AFFORDABLE HOUSING ADAPTATIONS USING MODULAR CONSTRUCTION –
A CASE STUDY IN APPLIED PROJECT MANAGEMENT

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ABSTRACT

In 1995 the U.K. Government, through the Department of Environment, Transport and the Regions announced a major research initiative called “Extend Quality of Life” (EQUAL for short) in order to address some of the problems of an ageing population. Increasing life span is often associated with disability, with some data showing (for those who reach the age of 65) a forecast average of 5 years disability for a man and 11 years disability for a woman. Bonnett (1996) reports that one in four U.K. households includes a person with a disability (usually elderly) and Heywood (1994) reports that most U.K. grant aid to the disabled goes to people over the age of 60. Similar problems are being experienced throughout the developed world and increasingly in developing societies.

A major problem associated with disability is mobility in the home. In the U.K. most people live in owner occupied two storey housing, where, following the tradition of centuries, key washing and toilet facilities are placed on the upper floor. This is inconvenient for the elderly, but much worse for people with disabilities. The problem is, to a certain extent, being addressed in new construction. For example, revised UK building regulations (HMSO 1998) require toilet facilities at entrance level in all new houses and many publications are encouraging the construction of “lifetime” homes (Brewerton and Danton 1994). However, only 1-2% of the housing stock is replaced each year and most U.K. housing is over 50 years old (Bonnett 1996). Any successful initiative addressing the need for entrance level facilities must, therefore, focus on the existing housing stock. Unfortunately, it is at the level of small extensions to owner occupied housing that the building industry is at its most chaotic. Such building works are of variable quality, slow, expensive, messy and often dangerous. There is often a lack of independent advice concerning adaptations (DETR 1998) and many architects or engineers are reluctant to get involved with such small contracts.

This paper reports research, which examines the feasibility of applying modular building technology to disabled users’ needs. The object of applying this technology is to dramatically improve the delivery of extensions to homes in the face of expected demand. However, the technology of manufacture was not initially thought likely to be the main focus of concern. It was suspected that technical solutions were already available. Indeed the “modular” solution has already been applied, with variable results, in similar circumstances. The focus of concern was the project management of the delivery process from feasibility in the form of identifying user needs to commissioning the completed work. This included examining constraints such as financial, town planning and technical controls, execution including the logistics of detailed specification and supply and completion in the form of user feedback. The interdisciplinary nature of project management was reflected in the research team, which included specialists from a wide range of professions.

KEYWORDS

Project management, modular housing adaptations, disability.
INTRODUCTION

A feature of recent population trends in the developed world is the increasing proportion of elderly people. In Britain it is forecast that by 2020, almost half the adult population will be over 50, with the over 80s being the most rapidly growing sector (Coleman 1993). European figures are similar. In 1995, Italy became the first country in the world in which the number of people aged 65 and over exceeded the number of children under 15 (Morini 1998). World-wide statistics tell a similar story. By 2025, 26% of the Japanese population will be over 65 years old (Ikeda 1998) and by 2050, 22% of the Australian population will be over 75 (Cappelli 1998). With an ageing population comes a number of challenges. A larger proportion of retired people in several countries is already causing problems with pension provisions and there have been moves in recent years to reverse the trend of earlier retirement. With age comes increased illness and this has caused spending on healthcare to rise disproportionately to the absolute increase in population. Often so called “illness” in older people is not acute, but associated with a gradual loss of physical and mental faculties leading to an inability to get around easily or carry out some tasks. In the UK, some data shows (for those who reach the age of 65) a forecast average of 5 years disability for a man and 11 years disability for a woman. Other publications support this perception of the issue. According to Bonnett (1996) one in four households includes a person with a disability (usually elderly) and Heywood (1994) reports that 75% of grant aided funding in the UK for people with disabilities goes to people over the age of 60.

At the same time as and, perhaps, because of the increasing proportion of elderly people, there have been moves towards empowering people with disabilities. The medical model of disability, which centres the “problem” with the individual has been challenged and a social model is being promoted, which argues that disability is a product of others’ attitudes and environmental factors. Acceptance of this view by governments has resulted in such legislation as the Americans with Disabilities Act and the UK Disability Discrimination Act (HMSO 1995). The latter generally outlaws discrimination against people with disabilities and specifically places a duty on employers and service providers to make enabling adjustments to the physical environment. It has given rise to revisions to building regulations (HMSO 1998) which require that reasonable provision be made for the access and use of new buildings and for sanitary conveniences to be provided at the entrance storey of dwellings.

UNIVERSAL DESIGN

A widespread response from the building professions to changes in attitudes to disability is universal design. Pioneered by Ronald Mace in the USA the principles of Universal Design include the principle of “equitable use”, which involves providing the same means of use for all users and the avoidance of segregating or stigmatising any users (Center for Universal Design 1997, Parker and Harrison 1998). Yet this concept of universal design masks a conflict between universality and choice. Satoshi Kose, the chair of CIB Task Group 19 (Designing for the Ageing Society) expresses the conflict thus (Kose 1998):

“Sometimes it is argued that one design should fit for all, and that is universal design. It is completely wrong. Forget about it. It is very rare that one design fits all……By the same token it is wrong to argue that what is good for the disabled and elderly is good for everyone. We already know that there are conflicts among the disabled, of different disabilities in particular” (page 187)

Fern (1998), echoes the theme of conflict between universal design and individual choice in the context of access to the Canadian National Parks. Recognition is sought that not everything could or should be made accessible and, sometimes, decisions are required by the user. Important for individual choice is the idea of equivalence rather than universality. The user should have the opportunity to experience an equivalent amenity provided perhaps by video, scale models or photographs.
Sonoda (1998), with specific reference to designing and adapting houses to suit the life-span of all people, expresses the conflict in the form of three choices. The first choice is to create “highly accommodating designs that can cope with various people’s needs comprehensively”. This represents the universal design ideal expressed above and is criticised by Sonoda as it is almost impossible to fulfil “all the people’s needs with just a single design”. The second choice is to design for each group of user separately. This represents the opposite of the universal design ideal and suggests the “ghetto-isation” of housing between users with different needs. This solution is criticised elsewhere (Cappelli 1998) because it involves re-locating and segregating users and disrupting the support networks established in local neighbourhoods. The solution, in requiring extensive physical development, also conflicts with national and international cost and sustainability objectives. The third choice is to recognise the natural progression of life from young to old and to provide housing which is adaptable according to need.

**ADAPTATIONS TO DWELLINGS IN A UK CONTEXT**

In the Japanese context within which Sonoda was writing, it is common for houses to be built and rebuilt over a relatively short time-span and for occupiers to remain in the same dwelling for the whole of their life. This gives much rise to both a greater scope for and need to design for adaptability. However, in many countries in the world, including the United Kingdom, conditions are less favourable. In the UK, although moves have been made to encourage the development of “lifetime homes” (Brewerton and Danton 1994, Bonnett and Walliman 1997), most housing stock is over 50 years old and only 1-2% is replaced each year (Bonnett 1996). Adaptability can, therefore, only be provided as alterations and adaptations to existing buildings.

The unsuitability for people with disabilities of much British housing is illustrated by research by Oldman and Beresford (1998) into the needs of disabled children. They report stress, difficulty in caring and reduced childhood experiences as arising from unsuitable accommodation. Lack of resources and shortage of information are cited as constraints on adaptations, with the benefits of easier caring and “a more independent” child noted where successful adaptations are carried out. The most prevalent problems are associated with the traditional English house layout, which places key washing and toilet facilities on the upper floor. Problems centre on negotiating stairs and using the “upstairs” bathroom, also expressed in solution terms as “the lack of a downstairs toilet”. Professionals are also criticised by users for a lack of understanding, a lack of overall assessment of needs, the provision of unsuitable adaptations and poor design (which gives a “medical/hospital like feel to adaptations”). The problems of poor design are reiterated by Heywood (1994), who identifies the need for discreet, aesthetically pleasing external adaptations which are “not a social embarrassment”. She also reports the desire of users for control over how adaptations are carried out, for information on adaptations and for independent advocacy or support. Time and cost constraints are cited by both Oldman and Beresford (1998) and Heywood (1994) with the latter noting long delays in assessment and implementation of adaptations. The Disabled Persons Accommodation Agency (DPAA 1995) raises similar concerns related to the delay and cost associated with adaptations and amplify the latter by noting that most respondents to their research have very low incomes. Most importantly, they also report the generally felt desire of people with a physical disability to remain in their existing home and raise as a specific issue the question of how to use public funds to “assist people with a physical disability to remain or become owner-occupiers thus reducing the need to move into rented accommodation”.

Wilson et al (1995) examine factors influencing the housing satisfaction of older people generally. Using as a measure of need, users’ own satisfaction with housing, they note that physical quality is a prime determinant of satisfaction. Specific defects of damp and draughts are cited, but the positive benefits of bathrooms and toilets at living room level are also very important to older people. With regard to modifications to existing homes, Bonnett (1996) also notes the appeal to users of a downstairs shower/WC option, but suggests that such a provision might involve space sacrifices elsewhere.
The combination of raised aspirations from property owners, a relatively inflexible housing stock, greatly increased numbers of elderly people and a general desire for people as they get older to stay in their own homes is leading to a tremendous increase in demand for small building works. Unfortunately, it is at the level of small extensions to owner occupied housing that the building industry is at its most chaotic. As a result of poor industry performance in this, less glamorous, sector many home owners of all ages are reluctant to invest in repair and maintenance work. Professionals, such as architects and engineers, who for larger works act on behalf of the client, find such work unprofitable and are reluctant to become involved. Owners, thus, lack competent independent advice (DETR 1998). Indeed, so problematic is the performance of the industry in this sector, the UK government has recently set up a working group to look into the activities of so called “Cowboy” builders (HMSO 1999) and has recommended the introduction of a quality assurance scheme (the “Quality Mark Scheme”) and standard form of contract designed specifically for small builders.

CURRENT RESEARCH

In 1995 the UK Government recognised the need for research into problems of an ageing population, by promoting a major initiative called “Extend Quality of Life” (EQUAL for short). This is funded through the Engineering and Physical Sciences Research Council. In response to the initiative, a successful bid was made by South Bank University to address the need for adaptations to existing dwellings (Atkinson 1998). Taking as a starting point the desire of many to have entrance level toilets and bathrooms the project set out to research whether some of the notorious problems associated with the building industry at the “small end” of minor adaptations and extensions for owner-occupiers could be avoided by harnessing modular construction technology. Modular technology holds out the possibility of improving the quality of the finished product, of reducing time and inconvenience during construction and of reducing cost. Costs might be reduced, both in absolute terms and by making adaptations re-useable. “Re-usability” and/or “removability” is an attractive attribute where an extension or adaptation is only needed for a short time, or where aesthetic constraints mean that regulatory authorities would not permit a permanent solution. This is commonly the case where the building to be adapted is of particular historic interest and is constructed from materials that are no longer available, that cannot meet modern building regulations, or are prohibitively expensive.

In project management terms, the proposal appeared to be jumping to conclusions by flouting the normal project management methodology of carrying out thorough feasibility studies prior to start-up. However, it was suspected that the advantages of modular construction were sufficiently large to start from an assumption that it deserved closer examination than had been given so far. In order to ensure that the views of potential users of adaptations were recognised, a project team was assembled, which includes two researchers from an occupational therapy and environmental health background respectively. User representatives are involved in the form of the “care and repair” agency of a major social housing provider (a UK “Housing Association”) and an umbrella organisation for self-help disabled persons housing groups. A manufacturer of modular buildings is also involved and several manufacturers have been consulted.

Despite the involvement of manufacturers, manufacturing technology was not initially thought likely to be the main constraint to implementing a modular construction solution. Modular construction techniques are well known and have been used for both new build and adaptations. The main constraint was likely to be associated with the project management required to ensure that users’ objectives are properly defined and that issues related to planning and implementation are properly addressed.

The methodology used was based on unstructured interviews with the various stakeholders in the process of adaptations, from the user/occupier of the buildings involved to the regulatory authorities governing the work and the manufacturers of modular extensions. Users and their representatives were recruited through the umbrella organisation mentioned above and other interviewees were
selected directly by the research team. The interviews carried out, or planned are summarised in table 1. In addition to carrying out interviews, a cost study was made by a qualified and experienced quantity surveyor, who compared the costs of four designs for extensions using modular construction technology with the traditional masonry alternative. Non-extension alternatives of providing a “stair” or “through floor” elevator to access the upper floors of a dwelling were also compared. A qualified construction manager was also asked to comment on the construction duration for the modular and traditional alternatives.

**TABLE 1 - INTERVIEWS**

<table>
<thead>
<tr>
<th>INTERVIEWEE</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual or proposed user of extension to property</td>
<td>23</td>
</tr>
<tr>
<td>User representatives (professional occupational therapists etc)</td>
<td>4</td>
</tr>
<tr>
<td>Representatives from local planning offices</td>
<td>4</td>
</tr>
<tr>
<td>Representatives from local building control office</td>
<td>4</td>
</tr>
<tr>
<td>UK Government development control representative</td>
<td>1</td>
</tr>
<tr>
<td>UK Government building regulations representative</td>
<td>1</td>
</tr>
<tr>
<td>Representatives from modular building manufacturers</td>
<td>3</td>
</tr>
<tr>
<td>Representative real estate agents*</td>
<td>3</td>
</tr>
</tbody>
</table>

*Planned at 21/9/00

**FINDINGS TO DATE**

a) **User and User Representatives**

Feedback from interviews with users produced some interesting findings. Given the conservative views of many older people a somewhat surprising finding, was that most users consider a modular building solution an acceptable alternative to traditional construction. Further, many welcome the possibility of being able to remove an extension when no longer required. “Removability” is welcomed in two respects. It means that costs might be reduced by promoting re-usability and it means that the value of the property might not be diminished by an adaptation made specifically to suit a particular user.

Several users criticised alternatives to extending their property. They faced pressures from professional agencies to adapt internal space rather than extend, but this was resisted as it represented a diminution of standards rather than an improvement. Some also noted that installing an electric “stairlift” was not a suitable alternative. This was on grounds of being inconvenient, too small,
technical difficulty with some staircases and, most pointedly, of having the effect of emphasising and publicising their “disability”.

Appearance was greatly emphasised by most interviewees, mainly from two angles. Firstly, designs of extensions should be in keeping with existing property and, where possible, have pitched roofs to match traditional English vernacular architecture. Good quality internal finishings and fittings were also considered important. Secondly, a “normal” appearance was also emphasised from the point of view of not wanting to appear “different” and from not wanting any extension or adaptation to have an “institutional” or “medical” feeling. Linked with appearance was the question of saleability. Interviewees wanted to preserve the value of their property and felt that this could be done by either ensuring any extension or adaptation matched closely their existing property and/or by making the extension/adaptation removable. Users’ representatives also emphasised issues of removability, internal and external appearance, but added the need to ensure that any extensions do not adversely affect the existing property, by for example blocking light. They also emphasised the need to involve the user in design and construction decisions, rather than imposing solutions.

On the question of costs, adaptations and extensions for disabled people are grant aided in the United Kingdom with a means tested grant (the Disabled Facilities Grant), but this is often insufficient to meet the full cost of a major adaptation. Financial constraints thus figured large for the owner-occupiers in the study. Minimising cost was important and most were prepared to consider modular construction and re-usability if it reduced cost, subject to providing an acceptable design. The benefits of re-usability on cost grounds were also emphasised by user representatives and the wider perspective was also noted in that reduced costs would allow a better provision to a larger number of users.

Time was also very important to users. Many had been waiting for extensions or adaptations to their property for some time and some were experiencing reducing physical ability brought on by illness. For them, time was “of the essence”. User representatives emphasised the need for speedy commissioning, design and construction, particularly where some users had a limited life expectancy.

Other issues mentioned by interviewees, which resonated with the literature mentioned earlier included the need to minimise the inconvenience, disruption and danger associated with traditional building work and the inability to get any building company interested in carrying out traditional work during a construction boom. For both issues, the use of modular construction was seen as a possible solution.

b) Regulatory Authorities
The UK has some of the most restrictive zoning and physical planning regulations in the world. Almost every proposal to build requires planning permission and is considered by either a full meeting of the elected members of the Local Authority concerned, a “planning committee” of members, or for smaller works, by a planning official under delegated powers. Exceptions to this regime include some agricultural buildings, works by the Authorities themselves (they effectively grant themselves planning permission!) and small extensions to houses. From this, it might be thought that modular extensions would be exempted from the need for approval. Unfortunately, this is unlikely to be the case except for the smallest extension - many proposals would be in excess of the limits placed on the exemption.

Planning officials interviewed for the research had no fundamental objection to the use of modular building technology for extensions, but they insisted that each extension would need to be considered on its merits, involving detailed consultations with other regulatory bodies and neighbours and a wait, whilst the wheels of bureaucracy turn, which currently extends from 6 to 16 weeks and upwards. The Local Authority has power to reject proposals for a wide variety of reasons, including architectural quality, size and shape of extension and the extent to which it overlooks adjoining property. The only ways of alleviating the stringency of these requirements are to apply for temporary permission
(usually for 5 years), where the Authority is somewhat more relaxed over details of the proposal as it can insist on removal at the end of the term, or to apply for a “personal permission”, which attaches to the person applying rather than being attached to the land, and could be withdrawn if the individual moves or dies. The upshot of these planning restrictions is that implementing a “modular” building solution can be stopped by the Local Authority in many instances. Even where permitted, control can be exercised over detailed designs and the whole building programme can be extended for several months.

A separate approval process is required to ensure that the proposal meets the technical requirements of the Local Authority. In the UK, technical requirements are produced nationally by the Government, but administered locally by a Local Authority Building Control Office. This gives rise to some large differences in interpretation between different Authorities, particularly over works necessary in foundations. As with planning officials, the building control officers interviewed suggested that each proposal for an extension would need to be treated separately. This is clearly a waste of time and resources for standardised building types, but in the UK there is no formal equivalent of the USA “HUD1 Code” (HUD 2000) for manufactured buildings. The HUD Code grants nation-wide approval for standardised manufactured building types, thus pre-empting local code requirements. English local authorities do operate an informal “type approval” system, which can give approval for standard building types on a “consent basis” (i.e. the local officer will accept such type approval without requiring extensive design details for each project). However, this will only normally apply to the superstructure of the building, and detailed approval will still be needed for foundations and site works. As with planning permission requirements, building control approval requires some considerable time, extending up to a month or more.

c) Manufacturers

Manufacturers of modular buildings are beginning to enter the extensions market, particularly in the social housing sector. A large proportion of lower cost social housing in the UK is provided for rent through Social Housing Landlords. These are usually either Housing Associations (not for profit Landlords providing housing funded directly by Government grant), or Local Authorities (providing housing funded partly by local taxes, but predominantly by Government grant). Dealing with large institutional social housing landlords has considerable advantages for manufacturers because they do not have to market their products to the general public, merely satisfy the financial requirements of a few large clients. This has led to an emphasis on cost and delivery at the expense of design. Manufacturers interviewed displayed a reluctance to embrace the aesthetic aspirations of users. No manufacturer was carrying out detailed research into the specific market (of extensions for elderly people with disabilities) and only two were interested in becoming involved in this area. This was despite statistics which reveal that there is likely to be a strongly growing demand for such adaptations. A wider telephone survey following up on interviews revealed a similar lack of knowledge or interest in this market.

Where manufacturers were involved in the market, the technology of manufacture appeared relatively inflexible, extending little beyond adapting a standardised unit designed for another purpose (for example, as a building site cabin). Where modifications to accommodate user needs were essential, they were proving technically difficult to implement and required expensive bespoke alterations of completed units. The lack of flexibility appeared to be driven by an obsession with production volumes and ease of tooling at the expense of designs tailored to specific user requirements.

d) Other findings

At the same time as interviews were being conducted, a review of international design standards was carried out and later combined with user information. This was centred on extensions to form entrance level bath, toilet and shower rooms but considered four variants in all, one of which is illustrated in figures 1 and 2. The variants are:-

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1 United States Department of Housing and Urban Development
• A basic shower/toilet extension
• A larger shower/bath/toilet extension
• A small bedroom/shower/toilet extension
• A large double bedroom/shower/bath/toilet extension

Preliminary feedback suggests that nearly all user requirements can be accommodated in these four designs. This scope for standardisation of layout coupled with the projected demand for such extensions indicates that the use of modularised manufacturing techniques should be worthwhile, achieve substantial benefits for users and provide profitable opportunities for manufacturers. Initial costing suggest that alternatives to extensions (whether modular or otherwise) are often nearly as expensive as a preferred “extension” solution, but without the same level of benefit. Further, the cost of a modular extension is about 1/3 less than a comparable traditionally built solution, without allowing for the reduced cost induced by re-usability. A construction process analysis also indicates that construction time would also be reduced by a factor of 4 if modular building technology were used.

The possibility of “re-usability” also raised an important legal issue, where extensions were grant aided. In English law, property passes on the erection or installation of permanent fixtures and this means that a granting Authority might not be able to insist on the physical return of a grant aided extension when no longer required (Morris 2000). The Authority would then be left to sue for the additional cost of not being able to re-use the building and this prospect was effectively discouraging grant aid for re-useable adaptations of all types. Changes in UK legislation (HMSO 2000) were required to allow granting authorities to finance such adaptations and it remains to be seen whether the legislation will over-ride the normal law of property.

CONCLUSIONS

This research shows that modular construction technology can be applied to extensions to domestic property for elderly people with disabilities. Costs can be reduced considerably and the potential exists to reduce costs further by encouraging “re-usability” - removing the extension when it is no longer required. Construction duration can also be considerably reduced, but this benefit is somewhat lost by regulatory procedures in the UK. Planning procedures can prohibit certain works and, even if not fatal to a proposal, could extend the time for implementation by several months.

Producing suitable designs for modular extensions appears to be more problematic, with attempt to date appearing clumsy and not taking full account of user requirements. Contrary to initial expectations, the technology of modularization is not well advanced in dealing with the shorter production runs and flexible designs needed for small extensions to dwellings. Thus, there appears to be scope for further research, which will bring together users, user agencies, manufacturers and regulatory authorities in a co-ordinated attempt to overcome, not only design and specification constraints, but also logistical problems. A further project has just been proposed to produce detailed designs and specifications in conjunction with a modular building manufacturer, a timber technology research and development association and several user groups.

On a more general note, the research programme, of which this research is a part, has a number of distinguishing features. The most important of these is that it, quite rightly, puts the user at the centre of any investigation and requires user involvement. Another key feature is the emphasis on multidisciplinary working. The promoters recognise that successful implementation of technology involves teams of like-minded, but specialist experts. However, this mode of working is uncomfortable for most experts, who are trained in one specialism and not in the overall management of temporary organisations. The discomfort is compounded by the fact that most academic research is carried out by single subject experts rather than wide ranging generalists. Managing multidisciplinary
teams requires more general skills of planning, integration, monitoring, control and conflict management as well as technical input. These skills have more in common with project management than any single discipline within either the built environment or health professions.

FIGURE 1 - TYPE 1 EXTENSION - PRELIMINARY ELEVATION

FIGURE 2 – TYPE 1 EXTENSION – PRELIMINARY PLAN
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