised by a tradition of dissent. Criticisms of the degree to which systems prevented architects from exercising their creative freedom were made both by those who used systems and the few senior architects who refused to. The wholesale support given to system building by the postwar R.I.B.A., and the consequent lack of coverage given to dissenters in the architectural press kept this a subdued voice between 1945 and 1970. However, by the early 1970s, the architectural profession had considerably less to gain by supporting a technologically orientated approach to social housing for, by now, technology had come to mean something else - mindless bureaucracy and the destruction of a 19th Centurey environment - a thing suddenly to be valued. From the late 1960s onwards, aided by the <u>R.I.B.A. Journal</u> under the radical editorship of Malcom McEwan, dissaffected architects proved willing to make increasingly vocal attacks on the effect which reducing design to an analogue of the production process was having on the environment. Within this new climate of opinion, system building was singled out as the most unacceptable face of Welfare architecture. The I.L.E.A. architects were not alone in denigrating their system. In 1973, the Board of Chief Architects of S.C.O.L.A. noted that they were having increasing difficulty in persuading job architects to use the system. [95]

While the anti-system building sentiment of the early 1970s may have speeded the eventual demise of the educational consortia it could not have had much effect on system building generally. By this time it was already in rapid decline due to the poor performance of the economy and cutbacks in housing and education programmes. The increasing criticism of system building by architects, less than being instrumental, accompanied its decline. Indeed it could be suggested that it was the same conditions which brought an end to large housing programmes and industrialised building - declining economic power and the conspicuous inability of technologism to prevent this - that sowed the seeds of discontent with modern architecure as the road to social progress and a new architectural era.

CONCLUSION

The use of system building in British social housing was specific to a particular epoch - the Welfare State: it is upon the relationship between this form of social policy and building technology that this study has concentrated. The dominance of the Welfare State between 1944 and 1975 gave rise to an unprecedented period of social building activity which, coupled with the demand for building created by the long economic upswing, placed a consistent strain on the building resources of this country. During the immediate postwar period, the mid-1950s and mid-1960s the coincidence of surges in welfare housing programmes and peaks in commercial building activity "overloaded" building resources in a particularly apparent way. The association of increases in system building with these peaks in building demand immediately suggests that new technolgies should be understood as the result of an excess of demand over supply. While this relationship cannot be ignored, to concentrate on a supply and demand explanation undervalues the two salient features of system building as it developed in British housing: firstly, its almost exclusive application to the state sector; and secondly, the role of policy - whether framed by government, local authorities or the building industry.

While the peculiarities of demand created by the Welfare State undoubtedly generated the conditions under which system building arose, it was the policies of the participants in the social housing process which determined the extent to which new methods of building were used. In the post World War Two stabilisation period the outright subsidy of non traditional houses by government grant created the market for a host of expensive building technologies which could not compete in cost with traditional methods. During the 1950s government also supported system building believing it to be a means of expanding housing supply with the least expansion of the building labour force. During the 1960s, industrialised building formed the major element of building industry policy within the MacMillan and Wilson governments' indicative planning strategies. Although not subsidised in the way that it was during the 1940s, system building was promoted during the 1950s and 1960s by a host of government measures ranging from the implementation of National Building Regulations to the establishment of a state funded quango, later to become part of the M.H.L.G., the National Building Agency.

The state promotion of system building was supported by a range of commercial interests eager to sponsor new building technologies in social housing. Of these, two in particular stand out; engineering industry and large building firms. The attempts of engineering industry to enter the housing market by developing new methods of construction based on their products can be observed early in the 20th Century. At times of a threatened diminution in engineering industry's markets, such as immediately following the Second World War, a number of systems were launched which used steel products almost exclusively. During the 1940s, due to government subsidy, over 30,000 houses were built by the B.I.S.F. Generally, however, these attempts were unsuccessful as the technologies involved were expensive. The involvement of large contracting firms, many of whom had been speculative housebuilders before the war, was also a conspicuous feature of system building. The prospect of large and continuous state housing programmes, let in increasingly large contracts, encouraged building firms to adopt new technologies, despite their historical aversion to capital investment. The degree to which this aversion was overcome was indicated by the flooding of the market by far more systems than could be accommodated even had programmes been maintained at projected levels. The expectation that building, and in particular social housing programmes, would be maintained at levels sufficient to justify expenditure on system building development and production plant was undoubtedly encouraged by government policy, but also by the industry's confidence in the continuing endurance of the postwar building boom. It is also likely that it was the intention of sponsors promoting the most sophisticated systems, such as Laing, to mimic the remarkable success of Wimpey's No-Fines system in monopolising a substantial portion of the social housing market.

Government and industry promoted system building, but it was the response of the local authority which ultimately determined the extent to which new technology was used. The response of local authorities was partial. On the one hand, most of the larger housing authorities, such as the L.C.C., willingly used large contractors sponsoring building systems for the realisation of their housing programmes. Indeed, many authorities felt that this was the only way in which their targets could be met and, as in the case of Coventry, the virtual monopolisation of an authority's housing programmes by one contractor was allowed to take place. On the other hand, the expectations of government and industry were not met by the many housing authorities which proved unwilling to provide the scale of contracts required for the most efficient use of system building. In particular, the government's consortia policy was made ineffective by authorities which, although prepared to join consortia, were unwilling to consign the major part of their housing over to joint programmes. Furthermore, although a great many houses were built in systems, the complaint of sponsors was that the local authority client was not prepared to make the most efficient use of new building technology. The reasons for the rejection of system building seem to have been varied, ranging from objections to the appearance of systems, fears of future maintenance problems, and high costs.

System building was by no means confined to the British Isles. However, the brief description of its use by other countries which follows emphasises the significance of welfare policy to its use in Britain. At one stage or another, the majority of industrialised economies - and although not referred to in this study, many less industrialised ones - have adopted housing systems. As Chapter Seven pointed out, capital intensive large panel systems for high-rise construction were used in Western Europe well before their adoption by the British building industry. Indeed, it appears that sponsors met with greater success abroad than they did in Britain. Higher labour costs and the willingness of the state to adopt social housebuilding policies sympathetic to system building seem to have been the factors favouring system building in other European countries. In France, in 1948, the government sponsored a competition to encourage designers and contractors to develop labour saving house building methods. This was followed in 1953 by a further competition in which system building was applied to 50,000 low-cost dwellings. From then on 12,000 houses were reserved annually by the state for system building sponsors. As the M.P.B.W. speaker, R.Walters, pointed out to a United Nations conference on system building in 1964: "by these means government induced contractors to invest in technical development and in the installation of plant and machinery, so that France now has a number of systems which continue to develop competitively without further assistance". [1] According to D.V.Donnison, the inability of system building to compete with traditional construction in Holland caused it to be highly dependent on government intervention:

> "the output of 'system built' dwellings rose steadily in number until the special subsidy paid for them was withdrawn in 1952; production then fell until a new boost was given to system building by offering continuous contracts designed to assume a predictable demand, but as soon as this arrangement came to an end

system building flagged once more"[2]

In 1962, 10,000 out of 80,000 houses in Holland were built by just four systems, and it seems that as long as the state limited the number of systems and fed them with steady contracts, system building flourished. [3] A similarly steady demand combined with restrictions on the numbers of systems was provided by the Danish government. Larsen & Nielsen and Jespersen are described by Gosschalk as having annual production figures consistently above 1,000 units per annum with the former having maintained this for over 20 years. The most dramatic example of system building flourishing under state intervention was in Eastern Europe. In 1966, in one organisation, the Moscow building department embodied 11,000 professional staff, 74,000 manual workers and 100 factories producing components for 100,000 dwellings that year on 400 sites. [4]

Throughout the postwar period system building has been a major feature of the private housing market in America: in 1964, 600 manufacturers produced 250,000 houses - 22% of total production. Rather than arising from direct state intervention - in America there is no 'state housing sector' as such although private housing supply is stimulated by Federal subsidies - system building seems to have been generated by the scarcity and expense of building labour. The "mail-order house", in which precut timber components were supplied to the purchaser, was a significant feature of the Mid-West housing market between 1910-14, with firms such as Sears & Roebuck major suppliers. Indeed, the attempts of prefabricators to introduce housing systems during the interwar period was frustrated, according to Burnham Kelly, by the relatively low cost of labour and high cost of capital during the Great Depression. [5] Nevertheless, in the relatively prosperous postwar years the off-site manufacture of timber housing has flourished. This seems to be because American building labour differs in three ways to that in Britain: it is very expensive (in 1968 three times as high), it is more expensive than factory labour, [6] and skill differentials are greater (in 1966 approximately 2:1 in America and 6:5 in Britain). [7] The expense of American building labour, coupled with a cheap indigenous timber - a material ideal for prefabrication - has generated a consistent development in the off-site manufacture of timber houses. In these, the labour content can not only be reduced, but unskilled substituted for skilled labour and factory substituted for building labour. Indeed, it was American timber-frame techniques which formed the basis for the British timber systems developed since the mid 1960s. Despite the prevalence of prefabricated timber housing, the American experience is very different in character from the use of system building described in this study. According to one Canadian, R.J.Poirer, this evolution of American timber technology has been so consistent that the European tendency to refer periodically to the concept of 'industrialising' building would "mystify the average North American builder". [8] The growth of timber frame in British speculative housing may be compared with the integration of premanufactured timber components into traditional American construction methods.

The adoption of system building in Britain can be explained in terms of the impact of welfare policy on building methods. However, the way in which it was promoted as the "solution" to state housing provision, can only be understood in the context of theories of mass production and the role of technology in Welfare State ideology. It is evident that system building did not in fact represent the mass production of buildings, and that this was apparent to a number of commentators at an early stage. The constant association made between system building and mass production by politicians illuminates the need of the Welfare State to assure society that it could provide housing in sufficient quantity to satisfy the needs of all social classes. Mass production theory was seen as the means of achieving abundance in housing provision and system building the translation of this theory into building practice. In this manner, system building played an important part in promoting the concept that it would be through technology that the Welfare State would provide the resources needed to ensure social cohesion.

The tendency of technology, wedded to welfare policy, to reinforce social stability can be seen in the response of organised building labour to system building. In the face of promises by the state "to secure equality of opportunity and service among all classes of the community" the N.F.B.T.O. found it difficult to obstruct technologies they felt would be injurious to their craft organisation. Furthermore, the hope that new building technology, in the service of the Welfare State, would provide the means of satisfying working class housing needs resulted in the building unions calling for the establishment of government owned industrialised building factories during the 1960s.

The belief in social progress through new technology also encouraged the acceptance of system building by the architectural profession. Furthermore, by giving substance to the belief in a social role for architects, the promotion of system building raised the profession's status in the postwar building world. Rather than being the means by which the architect was usurped by the production engineer, as many feared, system building was the quintessence of the architectural profession's dual ideologies of technology and social service. System building gave rise to a generation of architects venerated by both their profession and the departments of state in which they served.

It seems appropriate to conclude this study with a few observations on the relationship between welfare policy and some of the more general characteristics of system building. The purpose of welfare policy in postwar Britain was to compensate for the tendency of capitalism to create an inherently unstable social system characterised by competing economic classes. The Welfare State was designed to effect stability without fundamentally overturning the existing social structure. It attempted this in two ways: firstly, through welfare provision which redistributed wealth to a degree sufficient to mask the more unacceptable extremes of inequality; secondly, by securing a continuous rise in living standards through economic intervention designed to compensate for the inefficiencies of the free market. In terms of social housing provision, these dual aims presented a potential conflict. The more of the nation's resources that were devoted to social housing, the less there were to be applied to manufacture. Although there were obvious economic benefits in securing a well housed working population, these gains did not have the short term benefits to be had from increasing the output of manufactures, particularly for export. Indeed, the problem most pressing on postwar governments was the declining position of Britain in world trade and its recurring balance of payments deficits. It could be suggested that the benefits promised by system building offered the Welfare State a solution to this impass by increasing housing output without draining labour away from the factory floor. It was hoped that new, more productive, methods of building could raise the output of social housing, and for that matter, educational building too, without compromising attempts to secure the continuing rise in living standards.

Furthermore, this was to be achieved in a way that was consistent with the larger aim of the Welfare State - to ensure stability without fundamentally changing the relations of production. Just as welfare policy modified, rather than changed, the existing order of things so did system building in the form in which it was promoted in Britain. It is significant that the state attempted to implement its building technology policies without coercion, controls or regulation. Indeed, the absence of any attempt to regulate the disastrous proliferation of systems at the same time as authorities were badgered into using more of them, illustrates the determination with which the government hoped to secure a major change in building methods without fundamentally changing the relationship between it and the building industry. By subsidising the product in the immediate postwar years and judiciously juggling with the social building market during the 1960s, government hoped, through system building, to bring the benefits of industrialisation to an industry hitherto unwilling to achieve this. Furthermore, it was hoped that this could be done without major investment by the Exchequer. The industry was to industrialise itself through the introduction of a new party to the building process - the sponsor - a party willing to invest in capital intensive building methods. The relationship between builder and client was modified rather than fundamentally changed and it could be suggested that the character of Welfare State system building policy arose from this. The relationship that system building forced upon the client and producer avoided many of the more obvious inefficiencies of traditional building. These were primarily competitive tendering, design in isolation from production and the fragmentation of large programmes into discreet contractual packages carried out by separate contractors. While it is true that each of these inefficiencies could be rectified in traditional building technology, their elimination was firmly associated with system building by the majority of those involved in postwar housing policy. However, the traditional relationship between builder and client was retained - their separateness. The relationship between the client and the builder within the capitalist economy, remained fundamentally unaffected. System building, as it developed in Britain, was a panacea indeed: it promised the benefits of a "revolution in building" without a revolution actually taking place.

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ABBREVIATIONS

A.A.S. Annual Abstract of Statistics.
A.&B.N. Architects and Building News.
A.D. Architectural Design.
A.M.A. Association of Municipal Authorities.
A.M.C. Association of Municipal Corporations.
A.R. Architectural Review.
A.J. Architects' Journal.
B.D. Building Design.
B.I.S.F. British Iron and Steel Federation.
B.P.C. British Productivity Council.
B.R.S. Building Research Station.
C.&C.A. Cement and Concrete Association.
C.I.S.P.H. Council for the Industrial and Scientific Provision of Housing.
C.L.A.S.P. Consortium of Local Authorities Special Project.
C.M.R. Centre for Modern Records, University of Warwick.
C.S.O. Central Statistical Office.
C.R. Conference Report.
D.O.E. Department of the Environment.
D.S.I.R. Department of Scientific and Industrial Research.
E.D.C. Economic Development Committee.
G.L.C. Greater London Council.
G.R.O. Gloucestershire Records Office.
H.C.M. Housing Committee Minutes.
H.C.P. Housing Committee Papers.
H.&C.S. Housing and Construction Statistics.
H.S.G.B. Housing Statistics Great Britain.
I.B.S.A.C. Industrialised Building Systems and Components.
I.L.O. International Labour Office.
J.R.S.A. Journal of the Royal Society of Arts.
L.C.C. London County Council.
M.H.C. B.O.C.O. Midland Housing Consortium, Board of Chief Officers.
M.H.L.G. Ministry of Housing and Local Government.
M.J. Municipal Journal.
M.O.E. Ministry of Education.
M.O.H. Ministry of Health.
M.O.L. Ministry of Labour.
M.O.W. Ministry of Works.
M.P.B.W. Ministry of Public Buildings and Works.
M.R. Municipal Review.
N.B. National Builder.
N.B.A. National Building Agency.
N.B.S. National Building Studies.
N.E.D.C. National Economic Development Council.
N.E.D.O. National Economic Development Office.
N.F.B.T.E. National Federation of Building Trades Employers.
N.F.B.T.O. National Federation of Building Trades Operatives.
N.U.C.U.A. National Union of Conservative and Unionist Associations.
O.A. Official Architecture.

P.E.P. Political and Economic Planning.
P.P. Parliamentary Papers.
P.R.O. Public Records Office.
P.W.B.S. Post War Building Studies.
R.I.A.I. Royal Institute of Architects of Ireland.
R.I.B.A. Royal Institute of British Architects.
R.I.B.A.J. Royal Institute of British Architects' Journal.
S.C.O.L.A. B.O.C.A.M. Second Consortium of Local Authorities, Board of Chief Architects Minutes.
T.S. Team Spirit.
U.N. United Nations.
W.C.H.C.M. War Cabinet Housing Committee Minutes.

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CONCLUSION

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TABLE I: Houses Completed in England and Wales by Type of Agency 1924-1981

Source: C.S.O., A.A.S. (1952, 1960 & 1983).

	Permanent Local Authority	Permanent Private Enterprise	Permanent Others	Temporary Local Authority	TOTAL
1924-28*	59,739	127,539**			187,278
1929-33*	59,923	150,837**			210,760
1934-38*	69,081	264,915**			333,996
1945***	508	937	nil	8,939	10,384
1946	21,202	29,720	168	70,931	122,021
1947	86,576	39,626	1,348	34,351	161,892
1948	170,821	31,210	4,374	10,746	217,151
1949	141,766	24,688	5,326	3	171,783
1950	139,356	26,576	6,428		172,360
1951	141,587	21,406	8,190		171,903
1952	165,637	32,078	11,260		208,975
1953	202,891	60,528	15,812		279,231
1954	199,642	88,028	21,282		308,952
1955	162,525	109,934	10,867		283,326
1956	139,977	119,585	9,162		268,724
1957	137,584	122,942	8,127		268,653
1958	113,146	124,087	4,292		241,525
1959	99,456	146,476	3,449		249,381
1960	103,235	162,100	3,891		269,226
1961	92,880	170,366	5,586		268,832
1962	105,302	167,016	6,349		278,667
1963	97,015	168,242	5,398		270,655
1964	119,468	210,432	6,605		336,505
1965	133,024	206,246	7,911		347,181
1966	142,430	197,502	9,548		349,480
1967	159,347	192,940	10,611		362,898
1968	148,049	213,273	10,404		371,726
1969	139,850	173,377	10,938		324,165
1970	134,874	162,084	10,308		307,266
1971	117,215	179,998	12,563		309,776
1972	93,635	184,622	9,037		287,294
1973	79,289	174,413	10,345		264,047
1974	99,423	129,626	12,124		241,173
1975	122,857	140,381	15,456		278,694
1976	124,152	138,477	16,031		278,660
1977	121,246	128,688	26,077		276,011
1978	96,752	134,578	22,671		254,001
1979	77,192	125,306	18,224		220,722
1980	78,405	114,377	20,175		212,957
1981	58,933	103,156	17,398		179,487

Notes:
* averages; ** includes any not built by local authorities; *** April to December.

TABLE II: Houses Completed in Building Systems by Local Authorities and New Towns in England and Wales 1946-79

Sources: C.S.O., A.A.S. (1952, 1960 & 1983).
M.O.H., Housing Returns for England and Wales (1946-1955).
Hansard (Commons), 5th ser. 735, Nov.1 1966, cols.235-7.
M.H.L.G., H.S.G.B. (1964-70).
D.O.E., H.&C.S. (1970-80)

	A. Completions total	B. Completions systems	C. Completions systems %tage	D. In tender sytems	E. Intender systems %tage
1946	21202	2767	13.0		
1947	86576	20452	23.6		
1948	170821	52759	30.8		
1949	141766	34279	24.1		
1950	139356	20640	14.8		
1951	141587	20178	14.2		
1952	165637	26365	15.9		
1953	202891	41662	20.5		
1954	199642	52119	26.1		
1955	162525	34033	20.9		
1956*	139977	29000	20.0		
1957*	137584	29000	20.0		
1958*	113148	27000	18.0		
1959*	99456	17000	17.0		
1960*	103235	15000	15.0		
1961*	92880	14000	15.0		
1962*	105302	15000	15.0		
1963*	97015	14000	15.0		
1964	119468	17171	14.4	30047	21.0
1965	133024	25527	19.2	46564	29.1
1966	142430	37494	26.3	65481	38.3
1967	159347	49049	30.8	71465	42.6
1968	148049	50569	34.2	59574	39.4
1969	139850	53150	38.0	34766	30.1
1970	134874	55701	41.3	19382	19.4
1971	117215	38314	32.7	19320	20.6
1972	93635	24557	26.2	16243	21.0
1973	79289	17660	22.3	22430	24.4
1974	99423	24536	24.7	23067	19.1
1975	122857	25792	21.0	22970	17.5
1976	124152	23780	19.6	14863	12.1
1977	121246	19697	16.2	4153	5.5
1978	96752	10313	10.7	3243	4.5
1979	77192	4566	6.3	1214	3.1

Notes;
Col. A. is taken from the A.A.S.; Col. B. up to 1955 from Housing Returns for England and Wales and from 1964 from H.S.G.B. and H.&C.S.; Col.C. up to 1955 is computed from cols. A.&B. and from 1964 is taken from H.S.G.B. and H.&C.S.; cols. D.&E. are taken from H.S.G.B. & H.&C.S.. For years marked with an asterisk offial statistics for completions by systems were not compiled; the figures in column B.&C. for these years represent estimates made by the M.P.B.W. presented to Parliament (Hansard (Commons).

TABLE III: Percentage of Houses Completed in Building Systems by Local Authorities in England and Wales by Region 1945-1954 and Percentage of Houses Started in Building Systems by Local Authorities in England and Wales by Region 1965-1979.

Sources: M.O.H., Housing Returns for England and Wales (1946-1955).
M.H.L.G., H.S.G.B. (1964-1970).
D.O.E., H.&C.S. (1970-1979).

	A. 1945- end 1954	B. 1965- end 1969	C. 1970- end 1979
Northern	13.75		
North West	14.5		
East & West Ridings	22		
North Midlands	24.8		
Midlands	23.5		
Eastern	13.8		
Southern	21.6		
South East	9.5		
South Western	46.7		
London	8.5		
Wales	32.2		
North		27.7	9.8
North West		40.6	21
Yorks & Humberside		37.1	11.7
West Midlands		46.9	24.9
East Midlands		35.4	24.4
East Anglia		9.8	12.3
South East (exluding London)		28.2	18
South West		17.9	6.5
Greater London		38.6	12.3
Wales		32.8	16

Notes;
Col. A. is taken from Housing Returns for England and Wales; Cols. B. & C. from H.S.G.B. and H.&C.S.

TABLE IV: Houses Completed in Building Systems in England and Wales by Individual Systems 1946-1955.

Source: M.O.H., <u>Housing Returns for England and Wales</u> (1946-1956).

System;	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
PCC 4 Airey	168	612	7815	18643	21259	22161	23012	23963	25431	25991	RT
		444	7203	10828	2616	902	851	951	1468	560	YT
ALU 7 Aluminium	nl	138	9340	13461	14749	16785	nl	nl	nl	nl	RT
			9202	4121	1288	2036					YT
S/F 3 B.I.S.F.	94	13045	29828	31046	31120	31320	nl	nl	nl	nl	RT
		12951	16783	1218	74	200					YT
PCC 23 British Steel	16	138	360	716	1234	1730	2682	2886	3636	4317	RT
Construction		122	222	356	518	496	952	204	750	681	YT
PCC 5 Cornish Unit	nl	80	573	2416	4833	7693	11242	16226	22024	25601	RT
			493	1843	2417	2860	3549	4984	5798	3577	YT
S/F 20 Cussins	20	185	864	1196	1259	1347	nl	nl	nl	nl	RT
		165	679	332	63	88					YT
I/S 27 Dyke Clothed	—	—	—	236	396	nl	nl	nl	nl	nl	RT
Concrete Construction					160						YT
I/S 2 Easiform	717	2650	7411	11523	15917	20602	26208	33133	41433	47820	RT
		1933	4761	4112	4394	4685	5606	6925	8300	6387	YT
S/F 25 Hill	16	125	449	649	nl	nl	nl	nl	nl	nl	RT
		109	324	200							YT
S/F 19 Howard	458	1225	1404	1404	nl	nl	nl	nl	nl	nl	RT
		767	179	—							YT
COM 26 Kingston	nl	nl	nl	nl	nl	nl	102	202	244	402	RT
								100	42	158	YT
T/F 28 Lamella	6	50	183	nl	nl	nl	nl	nl	nl	nl	RT
		44	133								YT
S/F 16 L.C.System	—	—	122	760	1610	2000	2004	2296	2668	2856	RT
				638	850	390	4	292	372	188	YT
COM 18 Newland	nl	47	1250	2122	2329	2391	nl	nl	nl	nl	RT
(inc. Tarran for 47)			1203	872	207	62					YT
PCC 10 Orlit	109	778	3720	6287	7230	7377	7495	7772	8424	8524	RT
		669	2942	2567	943	147	118	277	652	100	YT
PCC 9 Reema	nl	nl	nl	392	800	1510	2428	3810	6539	8608	RT
					408	710	918	1382	2729	2069	YT

System;	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
T/F 22 Scottwood	nl	nl	nl	nl	nl	600	732	924	1029	1135	RT
							132	192	105	106	YT
T/F 14 Spooner	nl	124	579	909	1352	1450	1773	2412	3067	3920	RT
			455	330	443	98	323	639	655	853	YT
S/F 29 Steane	—	—	14	91	136	nl	nl	nl	nl	nl	RT
				76	45						YT
PCC 21 Stent	nl	nl	nl	nl	2	930	1197	1253	1253	1253	RT
						928	267	56	—		YT
T/F 17 Swedish	809	2122	2408	2420	2420	2444	nl	nl	nl	nl	RT
		1313	286	12	—	24					YT
S/F 15 Trusteel	2	62	764	1149	1190	1222	1720	2290	2707	3392	RT
		60	702	385	41	32	498	570	417	685	YT
I/S 24 Unit No-Fines	nl	nl	nl	nl	nl	650	1407	1981	3282	4310	RT
							757	574	1301	1028	YT
COM 8 Unity	2	107	838	1766	2619	3677	5069	8679	12808	15573	RT
		105	731	928	853	1058	1392	3610	4129	2765	YT
PCC 6 Wates	60	409	2495	4329	5628	6764	9159	12759	18063	19831	RT
		349	2086	1834	1299	1136	2395	3600	5304	1768	YT
I/S 1 Wimpey No-Fines	58	371	2923	4254	7177	10966	18284	33348	50538	61197	RT
		313	2552	1331	2923	3789	7318	15064	17190	10659	YT
PCC 11 Woolaway	10	96	419	824	1013	1444	2282	3369	4396	5336	RT
		86	323	405	189	431	838	1087	1027	940	YT
Others	224	857	2221	3666	6628	6014	60980	61801	63681	65190	RT
TOTAL	2767	23221	75980	110259	130899	151077	177442	219104	271223	305256	RT
		20452	52759	34279	20640	20178	26365	41662	52119	34033	YT

Notes;

Housing Returns For England and Wales list completions in running totals, and only list systems individually for the periods in which they were most frequently used. If not listed individually, a system's completions are included in 'others'. If a system is not listed to the end of the period, the last figure represents the total completions to that date and does not necessarily represent an absolute total. An attempt has been made to extract yearly totals, but in many cases these can only be computed for a limited number of years. The number preceding the name of the system refers to its ranking in total production over the period covered.

Key;

- RT running total
- YT yearly total
- nl system not listed seperately for this year
- — no completions for this year
- ALU aluminium structure and cladding
- COM composite steel and concrete structure
- I/S in situ concrete
- PCC precast concrete structure
- S/F steel frame
- T/F timber frame

TABLE V: Houses Completed in Building Systems in England and Wales by Individual Systems 1964-1979

Sources: M.H.L.G., H.S.G.B. (1965-1970).
D.O.E., H.&C.S. (1970-1980).

System	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
The Amey Chivers Housing Co.Ltd., Modus PCC L;	nl	nl	nl	32	-	65	46	125	10	nl	nl	nl	nl	nl	nl	nl	278
Anvil Enterprises Ltd., Anvil T/F L;	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	167	287	347	30	—	831
Barry High Ltd., Belfry PCC LM;	nl	—	48	151	182	471	258	32	2	nl	nl	nl	nl	nl	nl	nl	1144
Bernard Sunley & Sons Ltd., Sunley Albetong I/S LMH;	—	—	250	346	182	91	241	54	—	nl	nl	nl	nl	nl	nl	nl	1164
Blyth Dry Dock & Shipbuilding Ltd., Blyth COM L;	--	24	24	72	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	120
British Lift Slab Ltd., (Robert M.Douglas Ltd.), Lift Slab I/S MH;	129	94	128	128	128	128	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	735
C.Bryant & Sons Ltd., Bryant Low Rise/Wallframe PCC L;	--	225	1123	1593	1689	2689	1786	1158	461	721	753	20	—	127	281	48	12674
Building Research Station, B.R.S. (Battery Casting) PCC MH;	nl	nl	nl	282	599	694	744	526	741	—	nl	nl	nl	nl	nl	nl	3586
Building Systems Ltd. (British Ropes Ltd.) PCC L;	7	111	180	12	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	310
Calders Ltd., Calder Homes T/F L;	24	297	21	207	14	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	549
Camus (G.B) Ltd., Licensees: Unit Camus Ltd., Mitchell Camus Ltd., Fram, Higgs & Hill, Camus PCC LMH;	—	2	696	614	352	1034	1143	1205	671	521	24	nl	nl	nl	nl	nl	6262
Carlton Contractors Ltd., Carlton PCC LM;	nl	8	12	95	141	91	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	347
Centerprise Building Systems Ltd., Cebus PCC MH;	nl	—	12	194	95	—	240	80	—	nl	nl	nl	nl	nl	nl	nl	621
Concrete Ltd., Bison Wallframe PCC H;	612	1595	2733	2573	3624	5009	6227	4666	1308	497	904	571	652	688	9	—	31668
Cosmos PCC L;	nl	nl	nl	—	—	--	154	—	nl	nl	nl	nl	nl	nl	nl	nl	154
Costain Concrete Ltd., Siporex PCC L;	2	10	519	338	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	869

1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
Crudens Ltd., Skarne PCC LMH;																
--	27	187	328	1414	814	1404	1701	913	508	70	—	nl	nl	nl	nl	7384
Crux Developments Ltd., (English China Clay Group of Industries) Crux R/T LM;																
nl	nl	nl	—	—	—	36	179	105	102	--	nl	nl	nl	nl	nl	422
Cubitts Construction Systems Ltd., (Holland Hannen & Cubitts Ltd.), Balency PCC LMH;																
nl	nl	—	—	7	291	605	504	448	507	393	274	452	54	—	—	3535
• • • • • • • • • • • • • • • • • Lowtown-Cubitt S/F L;																
4	238	468	441	278	877	1455	831	802	936	1465	447	181	70	33	—	8526
Dorran Construction Ltd., Dorran COM L;																
--	—	94	192	354	23	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	663
Drury Building Service Ltd., Drury System 3 R/T LM;																
nl	nl	nl	—	14	16	642	891	830	302	345	—	nl	nl	nl	nl	3040
Dudley Coles Long Ltd., Faculty R/T L;																
nl	nl	—	—	17	58	53	—	nl	nl	nl	nl	nl	nl	nl	nl	128
• • • • • • Trim T/F LM;																
--	—	106	10	101	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	217
Engineered Homes (G.B.) Ltd., Engineered Homes T/F L;																
nl	6	106	245	264	128	58	2	nl	nl	nl	nl	nl	nl	nl	nl	809
Fram Gerrard Ltd., Gerrard Incon ??? ???;																
nl	nl	nl	—	—	28	226	—	nl	nl	nl	nl	nl	nl	nl	nl	254
• • • • • Gerrand Intrad I/S LMH;																
nl	—	—	88	—	nl	nl	nl	nl	—	—	268	148	115	—	—	619
The Fram Group Ltd., Fram/B.R.S. PCC MH;																
144	189	63	59	109	272	1226	385	11	nl	nl	nl	nl	nl	nl	nl	2458
• • • • • Fram Components PCC MH;																
—	192	288	248	51	51	—	100	—	nl	nl	nl	nl	nl	nl	nl	930
Fredericks and Pelhams Timber Buildings, Fredericks T/F L;																
nl	nl	nl	nl	nl	nl	—	8	51	—	nl	nl	nl	nl	nl	nl	59
W & C French Construction Ltd., Lecaplan PCC LM;																
--	—	120	4	—	470	669	275	4	nl	nl	nl	nl	nl	nl	nl	1542
Gee, Walker & Slater Ltd., (Sir Robert MacAlpine & Sons Ltd.), Arcal G.80 PCC L;																
nl	46	125	220	85	79	55	42	95	75	54	251	24	—	nl	nl	1151
George Calverly & Sons (Contractors Ltd), C.M. T/F LM;																
nl	nl	6	33	176	272	241	161	102	—	nl	nl	nl	nl	nl	nl	991
Gilbert Ash Ltd., (Bovis Ltd.), Tracoba PCC MH;																
--	—	462	142	—	69	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	673

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
Gleeson Industrialised Building Ltd., Gle-system PCC LMH;	nl	—	38	24	180	243	164	265	246	157	227	204	474	549	432	76	3279
Greater London Council, SFI S/F LMH;	nl	nl	nl	—	300	—	—	—	95	—	nl	nl	nl	nl	nl	nl	395
Gregory Housing Ltd., Gregory Housing PCC LM;	—	127	590	323	118	201	35	—	nl	nl	nl	nl	nl	nl	nl	nl	1394
Guildway Ltd., Guildway T/F L;	—	25	129	404	384	420	253	227	72	145	241	296	286	150	95	40	3167
Hawthorne Leslie (Buildings) Ltd., (The Hawthorne Leslie Group Ltd.), H.L.B. S/F L;	—	186	618	969	248	5	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	2026
Homeville Co. Ltd., Homeville Industrialised S/F L;	—	24	171	285	195	21	31	—	nl	nl	nl	nl	nl	nl	nl	nl	727
Housing Development & Construction Ltd., H.D.C. PCC LM;	40	278	141	65	—	—	—	nl	nl	nl	nl	nl	nl	—	—	nl	524
Industrial Building Services (Northern) Ltd., Peak Homes T/F LM;	—	—	86	637	628	178	539	-715	—	nl	nl	nl	nl	nl	nl	nl	1353
James Riley & Partners Ltd., Frameform T/F LM;	nl	—	—	39	189	405	876	298	855	1048	1629	1724	1818	2195	1112	637	12825
" " " " " " " Rileyform T/F LM;	nl	nl	nl	nl	nl	nl	nl	nl	nl	—	—	240	886	769	548	439	2882
John Laing Construction Ltd., Easiform I/S LM;	2520	2269	2763	2499	1080	1075	272	97	—	nl	nl	nl	nl	nl	nl	nl	12608
" " " " " " " Laings Rat-trad R/T L;	nl	nl	nl	nl	nl	—	—	70	—	nl	nl	nl	nl	nl	nl	nl	70
" " " " " " " Sectra I/S MH;	120	505	333	730	10	414	153	88	182	—	nl	nl	nl	nl	nl	nl	2535
" " " " " " " Storiform I/S MH;	—	51	421	983	620	905	182	145	—	nl	nl	nl	nl	nl	nl	nl	3307
" " " " " " " 12M Jespersen PCC LMH;	nl	—	133	765	1588	702	1893	1445	774	426	577	—	—	340	—	—	8643
John Lynn & Co Ltd., (Duxford & Sunderland Shipbuilding & Engineering Group), British Housing S/F L;	nl	2	10	62	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	74
Kenkast Buildings Ltd., Kenkast PCC L;	nl	115	54	226	196	100	39	164	7	40	24	44	—	nl	nl	nl	1009
Kier Ltd., B.D.C. R/T L;	nl	—	6	—	30	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	36

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
J.E.Lesser Building Ltd., Lesser R/T LM;	--	221	139	281	435	843	1109	694	284	189	--	80	122	159	--	--	4556
Sir Lindsay Parkinson & Co. Ltd., Parkwall I/S L;	--	38	722	289	276	691	491	511	141	--	nl	nl	nl	nl	nl	nl	3159
The Lilleshall Company Ltd., Lilleshall PCC L;	nl	nl	nl	nl	—	21	85	68	64	44	102	—	nl	nl	nl	nl	384
Lovell Housing Ltd., Lovell T/F L;	nl	nl	nl	nl	nl	—	—	17	60	95	407	282	414	251	281	188	2001
J. McLean & Sons (Wolverhampton) Ltd., Mactrad T/F LM;	nl	—	141	531	798	537	362	138	—	nl	nl	nl	nl	nl	nl	nl	2497
" " " " " " " " " McLean R/T L;	nl	58	42	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	100
" " " " " " " " " McLean Rat-trad R/T L;	nl	—	—	49	35	188	139	117	54	—	nl	nl	nl	nl	nl	nl	582
Mathews & Mumby Ltd., M2 PCC MH;	--	38	158	206	178	74	198	156	228	80	nl	nl	nl	nl	nl	nl	1316
Medway Buildings Ltd., Medway T/F L;	nl	—	—	154	100	52	130	—	nl	nl	nl	nl	nl	nl	nl	nl	436
Midland Housing Consortium, M.H.C. R/T L;	nl	153	106	770	855	1033	713	1292	605	271	564	1139	1857	631	468	711	11168
Ministry of Housing and Local Government, 5M S/F LM;	214	33	349	670	1010	568	624	—	nl	nl	nl	nl	nl	nl	nl	nl	3468
Minox Structures Ltd., Minox R/T LM;	nl	nl	—	126	73	261	314	38	213	94	57	206	314	230	150	145	2221
Modern Building Wales Ltd., Modern Building T/F LM;	nl	nl	nl	nl	11	14	201	520	191	19	nl	nl	nl	nl	nl	nl	931
Mowlem Buildings Ltd., Mowlem I/S LM;	382	519	460	657	1472	1179	1622	825	893	665	1485	1269	1253	1092	985	42	14800
North Eastern Major Authorities, N.E.M.A. R/T L;	nl	nl	nl	nl	—	24	41	23	nl	nl	nl	nl	nl	nl	nl	nl	88
The Northwest Construction Co. Ltd., Norwest S/F H;	—	142	234	8	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	384
Open System Building Ltd., O.S.B. S/F L;	nl	nl	—	8	54	288	113	19	nl	nl	nl	nl	nl	nl	nl	nl	482
Pearce & Barker Ltd., Surebuilt T/F LM;	nl	nl	—	33	617	308	327	112	22	nl	nl	nl	nl	nl	nl	nl	1419

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
Precast Associated Constructors Ltd., P.A.C. PCC MH;	nl	nl	—	114	95	45	—	35	1	nl	nl	nl	nl	nl	nl	nl	290
Purpose Built Ltd., Purpose Built T/F L;	nl	4	40	379	440	402	235	71	93	31	279	183	266	443	474	208	3548
Reema Construction Ltd., Contrad PCC L;	nl	nl	nl	nl	nl	nl	nl	nl	47	14	64	—	nl	nl	nl	nl	125
. . . . . . Reema PCC LMH;	638	613	1071	1544	1141	1138	928	177	103	209	539	282	36	171	—	—	8678
Rigid Frame Constructions Ltd., Rigid Frame S/F LM;	17	10	98	201	9	182	97	—	nl	nl	nl	nl	nl	nl	nl	nl	614
Rowlinson Constructions Ltd., Rowcon R/T LM;	—	13	307	367	278	231	430	306	82	—	nl	nl	nl	nl	nl	nl	2014
Rush & Tomkins Ltd., Rat-trad R/T L;	nl	nl	—	—	79	156	205	—	nl	nl	nl	nl	nl	nl	nl	nl	440
S.L.P. Industrialised Buildings Ltd., H.S.S.B. PCC LMH;	—	50	—	310	345	196	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	874
Selleck Nicholls Williams Ltd., Cornish Unit PCC LM;	nl	55	112	22	—	30	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	219
. . . . Metracon T/F L;	nl	nl	nl	nl	nl	nl	nl	nl	—	—	13	25	nl	nl	nl	nl	38
. . . . Metratim T/F L;	nl	nl	nl	nl	nl	nl	nl	nl	—	—	19	946	2414	1634	650	500	6163
. . . . Multilite I/S H;	—	52	38	218	114	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	422
. . . . Selleck Nicholls ??? ???;	nl	nl	nl	nl	nl	nl	nl	nl	nl	—	27	328	317	—	54	—	726
. . . . Selleck Nicholls Rat Trad R/T LM;	—	10	125	373	1029	1489	915	465	327	471	470	98	—	nl	nl	nl	5772
. . . . Selleck Nicholls Timber Frame T/F L;	nl	nl	nl	nl	nl	nl	nl	—	—	—	564	—	nl	nl	nl	nl	564
. . . . XW I/S LM;	—	—	37	511	1026	520	876	904	104	—	nl	nl	nl	nl	nl	nl	3978
The Shepherd Group Ltd., Shepherd's Rat Trad R/T L;	—	38	363	381	246	125	123	363	16	126	12	nl	nl	nl	nl	nl	1793
. . . . . . Spacemaker PCC M;	184	228	132	784	550	665	101	—	nl	—	23	171	98	nl	nl	nl	2936

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
W.J.Simms Sons & Cooks Ltd., Simmcast PCC MH;	nl	nl	—	—	225	436	137	—	nl	nl	nl	nl	nl	nl	nl	nl	798
" " " " " " " Simms G.D.A. R/T LM;	17	309	787	601	60	34	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	1808
Spooners Hull Ltd., Spooner T/F L;	nl	—	17	305	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	322
" " " " " Spooner/Caspon T/F L;	132	606	375	196	540	588	592	571	157	144	155	460	516	284	117	51	5484
" " " " " Spooner Urban T/F L;	nl	—	—	332	265	24	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	621
Stanley Miller Ltd., M.W.M. I/S MH;	nl	311	119	96	—	136	383	422	—	111	463	—	—	—	109	—	2150
Stoners Appliances Ltd., Canadian Timber Frame T/F LM;	nl	—	—	8	122	45	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	175
Geo Stubbings Ltd., Stubbings Industrial Low Rise PCC LM;	nl	—	—	13	63	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	76
" " " " " Stubbings Rat Trad R/T L;	nl	95	546	484	260	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	1385
Sundh (Great Britain) Ltd., Sundh I/S MH;	nl	—	—	35	58	23	56	104	110	—	nl	nl	nl	nl	nl	nl	386
F.& H.Sutcliffe, Shadow Wall ??? ???;	nl	73	17	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	90
Swiftplan Ltd., (The Taylor Woodrow Group), Multiflex H12 T/F L;	—	20	—	88	2	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	110
Taylor Woodrow Anglian, (The Taylor Woodrow Group Ltd.), Anglian PCC LM;	nl	nl	53	32	231	111	35	16	32	114	237	—	nl	nl	nl	nl	867
" " " " " " " " " " " " " " Larsen Nielson PCC MH;	40	406	664	1056	875	480	632	1528	880	393	669	457	—	nl	nl	nl	8080
Wm. Thornton & Sons, Prometo I/S H;	nl	—	—	144	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	144
Timber Research & Development Association, TRADA T/F LM;	—	—	40	91	5	—	47	52	64	60	224	465	444	224	146	127	1989
Truscon Ltd., Truscon PCC LMH;	16	—	304	—	126	108	158	—	nl	nl	nl	nl	nl	nl	nl	nl	712
Trusteel Corporation (Universal) Ltd., Trusteel Mk.II S/F LMH;	52	132	133	282	529	450	238	—	nl	nl	nl	nl	nl	nl	nl	nl	1816

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	TOTAL
" " " " " " " " " " Trusteel 3M. S/F LMH;	nl	5	40	530	412	537	392	423	428	245	352	364	84	147	107	—	4066
The Unit Construction Co. Ltd., Unit System 66 R/T L;	nl	—	113	567	772	461	261	80	—	nl	nl	nl	nl	nl	nl	nl	2249
Vic Hallam Ltd., Vic Hallam Mks I, II & III T/F LM;	158	1002	1107	248	602	512	1398	1143	4	nl	nl	nl	nl	nl	nl	nl	6174
" " " " Vic Hallam (Homepack) T/F L;	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	—	19	116	154	56	27	372
Wale Sindall Developments Ltd., SB2 PCC LM;	—	—	73	91	—	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	nl	164
Walter Llewellyn & Sons Ltd., Quikbild T/F L;	—	20	168	213	442	385	547	272	777	878	1130	2222	2676	1817	744	293	12584
Wates Ltd., Wates High Rise PCC MH;	1234	1160	1980	2181	2476	3290	2503	1156	672	460	473	177	—	nl	nl	nl	17762
" " " Wates Low Rise T/F L;*	nl	nl	nl	nl	nl	688	764	526	236	84	303	361	51	—	nl	—	3013
Weir Housing Corporation Ltd., Weir T/F L;	nl	nl	nl	nl	nl	nl	nl	nl	—	—	57	383	149	—	nl	—	586
William Moss & Sons Ltd., M.F.C. PCC LM;	nl	—	—	128	129	53	305	249	—	nl	nl	nl	nl	nl	nl	nl	864
William Old & Co. Ltd., Resiform GRP LM;	nl	nl	nl	—	20	54	177	161	178	43	86	660	68	14	—	—	1461
Williams & Williams Ltd., (British Steel Corporation), Rofton S/F L;	nl	—	—	63	229	87	7	19	67	59	37	33	—	nl	nl	nl	601
Geo. Wimpey & Co. Ltd., Wimpey No Fines I/S LM;	9085	10271	12085	14420	10031	11077	9906	7204	6477	5496	8018	9565	6066	5782	2803	612	128898
" " " " " " Wimpey 6M I/S H;	nl	—	—	270	1805	706	337	234	5	nl	nl	nl	nl	nl	nl	nl	3357
Yorkshire Development Group, Y.D.G.H.MK.I PCC M;	—	—	—	—	541	730	2007	456	nl	nl	nl	nl	nl	nl	nl	nl	3734

Notes;

The figures for yearly completions of individual systems have been taken from H.S.G.B. and H.&C.S.. The table lists 121 of the 153 systems listed and are confined to those systems where the sponsoring company, the type of structural system and its housing form could be identified. The 32 'unidentified' systems are mainly those with small production figures, often introduced during the 1970s during which time catalogues of systems, giving their details, tended not to be published. The 'unidentified' systems listed by the M.H.L.G. and D.O.E., with their total completions throughout the period covered by this table, are as follows: Beal & Son (360), Boro (82), Bury Boulton (49), Discus (74), Eurodean (581), Framecourt (82), Grayholme (148), Hales Rat Trad (140), Wellbuilt (146), F.J.Halliwell (33), 4H/7 (183), Housing System Design (508), Howard Mersham Housing (58), ISEC (258), Martin Construction (39), M.C.Meyer

(235), Middleton Rat Trad (740), Mucklow (190), Multi Storey Construction (354), J.Murphy Rat Trad (280), Plus 3 Contracts (49), Ridgeway (69), Rowland (zero), Scan (225), Shanly Rat Trad (622), Spaceway (48), Timber Frame Ltd. (zero), Trygon Rat Trad (981), Volumetric (zero), Lawrence Weaver Rat Trad (6), W.G. West & Sons (1329), C.M.Yuill (460). It may be assumed that most of the 'unidentified' systems were of timber framed or rationalised traditional construction. The names of the sponsoring companies, type of structural system and building form have been taken from sources too numerous to mention individually. The names in brackets refer to the larger industrial groups to which sponsors belonged in cases where these have been identified.

* Figures for this system were included in Wates High Rise until 1969.

Key:

L	1-2 storeys
M	3-6 storeys
H	6 and above storeys
nl	system not listed individually for this year
—	no completions for this year
COM	composite steel and concrete structure
GRP	glass reinforced plastic panels
I/S	in situ concrete
PCC	precast concrete
S/F	steel frame
T/F	timber frame

TABLE VI: Houses Completed in Building Systems in England and Wales by Structural Type of System 1964-1979

Sources M.H.L.G., H.S.G.B. (1964-1970).
D.O.E., H.S.G.B. (1970-1980).

	Insitu Concrete	Precast Concrete	Steel Frame	Timber Frame	Rationalised Traditional	TOTAL
1964	13280	3234	291	347	19	17171
1965	15647	6021	886	2073	898	25527
1966	17058	13043	2370	2545	2443	37494
1967	20354	16471	3759	3632	4821	49049
1968	15774	19231	3469	5958	6101	50569
1969	16138	21794	3154	5189	6874	53150
1970	13204	25566	3012	6681	7238	55701
1971	9158	18265	1334	4380	5177	38314
1972	7773	8004	1487	3181	4112	24557
1973	6161	4914	1315	2727	2543	17660
1974	9503	5503	1908	5995	1627	24536
1975	11102	2255	1120	10230	1086	25792
1976	7467	1766	332	13139	1076	23780
1977	6991	1955	223	9971	559	19691
1978	3788	922	140	5171	292	10313
1979	654	188	—	3571	97	4510

Notes:
The categories of system defined by these statistics may be described as based on the following principles: Insitu Concrete, concrete placed into reusable shutters assembled on site; Precast Concrete, concrete components caste either on site or in factories and then lifted into position; Steel Frame, loadbearing steel frame supporting a non-structural cladding; Timber Frame, loadbearing timber frame or panels supporting a non-structural cladding; Rationalised Traditional (or crosswall), loadbearing masonry construction reduced to the minimum necessary to support timber floors and roof components and non-structural cladding panels.

TABLE VII: Average Costs of Local Authority Housing in England and Wales 1964-1977

Sources: M.H.L.G., H.S.G.B. (1964-1970).
D.O.E., H.&C.S. (1970-1978).

	Houses & Bungalows			Flats under 5 st.			Flats 5 st. & over		
	IB	Trad	All	IB	Trad	All	IB	Trad	All
Shillings/sq.'									
1964	55,3.5	52,0.5	52,7.5	71,5.5	69,3.5	69,6.5	94,4	96,8.5	95,11
1965	59,0.5	56,9.5	57,5	76,0	75,4	75,6	99,3.5	104,4.5	102,3.5
1966	61,6	60,3	60,9	83,4	79,10.5	80,7.5	106,0.5	109,11.5	107,10.5
1967	65,0.5	63,9	64,4	84,7.5	80,3	81.7.5	105,0.5	110,1	106,11
1968	65,6.5	65,5	65,5.5	85,3	83,3.5	83,10.5	99,10.5	114,11	105,6.5
Pounds/sq.M.									
1969	36.06	37.35	37.03	49.62	50.38	50.27	59.53	63.62	61.25
1970	38.54	40.04	39.72	51.13	54.36	53.82	68.35	62.97	64.48
1971	42.84	46.50	45.75	55.76	63.08	61.89	68.14	80.19	77.93
1972	53.28	55.44	55.00	72.87	77.50	76.64	111.19	95.37	96.02
1973	71.37	74.16	73.41	89.13	104.95	102.04	105.92	147.90	143.91
1974	83.06	88.99	87.63	112.18	123.25	121.84	132.66	213.03	179.97
1975	94.39	96.33	96.02	125.35	134.76	133.51	193.27	186.93	187.24
1976	97.89	101.71	101.13	136.03	142.54	142.16	239.60	234.58	234.82
1977	112.67	115.46	115.35	109.48	167.18	165.37	—	226.83	226.83