Modern methods of construction in Germany – playing the off-site rule

MARCH 2004
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Modern methods of construction in Germany
– playing the off-site rule

REPORT OF A DTI GLOBAL WATCH MISSION
MARCH 2004

Report prepared by
Tim Venables
Roger Courtney
with contributions from
Karin Stockerl
Andrew Ogorzalek
Clive Clowes
Paul Newman
Russell Matthews
John Mitchell
Simon Palmer
Rodger Evans
David Whitton
# MODERN METHODS OF CONSTRUCTION IN GERMANY – PLAYING THE OFF-SITE RULE

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EXECUTIVE SUMMARY

S.1 Background to mission

There is widespread concern that the rate of construction of new housing in the UK is insufficient to meet current needs. The reasons for this shortfall are the subject of debate, but it is clear that any significant increase in the rate of construction of new homes by traditional methods would impose considerable strain on an industry which is having difficulty recruiting sufficient skilled labour to meet present rates of construction.

One means of increasing production without a corresponding increase in the demand for site labour is to move to off-site manufacturing (OSM). In OSM, the main elements of the house are constructed away from the building site in a factory environment. This facilitates the application of machinery and automation to construction and reduces the demand for site labour. It provides a better working environment, enhances quality and leads to greater predictability in delivery.

OSM has been more widely adopted in some countries than in the UK, and previous DTI Global Watch Missions have examined its application in Japan, northern Europe and North America. This report presents the findings of the latest mission, to Southern Germany, which took place during 14-19 March 2004.

Members of the mission were representative of major interests in housing, including private house building, funding and provision of social housing, provision of housing warranties, housing design, research and technology transfer, and the development of housing policy.

The mission visited eight suppliers of OSM housing, a supplier of prefabricated concrete basements, two ‘show home’ parks each with some 50 OSM houses, and a university research group.

S.2 OSM in the German market

Annual production of new homes in Germany is considerably larger than in the UK, at around 285,000 units. Of these, around 25,000 are constructed from OSM systems, and this figure is increasing even though the overall market is in recession.

OSM is most commonly used in the construction of new detached housing, much of which is ‘self-procured’, ie purchased by the owner of a serviced plot of land. This contrasts with the normal developer-led supply route for private housing in the UK, and means that OSM suppliers are competing in a market for houses rather than a market for the house-land-location ‘package’ as in the UK.

OSM housing in Germany has a good image, being associated with high quality of construction. However, this was not the case in the 1980s; the industry has regained its position through the development of quality standards and certification schemes and consistent promotion of the merits of OSM.

The houses are generally of ‘chalet’ design but other forms are marketed, and there is considerable variety and flexibility in external features. The housing is characterised by open living areas and, often, large areas of glazing. Most have basements. Fittings and final finish are invariably of a high quality.
OSM suppliers serve a wide range of markets, from ‘starter’ homes to luxury housing, at prices ranging from €80,000 to more than €400,000. Some supply different levels of finishing to match customers’ budgets. At the upper end, firms will undertake to build to any plan desired by the customer while the cheaper houses offer less flexibility, although internal layouts and specifications can be changed.

Generally, firms sell to the final customer but one supplier is supplying to a developer in Ireland and another has supplied 3-storey units for a mixed retail/residential development.

S.3 The OSM industry

There are more than 100 OSM suppliers of timber systems in Germany, with capacities ranging from 50 to 2,800 units annually. Many are family-owned. OSM is viable at low production volumes, using the flexibility offered by modern production systems to meet customers’ individual requirements.

Component suppliers have production systems linked to those of the OSM suppliers, so that prefabricated basements, for example, can be produced in highly automated plant to the exact dimensions required.

OSM firms are product and customer-focused. Their competitive position depends on the design, specification and build quality of their homes, and their ability to accommodate individual customer requirements. They invest in research and development (R&D) in order to keep their product competitive and have developed new forms of housing to meet new needs (eg for two generations living in the same house).

OSM has generally been a pace-setter for the housing sector, particularly in the introduction of environmental technologies; for example, energy and water conservation, and most recently in technologies such as external envelopes that offer protection from electromagnetic radiation.

S.4 OSM technologies

Timber

Timber-based OSM systems take the form of post-and-beam construction, structural insulated panels, or a combination of both. External finishes are normally rendering or timber cladding. The specifications and dimensions of the timber used exceed those in the UK, with great concern for final quality in the finished product. Post-and-beam systems are aimed at the upper end of the market, and application in the UK is likely to be limited. But structural panel systems could have wider application, once the absence of a cavity is accepted. There is considerable spare production capacity in Germany, so either manufacture in the UK or import would be possible.

Concrete and masonry

The concrete OSM systems viewed by the mission were either based on large blocks and roof elements manufactured from low-density concrete (which save labour on site but do not represent the degree of factory manufacture as other systems) or, at the other extreme, utilise concrete ‘modules’ fully fitted out in the factory. The latter were aimed at the lower end of the market, prices being in the €80-100,000 range. The technology was transferable to the UK. Some OSM firms supply factory-built brick panels; these could be investigated further but the plant visited by the mission had largely manual processes.

Components

A manufacturer of concrete basements for OSM housing produced these with an impressive degree of automation, and
demonstrated the waterproof final product by having a floating marketing facility. The technology could be used for above-ground construction and was particularly relevant to areas prone to flooding.

**Production**

The degree of mechanisation and automation observed, and the balance between factory and site activities, varied widely, with firms taking a pragmatic view based on their position in the market. Firms offering a great deal of flexibility tended to undertake more work on site, to be able to accommodate late changes. But they sought to bring work back to the factory and one firm had developed a packaged heating/water supply unit to reduce installation time on site.

**S.5 Marketing of OSM homes**

As in any product-based competitive market, suppliers invest heavily in marketing and sales outlets. A distinctive role is played by ‘show home’ parks. These enable prospective customers to view a range of houses on a single visit and thus help the selection process, to the benefit of the OSM sector generally. Firms also have show homes on their production sites, together with ‘customer centres’ which exhibit finishes and fittings. One has constructed a ‘World of Living’ which combines a walk-through history of housing with exhibition and conference facilities. Other promotion takes place through magazines dedicated to OSM housing.

**S.6 Conclusions**

Traditional house buying practices, in particular the practice of purchasing land and then having the house constructed on it, has facilitated the growth of OSM in Germany. The outcome is a highly competitive industry focused on continuous product development to improve the design and quality of the final product, setting standards for housing generally. The same effect in the UK might be achieved through relationships between OSM suppliers and developers or social housing interests.

Some of the technologies employed in Germany – notably for insulated structural panels, modular concrete housing and automated production of concrete panels for walls and basements – should be investigated further with a view to application in the UK. There is currently spare production capacity, and import of timber units may be economic, although concrete units would need to be manufactured in the UK. In addition, the advanced environmental technologies now being deployed in German housing may warrant further study.

The German OSM industry has overcome an image of poor quality through developing rigorous quality standards and promoting certification schemes; a similar strategy would assist the UK OSM sector to address current public perceptions.

An industry-wide initiative to establish a ‘show home’ park might also be considered, as a means of raising the profile of OSM and giving developers and public first-hand experience of OSM housing.
1 INTRODUCTION

1.1 The policy context

Many recent reports, including Kate Barker’s review of housing supply\(^1\), the ODPM’s Sustainable Communities report\(^2\), and the Joseph Rowntree Land Enquiry\(^3\), have drawn attention to the shortfall in production of housing in the UK as compared with estimates of needs, and to the low replacement rate of the present housing stock. While the reasons for this shortfall are the subject of debate, it is clear that any significant increase in the rate of construction of new homes by traditional methods would impose considerable strain on an industry which is having difficulty recruiting sufficient skilled labour to meet present rates of construction.

One means of increasing production without a corresponding increase in the demand for site labour is to move to off-site manufacturing (OSM). In OSM, the main elements of house construction take place away from the building site in a factory environment, with site works confined to the installation of mains services, construction of foundations, and final assembly of manufactured components. Complementing OSM, forms of site-based construction (eg large block systems) have been developed which reduce the amount of labour required. Collectively, these approaches to housing production are described as ‘modern methods of construction’ (MMC).

Issues relating to the current state of OSM in the UK are addressed in the report Manufacturing Excellence\(^4\).

1.2 UK interest in OSM

OSM techniques are not novel; off-site production has been employed in various ways in the UK for the past 50 years. But with some exceptions (eg temporary buildings), use of OSM has been experimental, with both social and economic factors constraining its mainstream application, notably in housing. Changes in both production technologies, and in the wider social and economic context as outlined above, have stimulated much greater attention to the potential of OSM in recent years, with significant research investment, of which the £1.8 million ‘PrOspA’\(^5\) programme led by CIRIA is the latest phase.

Within the general concept of OSM, five subdivisions are recognised\(^6\):

**Volumetric systems**

The most factory-based form of production, volumetric systems use three-dimensional (3D) modules, either in isolation or in multiples, to form the structure of the building. These modules can be pre-finished in the factory to include all fixtures and fittings, requiring a very limited amount of installation work on site.

**Panelised systems**

The construction of the structural frame for the building using panels assembled in the factory. Panelised systems can either be

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\(^5\) www.prospa.org, led by CIRIA on behalf of Co-Construct and Loughborough University. Sponsored by DTI.
\(^6\) Based on definitions from the Housing Corporation.
open (typically delivered to the site purely as a structural element) or closed (typically including additional factory based fabrication such as lining materials, insulation, cladding, internal finishes, services, doors and windows).

**Hybrid systems**

A combination of volumetric and panelised systems where the high value areas (kitchen and bathroom) are typically formed from volumetric units (sometimes referred to as pods) and the rest of the structure from some form of framing system.

**Subassemblies**

Major building elements that are manufactured off site but do not form the primary structure of the building. Foundation systems and cassette panels are typical examples.

**Components**

Non-structural elements that are assembled off site. Although currently less common than structural elements, components such as mechanical and electrical services infrastructures are being developed with significant assembly work being carried out off site.

Associated with the rise in interest in OSM has been a desire to learn from the experience of other countries where the use of OSM and other non-traditional technologies is more prevalent. In these countries – notably Japan, the USA and certain countries in northern Europe – housing technologies and associated production systems have been refined both through experience and through suppliers’ investment in research and development (R&D). Missions sponsored by DTI have examined the housing technologies and production techniques used in these countries and identified ways that these can be transferred to a UK context.

**Figure 1.1 Previous mission reports**

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This report presents the findings of the latest of these missions, to Germany, which took place during 14-19 March 2004.

1.3 Aims of mission

The mission examined the factory production of new homes and building components in Germany. Its aims were:

- To develop improved understanding of the technologies incorporated in prefabricated housing in Germany and employed in its design and production
- To assess the scope for application of these technologies in the UK, and the factors that would promote or inhibit take-up
- To disseminate the knowledge gained, and stimulate appropriate debate and application

To minimise time spent travelling, the firms visited by the mission were mainly in Southern Germany – the Länder (federal states) of Bavaria and Baden-Württemberg. In these regions, most housing is constructed from timber, masonry and concrete; the mission therefore focused on suppliers of housing made from these materials. Other forms of prefabricated construction (eg lightweight steel frames) are to be found in Germany, but have a very small presence in the market. Steel framed systems, for example, account for less than 1% of the OSM housing market8.

Appendix B presents the mission itinerary and Appendix C provides details of the organisations visited.

1.4 Mission participants

Members of the mission brought to the study of OSM in Germany a range of backgrounds, experience and viewpoints. They are listed in Table 1.1 below, with further details in Appendix D.

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<tr>
<th>Participant</th>
<th>Position</th>
<th>Viewpoint</th>
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<tr>
<td>Clive Clowes</td>
<td>Head of Housing Procurement, Housing Corporation</td>
<td>Provider of housing finance</td>
</tr>
<tr>
<td>Roger Courtney</td>
<td>Consultant, innovation in construction</td>
<td>Mission coordinator for CIRIA</td>
</tr>
<tr>
<td>Dr Rodger Evans</td>
<td>Construction Sector Unit, DTI</td>
<td>Policy towards MMC</td>
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<tr>
<td>Prof David Gann</td>
<td>Tanaka Business School – Imperial College London</td>
<td>Academic advisor</td>
</tr>
<tr>
<td>Dr Russell Matthews</td>
<td>Taylor Woodrow Engineering</td>
<td>Housing developer</td>
</tr>
<tr>
<td>John Mitchell</td>
<td>Surveying Services Manager, Zurich Building Guarantee</td>
<td>Provider of housing warranty services</td>
</tr>
<tr>
<td>Dr Paul Newman</td>
<td>Head of Timber Technology, TRADA</td>
<td>Research and technology transfer, timber housing</td>
</tr>
<tr>
<td>Andrew Ogorzalek</td>
<td>Director, PCKO Architects</td>
<td>Housing architect</td>
</tr>
<tr>
<td>Simon Palmer</td>
<td>Director, Palmer Partnership</td>
<td>Consultant on OSM housing</td>
</tr>
<tr>
<td>Canda Smith</td>
<td>Head of Design and Sustainable Communities, ODPM</td>
<td>Policy towards MMC in housing</td>
</tr>
<tr>
<td>Dr Karin Stockerl</td>
<td>Innovation Coordinator, Southern Housing Group</td>
<td>Social housing provider/German market expert</td>
</tr>
<tr>
<td>Tim Venables</td>
<td>Tanaka Business School – Imperial College London</td>
<td>Academic advisor</td>
</tr>
<tr>
<td>David Whitton</td>
<td>Group Chief Architect, Home Group Ltd</td>
<td>Social housing provider</td>
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Table 1.1 Position and viewpoint of mission participants

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2 HOUSING IN GERMANY

2.1 Introduction

About 285,000 new homes will be completed in Germany in 2004. This is a significant decrease since the mid-1990s, when annual new-build figures were as high as 500,000 (Figure 2.1). The decline has been particularly marked in the Länder of the former East Germany. Construction of apartments has shown the greatest decline; the number of detached and semi-detached houses built each year has been relatively stable in comparison.

As in the UK, the new-build level in Germany is well below estimates of number of homes required. These suggest that construction of between 350,000 and 400,000 new homes annually is required to deal with the projected rate of formation of new households10.

The low new-build figures can be partly attributed to a reduction of public funds for social housing coupled with a reduction by the government of financial incentives for private mortgages. The general economic downturn is also significant and has affected affordability levels, despite (in sharp contrast to the UK) falling house prices.

New-build prices, excluding land, declined by 7.4% between 1995 and 2002. In part, this reflected a reduction in build costs (by 1.4%) but also purchasers wished to save money by omitting expensive fit-out details10.

2.2 Main supply routes and types of homes

The most significant difference between the German new housing market and that in the UK is the relative share of the three main supply routes.

In the UK, speculative production of new housing is dominant, with about 79% of new homes being provided by developers. Some 13% of homes are built for non- or limited-profit organisations, and about 8% are self procured11 (Figure 2.2).

In Germany, the dominant supply route is self-procurement (ie constructed by their eventual occupants either directly or through subcontractors), accounting for about 55%, followed by speculative developments with 32% and social housing with about 13% (Figure 2.3).


There is also a strong link between the procurement route and the type of housing constructed. Both speculative development and social housing provision tend to focus on multiple occupancy buildings rather than detached or semi-detached housing which is almost exclusively self-procured. In a similar manner, the uptake of OSM as the main structural technology has mainly been limited to homes that have been self procured. Additionally, the German taxation system imposes a second layer of tax on developers that also design the homes they build; this currently discourages the manufacturers of OSM homes from engaging in speculative development, an activity that they anyway consider risky because of the uncertainty in the eventual sale.

Table 2.1 presents the main forms of housing and the associated usage of OSM based on procurement route.

<table>
<thead>
<tr>
<th>Type of procurement</th>
<th>Speculative Housing</th>
<th>Social Housing</th>
<th>Self-procured Housing</th>
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<tbody>
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<td>Main built form</td>
<td>Flats and terraced</td>
<td>Flats</td>
<td>Detached or semi-detached</td>
</tr>
<tr>
<td>Level of OSM used</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
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Three principal forms of self-procurement are employed dependent on the amount of input the homeowner puts into the construction of the home:

- **Self-build**, where the owner constructs the house
- **Commissioned**, where the owner prepares a design and contracts with a builder (who may then use OSM components)
- **Catalogue purchase**, where the owner selects from a portfolio of house designs and types

Table 2.2 shows the usage of OSM under these three routes.

<table>
<thead>
<tr>
<th>Self-procurement routes</th>
<th>Self-build</th>
<th>Commissioned</th>
<th>Catalogue purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage of OSM</td>
<td>Mainly use of traditional methods or kit-houses for ease of self-build process</td>
<td>Mainly traditional methods but some OSM</td>
<td>Various types of OSM, with timber, brick, concrete or steel technologies</td>
</tr>
</tbody>
</table>

Table 2.2 Usage of OSM by self-procurement route
2.3 Tenure patterns

Social rented

About 38,400 social housing units were built in 2002, supported by about €7,400 million of government funds. The last decade has seen a significant decrease in construction of social housing; by about 70% in the former West Germany and as much as 90% in Eastern Germany12.

Home ownership and private rented market

In the last decade also, the number of households owning their home has risen significantly. From a level of about one third in the mid-1990s, by 2003 the figure had risen to 41%. This trend is expected to continue; recent surveys have shown that about 40% of those currently renting had aspirations to own their own home.

About 12% of home owners live in flats and the remaining (88%) in single family houses10. Home ownership figures vary greatly between regions and are generally lower in cities, where property values can be significantly higher than national averages. For example in Munich, where house prices can be more than twice those in the surrounding area, the level of home ownership is below 20%.

2.4 OSM and MMC housing

The history of OSM in Germany extends back 70-80 years. In the 1920s and 1930s the first industrially produced homes were seen as a symbol of modernism and progress. Their development was very much part of the ‘Bauhaus’ movement; architects such as Walter Gropius saw prefabrication as the way to build large numbers of dwellings in a fast and effective way. Some examples of this period survive and are now listed buildings.

After 1945, the production of homes in a factory environment attracted the attention of American interests who organised an exhibition of OSM homes in Stuttgart-Zuffenhausen in 1947. Today, six of the eighteen prefabricated homes survive13.

In the 1950s and 1960s, the German timber industry and house builders started to invest heavily in modern methods of production. The industry is now a significant force in the German market. In 2002, over 23,000 lightweight prefabricated homes (ie based on timber frame or timber panel construction) were completed, equivalent to some 13% of all new detached or semi-detached homes built that year. In Eastern Germany, the proportion was higher than the national average, at around 20%14.

The corresponding figures for other OSM technologies (steel, concrete and brick) are uncertain. However, the overall share of the detached and semi-detached housing market taken by prefabricated homes is estimated to be close to one third, with the remaining two thirds being produced by traditional but increasingly standardised and mechanised on-site processes.

There are more than 100 OSM producers in Germany, the majority being very small family firms. The five largest firms (Massa, Elk-Bien-Zenker, Kampa, WeberHaus and Schwörerhaus) each sell between 1,000 and 3,000 homes per year and together account for more than half of the timber-based OSM market.

Some German OSM house builders have started to extend their operations to other European countries. In 2002, exports were twice the level of 2001 but still account for less than 5% of production. Some individual firms, however, aim to increase export sales.

to 40% of overall turnover rates. Key export markets are the UK, Switzerland and Austria. Homes are also exported to many other European countries, and also to Russia and Japan.

Some concentration of suppliers is taking place, with some large companies now emerging that have operations across Europe. As an example, Elk-Fertighaus AG, the leading Austrian OSM house builder, recently acquired the majority share in Bien-Zenker, a large German house builder, and now the Elk-Bien-Zenker Group is the largest OSM manufacturer in Europe with a turnover of about €275 million and 2,800 homes sold in 2002. The group now operates in eight countries, including Ireland.

2.5 OSM and quality

As happened in the UK, some first generation OSM homes in Germany were perceived as being of lower quality than traditionally built homes. This was exemplified by the fact that ‘Pappdeckelhäuser’ (literally, ‘cardboard houses’) was once a widely used nickname for off-site manufactured homes in Germany. However, after some 50 years of development and experience by manufacturers, this perception seems to have been more than overcome.

Today, the image of OSM has changed very significantly. A recent survey by LBS (a large German mortgage lender) amongst 6,300 readers of its mortgage magazine Das Haus revealed current perceptions about the popularity of OSM homes15:

- 20% of respondents lived in a factory built home
- Almost all the respondents knew someone living in a factory built home
- 82% of respondents would consider buying a factory built home
- 92% of respondents knew that a factory built home could be planned to their specific requirements
- 84% of respondents perceived current prices as good value
- 95% of respondents saw OSM technologies as trustworthy, and a practical and sensible way of building
- 75% believed that OSM homes could be resold in the same way as a traditionally built home
- 50% of respondents indicated that OSM homes are setting trends in areas such as design and energy efficiency

Today, producers of OSM homes in Germany focus on providing high quality products through continuous innovation supported by in-house R&D, training, and quality assurance processes that are visible to the customer.

Lobbying and coordinating bodies in the OSM housing industry played a crucial role in achieving higher acceptance for OSM homes in the market. Both the Bundesverband Deutscher Fertigbau (BDF) and the Deutscher Fertigbau Verband (DFV) represent suppliers of timber framed OSM homes and their supply chains (eg suppliers of windows, internal drywalls, basements, garages, heating, ventilation and electrical systems). The BDF, for instance, has about 40 main members and 78 supply chain members.

Both are concerned with marketing and quality assurance issues related to the OSM products of their members, and have subsidiaries providing quality inspection and testing services. The Gütegemeinschaft Deutscher Fertigbau (GDF), a subsidiary of the DFV, has its own widely recognised ‘seal of quality’ which it awards to OSM homes that it inspects directly or which are inspected by independent experts on its behalf. About 80 producers are members of the GDF. A number of other quality marks apply to timber frame

OSM homes but only three or four are widely recognised, such as the RAL sign assuring the quality of timber components used.

Similar associations represent suppliers of OSM housing based on other materials: bricks (brick panels for walls, ceiling and roof), steel (panelised and modular applications) and concrete (panelised and modular concrete systems).

Training

OSM housing suppliers regard training as an important investment for sustaining quality and their ability to maintain production in the future. The BDF reported in 2002 that its members had 520 apprentices, an increase of 6% over the 2001 figure. Total employment had risen by 7% to 9,300 in contrast with a decline amongst traditional builders. On average, each BDF member organisation had 14 apprentices15.

Energy efficient OSM homes

OSM housing producers have set new standards in a number of areas including the environmental performance of new homes. Many offer homes built to the German ‘Passivhaus’ standard, which requires a high level of energy efficiency equivalent to oil usage of less than 1.5 litres per square metre of living space. (This corresponds to annual energy consumption of 10-15 kWh/m²). Compared with traditional homes, this is a saving of up to 90%. Between 1998 and 2002 the number of homes built to this standard doubled each year, aided by government grants to purchasers.

Features of a Passivhaus can include: highly insulated walls (U-value of 0.125 W/m²K), highly insulating windows (triple glazing, maximum U-value of 0.70 W/m²K), external doors which minimise heat losses, heat recovery ventilation systems, photovoltaic panels and solar heating, and heat pumps.

2.6 Producer-client relationship

As discussed above, clients choosing the self-procurement option to home ownership have essentially three major sub-routes16. The first one is self-build, the second is to commission a building company, and the third is to order an OSM house from a ‘catalogue house builder’. The third option is growing in popularity and the majority of OSM homes in Germany are procured this way.

A prospective purchaser can order a house from a catalogue house builder or supplier just like any other product. The land upon which to build the house is sourced and purchased separately by the prospective homeowner. Statutory permissions and approvals together with any infrastructure costs are also the responsibility of the prospective homeowner. In this instance it is the design quality, aesthetics, functionality and durability of the house as a product that are the prime considerations of the prospective purchaser and consequently of the house builder or supplier. These factors are at the heart of the interface between the customer and the house builder and/or supplier in Germany.

New houses in Germany can be bought at different stages of the construction process. One particular form of procurement is ‘Ausbauhaus’ where the shell of the house is constructed by a contractor but the interior fit-out has not been, or is only partially, completed. This is an increasingly popular choice for homebuyers. It allows them to save between €10,000 and €35,000 in labour costs by doing their own tiling, decorating, installation of heating system, etc. It also allows them to get even more involved in choosing the detailed fit-out products.

16 Stockerl & Barlow (1999).
OSM suppliers offer additional services by providing various types of ‘all-in-one’ packages. These can include the following products and services:

- Site finding/estate agent service
- Mortgage finance packages: for instance, the Deutsche Fertighaus Holding (three OSM manufacturers/builders and one refurbishment organisation) offer mortgages for 1.99% fixed for the first five years (Hausbau, 2003)
- Fit-out centres and show homes for clients, 3D visualisations, and individual floor plans

A key characteristic of German OSM housing products that has made them attractive to clients is the flexibility in production and design, which makes it possible to achieve high levels of customisation. With the aid of CAD/CAM technology, plans and designs can be produced to fulfil individual customer preferences.\(^\text{17}\)

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DESIGN ASPECTS AND CUSTOMER SERVICES

Figure 3.1  Single occupancy house

Figure 3.2  Family home
3.1 Introduction

In this chapter, we summarise the general design characteristics of the houses that we saw – these varied from small single-occupancy starter homes through to large luxury homes. The chapter focuses on the significant differences in design between Germany and the UK, many of which arise from differences in cultural context and aesthetics. Additionally, we review the interactions between the housing suppliers and their customers.

3.2 Design

Most of the housing that we saw was for single families, although some larger homes were designed for two generations or multiple families living in a single building (multiple family homes). This reflects the market being addressed by manufactured housing suppliers, which is predominantly the ‘family home’ market. However, the technologies employed in both the products and production processes were applicable to other forms of housing.

We describe below some of the main design features that we observed. Some derive from local traditions and expectations, which differ from UK requirements and expectations. They illustrate the ability of the manufactured housing sector to serve a highly competitive and demanding market, with products that address a wide range of individual requirements and price brackets. While individual designs had been developed to match requirements in the particular sector of the market that the supplier wished to address, every supplier had a strong focus on the quality of the final product, and sought within the economics of the production process to accommodate as many individual variations as possible.

This focus on the product is, of course, a consequence of suppliers competing in a market defined entirely by the product, without the other considerations of land and location that typically enter the new housing market in the UK. This is not to suggest that the product is unimportant in the UK market, but clearly the competitive position of housing developers in the UK is dependent on many other factors whereas in Germany the suppliers of manufactured houses stand or fall on the way that their delivered product meets the customer’s requirements and expectations, at a price level set by competitors.

3.2.1 Light, space and quality

Three words can sum up lasting impressions of the housing studied in Germany – Light, Space, Quality. Whilst there were variations according to the particular part of the market being targeted, these features were always present, whatever the type of construction – post and beam, timber panel, concrete panel or large thin-joint block.

The typical house type was the ‘chalet’, with upper floor bedrooms in the roof space. Larger homes had a full second storey and we saw some examples of bungalows. Floor areas were generous by current UK standards, ranging from 110 m² upwards, with a cellar providing a further 50 m² or more. However, prefabrication techniques were also being applied to one-bedroom ‘entry level’ homes of 60 m².

3.2.2 Spaces and fittings

Ground floor accommodation

This was generally open plan, with a living/dining/kitchen area and flexible filling of space. The entrance hall was normally a good size with a prominent entrance feature: a deck or podium, with an attractive porch or canopy and a substantial external door. The main entrance hall always incorporated substantial storage; off it was the ground floor WC/shower room. Most houses had one
additional room on the ground floor, for use as a study, guest bedroom, hobby room, etc.

First floor accommodation

This was generally the bedroom level. The first floor was in most cases accommodated within the roof space with the roof slope starting at a height of around 900 mm. Hence most rooms had sloping ceilings and the roof volume was generally used for habitable space rather than for loft space or storage.

There was often a visual and spatial link between ground and first floor, achieved through an interesting staircase/gallery arrangement or double rooms linked to a conservatory, sunspace or double height living space. Sometimes one of the bedrooms was open plan (open to a double height space or stairwell) creating a feeling of openness, space and connectivity. Double height spaces within the roof shape often allowed an additional play area as an extension of bedroom space.

Several houses provided a large landing area as an extension of the living space. This would be arranged as a sitting area or play space and was often linked to double height spaces, overlooking the ground floor accommodation.

Bathrooms

To UK eyes, it was surprising that most houses, even at the top end of the market, did not offer en-suite bathrooms. In most houses, only family bathrooms were provided, but these were normally a very good size, and fully equipped with bath, Jacuzzi and shower, and in some cases linked to a hot tub, a Jacuzzi on a balcony, etc. Some homes had an additional bathroom or a sauna in the basement.
Storage

Storage was provided in all main areas of the house: entrance hall, living/dining/kitchen, bedrooms, bathrooms and circulation spaces. It was generally part of the main fabric of the building, forming an integral part of the partitioning system, as a definition of circulation areas or accommodated in the construction of internal or external walls.

Basements

Most houses had basements; overall, around 80% of new housing in Germany has a basement, and one basement supplier claimed that a quality cellar raised the resale value of a house by as much as 30%. They substantially increased the usable space of the house at a relatively low cost. Automated, prefabricated construction kept the cost down while enabling individual layouts to be accommodated. Not all basements were of insulated construction; it depended on the intended use.

Basements generally matched the footprint of the building and provided the substructure for the main house. However, we saw some basements that were larger than the main house, extending under patios, terraces, etc. On flat sites, basements were provided with high-level windows, either by excavating an area outside the window (taking full account of drainage requirements) or by having the ground floor raised above ground level. On sloping sites, windows could be up to full height.

From observation, basements were used for a variety of functions:

- **Extension of living space**
  - home cinema, games, hobbies, etc
- **Recreation complex**
  - sauna, Jacuzzi, gymnasium
- **Home office** – this appeared to be a principal use, particularly in situations where natural light is available
Plant room – central ‘House Engine’ combining heating, water saving services, heat pumps, heat recovery systems, IT controls, ventilation systems, electrical panels, etc

- Storage – household goods, cold storage, wine store, etc
- Laundry room

3.3 Architecture – not just boxes

Architectural concept

As noted earlier, most prefabricated homes took the form of the ‘chalet bungalow’, ie a rectangular box covered with double pitch roof with cantilevered eaves. This is eminently suited to factory production, since it requires only a small number of wall and roof components, which can be produced in differing sizes to cover a range of house sizes and layouts. It is also very suited to modular construction.

The treatment of the space under the cantilevered eaves, creating the flow of external and internal spaces, provided the main architectural attraction and individuality of the houses. The range of options available included glazed sunspaces and bay windows, decks and terraces to the ground floor, and balconies to the first floor. Roof windows and glazed roof sections were often used to complement the fenestration of the houses.
Light, sun, energy conservation

All the designs that we saw, aimed to take full advantage of natural light and to secure the energy benefits of direct solar gain. The most successful designs provided spacious, airy, light and open interiors through having a large proportion of glazing on external elevations, with a natural extension of internal space to the external deck and patios. Solar gain was controlled by systems of external grilles and brises-soleil, creating an attractive element of architectural detailing.

All full-height windows were equipped with integral blinds, and most windows were also equipped with electronic security/energy-saving shutters. The latter were considered a standard fitment; all structural systems, including those in prefabricated masonry, provided space and boxing for shutters as part of window installations.

External glazing, full-height glazed walls, and double-height glazing often formed the main architectural feature of the houses, being complemented by internal glazing, glazed partitions and screens, high-level glazing and internal windows. These added to the integration of spaces, enhanced openness and transparency, and facilitated the penetration of natural light deep into the plan.

Detailing

Attention to detail and quality was a universal characteristic. Since the internal finishes and details came predominantly from factory-installed components, the quality of finish was very high. Window joinery and balustrades for staircases and landings were of high quality. Manufacturers have developed their ‘signature’ details and components, and their designs are recognisable through these. Examples are:

- Carl Platz: large timber sections, consistency of detail throughout – both internally and externally
- Hebel Haus: double height sunspaces

Figure 3.11 Solar shading

Figure 3.12 Double height spaces
3.4 Customisation

Each manufacturer offered a range of standard products, which could then be customised to a greater or lesser extent. Broadly, suppliers addressing the upper end of the market offered greater flexibility. At the top end, they would provide a house that was entirely determined by the customer’s wishes; at lower levels, there were more constraints on size, plan, etc. The modular houses produced by Veit Dennert came essentially in two sizes, but even then the customer could change the position and size of windows, and alter internal layouts.

Suppliers recognised that customers did not necessarily come with fully formed ideas. They therefore offered a design service, generally provided through retained architects rather than directly employed staff. Alternatively, customers could have a plan prepared by their own architect. This would be examined for compatibility with the supplier’s construction system and, once agreed, put into production.

Customer choice could readily extend to external features and internal fixtures and fittings. Options included different external finishes, bay windows, dormers, roof lights, sunspaces, balconies, decks, etc. Similarly, there were options for internal finishes, equipment and accessories including kitchens, bathrooms, joinery, blinds, louvres, mechanical and electrical specification, energy conservation features, IT equipment, sauna, solarium, gymnasium, etc.
Customer centres and model houses

To facilitate these choices, suppliers have show homes on their production sites and extensive showrooms for the various external and internal options. Notable amongst these were:

Hebel Haus. Hebel have four show houses in a mature woodland setting on the edge of the factory complex. The ‘Passiv’ house, built to a particularly high energy specification, is left only partly internally finished in order that potential customers may see the ‘big-block, thin-joint’ construction. This also aids customers who may be considering undertaking finishing works themselves since it demonstrates the product as delivered by Hebel Haus. In addition, a substantial demonstration area exists within the customer selection area. This includes not only options for finishes and fittings but also full-size cut-away sections of rooms to demonstrate exactly how the house is constructed, from its foundations through to the roof.

WeberHaus. Alongside their production plant, WeberHaus have built the ‘World of Living’, a landmark building in its own right designed by a prominent Italian architect. Two extensive floors of customer choice products encompassing the widest possible range of house fit-out from transparent ‘teddy-bear’-filled toilet seats to the latest in computerised in-house technology. But the World of Living is more than a demonstration centre; it aims to be a ‘theme’ experience for the whole

Figure 3.14 Section through house construction

Figure 3.15 The World of Living
family, with features including an interactive museum of the history of housing. In addition, it has high-tech conference facilities in order to attract business users (and prospective purchasers).

In the adjacent extensive landscaped area, a wide variety of fully furnished show houses have been constructed, ranging from a small two-person ‘starter’ house capable of extension to a large ‘mansion’ in traditional style.

The image of housing supply presented by the World of Living and its counterparts is a world away from that presented by the average house construction site in the UK, where the show home is often an island surrounded by a sea of mud.
Figure 3.20  Show village house

Figure 3.21  Show village house

Figure 3.22  Map of Fellbach show village
Show villages

A distinctive feature of the customer interface in Germany is the role played by show villages. Six such ‘villages’ are operated by Ausstellung Eigenheim & Garten in locations near Hannover, Leipzig, Wuppertal, Frankfurt, Stuttgart and Munich. Each presents between 40 and 70 houses, from nearly that number of suppliers. The villages visited by the mission, in Stuttgart and Frankfurt, were two of the larger sites.

The show villages enable customers to view products from many suppliers in one location. Every house is set in its own plot and is fully furnished. The villages are the largest source of orders for new-home suppliers and complement the opportunities for viewing provided at individual plants.

Participation in a show village represents a large investment for the suppliers. Fittings in the show houses are generally of superior quality (even though the customer is more likely to specify more standard fittings) although the cost can be shared with suppliers. Houses have to be upgraded regularly and are typically replaced at around seven-year intervals. House suppliers commented that marketing costs could absorb 16% of revenue, much being accounted for by the show villages. But they have to have a presence in these locations, and the larger suppliers have several houses in each.

'Lifestyle’ magazines

Magazines devoted to manufactured housing provide a further marketing route, and the manufacturers use these to maintain a high profile. Whilst the UK has an active market in general lifestyle magazines such as ‘Home & Garden’, there is nothing like those available in Germany such as ‘Pro FertigHaus’ (ie About Prefabricated Housing).

This 80-page glossy magazine, published bimonthly and with a circulation of 80,000, specialises in covering detailed issues in house design including alternative layouts and styles, and product innovations. Customer feedback reports feature strongly as do comparative reports on particular popular house types. House plans and layouts showing room floor areas, specifications and prices are reported on in detail. There is a wealth of house builder and product supplier advertising material in such magazines that
clearly have an influence on customer perceptions and aspirations. In one recent issue, 84 individual house builders or suppliers had advertising space.

Other such magazines are ‘Haus Test’ and ‘Fertig-Häuser’. The former is the German equivalent of ‘Which?’ for housing. The latter provides detailed descriptions, photographs and reports on 100 house designs available in the market.

And now supermarket sales?

While IKEA have commenced marketing flat-pack housing kits in some countries, several companies in Germany have taken the idea of using retail outlets to sell houses forward by at least two steps. The first step is being demonstrated by the cooperation between DIY store Praktiker Baumarkt and house manufacturer Massa, in which ‘house packs’ are being sold in the DIY store. The second, more radical, step breaks even the link with DIY. The superstore chain Allkauf is marketing manufactured houses through their retail outlets. Manufactured housing is truly a consumer product.

3.5 Housing finance

Some suppliers offered financing arrangements in liaison with partner banks. A feature of the German market was the way that some of the financing bodies actively encourage the use and development of OSM housing solutions. A good example of this is Schwäbisch Hall.

Although we did not have the opportunity to visit Schwäbisch Hall, members of the mission had previously visited the company and were able to observe the active role the lender plays in informing prospective house buyers of the variety of different construction options available.

Its mortgage magazine features regular items on OSM house building, and Schwäbisch Hall had itself invested in a number of steel-frame methods in combination with external wall panels. They also offer additional services such as assistance in finding sites, and quality assurance check on completed works.

Partnership with OSM manufacturers such as Bien-Zenker allows Schwäbisch Hall to act as a one-stop shop for assistance in housing procurement18.

3.6 Customer care

We were informed that many purchases of manufactured houses are the result of personal recommendations or may be attributed to ‘brand loyalty’. Housing suppliers take pride in this and are concerned to maintain the reputations that lead to such sales.

While this effect is not unknown in the UK, it is more difficult for most house builders to benefit from such a reputation because of the intrinsic connection between land and housing in the UK; they may just not be building houses in the area desired by the prospective purchaser.

German housing suppliers therefore have good commercial reasons for cultivating long-lasting relationships with their customers:

- Satisfied (enthusiastic, even) current customers are more likely to provide references and recommendations to other prospective customers, thus providing free marketing
- Current customers are able to give feedback which leads to changes in standard layouts or specifications offered to future potential customers (eg Weber Haus operate a ‘Customer Club’)

• Current customers may need extensions, specification upgrades or refurbishments in the future
• Current customers’ children and relatives may need their own home in the future

This long-term ‘family friend’ relationship with the customer is reinforced in many instances by the evident pride in their history shown by the private family-owned businesses that we visited, where the firm has passed down through four or five generations, each new generation bringing with it new ideas, skills and enthusiasm. All showed a desire to meet the challenges of the present decline in the housing market, and had the freedom of their private status to support investment in state-of-the-art equipment, R&D and marketing facilities, without the need to raise capital from financial markets.

However, it did not appear that the suppliers differed radically from those in the UK in their approaches to after-sales service. Generally, they offered some form of charged maintenance check or service following a one-year free maintenance period, but all said that there was by no means 100% take-up of these services. Arrangements varied, for example:

• Baufritz stated that their follow-on maintenance contract cost as little as €300 a year, but this was thought to be a service which included only a ‘health check’ of structures and systems rather than for actually carrying out any servicing or maintenance
• Carl Platz offered maintenance and an interior design service for a fee. It supplied a free maintenance handbook, and observed that wooden cladding panel surfaces with a rough finish normally required repainting every ten years, depending on orientation. Panels with a smooth finish needed more regular repainting
• WeberHaus offered a two-year maintenance-free period. Like most other suppliers, they also offered a 30-year warranty on the external structure, including work carried by their subcontractors. They also offered an interior design service for a fee
• Elk offered a maintenance service to customers. Its own warranty was for ten years on the external structure, and three years on the rest

We formed the impression that suppliers met the post-sales requests of customers when it was reasonable to do so. They would attend to minor problems and continue to offer advice on operational matters.

Overall, it was clear that the firms in the industry saw product design and construction quality as the principal pillars of market success, with customer care before and after the sale being also important. In this, they emulated product manufacturers the world over. Some of their marketing approaches required heavy investment but were clearly considered essential, although some innovative and lower cost approaches were now being explored. Further substantial investment in product development kept them competitive. The parallels with other consumer product sectors – white goods, cars, etc – are almost exact.
4 HOUSING TECHNOLOGIES

4.1 Introduction

Housing in Germany can be split into two main forms of structural technology:

- ‘Fertigbauweise’
- ‘Massivbauweise’

**Fertigbauweise**

The term Fertigbauweise literally means prefabricated construction, with ‘Fertighaus’ the term for the final product, the actual home. Fertigbauweise is often associated with ‘traditional’ prefabrication industry in German housebuilding. This almost exclusively relates to timber panel or timber framed homes. Its share of the new build market, currently (Chapter 2) around 13%, is expected to grow further.

**Massivbauweise**

The second category of structural technologies is called Massivbauweise – literally, heavy construction. This produces a ‘Massivhaus’. Nearly 90% of all homes built fall into this category, which includes traditional brick and block technologies such as clay and limestone brick and blocks, and all forms of concrete (including lightweight concrete and ‘aircrete’). The market shares of the different types of block are shown in Table 4.1. While Massivbauweise is predominantly constructed on site, the development of manufactured panel systems and large block systems to satisfy demand for faster construction times is leading to an increase in market share of these systems.

<table>
<thead>
<tr>
<th>Type</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay brick and block</td>
<td>45.2%</td>
</tr>
<tr>
<td>Limestone brick</td>
<td>25.5%</td>
</tr>
<tr>
<td>Aircrete</td>
<td>18.0%</td>
</tr>
<tr>
<td>Concrete</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

*Table 4.1 Market shares of different types of block for ‘Massivbauweise’*

4.2 Fertigbauweise and OSM

4.2.1 Introduction

Timber frame manufacturers in Germany produce a vastly different product to that in the UK. Like all good manufacturers, the product they produce is designed and manufactured to meet the needs and expectations of their customers. These, in turn, are driven by the market structure discussed in Chapter 2.

The principal difference between timber frame produced in Germany and the UK is in the degree of prefabrication provided in the factory. However, there are also significant differences in design and quality, and one is inexorably drawn to the conclusion that each of these aspects is inextricably linked.

During the mission we visited four timber frame manufacturing facilities and the associated manufacturers’ show homes. In addition, we had an extensive meeting with one other timber frame manufacturer at their house in a show village.

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### Feature Observation

<table>
<thead>
<tr>
<th>Feature</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Rigid insulants</td>
<td>A wide variety, including foams, mineral wools and wood wool slabs</td>
</tr>
<tr>
<td>2 External cavities</td>
<td>Sometimes used, depending on manufacturer and type of cladding</td>
</tr>
<tr>
<td>3 Breathable wood-based panels</td>
<td>Sometimes replaced with OSB or chipboard, and in these cases was protected by a breather membrane</td>
</tr>
<tr>
<td>4 Vapour control layer</td>
<td>Not always present; sometimes the wall was constructed as a breathing wall</td>
</tr>
<tr>
<td>5 Stud insulation</td>
<td>Either mineral wool or cellulose-based (paper or wood shavings)</td>
</tr>
<tr>
<td>6 Renders</td>
<td>Sometimes cementitious rather than synthetic</td>
</tr>
<tr>
<td>7 Service cavities</td>
<td>Generally created using battens on internal surfaces</td>
</tr>
</tbody>
</table>
Technology overview

The UK market for timber frame buildings is almost overwhelmingly dominated by factory-manufactured open-panel platform-frame systems where insulation, services, linings, windows, doors and cladding are site-installed. In contrast, a typical German timber frame manufacturer produces a post-and-beam/closed-panel hybrid system. The hybrid nature of the system gives designers increased flexibility, and the capability to produce closed panels facilitates the inclusion of insulation, services, linings, windows, doors and claddings in the factory. However, it must be emphasised that in many cases the product leaving the factory is a basic frame with only linings, insulation and service conduits pre-installed.

A detailed review of building performance and comparison of UK and German building regulations is beyond the scope of this document. However, the ‘sketch review’ of specific highlights given below will provide the reader with a feel for the performance of the buildings compared with timber frame in the UK.

Most of the timber frame produced in Germany is for single family homes – detached houses. We did not see any ‘party’ floors or walls.

Most timber frame wall panels manufactured in Germany use similar width studs to the UK – 160 x 140 mm – and the same insulation material. Thus the basic U-values of the timber frame component of the wall will be similar (U = 0.30 – 0.27 W/m²K). Many of the German manufacturers utilise insulated render systems on the outside of the frame and this reduces the U-Value to around 0.2. Where timber or other forms of cladding are used, a ventilated cavity is often provided.

In contrast to the UK, a significant amount of attention is paid to air-tightness, with gaskets and sealants used to create sealed joints. This enhances thermal performance significantly and would represent a significant improvement on current practice in the UK.

The acoustic performance of typical intermediate floors in Germany is likely to far exceed that in the UK. They often contain large volumes of solid timber, and efforts are made to include isolation/separation layers, additional mass in the form of plasterboard, and a floating top surface. In many respects, most of the intermediate floors seen reflect constructions more commonly found as ‘party’ floors in the UK. Within-dwelling acoustic performance was further improved by the use of ‘sealed’ doorsets.

Individual company reviews

The individual company reviews that follow, each take a theme and explore it considering how and why the companies have positioned themselves by occupying niche markets and/or by providing some form of differentiation from their competitors. The differentiation does not necessarily come from the technology of the timber frame.
system used but might instead be related to finance provision, interior design services or other aspects of customer service. Although we have highlighted a theme for each company, it does not follow that the features described are unique to that company.

4.2.2 High quality eco-friendly construction – Baufritz

Introduction

Baufritz are a private company established in 1896, with the fourth generation of the family beginning to enter senior management. They aim to produce approximately 220 units in 2004, which represents growth of approximately 10% on 2003 figures, and to maintain this rate of growth over the next few years.

Their product is a high quality, large-panel timber-frame system aimed at the very top end of the market.

Markets and customers

Baufritz differentiate themselves from their competitors at the top end of the market by focusing on a range of sustainable development issues around which they produce innovative systems and products and protect them with patents. As theirs is a top-end product, the quality of the raw materials and the manufacturing process are taken as givens.

Their design approach is oriented around the system but sufficient flexibility is incorporated to enable customers to employ their own architects and produce ‘bespoke’ designs. However, the architects employed by the customer are recommended by Baufritz and ‘steered’ by them to work within the limits of the system.

Baufritz present themselves to customers as a one-stop shop although, in reality, much of the on-site work is carried out by subcontractors.

Post-construction contact with customers is recognised as an increasingly important means of marketing the company, and Baufritz are more developed in this regard than most as they already employ in-house ‘service teams’ who inspect and maintain customers’ properties on an ongoing contract basis. Most of the buildings are sold to customers within a 100-km radius of Munich or Stuttgart.

Construction technology

The Baufritz timber frame system is typical of other German systems in many ways. It is a large-scale panel, single-skin system with a good degree of prefabrication undertaken in the factory, eg external cladding installed, dry-lining and insulation in place. However, there are also some important differences which characterise the system and are used
extensively in marketing the product to potential customers.

The major differences between the Baufritz system and those of their competitors are:

- The use of wood shavings, treated with soda and whey, as an insulant. The soda and whey are reported to improve reaction to fire performance and provide protection against biodegradation. Baufritz have protected this innovation with patents and supported its acceptance in the marketplace with test evidence and independent certification. As further support for the green credentials of this innovation, the insulation is manufactured for Baufritz using their own off cuts and ‘waste’ wood shavings.

- A bespoke dry-lining, providing the building occupier with protection against radiation from electronic devices, has been developed and protected by Baufritz working in collaboration with their supply partners. The product incorporates fine carbon particles into a conventional gypsum board. The carbon absorbs radiation from a wide variety of sources, eg overhead power lines, mobile telephones and their transmission equipment, and microwave communication equipment.

- The houses are all clad with timber (European whitewood) finished and detailed in a variety of different ways to offer a range of appearances. The cladding, which does not receive any preservative treatment, contributes to the racking resistance of structure through the use of dovetailed joints.

- The major building service connections are integrated in a double storey service panel which means that many of the most complicated building elements are contained with a single zone and can be quickly and easily accessed for maintenance and upgrading.

- The wall construction adopted by Baufritz may be conveniently described as a breathing wall. The construction does not contain a separate vapour control layer but manages the risk of interstitial condensation by ensuring that the warm-side construction is considerably more vapour resistant than the cold-side. Similar timber frame constructions have been available in the UK for many years. The design adopted by Baufritz incorporates a significant amount of insulation into the wall panels, manages solar gain effectively, and through the effective use of gaskets and sealants delivers airtight constructions. High-quality manufacturing and construction processes on site ensure that these aspects of energy efficient construction are achieved in the final building.

Figure 4.6 Model of Baufritz wall construction
The floor and roof constructions adopted by Baufritz are typical of those used by other timber frame manufacturers visited during the mission. Roof structures are standard purlin roofs with tongued and grooved internal linings, with the insulation above protected by a breather membrane. The floors are much more massive constructions than those typical in UK buildings, and even in single dwellings would reach performance levels similar to those for ‘party’ floors in the UK. Typical floor constructions consist of a thick (eg 75 mm) structural deck supported on beams, topped with a gypsum screed or a floating floor on a resilient layer.

The basic frame of a smaller Baufritz house can be erected in one day but the entire construction process normally takes around three months – especially for larger sites – this is consistent with timescales reported by other manufacturers. The manufacturing process takes approximately one week but currently there is a waiting time of around five months from order.

4.2.3 Standardisation and customisation; striking a balance – Kampa ExNorm

Introduction

The Kampa Group consists of five companies – Kampa, Creativ, Libella, ExNorm and Novy – who all produce manufactured homes. They have a combined output of ~100 houses per month, more than half of which come with cellars manufactured by another subsidiary company, Kellerbau. To further the integrated offering, another company – Kampa Baulogistik – builds most of the houses on site, and Hausbaufinanz provides related financial services. The group employs in total ~1,000 people, and in 2003 had a combined turnover of €3.1 million.
Sensibly, the published strategy is to:

- Increase pre-tax profits to more than 6%
- Expand within the EU
- Increase capacity utilisation
- Improve operational efficiency
- Exploit group synergies more effectively

Markets and customers

Across the group, Kampa provide houses to most market sectors. The ExNorm factory produces houses specifically directed at the lower end of the market. They currently produce ~500 units per year from their highly automated factory and aim to increase this to a perceived maximum of ~1,100 units shortly. Interestingly, the original design capacity of the factory they now own was stated at 2,000 units per year. It is important to note that Kampa did not build the factory; they bought it after the business that commissioned it went into receivership.

Kampa believe that overall the German housing market will remain stagnant in the medium term, that any growth will take place at the expense of other forms of construction, and the best opportunities lie at the top and bottom ends of the market.

Construction technology

The overall form of construction adopted by Kampa is similar to that of the other timber frame manufacturers visited, although in some ways it also more closely resembles common practice in the UK. The wall construction is conventional timber frame with both a vapour control layer and a breather membrane. However, there is no drained and vented cavity between the external cladding and the timber frame structure. The intermediate floor construction adopted reflects the more affordable nature of ExNorm houses when compared with products from some of the other manufacturers visited. Nevertheless, the construction would still perform better than typical intermediate floors in the UK.

The Kampa factory is almost unique. Almost every aspect of the design and manufacturing process has been automated, including material preparation, frame assembly, sheathing, service conduit installation and lining. The automation process is not easy. Any timber frame factory produces a large number of house types and an even larger number of panel types. In order to ensure that the factory has a future as an ongoing concern, Kampa ExNorm have decided that they need to produce a limited range of standard house types and offer only limited modifications or ‘tailoring’ to those.

This cleverly achieves two things. One, it helps to ensure that a complicated and expensive factory runs at as close to
optimum as possible. Two, it addresses the more affordable end of the German housing market with a good quality product. People purchasing houses in this sector are more likely to accept the limited tailoring offered. Those purchasing houses at the top end of the market will want bespoke options.

The production of a good quality product is important to Kampa ExNorm. Being a public company has helped them to provide a quality product due to the increased exposure and attention from the public, lenders and insurers. There is no corporate belief in ISO 9000 management standards – they have an in-house standard and work hard at achieving results rather than investing in formal documented systems. They can provide independent checks on quality of construction but charge extra for these and state that there is no need or demand as quality is good. Although this was a standard response during the mission when anyone was asked anything about quality, it began to transpire that they were serious!

A range of tailoring options are possible including basements, conservatories, balconies, roof windows, changes to window sizes, roof overhangs and external claddings. Judicial mixing of these enables customers to create sufficiently flexible houses that they provide a degree of individualism, and the limited number of construction details required means that Kampa ExNorm can optimise their factory production to produce a good quality affordable product.

4.2.4 WeberHaus – flexible, affordable and good quality!

Introduction

The WeberHaus company was founded in 1960; the first customer was the founder’s sister in 1961. They have grown consistently since then and now employ just over 1,000 staff at sites in both the former East and West Germany. The company has a turnover of around €150 million and produces over 800 houses per year. The staff for the factories in the former East Germany received 18 months training in the main Rheinau-Linx factory prior to returning to the facilities in East Germany. The East German factories were built in 1995 and 1997. The unique marketing facility ‘World of Living’ was created in 2000 (see Section 3.4 for more detail).

Markets and customers

The company maintains four brands which target different market sectors. The three housing brands use the same timber frame technology.

WeberHaus

More than half of the homes produced by WeberHaus are bespoke and designed by architects that are recommended to potential customers by the company. Their experience is that customers come with a wide variety of design aspirations. Some have no idea, some want to lead the process, and others have concepts they wish to pursue. Architects employed by the customer only take the building up to planning stages. Post-planning work is done by WeberHaus staff.

Twinhaus

Standard house types with limited tailoring possibilities similar to Kampa ExNorm. In-house technicians provide the customer with advice on the range of tailoring options possible.

Objektbau

Commercial buildings and developer-led contracts, eg for mixed use projects, retail, hotels, offices, apartments. Building regulations limit timber frame to three storeys, so for taller buildings the lower floors are typically constructed from concrete.
Weberith
Basements and special projects. Approximately half of all WeberHaus properties have basements.

WeberHaus are working hard to improve the range of services that they offer to new and existing customers, eg Customer Club, ongoing maintenance, financing and interior design, and see developments in this area intensifying over the next few years.

Construction technology

WeberHaus have recently launched a new product – Option. The Option house provides entry level affordable housing for the German market. The timber frame system used is identical to that used in the other company brands, so basic build quality is good. They have employed an external, high profile architect to work with them to develop a concept which is based around a series of ‘modular’ units that can be assembled in a variety of different ways to create attractive, flexible homes.

The timber frame construction used by WeberHaus is similar to that adopted by Kampa ExNorm.
The Option houses have an undeniably small footprint but it is easy to envisage how, with a bit of careful thought, the range of ‘modules’ available could be extended to enable more accommodation for larger family groups, or even that the building could be re-engineered to provide apartments. This or similar derivative products must be able to provide good quality, affordable and flexible accommodation to meet a variety of end-user needs. The principal drawback of this and similar systems is that it needs informed architectural input if it is to achieve a desirable output.

4.2.5 Carl Platz – top of the range, niche product from a family firm

Introduction

Carl Platz are a medium sized family company trading from Bad Salgau, their base since 1931. They turn over around €60 million, directly employ 300 staff, and are a top-10 house manufacturer (based on turnover). In addition to the manufacturing facility, their impressive operation includes a show village of their standard house types and a sales centre to assist potential clients with visualising and selecting finishes for their home. Carl Platz are one of the few manufacturers that follow the manufacturing process through from sawmill to finished home.

Markets and customers

Company size puts Carl Platz firmly within a group of around a dozen manufacturers in the 200-500 unit range. In such a competitive market, with a cautious consumer, both product and company differentiation was viewed as critical to their future success. This was evidenced within the marketing strategy via a heavy reliance on the historical importance of being a family business and...
aiming to produce a high quality top-of-the-range product.

A typical home is around 140 m² with the addition of a 70 m² basement. 90% of the homes are bespoke in specification and design, with the remaining 10% using a series of templated designs to assist the cost effectiveness of manufacture. The average home is priced at approximately €250,000.

Sales are generated via regional sales centres based around show villages and show homes on their own sites. Partnerships with architects were also a common sales route, with 2% of sales value being architects’ fees. Typically, around 80% of their production is for the home market, with the remainder being exported – primarily to Switzerland and Austria. With the current dip in the home market, Platz are now focusing on export to deliver continuing sustainable growth for their business.

Interestingly, a maintenance package option was available on all new homes.

**Construction technology**

The key design features of the core product concentrated on providing excellence in the internal environment. This was achieved by large glazed wall sections providing tremendous light quality and use of large-section exposed timber which is the more traditional product in the marketplace. Overall, the product provided a contemporary appearance with high-quality finishes. This was achieved in part via a combination of large-scale off-site manufacture (typically 40% of the sales value was direct from the factory) and use of in-house follow-on trades (rather than subcontractors), although as sales are achieved further from the factory location, this becomes less viable and more subcontracting occurs.

‘Customers don’t want to see services or hear services.’ This market focus had led to the development of serviced panels from the factory as a standard across the product range. The cisterns and associated first-fix pipework are all constructed in the factory.

When the panels are installed on site, the second-fix sanitary fittings are hung directly from the wall panel, with no visible pipework on show. When asked about leaks within the

![Figure 4.16 Carl Platz demonstration homes](image)

![Figure 4.17 Interior of a Carl Platz house](image)

![Figure 4.18 Insulated sanitary ware being fitted](image)
wall panels the response was an incredulous but interesting – ‘Why would we put something in the wall that would leak?’

The panels are fitted with windows, and special feature windows are also assembled on the lines.

They then proceed to have rendered or timber external rainscreen claddings applied; the final paint finishes are spray applied in booths at the end of each line. Heavy finishes such as masonry are site-applied as in the UK.

Despite the general media presentation of homes that are erected in a day, the reality is that the homes are often watertight in a day but still require all the internal finishing. This can take 8-13 weeks to complete – again, similar to the UK.

4.2.6 ELK Haus – is the technology really transferable?

Introduction

Elk Haus were historically a family company originally based in Austria that commenced trading in 1959. Since then, the company has grown by acquisition and merger and now has six plants producing a total of 2,472 units in 2003. Of these, only 100 are apartments, a new market for the group. The plants are located in Austria (two plants producing 1,500 units), Czech Republic (300 units), Germany (400 units), Poland (50 units) and Ireland (250 units). In Austria they have 25% share of the prefabrication market, and in Germany 11%.

As stated earlier, the company has grown by acquisition and is familiar with entering new overseas markets. It entered the German market in 1987, the Czech market in 1997 and, most recently, the Irish market in 2003. The group of companies has a turnover of around €350 million making them possibly the largest in Europe. They have strategic plans to expand into other markets in the near future. Usually this expansion is in partnership with a local provider. The company is still 100% owned by the Weichselbaum family, and typically aims to achieve a 4% pre-tax profit on its trading activities.
Markets and customers

Elk operate across all the market types, including luxury housing, schools and other commercial buildings and apartments – a new market for them. Their market entry approach is simple – to partner with a local provider to ensure a secure supply chain for the production facility. This is an approach that has worked well for the group and is the model being followed for the Irish production plant.

The key differences between Elk and a typical UK provider are:

- Effectively act as a design-and-build contractor for the superstructure (rather than just supplying the timber frame)
- Capability to produce a closed-panel timber frame system
- Products developed in partnership with key customers
- Continual programme of innovation

Construction technology

A typical facility would be 8-9,000 m² which can produce 250 units single shift (maximum 450). The facilities have the capability to produce two types of product, ie:

- Basic timber frame (open panel)
- Single wall (closed panel)
The basic timber frame is as the UK product. The closed-panel frame is manufactured from a 150-mm stud frame sheathed with OSB-3 material on the exterior face. Insulation, vapour barrier, gypsum board linings and external joinery are all added in the factory environment. External rainscreen render cladding can also be added if required.

For the Irish market, their largest learning curve has been accommodating the current health and safety requirements that are not designed for (and in many cases, are incompatible with) closed-panel construction. Scaffolding, in particular, is not compatible with lifting closed panels, and many consider it actually more dangerous to have the scaffolding in place during lifting.

4.2.7 Transferable lessons

A number of transferable lessons can be drawn from the timber frame manufacturers visited. The most important of these are mentioned below. Interestingly, many of them have a foundation in some aspect of marketing rather than the nature of the technology used.

- Having identified and occupied a niche you will need to continue to innovate to maintain differentiation from your competitors
- Strategic partnership with customers helps ensure sufficient ‘pull’ for new factories
- The timber frame manufacturer gets a significant proportion of the value from properties even if much of the work is done on site
- Highly mechanised plants can reduce production and lead times
- Tailoring provides a means of achieving balance between standardisation and customisation
- Affordable housing can be modular, flexible and of a good quality – but it’s not easy
- Sustainability can be made to pay
- Maintenance packages for new homes help to improve customer loyalty
- Closed-panel technology gives structures that are rapidly watertight and facilitate follow-on work
• Lightweight cladding systems, e.g., timber and render, can successfully be factory applied and should be explored in more detail in the UK.
• Prefabricated service walls improve quality by reducing the amount of follow-on trades active on site.
• The implications of closed-panel technology on current timber frame erection practices should be explored.

4.3 Massivbauweise and OSM

4.3.1 Introduction

The large majority of ‘Massivhaus’ homes are built using brick and block components, assembled in a traditional manner. However, to meet the challenge of the ‘Fertighaus’ producers, suppliers have needed to develop products that reduce the amount of labour required on site, and to increase the speed of assembly.

The various approaches range from large block systems through to volumetric units constructed of concrete. The mission visited a number of manufacturers, and saw housing produced by a wide variety of construction techniques, from fairly simple structural units to highly finished modules.

As noted earlier in relation to OSM housing generally, the manufacturers of concrete and masonry housing were strongly focused on the quality of the final product and the way that their production processes enabled them to meet customer requirements. The extent to which individual preferences could be met was a matter of positioning in the market; the lower-priced housing was more standardised. But even at the most ‘affordable’ end of the spectrum, the suppliers were promoting a lifestyle, not simply selling rapidly erected housing which could be completed by the purchaser.

Companies manufacturing concrete or brick-based homes recognised that they were in increasing competition with suppliers of OSM timber housing, and therefore needed to match them on price, specification (e.g., insulation levels and environmental features) and construction quality. These companies considered that ‘prefabricated’ or, as they preferred, ‘factory made’ houses still had a negative market image (in contrast to the survey results summarised earlier), and that they needed to make extra efforts to overcome this by ensuring quality and value.

All were responsive to customer demand and offered customers a range of options. For one manufacturer, this included options on the extent to which the house was finished; the basic shell could be supplied, leaving the customer to arrange or carry out installation of all finishes and services. This had proved a popular option in the new Länder as it permitted early occupation at low cost, with other costs being incurred at the owner’s discretion and over a timescale of their choosing. Standard designs offered a range of options such as ‘winter gardens’ or conservatories, balconies, etc. It was clear, though, that if the customer wanted a design that was outside the standard design envelope, there would be a significant cost premium, although variations could generally be accommodated.

The producers of concrete housing we observed had invested heavily in their manufacturing facilities. Factories were generally modern, and substantial investment had been made in production machinery and automated equipment. Standards of lighting and environmental conditions were good, and offered the possibility of all-year-round working, a significant advantage in Germany where winter conditions can be more severe than in the UK. They considered that factory production enabled them to supply better products to a more consistent finish; supply to site was more reliable and erection on site...
was far quicker than with traditional building techniques.

The cost of transporting heavy concrete units, however, was an important factor in business development. Some producers had addressed this by focusing largely on their local (within 150 km) market whilst others (eg Glatthaar Fertigkeller) had developed a network of manufacturing facilities in order to reduce transport distances to 100 km or less (see further discussion of transport issues in Section 5.1).

Investment in research and product development was also evident. Most companies had taken out patents on their key products and processes.

In general, companies had few problems attracting and retaining a skilled workforce. Unemployment in Germany is significantly higher than in the UK, and labour mobility is lower. Many companies still make a substantial investment in apprentice training, and expect their apprentices to remain with the company for many years on completion of their training.

4.3.2 Prefabricated basements – Glatthaar Fertigkeller

Glatthaar Fertigkeller is the largest manufacturer in Germany of prefabricated basements, with an annual production of 7-10,000 basements from 12 locations in Germany – 2,000 from three highly automated plants owned by the company and an additional 5-8,000 from nine franchised operations. The company is privately owned and has been trading for 25 years. Whilst it specialises in the supply of prefabricated basements, it can also undertake planning, structural engineering, and ground-works. Glatthaar Fertigkeller supplies cellars for some 40 OSM housing producers, these cellars incorporating stairs, ceiling, light-shafts, chimneys and service shafts as required.

The company’s success has been founded on a patented design for a 100% waterproof cellar, together with continual attention to product quality. To remain competitive, it invests about 2% of turnover in R&D, with its product development activities now resulting in four patents and several registered designs. Development of the foaming process for its ‘Thermo-safe’ product (see below) cost in excess of €2 million. Other innovations and proprietary techniques include a land drain used adjacent to the basements, the concrete mix used in factory production, the site assembly process, and a specially designed temporary support beam.

As a demonstration of its basement technologies, Glatthaar has built a 300-tonne floating show-house, used as a marketing suite, at its factory headquarters site in Schramberg-Waldmössingen. The floor slab of the basement floats 40 cm above the bottom of a pond; windows in the basement show the water level. By moving a water tank mounted on rails in the basement, the whole structure is made to tilt, the change in water level demonstrating that it is indeed floating.

Figure 4.27 Floating demonstration facility
Glatthaar’s systems are priced at a premium, just above traditionally constructed basements. Typical prices are in the region of €250/m² with an additional €2,000 for excavation. Its main product is ‘Aqua-safe’, a prefabricated, panelised cellar that can be constructed in one day following excavation. A more complex product is ‘Thermo-safe’; in this, a patented foaming process is used to produce highly insulated panels for cellars which include living space. It has other product lines including a 3D modular basement and an associated ‘mini-basement’, a single module with dimensions of 5 x 3 m.

The factory process is highly automated, with computer-controlled equipment taking the required panel dimensions from files supplied by the housing suppliers. These also provide information on the position and size of openings. We were informed that the investment in the factory, which produced three complete cellars daily with only eight workers, was around €8.5 million.

In the production process, 50 mm thick reinforced concrete panels are created on steel former beds with exposed reinforcing wire. Metal edge plates, automatically positioned by computer controlled machinery and held in place magnetically, determine the size and shape of the panel and any openings. Reinforcing meshes are similarly cut and positioned automatically. Once the base unit with exposed reinforcing has been completed and cured, it is picked up by large suction pads and turned through 180 degrees and the exposed reinforcement inserted into a newly poured second bed of concrete 50 mm thick. The automated rotation ensures the correct spacing between the slabs. Concrete pouring is controlled manually using an overhead hopper system. The completed two-leaf composite panel is then transferred into a drying chamber for eight hours. The flexible production process enables special fittings such as windows, doors and electrical conduits to be pre-installed to the customer’s requirements.

On site, water protection is assured both by the pouring of concrete between the leaves of the prefabricated panel and by the use of a patented hinged plastic sealing strip fixed to the panels by a specially formulated silicone adhesive derived from the aerospace industry. Glatthaar claim (and demonstrate)
that either means of waterproofing is 100% effective, but both are used for added assurance. They have experience in building in earthquake zones, areas prone to subsidence, on slopes and in areas with high water table.

A team of four with a mobile crane complete a cellar in an 11-hour day commencing at 7am with laying the polythene sheeting and fixing reinforcement for the base, continuing with erection of the panels and permanent formwork for the ceiling and sealing all the joints, and finishing with pouring the concrete for the base, the panels and the ceiling. This produces a complete foundation on which the house supplier may erect the house.

Almost 70% of panels leaving the factory are now insulated. A layer of polyurethane foam to a patented specification is produced on the concrete panel in an automated foaming unit, which was said to be one of only three built in the world. The process is largely enclosed and requires good ventilation. As well as wall panels for cellars intended to provide living space, the foam is added to ceiling panels which form the ground floor of the completed house in order to provide enhanced thermal and noise insulation. A top layer of concrete for the floor is added on site. This process is in principle capable of producing wall panels for above-ground use, but Glatthaar have specifically chosen not to diversify into production of housing panels, as this would bring them into direct competition with their customers.

4.3.3 Large block systems – Hebel Haus

Hebel Haus is principally a manufacturer and supplier of porous concrete (aircrete) blocks and products and the market leader in Germany in porous concrete building materials and components. They have developed a reputation as a leader in innovation in this material, having developed and extended their product range from standard block sizes to reinforced aerated concrete floor and roof panels, and now to the supply of complete houses. The Hebel Haus factory employs 113 workers on three shifts and has 20 office/management staff. Output is currently 215,000 m³ per year on two shifts, with a maximum capacity of 300,000 m³.

The production facility for blocks is modern and highly automated. Aggregate is sourced from the company’s own sand quarry; it has been ground on site to the specific requirements of their manufacturing processes since 1926. All of the aerated concrete products are manufactured on a production line by casting into pre-prepared moulds, curing in a heated environment, and then cutting to size before finally being autoclaved at 16 bar for eight hours. Larger panels are reinforced with steel cages manufactured on site from coiled wire and
coated with water-based paint prior to casting. Very little manual labour is used in this process, and research is underway to see if some of the remaining manual activities (such as loading reinforcement cages into moulds) could be automated. Products are tracked automatically using barcodes as they go through the production process and into inventory.

Through market research, Hebel Haus identified a desire for a complete building product from people building their own homes. This matched their wish to diversify into higher value products, and the company have over the last 30 years developed a complete building system. This uses large aerated concrete blocks and reinforced aerated concrete panels of up to 6.5 x 1.5 x 0.75 m to construct the basic building structure. They now market a complete house product constructed using this system. Prices depend on the size, the specification of finishes and fittings and the degree of finishing, but a finished house (excluding land) with standard fittings may be purchased for around €1,230/m²: for a house of 130 m², a complete cost of €160,000.

The Hebel Haus system, utilising porous concrete panels/block offers considerable flexibility to the purchaser, with almost unlimited variations being possible, but at the expense of requiring more on-site labour than some other systems. Only the panels are

Figure 4.33  Reinforcement cages being lifted into position

Figure 4.34  Aerated concrete curing

Figure 4.35  Bar coded panels
prefabricated in the factory. The basic structure of the house can be assembled in one day on site, using thin jointing techniques for the walling, and reinforced panels for both the floors and roof, but there is no scope in the process for incorporation in the factory of additional items such as services.

Of particular interest in the products produced by Hebel Haus is their range of energy performance levels offered through the specification of different thicknesses of structure. Hebel Haus were the first Massivhaus manufacturer to achieve the demanding ‘Passiv Haus’ requirements.

4.3.4 Storey height panel systems – Johanni Ziegelhaus

Johanni Ziegelhaus entered the OSM housing market on the back of their existing business of precast concrete fabrication. They have licensed a production system from its inventors, Winklmann, for a panel system that uses specially designed clay bricks set in a reinforced concrete panel. These panels can then be used to form the external envelope and internal walls of a home, with precast concrete panels used for the floor structures.
Perforated clay bricks are placed in a grid pattern onto a steel form. The shape of the bricks allows for reinforcement and conduit to be inserted where appropriate between bricks. Precast lintels are placed over any openings and concrete is cast over these components to form a solid panel. Once the concrete has cured, any formwork can be stripped, and the panels lifted and moved to vertical storage racks where external insulation is applied.

Additionally, the Winklmann facility internally finishes the panels and fits doors and windows in the factory.

The system used by Johanni Ziegelhaus and Winklmann can be applied to panels up to 3.6 m high and 12 m long. It is specifically aimed at consumers that want a masonry-constructed home but assembled in a similar timescale to those constructed from timber.

4.3.5 Volumetric units – Veit Dennert

Founded in 1933, Veit Dennert is a third generation, family run, private company. Initially, Dennert was a supplier and manufacturer of concrete-based building components and products. From the 1990s onwards it has developed into a supplier not only of components but also of complete concrete-based building systems and now has a turnover of around €100 million, with some 850 employees in 10 precast plants in northern Bavaria and Thuringia in the centre of Germany. Its range of components is very wide, and includes floors and ceilings, walls, basement walls, blocks, stairs, lintels, garage elements, etc. Dennert is focused solely on Germany but has licensed its products to companies around the world.

In response to a market for complete systems from those building their own houses, over the last 15 years the company has developed three main product lines:

- ‘Big block’ – a type of panelised system using large blocks of up to one-third storey height which also makes use of other components in the product range to create the basic structure of the building
- ‘ICON-haus’ – a volumetric system fully fitted out in the factory and assembled on site with a minimum of labour
- ‘ALFA-haus’ – a panelised version of ICON giving greater flexibility at the expense of manufacturing efficiency
Like other manufacturers, Dennert are very focused on product quality and on keeping competitive through innovation. They have undertaken R&D into lightweight concrete, including the use of expanded clay and glass granules, and have patented and licensed production processes. These developments have been used in their block and wall system products (‘Big Block’ and ‘PORAVERT’) to give increased thermal efficiency, and have been important factors in the development of the ICON and ALFA housing systems.

We particularly noted the ICON system for its distinctive approach to OSM housing. About 300 ICON units are produced each year, the selling price being around €840/m² (excluding land).

The ICON-haus is a volumetric system, utilising concrete modules with a high level of internal completion in the factory. Flexibility in size and layout is limited; only seven variants of two basic house sizes (110 and 140 m²) are offered, using limited differences in module size and internal layout. Much greater flexibility in finishes is available, however, with three basic specification levels and a menu of choices both within each level and for extras – emulating the automobile industry.

The ICON factory comprises a panel production circuit, an assembly and fit-out line, and outside space for storage and dispatch of units. The panel production technology was fairly advanced, although not as automated as the Glatthaar process for production of basement panels (for example, automatic positioning of magnetic formwork was not used). The panels were cured for eight hours at 450°C.

The panels passed from the curing area to the beginning of the module production line, where they were framed and assembled into modules. There was no automatic framing equipment evident; workers assembled the panels using the overhead crane. The joints were bolted, with a mortar bed. The modules were 8.2 x 3 m in plan, and weighed up to 24 tons each.

The modules then moved down a production line comprising 11 stations, at each of which they were progressively fitted-out. The production line did not move continuously; instead, the modules were moved incrementally by a jacking bogey running along a trench underneath the line. By the end of the line, the modules were fully fitted out, including kitchens, bathrooms, plumbing/heating etc. Also, 200-mm
polystyrene insulation was directly bonded to the units, and one coat of render applied before leaving the factory.

The factory had an area of ~10,000 m², with a total of 50 workers and 30 administrative/management staff. Production takes place over two shifts, with the ‘third shift’ being set aside for essential maintenance. An ICON house can be produced in a total of five days: one in the factory, and four on site (one for assembly, and three for completion).

‘ALFA-haus’, a panelised version of ICON, is produced on an adjacent production facility, and offers greater flexibility in design but with less potential for fitting out in the factory. ALFA units are typically supplied with service conduits, internal (bare concrete) finish, and a first coat of external render.
5 POST-PRODUCTION ASPECTS

5.1 Transport of components

Once the factory process is complete, three considerations impact on haulage:

- Weight of units (e.g., timber/lightweight steel v concrete)
- Panelised v modular systems
- Logistics

Weight

At one end of the spectrum are concrete modules which, if fitted out at the factory, can weigh between 18 and 24 tonnes each. The ground floor of a typical house might consist of three modules. Less onerous are concrete single-storey and whole-façade panels such as those from Johanni Ziegelhaus weighing between 6 and 7 tonnes.

Continuing down through the spectrum are whole-wall timber panels requiring far lighter craneage (but if factory-fitted with doors and windows, the panels will require to be transported vertically which reduces the load per lorry).

At the bottom end of the weight spectrum are companies such as Purholz who produce timber panels specifically designed for manual handling at less than 100 kg per panel, with doors and windows fitted on site (this allows the panels to be transported horizontally, maximising the load per lorry).

Panelised v modular systems

A typical modular dwelling takes about six lorry loads compared with a panelised dwelling of equivalent area which averages only two loads. Continental European restrictions on loadings are generally less onerous than in the UK, allowing modular dwellings to be transported in fewer, but larger, lorry loads.

Module sizes varied widely. At one end of the spectrum was Veit Dennert, producing only two plan forms primarily for sale within central Europe only, with consequently very specific haulage requirements. At the other extreme was Cadolto, who work with a wide variety of building forms, from hospitals to housing to laboratories, and supply across

Figure 5.1 Purholz wall panels

Figure 5.2 Vertically stacked wall panels
the whole of Europe. Interestingly, this diversity has generated an approach to manufacture and to design that is determined, not by manufacturing issues such as jig sizes or formwork but, at least initially, by the route between factory and site, maximising the module sizes within the constraints of transport logistics.

**Logistics**

Distance from production unit to site is generally not a particularly significant factor (particularly if external haulage companies are used and lorries are able to return with other loads). One company quoted the total cost of haulage from their plant to Munich (a distance of approximately 100 km) as being €1,500-1,800 compared with an identical load to Berlin (approximately 670 km) at €2,000. More significant is the number of loads required and the handling plant needed at both ends. However, a sea crossing can add at least another €800 per lorry load. This led Elk to open a factory in Ireland since it was more economic to transport the raw materials that were sourced from central Europe to the Irish plant than to fabricate in Germany or Austria and then distribute to Ireland.

The only company visited that had a specific policy of creating production units no more than (in their case) 100 km from likely markets was Glatthaar Fertigkeller. For them, however, transport costs were a higher proportion of the selling price of their product than would be the case for the supplier of a complete housing system, and they had needed to increase the number of production plants to meet demand.

**Damage in transit and on site**

All the companies visited used dense gypsum board as an internal, factory-fitted lining, and none reported any particular problems with damage in transit, or through site assembly. Since nearly all manufacturers (panelised or modular) went from serviced slab to watertight shell within one day on site, water damage on site was not a serious problem.

Some companies chose to shrink-wrap individual wall panels or floor/roof cassettes while others only protected exposed, leading edges with temporarily-stapled polythene. These precautions sufficed for erection in ‘normal’ wet conditions. Only in the most extreme weather might erection have to be delayed to avoid water damage.

**5.2 Assembly processes**

The firms visited exhibited large variation in the extent to which final assembly was carried out on site. At one end of the spectrum was Veit Dennert whose factory-finished modules minimised on-site working (see ‘Timescales for erection/fit-out’, following) but offered a limited range of client choices: two dwelling plans available to three levels of finish.
At the other end of the spectrum were companies like Purholz who produced for the self-build market, with systems based on small panels capable of being manually handled and not incorporating services, doors or windows. This approach has the advantages of lower initial cost, maximising haulage loads, and greater flexibility, but relies on relatively high levels of on-site labour with attendant issues of workmanship, vulnerability to the weather, etc.

Within the spectrum were some companies whose processes were relatively inflexible and labour-intensive in the factory, but whose systems still required a high degree of site-finishing. Masonry and concrete panel systems aimed to compete with traditionally built homes based on these materials, but it was not clear whether in practice they offered sufficient advantage to outweigh the lack of flexibility for the purchaser.

Again as a generalisation, there was a trade-off between the flexibility offered to customers and the proportion of work carried out in the factory. Bespoke products were fitted out on site, and some manufacturers left the associated decisions to that stage, realising from experience that customers might wish to change their initial choices. Cost uplifts of 10-15% were quoted for diverging from standard details, eg non-standard storey heights or junction detailing, taking account of both decreased factory efficiency and increased on-site labour. Some companies built ‘non-standard’ components such as bay windows, balconies or dormer windows in the factory as complete 3D modules, ready to offer up to the completed envelope on site in order to minimise on-site working.

Interestingly, more than one company that (in order to facilitate greater client choice) had consciously shifted the balance from off-site to on-site working, was now trying to find ways of pulling that back into the factory whilst not compromising customer choice, in order to increase the cost efficiency of the overall process.

The following sections illustrate some of the ways different companies had approached this balance of off-site to on-site working.

Achieving construction quality

The key factor in achieving the quality desired in the erection of components was preparation. There was close liaison between factory-based staff and site workers; products were manufactured to close dimensional tolerances, and there were ‘fail-safe’ devices to ensure the correct interlocking of all structural elements within those tolerances. Within the range of systems experienced, modular approaches offered the least potential for site error, and whole-wall panels were preferable to small panels in this regard.

Air permeability between site-assembled elements received close attention. The highest performing systems had factory-fitted gaskets at wall/floor, floor/roof etc junctions rather than relying on site-applied sealing devices.

Managers of timber-based systems generally provided insulated, felted and battened roof panels requiring only on-site tiling, where interlocking tiles were specified. We noted also that, while most concrete-based manufacturers also offered
concrete roof panels, 85-90% of customers, given the choice, opted for timber roof structures for cost reasons.

**External cladding and internal finishes**

Companies offering external cladding systems in timber had the advantage that these could be totally factory-finished and decorated leaving only panel/module erection and internal finishing/decoration to on-site labour. By contrast, most companies offering externally rendered walls only applied the first coat of render to each panel in the factory, leaving taping of joints and the second coat render to site workers. Some companies such as Huf and Davinci avoided the attendant problems by using rendered elements only within post and beam panels so that they could be totally factory-finished. All site-formed junctions were then effected frame to frame.

The render coats seen ranged from a variety of traditional, trowel-applied systems through to thin, two-coat flexible polymer systems applied onto insulated substrates which varied from dense mineral fibre boards to expanded polystyrene batts.

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**Activity** | **Week**
---|---
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Erect structure | | | | | | | | | |
| First-fit plumbing | | | | | | | | | |
| First-fit electrical | | | | | | | | | |
| Floor screed and cure | | | | | | | | | |
| Decoration | | | | | | | | | |
| Tiling | | | | | | | | | |
| Second-fit services | | | | | | | | | |
| Final finishing | | | | | | | | | |

*Figure 5.6 Timescales for erection/fit-out of a 230-m² property*
For internal finishes, the best-thought through processes achieved almost complete factory-fitting of plasterboard with only minimal piecing between panels on site. Generally, this left only taping and jointing of major junctions on site, together with internal decoration of panel-based systems.

**Servicing**

A wide variety of approaches was observed. For electrical service, suppliers generally provided factory-fitted conduits, leaving wiring entirely to site. Some companies provided draw wires in lieu of conduits to avoid issues of air permeability through service routes. Two companies had achieved full factory-wiring based on junction boxes, necessitating only on-site connections between the building elements. Some companies commented that it caused problems when electrical outlets were factory fitted, since when ‘non-professional’ one-off clients saw the product ‘in the flesh’, they wanted them moved.

It was noted that the common German practice of distributing electrical service in floor ducts and positioning outlets at skirting level on site is not transferable to the UK owing to the regulatory requirements for higher outlet positions on accessibility grounds.

Only suppliers of modular based systems fully fitted plumbing in the factory. The most integrated plumbing installations from panel-based manufacturers consisted of storey height boiler/control system/vertical waste and plumbing modules constructed in lightweight steel which were offered up to the completed shell apertures on site, requiring only pipe couplings and horizontal pipe distribution to be carried out.

**Timescales for erection/fit-out**

Again, a wide variety of practices was observed depending on the degree of factory finish and customer choice. Overall time to completion varied widely.

Almost all manufacturers (timber, steel or concrete; panelised or modular) designed their product around a one-day erection period from serviced slab to watertight shell. Thereafter, fit-out and finishing to the point of hand-over took anything from three days (for...
factory-finished modules) to five months (for block-panelised systems requiring full in-situ servicing and fit-out). Typical times for fit-out of panelised timber systems were four to eight weeks allowing for service installations, kitchen and sanitary appliance fittings, second fix, making good and decorating.

Figure 5.6 shows an example programme of fit-out works based on a 230-m² property. The client would typically be quoted 12 weeks duration to give some flexibility in return dates for labour.

**Labour, skills and subcontracting**

In every company visited, the assembly of components to form the structure of the house was carried out by labour directly employed and trained by the manufacturer. Generally, this consisted of roving ‘assembly teams’, but in the case of WeberHaus the factory-based staff were rotated through the on-site teams in order to provide feedback into the factory production processes.

None of the housing manufacturers directly contracted to provide foundations or cellars. Instead, they tended to have strong links with a number of groundworks companies who were aware of the specific requirements of their system. These contractors, particularly firms like Glatthaar installing prefabricated components, employed their own labour.

On-site fit-out was handled in a variety of ways. Companies that serviced and fitted out to a high degree in the factory, or which operated at a larger scale, generally used their own labour for the limited works required for completion on site. Smaller companies, and companies with more ‘open’ systems, used partnered, subcontract labour on site to balance the requirements of labour availability across wide geographical areas, with the need for consistent quality control and product familiarity.

All companies used dedicated trades (whether own labour or subcontract) rather than multi-skilled operatives even where there was only a limited requirement for a particular trade. And it was interesting to observe that these separate trades often worked sequentially, with only a single trade being present in the home at any one time. A few companies offered the option of fit-out by clients.

As noted above, WeberHaus sought to integrate off-site and on-site joinery skills. This integration was enhanced by their policy of retaining older, skilled labour in the factory when health or age precluded their working on site. They thus transferred their knowledge within the company as ‘master joiners’ heading the apprentice teams (there were 30 apprentices on the company’s books) and using the ‘non-standard’ prefabricated modules referred to earlier to provide a thorough grounding in trade skills for all future factory/site crews. Not only did this approach transfer valuable skills within the company, it resulted in a very high degree of labour retention in an area of high employment with a keenly competitive labour market.

**Quality assurance and health and safety issues**

Interestingly, in a culture renowned for its quality control, none of the companies had opted to adopt formal QA systems. Rather, they relied on training and integrated teamworking to minimise errors. The generally high degree of factory finishing was relied on to minimise the opportunities for site errors. Some manufacturers offered independent DFV (Deutsche Fertigbau Verband) site-certification where specifically required. This is based on unprogrammed inspections of site activities by DFV staff.
Likewise, there was a perception that the high factory-based component in the housing systems minimised health and safety risks on site, although, as noted earlier, no data were available to support this. However, one company said that its insurance premium for accidents at work had recently reduced by 15% since it had switched to a higher level of off-site manufacture (closed, timber wall, floor and roof panels with factory-built ‘plumbing modules’).

While health and safety provisions were in general good throughout production and assembly processes, there were evident differences from UK practice, with examples of unguarded machines and poor fume extraction. From informal comments, and the experience of individuals that had worked in both Germany and the UK or Ireland, it would appear that there was a lower level of enforcement of health and safety regulations in Germany. But it also seemed that, in contrast to the UK, accident rates were not at a level which stimulated concern and public debate.
6 COMMENTARY AND CONCLUSIONS

6.1 Introduction

While some features of the OSM housing that we saw in Germany are a reflection of local traditions and preferences, many of the technologies and business processes demonstrated deserve further consideration for potential application in the UK. And the experience of Germany in developing a significant OSM sector is particularly relevant now, when the UK is experiencing rising demand for new homes coupled with a shortage of traditional construction skills.

We record our conclusions under the following headings:

- Market aspects
- Business philosophies and processes
- Technologies and production processes
- Follow-up actions

6.2 Market aspects

Market share

The share of the overall housing market taken by OSM housing in Germany is similar to that in the UK but the use of OSM in the principal structural system is limited in Germany to detached and semi-detached homes whereas in the UK usage is spread across all forms of housing. However, at a time where housing production in Germany is in decline, the production of OSM homes is increasing and its market share is growing. This reflects the public perception of OSM as a high quality form of production with fast site assembly times and greater certainty of cost and quality as compared with traditional forms of house construction.

Quality standards

This position has been reached after a long process of product development, extending back more than 80 years. As in the UK, however, the industry has had to work hard to overcome perceptions that OSM homes are cheap and of poor quality. This image was created by insufficient attention to quality amongst some suppliers and led to the creation of quality standards and associated certification schemes. There are lessons here for the UK supply industry. The German experience is that with a focused and sustained effort to improve quality, and consistent marketing, it is possible to change the image of OSM homes and to put the sector on a rising curve in a domestic market that is famed for its demand for high final quality in manufactured goods.

It was clear that concern for quality ran through the whole production process, from the selection of materials to final workmanship on site. Firms knew that their reputations depended on maintaining their high standards. At the same time, they were very aware that they were competing in a highly demanding marketplace, and needed continuously to research and develop new designs and technical solutions that would distinguish their products from those of other suppliers and give them competitive advantage. As in other sectors, informed and demanding clients have driven up specifications and quality and stimulated a continual search for higher value for money.
Product development

This focus on the performance, quality and value of the final product has led to the OSM sector being a market leader in the introduction of new technologies – for example for energy and water conservation. Similarly, the structural systems employed in some OSM housing have enabled firms to offer great flexibility in internal layout and to provide large areas of glazing. OSM firms have invested in R&D, both to improve products and to create more efficient production processes, and some hold multiple patents. In Germany, OSM has been a pace-setter in design and specification for the whole housing sector; suppliers of traditionally built homes have had to introduce similar features in order to remain competitive. OSM could have the same effect in the UK.

However, the focus on the final product also is a reflection of the fundamental difference between the OSM market in Germany and the developer-led market for new housing in the UK. OSM housing firms in Germany compete in a market for houses, divorced from the market for land. Prospective purchasers examine alternative housing ‘products’ in order to find the one that best matches their needs and budget, just as they would when purchasing a car.

Because the firms are selling only the house, and not (in contrast to the norm in the UK) offering a package which is a combination of the house, the land and the location, their competitive position is based entirely on the house and associated customer-related services (delivery processes, maintenance etc). They thus have a clear business incentive to invest in technologies and processes that will give their house an edge over its competitors. In the UK, the same market drivers are of course present, but are diluted by the other aspects of the house-land-location package. As a consequence, there is not the same history of product development by housing developers; however, with greater use of OSM, this may change.

‘Dream homes’

Although OSM firms strongly promote distinctive features of their houses, it is clear from the product literature and advertising that overall each firm is marketing a ‘lifestyle’ choice, and this was reinforced by design features such as the light and open living areas noted earlier.

The concept of the ‘dream home’ in which to bring up one’s family, and which represents the summit of aspirations, is a powerful one. This again reflects a marked difference between the German housing market and that in the UK, in that it has been traditional in Germany for house purchase to be deferred until the family is settled in a location, when a plot of land is selected and the ‘dream’ house purchased.

The tendency for purchasers to regard the house as their ‘permanent’ residence and therefore to live in it for many years prevented our investigating some aspects of the housing market that would be more significant in the UK. Firms supplying OSM housing had no perception of whether manufactured houses commanded a premium over traditional housing in the second-hand market, or were regarded as a
less desirable purchase, and owing to shortage of time, the views of lenders or of building professionals on this subject could not be explored.

While some ‘dream’ houses were aimed at the more affluent sectors of the population, other suppliers aimed at a different income level, including purchasers who were prepared to install finishes and services themselves. The image in the UK of German manufactured homes has been shaped in particular by the promotion of houses aimed at the top end of the market. Certainly, this is a key market sector for some OSM companies but the OSM sector serves a wide range of market needs, including (in one example explained to us) the supply of housing to the developer of a mixed retail/residential development. We also saw examples of OSM ‘starter’ homes.

However, whatever the target income bracket, the houses were marked by the same focus on quality: in construction, in fittings and in customer service.

Pricing

The range of prices quoted for OSM housing reflected the different markets. At the bottom end, it appeared possible to purchase a fully fitted concrete modular house for around €80,000, or around €900/m². At the top end, there was no limit but ‘luxury’ houses were priced in the region of €350,000, or around €1,200/m².

While these appear in the UK context to be very competitive prices, they exclude the cost of purchasing and servicing the land, which will vary widely according to location. However, the general impression given was that OSM housing was marginally more expensive to purchase than traditionally built housing, the extra cost being justified by the higher quality and more assured delivery that could be provided through the OSM route.

House types

Because OSM firms aim to satisfy the specific requirements of the purchaser, the predominant house form supplied is the detached house. Generally, this is of ‘chalet’ appearance and the OSM production systems that companies have evolved are at times tailored to this style.

However, other designs are readily available and we noted particularly the way in which suppliers had recognised a developing market sector and had developed a new type of ‘two-family’ house, suitable for two generations living in the same property. With many commentators predicting a rise in the average age for first house purchase in the UK, this is perhaps a housing concept that will be emulated here, whether through OSM or traditional construction.

Matching the variety of house types possible, OSM housing in Germany – even from a single supplier – demonstrates none of the poor appearance or uniformity feared by some when the subject is raised. The houses are indistinguishable externally from conventionally constructed houses, and most manufacturers offer considerable choice in dimensions, finishes, external features such as balconies, the size and position of windows etc. Some indeed make a feature of being able to accommodate any plan desired by the customer.

Flexibility is correlated with price; the lowest price houses come as ‘standard’ packages but even then there is external variety through choice of windows, doors and finishes.

Market summary

Overall, therefore, manufactured housing in Germany is a significant and growing sector within the housing market. While at present it is particularly established at the upper end of the market for new housing, we saw
sufficient examples to demonstrate that it can address a wide range of market needs, but always with high quality of construction, matching high customer expectations. OSM housing in Germany demonstrates all the attributes of a highly competitive product sector, with suppliers investing in the technologies and processes that will create market advantage, and developing new housing forms in order to keep pace with customer needs.

6.3 Business philosophies and processes

Two aspects of the OSM housing industry seemed to us of particular note:

- the role played by long-established family-owned firms
- investment in marketing

*Private, family-owned firms*

With two exceptions, the firms visited were privately owned, some being in the fourth of fifth generation of family ownership. A typical pattern in OSM timber housing was that the firm had been originally founded as a carpentry business or sawmill, and had steadily diversified and expanded, to become a significant employer in the (generally rural) locality.

As a consequence, tradition, reputation and the desire to be a good contributor to the local economy were important factors underpinning the business philosophies and practices of the firm, but this did not prevent their seeking out new technologies and products, in order to ensure that the firm remained fully competitive. The present generation of owners were determined that they would pass the firm on to the next in good health, and private ownership appeared to give them considerable freedom to invest heavily in research, technologies and marketing; without calling on investors or bank loans.

This longer term view, coupled with a determination to ensure that the firm retained its reputation for quality and customer service, led firms to be flexible in meeting customers’ after-sale requests, thus building up a stock of goodwill which they hoped would in due course be translated into future orders. It is understandable that this is a stronger driver in self procured, rather than developer led housing, since the product is independent of location and there is a greater possibility of selling again to an existing customer. As with the introduction of new technologies, however, it illustrates how OSM can lead to real customer benefits, not only for purchasers of OSM homes but, through setting the competitive standard, more generally.

The desire to be a good employer was manifest in firms’ considerable investment in training and in the way that workers who were no longer able to undertake site work were retained in the factory, passing on their skills and experience to others. In return, firms enjoyed considerable stability in their labour force, aided perhaps by being situated in areas where there were few alternative opportunities for factory employment. These may be features of German employment practice generally, rather than of the OSM housing sector, but they undoubtedly aided the drive for quality in the final product.

Stable relationships were also evident in the way that OSM suppliers featured products by their suppliers in their customer centres and show houses. These were partnership arrangements, with manufacturers having their own exhibition spaces in the customer centres.

*Investment in marketing*

Turning to the marketing of OSM housing, it was clear that suppliers of OSM homes saw the need to invest heavily in marketing and sales outlets, and this has led to the creation
not only of the ‘show-home’ parks but also to elaborate customer centres such as the WeberHaus ‘World of Living’. This level of investment is again typical of a manufacturing sector marketing a consumer product, and reflects both the competitive nature of the market and the fact that the cost can be spread over a relatively large number of unit sales.

The ‘show-home’ parks, in particular, play an important and distinctive role in the promotion not only of individual firms’ products but of the OSM sector generally. By offering the opportunity for rapid comparison of homes from different suppliers, they ease the process of selection and make choosing an OSM home an easier process than if customers had to visit a number of demonstration sites.

Could the ‘show-home’ park concept be emulated in the UK? It would be more difficult to justify the investment as a marketing aid for individual firms, since sales to final purchasers would be constrained by the lack of a ‘self-procure’ tradition in the UK. On the other hand, the concept might have merit as a tool (a) for helping the public to gain first-hand experience of OSM homes, and overcoming some of the current perceptions, and (b) for marketing the concept of factory production both to the public and to developers. Developing such a park might be a collaborative initiative by the OSM housing industry.

6.4 Technologies and production processes

Timber systems

Most of the housing systems viewed were based on timber – either post-and-beam structures or insulated structural panels. In Southern Germany, which has extensive forests, there is a tradition of building in timber, and many OSM producers have come from that background. However, Scandinavian timber is now supplementing local sources. The quality of the timber used was high, and the sections employed for structural members exceeded those required in the UK. One firm, now working in Ireland essentially to UK specifications, had found that they had needed to reduce their normal specifications to comply with commercial requirements.

The structural systems employed were not innovative, but some of the technologies incorporated in them demonstrated the suppliers’ quest for features that would distinguish them in the market. This was illustrated by the insulation employed by Baufritz, which is manufactured from its waste timber. The same firm offered roof panels which incorporated a conducting mesh to protect against electromagnetic radiation.

The scope for application of post-and-beam systems in the UK appears limited. They are typically aimed at the upper levels of the market and – as demonstrated by the response to the TV programme on the Huf house – a niche market exists in the UK for houses based on such systems. But they are unlikely to have wide application.

By contrast, systems based on structural panels are much more similar to current UK technology. Such systems could be adopted in the UK, either through licensed manufacture or through taking advantage of the considerable spare capacity that currently exists in the German OSM sector, and importing from Germany. While transport costs would need to be taken into account, these do not appear to rule out the import option.

Concrete systems

More radical innovation was to be seen in the concrete OSM sector, where fully fitted modular housing was being supplied by Dennert, at very competitive prices. As put into practice by Dennert, this concept offered less flexibility to the user, but it would seem that a
combination of the Dennert modular concept and the high degree of automation exhibited in the Glatthaar factory making prefabricated basement panels, might offer the customer the best of both worlds. Certainly, the latter factory was a very effective demonstration of the application of modern manufacturing methods to the production of concrete units.

While Glatthaar focused on basements, the same technology could in principle be applied to above-ground construction. The ability, using the patented sealing technologies, to create completely waterproof prefabricated structures could be very relevant in areas at risk of flooding.

Application of these technologies in the UK would need to be through local manufacture, since transport costs would otherwise be excessive.

Brick systems

We visited only one supplier of OSM brick housing, and at that factory there was extensive use of manual processes. However, we understand that elsewhere in Germany, automation has been applied to the manufacture of brick panels. With the extensive use of brick for housing in the UK, this is clearly worthy of further investigation. As with concrete housing, however, application would need to be through manufacture in the UK.

Cavities

The introduction of any new technology into housing would need to follow careful investigation and testing, in particular to satisfy regulatory authorities and warranty providers. One particular aspect of German housing would represent a move from UK norms, and that is the absence of a cavity in most of the systems studied. German housing relies on the external render to provide a waterproof external surface.

Housing systems without cavities are being used in the UK, but generally warranty providers look for the extra barrier to water ingress associated with the cavity. It is possible that modified systems, with a cavity, would find more ready application.

Environmental features

Within the houses, we have commented earlier on the emphasis placed by some suppliers on environmental features, and indeed all suppliers made reference to environmental aspects in their marketing literature. Some had built demonstration facilities and show homes to demanding energy standards, and there was widespread demonstration of energy saving measures such as photovoltaic systems. Systems for the re-use of water were also to be found in the show homes; these along with the heating system occupied a ‘plant room’ in the basement, with ready access for maintenance.

While environmental technologies fell outside the scope of the mission, it seems likely that some of the energy and water systems now being developed in Germany could find application in the UK.

Technologies within the factory

A common perception of factory-built housing is that it is only viable when produced in large volumes, leading to a fear of uniformity, with housing developments constructed from identical units (as happened in many conventionally constructed developments from the 1930s to the 1970s). The German OSM housing sector shows this fear to be unwarranted.

Several of the factories visited produced only 2-300 units annually, while the largest had an annual capacity of around 1,400 units although it was operating at below that level.
And within this range of outputs, there was little repetition; the computer-based production systems permitted a high degree of customisation even at these small production levels. Thus factory production is viable at volumes far lower than those conventionally associated with off-site manufacture.

The firms visited demonstrated an essentially pragmatic approach, based on experience, towards the balance between automated and manual processes in the factory and between factory and site-based operations. Some had attempted to increase the factory component, only to find that late variations made this uneconomic.

Generally, they were seeking ways of adding more value in the factory and reducing the site content – such as through the development of packaged heating and water supply systems – but they did not wish to prejudice their ability to tailor the final product to customers’ requirements, or to reduce their ability to cope with changes in demand. It was notable that Kampa, which had purchased a highly automated factory when the downturn in the housing market had forced its owner into bankruptcy, had substituted manual for automated processes in some areas.

There seemed little pressure for reducing the time spent on site, even if the labour element were reduced. While the waterproof shell of the house was typically constructed in a day, it was accepted that it would then take six weeks or more for final completion. Again, this enabled late changes to be accommodated.

The production processes observed therefore reflected the characteristics noted earlier in the firms. Advanced technology was sought and used, but only to the extent that it enhanced the firm’s ability to serve its customers. The focus was on the product and the customer, and the production process followed.

Firms clearly considered that they had little to learn from other sectors. In a country noted for its advanced manufacturing technologies, exchange of information or personnel between OSM housing firms and other manufacturing sectors seemed to be at a very low level, and it was notable that much of the equipment in the factories visited came from the same small number of suppliers.

**Technology summary**

Overall, the conclusion drawn from the visits was that OSM housing can be produced very flexibly using modern manufacturing technologies, with many options for changing the balance between factory and site-based activities and between automated and manual activities in the factory. ‘Mass-customisation’, even at small volumes, is viable and there should be no fear that OSM leads to uniformity in output or loss of customer choice.

### 6.5 Follow-up actions

This report has summarised findings from a short but intense visit to OSM housing supplier firms in only one part of Germany. It found a highly competitive, product and customer-focused industry, able to meet a wide range of market requirements. Further investigations in other Länder would no doubt add to this picture, and reveal further technologies for potential application in the UK. However, based on our observations and conclusions from this first visit, we set out below some actions that would build upon the contacts made during the visit.

**Timber systems**

Housing developers, providers of social housing and suppliers of timber-famed systems may wish to make contact with German suppliers of timber structural panel systems to discuss the feasibility and economics of supply to the UK from existing but under-used manufacturing facilities,
or alternatively the establishment in the UK of new facilities. There is already an example of a commercial relationship between one such supplier and a developer, which has led to the construction of a factory in Ireland. Another firm is supplying from Germany for a hospital project in the UK.

We saw no desire by German OSM companies to take the place of developers – they recognised that theirs was a different business – but certainly they were open to approaches to exploit their technologies and production facilities.

Concrete systems

Similarly, there is potential for the exploitation of the German experience in producing modular concrete housing, and this could be investigated further, building upon studies already undertaken within the UK.

The technologies used in the prefabricated concrete basements, and in their manufacture, also warrant further examination. As noted earlier, this could be employed either for sub-surface works, in basements and underground garages, or in above-ground wall construction, and would be very relevant to the construction of housing in areas prone to flooding. A joint venture or licensing arrangement might be the exploitation route.

Area development

As a means of stimulating investment in the kinds of technologies that have been discussed in this report, we suggest that one of the bodies responsible for the development of major sites in the South East, identify specific areas for development by the private sector or housing associations using OSM methods, and encourage the development of partnerships between UK and overseas interests.

Show homes

The ‘show-home’ park is a powerful marketing tool, capable of changing perceptions about OSM housing and benefiting the whole OSM sector. It would require careful appraisal, but the development of an OSM show park could be an action which would provide focus and profile for the industry, and a means of demonstrating to all stakeholders – regulatory, financial, professional, consumer etc – the merits of OSM housing.

Quality standards and certification

Certification of OSM housing systems has commenced in the UK, but the German experience of changing the public image of manufactured housing reinforces the case for the development, application and promotion of rigorous quality standards in the OSM sector. Manufacturers who have yet to embark on this route would be well advised to do so.

Environmental technologies

While the investigation of environmental technologies was not the subject of this mission, it is clear that considerable investment in these technologies has taken place both by public bodies and industry (including housing suppliers) in Germany. Equipment supply interests might undertake further investigation of the technologies now being incorporated in German homes.
Appendix A

ACKNOWLEDGMENTS

The mission members would like to express their thanks to all the German companies (see Appendix C) who gave up their time to welcome us into their organisations. Particular thanks are extended to the individuals in these companies who acted as impeccable hosts and provided such valuable information and insight, much of which has been used in the formation of this report.

The arrangement of the mission itinerary was greatly assisted by Karin Stockerl’s knowledge of the German industry, and the help and support of Nicola Smoker – the DTI International Technology Promoter for Sustainable Energy and Environmental Technologies in Europe – whose efforts at arranging and coordinating the visits in Germany leave us in her debt. Special thanks are also extended to our interpreter Jane Mountford for her patience and skill in translating for such a large group.

The report includes inputs provided by all the mission members and was edited by Tim Venables and Roger Courtney.

Finally we would like to thank the staff at the DTI’s Global Watch Service for their help and financial support in arranging the mission and the team at CIRIA for their assistance in coordinating our activities both before and after the mission.

Any errors or omissions are of course solely the responsibility of the authors.

Figure A.1 Mission participants at Hebel Haus
Appendix B

MISSION ITINERARY

Sunday 14 March
Arrival at Munich: Mission briefing for all participants

Monday 15 March
0830-1200 Munich Technical University
  • Professor Thomas Bock
  • Cadolto Flohr & Söhne GmbH & Co KG
  • Purholz Verbundelemente GmbH
1330-1600 Baufritz – Erkheim
1700-1800 Ziegelmontagebau Johanni – Deisenhausen

Tuesday 16 March
0830-1130 Platz Haus – Bad Salgau
1500-1800 WeberHaus GmbH & Co KG – Rheinau Linx

Wednesday 17 March
0830-1100 Glatthaar Fertigkeller GmbH – Schramberg
1230-1800 Fellbach Show Village

Evening: Midweek review of progress by team

Thursday 18 March
0900-1130 Kampa AG (at NovEx Hausbau GmbH) – Steinheim
1430-1730 Veit Dennert KG – Schlüsselfeld

Friday 19 March
0900-1200 Hebel Haus GmbH – Alzenau
1330-1600 ELK Fertighaus – at Frankfurt Show Village

Depart Frankfurt Airport
Appendix C

HOST ORGANISATIONS

Baufritz
Alpenstrasse 25
87746 Erkheim/Allgau
GERMANY
T +49 8336 900 – 0
F +49 8336 900 – 260
www.baufritz.de

Cadolto Flohr & Söhne GmbH & Co KG
Wachendorfer Strasse 34
PO Box 25
D-90553 Cadolzburg
GERMANY
T +49 9103 502 265
F +49 9103 502 120
www.cadolto.com

ELK House Ireland Company Ltd
Athy Business Park
Athy
County Kildare
IRELAND
T +35 5359 8633 840
F +35 5359 8633 841
www.elk.at

Glatthaar Fertigkeller GmbH
Im Moos 17
71713 Schramberg
GERMANY
T +49 740 2929 473
F +49 740 2929 424
www.glatthaar.com

Hebel Haus GmbH
Brentanostrasse 2A
63755 Alzenau
GERMANY
T +49 6023 940 611
F +49 6023 940 612
www.hebelhaus.de

Kampa AG
Uphauser Weg 78
D-32429 Minden
GERMANY
T +49 571 955 7229
F +49 571 955 7476
www.kampa.de

Lehrstuhl für Baurealisierung und
Bauinformatik
Technische Universität München
Archisstrasse 21
80333 München
GERMANY
T +49 89 289 22100
F +49 89 289 22102
www.bri.ar.tum.de

NovEx Hausbau GmbH
Schwabstrasse 37-45
89555 Steinheim
GERMANY
T +49 7329 951 405
F +49 7329 951 419
www.exnorm.de

Platz Haus
Platzstrasse 2-16
D-88348 Bad Salgau
GERMANY
T +49 7581 201 012
F +49 7581 201 123
www.platz.de

Purholz Verbundelemente GmbH
Bahnhofstrasse No 69
Mittweida
GERMANY
T +49 372 794 620
F +49 372 751 65
www.purholz.de
## Appendix D

### MISSION TEAM

<table>
<thead>
<tr>
<th>Name</th>
<th>Job title/Company</th>
<th>Website</th>
<th>Telephone</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clive Clowes</td>
<td>Head of Housing Procurement, Housing Corporation</td>
<td><a href="http://www.housingcorp.gov.uk">www.housingcorp.gov.uk</a></td>
<td>020 7393 2025</td>
<td><a href="mailto:clive.clowes@housingcorp.gsa.gov.uk">clive.clowes@housingcorp.gsa.gov.uk</a></td>
</tr>
<tr>
<td>Dr. Rodger Evans</td>
<td>Construction Sector Unit, DTI</td>
<td><a href="http://www.dti.gov.uk/construction">www.dti.gov.uk/construction</a></td>
<td>01785 223 261</td>
<td><a href="mailto:rodger.evans@di.dti.gov.uk">rodger.evans@di.dti.gov.uk</a></td>
</tr>
<tr>
<td>Dr. Russell Matthews</td>
<td>Taylor Woodrow Engineering</td>
<td><a href="http://www.taylorwoodrow.com">www.taylorwoodrow.com</a></td>
<td>01252 377 474</td>
<td><a href="mailto:russell.matthews@uk.taylorwoodrow.com">russell.matthews@uk.taylorwoodrow.com</a></td>
</tr>
<tr>
<td>John Mitchell</td>
<td>Surveying Services Manager, Zurich Building Guarantee</td>
<td><a href="http://www.zurich.co.uk">www.zurich.co.uk</a></td>
<td>01494 569 600</td>
<td><a href="mailto:john.1.mitchell@uk.zurich.com">john.1.mitchell@uk.zurich.com</a></td>
</tr>
<tr>
<td>Dr. Paul Newman</td>
<td>Head of Timber Technology, Timber Research and Development Association</td>
<td><a href="http://www.trada.co.uk">www.trada.co.uk</a></td>
<td>020 8861 1444</td>
<td><a href="mailto:pnewman@trada.co.uk">pnewman@trada.co.uk</a></td>
</tr>
<tr>
<td>Andrew Ogorzalek</td>
<td>Director, PCKO Architects</td>
<td><a href="http://www.pcko.co.uk">www.pcko.co.uk</a></td>
<td>01322 267 510</td>
<td><a href="mailto:ao@pcko.co.uk">ao@pcko.co.uk</a></td>
</tr>
<tr>
<td>Simon Palmer</td>
<td>Director, Palmer Partnership</td>
<td><a href="http://www.southernhousing.org">www.southernhousing.org</a></td>
<td>020 7553 6410</td>
<td><a href="mailto:simon.palmer@pcko.co.uk">simon.palmer@pcko.co.uk</a></td>
</tr>
<tr>
<td>Canda Smith</td>
<td>Head of Design and Sustainable Communities, COPM</td>
<td><a href="http://www.southernhousing.org">www.southernhousing.org</a></td>
<td>020 7553 6410</td>
<td><a href="mailto:canda.smith@odpm.gsa.gov.uk">canda.smith@odpm.gsa.gov.uk</a></td>
</tr>
<tr>
<td>Dr. Karin Stocker</td>
<td>Innovation Coordinator, Southern Housing Group</td>
<td><a href="http://www.shgroup.org.uk">www.shgroup.org.uk</a></td>
<td>020 7553 6410</td>
<td><a href="mailto:karin.stocker@shgroup.org.uk">karin.stocker@shgroup.org.uk</a></td>
</tr>
<tr>
<td>David Whitton</td>
<td>Group Chief Architect, Home Group Ltd</td>
<td><a href="http://www.homegroup.org.uk">www.homegroup.org.uk</a></td>
<td>0191 285 0311</td>
<td><a href="mailto:david.whitton@homegroup.org.uk">david.whitton@homegroup.org.uk</a></td>
</tr>
<tr>
<td>Roger Courtney</td>
<td>Consultant, innovation in construction/Mission coordinator for CIRIA*</td>
<td><a href="http://www.ciria.org">www.ciria.org</a></td>
<td>020 7549 3300</td>
<td><a href="mailto:roger.courtney@ntworld.com">roger.courtney@ntworld.com</a></td>
</tr>
<tr>
<td>Tim Venables</td>
<td>Taraka Business School – Imperial College London</td>
<td><a href="http://www.imperial.ac.uk/taraka/innovationstudies">www.imperial.ac.uk/taraka/innovationstudies</a></td>
<td>020 7594 6604</td>
<td><a href="mailto:tvenables@imperial.ac.uk">tvenables@imperial.ac.uk</a></td>
</tr>
<tr>
<td>Prof David Gann</td>
<td>Taraka Business School – Imperial College London</td>
<td><a href="http://www.imperial.ac.uk/taraka/innovationstudies">www.imperial.ac.uk/taraka/innovationstudies</a></td>
<td>020 1594 6604</td>
<td><a href="mailto:djang@imperial.ac.uk">djang@imperial.ac.uk</a></td>
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* CIRIA Project Director - owen.jenkins@ciria.org
Appendix E

GLOSSARY

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>3D</td>
<td>three dimensional</td>
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<tr>
<td>BDF</td>
<td>Bundesverband Deutscher Fertigbau</td>
</tr>
<tr>
<td>°C</td>
<td>degrees Celsius</td>
</tr>
<tr>
<td>CAD</td>
<td>computer-aided design</td>
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<tr>
<td>CAM</td>
<td>computer-aided manufacturing</td>
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<tr>
<td>CIRIA</td>
<td>Construction Industry Research and Information Association (UK)</td>
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<tr>
<td>cm</td>
<td>centimetre</td>
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<tr>
<td>DFV</td>
<td>Deutscher Fertigbau Verband</td>
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<tr>
<td>DIY</td>
<td>do-it-yourself</td>
</tr>
<tr>
<td>DTI</td>
<td>Department of Trade and industry (UK)</td>
</tr>
<tr>
<td>GDF</td>
<td>Gütegemeinschaft Deutscher Fertigbau</td>
</tr>
<tr>
<td>IT</td>
<td>information technology</td>
</tr>
<tr>
<td>K</td>
<td>kelvin</td>
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<tr>
<td>kg</td>
<td>kilogram(me)</td>
</tr>
<tr>
<td>km</td>
<td>kilometre</td>
</tr>
<tr>
<td>kWh</td>
<td>kilowatt-hour</td>
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<tr>
<td>m</td>
<td>metre</td>
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<tr>
<td>mm</td>
<td>millimetre</td>
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<tr>
<td>MMC</td>
<td>modern methods of construction</td>
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<tr>
<td>ODPM</td>
<td>Office of the Deputy Prime Minister (UK)</td>
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<tr>
<td>OSB</td>
<td>oriented strand board</td>
</tr>
<tr>
<td>OSM</td>
<td>off-site manufacturing</td>
</tr>
<tr>
<td>QA</td>
<td>quality assurance</td>
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<tr>
<td>R&amp;D</td>
<td>research and development</td>
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<tr>
<td>SIZ</td>
<td>Stahl-Informations-Zentrum</td>
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<tr>
<td>SPRU</td>
<td>Science and Technology Policy Research (University of Sussex, UK)</td>
</tr>
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<td>TRADA</td>
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<td>UK</td>
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<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>v</td>
<td>versus</td>
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<td>watt</td>
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<td>WC</td>
<td>water closet</td>
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*Contact: itp@globalwatchonline.com*

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