Consumer Response to Steel Frame Housing: A Choice Modelling Experiment

A paper presented to the European Network for Housing Research Conference Cambridge, July 2004

Tom Hughes
School of Art and Design
Nottingham Trent University
Burton Street
Nottingham NG2 4FS

Michael Burton,
School of Agricultural and Resource Economics,
University of Western Australia
Perth 6009
Western Australia

Abstract

It is widely recognised that there is a resistance to prefabrication in the English housing market. Despite this, a number of initiatives are in place to promote alternatives to conventional, site-based construction methods.

A series of new steel framing systems have been introduced over the last decade, and several major house builders are involved in their testing and development. There has been a general perception that steel framing will be unpopular with English house buyers, but little hard evidence has been made available about consumers' attitudes. With levels of production still low, gathering data on revealed preferences through real-life choices is also problematic.

This paper presents the results of a research project designed to test for the existence of a consumer preference against steel framing. This is based on a stated preference, choice modelling survey administered in the Nottingham area. Respondents were asked to choose between a selection of houses built using conventional methods or steel frame, and having a range of price and room size attributes. Choice modelling of this kind has been identified as a method well suited to examining preferences in relation to new house types. The method also allows predictions to be made about how these preferences might be offset by price and other incentives.

The results show that the majority of respondents do not favour steel framing, and on average the sample would require a £15,600 discount to purchase a steel framed house, compared to an identical, conventionally built house. However, a range of preferences is identified in the sample, with those who are younger, and with higher education levels, more favourably disposed towards the steel frame system.

Many advantages are claimed for steel framing over conventional construction, but take-up of the system by house builders may have been slowed by their expectation of resistance from buyers. Whilst this research confirms that there is considerable resistance, it also suggests the existence of a market for steel framed housing, including a proportion of consumers who would accept the system without the need for any additional incentive.

Introduction

As a result of Government-backed initiatives to improve efficiency, construction quality and customer satisfaction in the UK housebuilding industry (Egan 1998, Housing Forum 2002) there has been an upsurge in interest in housebuilding methods in recent years. Around 90% of newly built houses in England are currently of 'traditional construction'; an inner leaf of load bearing concrete block and an outer cladding of brick is typically topped by a timber trussed rafter roof covered with clay tiles. There are several structural alternatives to the concrete block inner leaf, including timber stud walls, concrete 'tunnel form'

construction and light steel framing. The latter has had regular coverage since the late 1980s in the technical press (Stokdyk 1988, Smit 1996, Jones 2003 etc), where it tends to be profiled as an 'emerging technology', but it has so far been unable to live up to steel industry aspirations in terms of market penetration.

Previous attempts to introduce iron and steel frame housing in the UK have tended to focus on emergency or temporary solutions, for example the export of iron framed and clad bungalows to the colonies during the 19th century (Herbert 1978), the post-WWI 'Homes for Heroes' (Swenarton 1981) and the 'prefabs' of the post-WWII period (Bowley 1960, Vale 1995). More recently, steel frame has been applied to public sector housing and mixed public/private developments with strong 'innovation agendas', but whilst several volume housebuilders have trialled steel frame they have been slow to adopt it for large scale speculative developments.

Improving take up of steel frame in the private housing market will be important to steel systems producers for two reasons; volume of production and sustainability of demand. Around 80% of housing production is currently in the private speculative sector, and the output of this sector, though volatile, is more stable than the public sector as it is not so profoundly affected by changes in Government funding and policy. Stable, high volume output is required in order to both establish steel frame as a 'normal' housebuilding material, and to allow sustained technical innovation.

Resistance to a change in housebuilding methods has been traced to several sources, including the fragmented nature of the industry, the regulatory system, land prices, the high level of borrowing to finance private ownership and volatility in the housing market (Ball 1996). Resistance also results from the perception (held by various parties involved in the financing, regulation and production of housing) that house buyers prefer traditional construction, though evidence for this preference has tended to be anecdotal (Edge et al 2002). Overcoming customer resistance, both real and perceived, will be an important step if steel frame is to penetrate the private housing market.

This paper reports on research into public perceptions of steel frame as a housebuilding method, using 'traditional' construction as a benchmark against which to measure the expected value and performance of steel frame housing. The research aimed to establish whether a resistance to (or preference for) steel frame exists amongst the general public and to gauge the magnitude of any such resistance/preference when compared to other attributes of the home. The research also attempted to establish whether there are any predictive factors in the population for attitudes towards steel frame housing.

Methods

The small number of steel frame houses currently being produced has necessitated the use of 'stated preference' rather than 'revealed preference' data in this research. The essential difference is that revealed preference data can be collected by examining real-world purchase decisions, whereas stated preference data is collected using simulated choice scenarios. Molin et al (1996) have argued that stated preference data is preferable to revealed preference data when examining new housing types. The preparation of a stated preference choice modelling survey instrument to test consumer responses to steel frame is described below.

In order to administer the survey, 15 cluster areas, based on average house prices, were identified in and around the city of Nottingham. Six of these areas were selected by stratified random sampling, and 504 surveys were delivered to addresses on randomly selected streets in these clusters. 127 completed surveys were returned (25.2%) which was considered a satisfactory result given the complexity of the survey task.

The conditional logit model.

Although attitudinal response questions can give information on general perspectives on an issue, of more use are estimates of the value that the respondent places on the attributes of the different types of house. In order to investigate this a choice modelling framework was employed (see Louviere et al., 2000 for an

overview of the technique). In this situation respondents are presented with a number of choices (in this case houses) with different attributes (price, size and construction technique) and asked to choose between them. Analysis of the choices with respect to the attributes of the houses allows one to infer the values attached to attributes. The approach has been widely used in the transport, marketing and environmental economics literature, and there have been applications in the area of residential choice (e.g Walker et al. 2002, Molin and Timmermans, 2002)

Appendix A shows the survey instrument, including the preliminary information given to respondents, and examples of the 6 choice sets they were presented with. The attribute levels used are shown in Table 1.

Table 1 Attribute levels for the Choice Sets

Attribute	Levels
Price (thousand pounds)	105,110, 120, 130,135
Size (% change from average)	-20,-10,0,10,20
Structural system	Steel, Concrete

25 different 'houses' were constructed by identifying each combination of price and size, and then assigning a construction type to each (ensuring that the type was distributed evenly across all levels). One combination was discarded, as it had the highest price, smallest size and constructed using a steel frame. The remaining 24 houses were grouped into 12 pairs, and allied with a 'conventional' design, of concrete construction, average size and a price of 120k, to give the three-house choice sets outlined in the appendix.

The 12 pairs are in turn split into 2 groups of 6, so that each respondent is asked to complete only 6 of the choice sets. The use of 2 separate survey instruments, that differ only in the attribute mix of the choice sets, allows one to undertake a number of investigations into the design of the survey. In particular, within the choice sets, the position of the 'status quo' or conventional house is varied. In the first set it appears as the first in each set. In the second version it appears as the last house in the set. In many studies it has been found that the "status quo" option is selected at a higher rate than one would expect, given the attributes in the other choices. This may be explained by a form of risk aversion or inertia in choices. However, it may also be that respondents who are confused or not processing the information fully simply select the first option as the easiest way to complete the task. By having a second version of the survey with the status quo as the final option one can distinguish between true inertia in preferences, and a spatial phenomenon.

The conditional logit model is a method commonly used to analyse choice models. It has a theoretical basis derived from Random Utility Theory. This assumes that observed choices made by an individual are based on comparisons of utility, and that the determinants of utility (and hence choice) can be identified by the researcher, but there is always some, unobservable, random element that cannot be identified by the researcher. Thus, in analysing these choices one has to accept that there an irreducible element of error involved.

Formally, let the utility obtained from outcome j, identified by the set of k attributes X_{kj} be given by:

$$U_j = \Sigma_k \beta_k X_{kj} + \varepsilon_j$$

where β is a vector of parameters, and ε a random variable.

Outcome j will be chosen if the utility of j is greater than that generated by all other options, but because the random component is unobserved one can only infer that:
$\text{Prob}(U_j > U_i)$ for all other $i \neq j$

The model is implemented by choosing a particular distribution of disturbances. If it is assumed that the disturbances are independent and identically distributed, with a Type 1 extreme value distribution (Greene, 1997):

It can then be shown that the probability of choosing j from a set of n alternatives can be expressed as

$$\text{Prob}(Y = j) = \frac{\exp\left[\lambda \sum_k \beta_k X_{kj} \right]}{\sum_n \exp\left[\lambda \sum_k \beta_k X_{kn} \right]}$$

where λ is a scale parameter linked to the variance of the residuals. The scale parameter is usually normalised to equal one, as it cannot be uniquely identified unless one has some hypothesis as to how the variance alters across sub-populations of the sample.

Individual specific covariates are included as interaction terms with the attributes, as otherwise they cannot explain choice per se (as they do not vary across choices).
If one defines Z_{mi} is the m'th characteristic which may affect values (i.e. age, education etc) a more general specification can be given as:

$U_{ij}=\Sigma_k\beta_k X_{kj} + \Sigma_k\Sigma_m\alpha_{km} X_{kj}Z_{mi} + \varepsilon_j$.

Not all of the interaction terms need to be included, and one may have some prior beliefs as to which attributes will be affected by which characteristics, but this can, to some extent, be determined empirically.

In the current context the number of alternatives (n) is 3, and the attributes (X) are the price, size and construction type of the house. Individual specific attributes (Z) are drawn from those identified in the survey, and potentially include age, gender, education, employment, history of house purchase and occupation and the responses to the opinion questions. Table 2 reports the results from estimating a general model.

Table 2: Initial estimates of the Choice Model

Number of obs = 2241 LR chi2(12) = 663.43 Prob > chi2 = 0.0000 Log likelihood = -488.94798 Pseudo R2 = 0.4042				
	Coef.	Std. Err.	z	P>|z
Price	-0.055	0.008	-6.670	0.000
Frame	8.681	0.881	9.850	0.000
Frame*Age	-0.022	0.008	-2.830	0.005
Frame*IND	-2.460	0.258	-9.520	0.000
Size(-20)	-1.680	0.382	-4.400	0.000
Size(-10)	-1.698	0.354	-4.800	0.000
Size(+10)	1.891	0.232	8.140	0.000
Size(+20)	2.030	0.261	7.780	0.000
D1a	1.157	0.266	4.350	0.000
D1b	-0.057	0.206	-0.270	0.783
D3a	0.492	0.261	1.890	0.059
D3b	0.973	0.243	4.010	0.000

Variable definitions:
Price: price of house
Frame: dummy variable =1 if steel frame used, 0 otherwise
Size(x): dummy variables, =1 if house is X different to average, 0 otherwise
D1a: alternative specific dummy =1 if it is the first house in sample a, 0 otherwise
D1b: alternative specific dummy =1 if it is the first house in sample b, 0 otherwise
D3a: alternative specific dummy =1 if it is the third house in sample a, 0 otherwise
D3b: alternative specific dummy =1 if it is the third house in sample b, 0 otherwise
Age: age of respondent

IND: index of opinions on concrete v steel frames.

Reassuringly, the coefficient on Price is negative and significant: respondents prefer cheaper houses.

When looking at the value placed upon frame type, a number of interaction terms have been explored, to see if they have any impact on the valuation placed on the Steel frame. The intention is to test whether the marginal value placed on the presence of a Steel frame is constant across the population, or varies according to the individual attributes included. The demographic variables used have included age, education, gender and employment status, as well as previous experience of house purchase. However, apart from age, none of these variables are significant.

The model also includes a variable that reflects their expressed opinion on concrete and steel frames. The use of variables that capture the views of respondents in the model may seem to be tautological: both are outcomes of the same value set. To some extent this is true. One should not be surprised if the choices made across house types reflect their views on steel and concrete house types. However, although the opinion questions reveal the diversity of opinions, they do not reflect how that diversity will translate into the valuation of the house characteristics. Estimating the choice model without including information on opinions will report an estimate of the 'average' valuation across the sample, but tell us little about the variability. By combining data on subjective opinions with the choice sets allows us to measure the extent to which there is heterogeneity in valuations of steel frames within the sample.

There are a considerable number of Opinion questions asked and hence a large number of variables that could be included in the model: potentially 21. Although these give a perspective on a wide range of issues relating to steel and concrete construction houses, the responses are likely to be highly correlated. The simplest means of including the opinion data is to take an average score of all 21 questions for each individual: a high score represents a positive view on concrete frames, and a low score the opposite[1]. Not surprisingly, those who hold favourable opinions on concrete tend to place a negative value on the use of a steel framed construction technique.

Because of the inclusion of the interaction terms, whether a particular individual places a positive or negative value on a steel frame will depend on their age and opinions.

There is a strong positive relationship between the size of the house and the value placed upon it, but preliminary investigations revealed that this effect is strongly non-linear. To illustrate this the 'size' variable has been represented by a series of dummy variables, linked to the size of the house relative to the average. As expected, the sign on the dummy variables associated with reductions in room size are negative, while those on the positive changes are positive. However, it is clear that the size of these effects does not reflect the size of the change. In fact, it appears as if a reduction of either 10 or 20% is viewed as equivalent, as is an increase of either 10 or 20%. Thus, the data suggests that individuals have responded to the direction of the change, rather than the size *per se*. It is unclear whether this result would hold if the range of changes were to be greater: one might expect a 50% decline to be distinguished form a 10% decline, but the current study cannot detect this.

A sequence of alternative specific constants are included, to capture the 'status quo' effects. Alternative specific constants reflect influences on choice that are not reflected in the attributes themselves, but may be due to ordering, labelling or other design influences. In this case, these are dummy variables linked to whether the house under consideration is the 1st or 3rd in the set, and whether it is labelled as the 'status

[1] A wide range of alternative methods have been explored to construct (an) appropriate variable(s) for attitudes. These included splitting the opinion data into 3 sets relating to Building and Purchasing (6 questions), Design and Occupation (9 questions) and Making Changes (6 questions) and then conducting a Principle Components analysis to extract systematic indices that reflect views on these 3 aspects. However, the three indices were highly correlated, and led to almost exactly the same results as presented here.

quo'". For sample A, the first house will be the 'status quo' house but for sample B it will be the third house. Signs and significance of the 4 dummy variables thus allows us to test for status quo and ordering effects. If there is a pure status quo effect we would expect only D1A and D3B to be significant, and of the same value.

Table 3 imposes a restriction that D1a and D3b are equal, and that D3a and D1b are equal to zero. This set of restrictions is also accepted statistically.

Table 3: Restricted alternative specific constants

Number of obs = 2241 LR chi2(9) = 659.41 Prob > chi2 = 0.0000 Log likelihood = -490.95758 Pseudo R2 = 0.4018				
	Coef.	Std. Err.	z	P>|z
Price	-0.060	0.008	-7.73	0.000
Frame	8.571	0.862	9.95	0.000
Frame*Age	-0.023	0.008	-2.91	0.004
Frame*IND	-2.443	0.254	-9.61	0.000
Size(-20)	-1.573	0.360	-4.37	0.000
Size(-10)	-1.783	0.353	-5.05	0.000
Size(+10)	1.990	0.213	9.36	0.000
Size(+20)	1.933	0.254	7.61	0.000
sq	0.918	0.206	4.47	0.000

It is apparent from Table 3 that the coefficients on the size variables may be equal for differing size changes. Table 4 reports estimates of a model that restricts the coefficients on the size variable to be equal, whether there are 10 or 20% changes i.e. a 10 and 20% reduction in size are restricted to have the same valuation, as does a 10 or 20% increase. Statistically one can accept these restrictions: it is the case that respondents appear to be treating 10 and 20% changes in house size (of a particular sign) as equivalent.

Table 4: Choice model with restricted size effects.

Number of obs=2241 LR chi2(7)=659.05 Prob > chi2=0.0000 Log likelihood = -491.13616 Pseudo R2=0.4015				
	Coef.	Std. Err.	z	P>|z
Price	-0.060	0.008	-7.760	0.000
Frame	8.515	0.854	9.970	0.000
Frame*Age	-0.023	0.008	-2.890	0.004
Frame*IND	-2.433	0.253	-9.610	0.000
Size(-10,20)	-1.675	0.290	-5.770	0.000
Size(+10,20)	1.973	0.204	9.680	0.000
sq	0.918	0.204	4.490	0.000

The model in table 4 is therefore our preferred model for further discussion.

The estimated parameters can be interpreted as (normalised) marginal utilities, and have no clear numerical interpretation. However, one can identify what are known as partworths (PW). A partworth is defined as the maximum $ valuation of a marginal change in an attribute. Thus, for a simple 2 attribute model, utility could be expressed as:

$U = \beta_1 Price + \beta_2 X$

Where price is the payment required for the good, and Z is the attribute. One can identify the maximum amount that a person is willing to pay for a marginal increase in attribute by considering the offsetting change in the price that would leave utility unchanged i.e.

$\bullet\ U = [\beta_1(Price+PW) + \beta_2 (X+1)] - [\beta_1 Price + \beta_2 X] = 0$

$PW = -\beta_2/\beta_1$

One would expect β_1 to be negative, so where +ve changes in X lead to increases in utility, the partworth is positive: it represents the amount that an individual is prepared to pay to gain the marginal change in X. If the attribute is non-beneficial ($\beta_2 < 0$) then the partworth is negative: it gives the amount required to be paid to the respondent (or the reduction in price needed) compensate for the change in the attribute. As they have a $ value, they are more easily interpreted than the underlying parameters.

As noted before, the interaction terms effectively mean that the marginal utility associated with the Steel Frame changes according to the characteristics of the individual and partworths therefore vary accordingly:

(8.515-0.023*AGE-2.443*IND)/0.06

If one evaluates the partworth for the "average" respondent then the value associated with steel frames is -15.6k i.e. they would require a discount of this amount to consider purchasing such a house. However, one can identify a wide range of values, depending on the assumed characteristics of the respondent. Table 6 reports a number of such 'constructed' individuals:

Table 6 Partworths associated with Steel Frames, by individual type ('000 pounds)

Respondent	Partworth
Aged 20, average opinions of Steel frame (IND=3.37)	-2.4
Aged 70, average opinions of Steel frame (IND=3.37)	-21.6
Aged 53, Positive opinions of Steel frame (IND at 10th percentile: 2.77)	+9.3
Aged 53, Negative opinions of Steel frames (IND at 90th percentile: 4.09)	-44.2

The final two types have been selected to give extreme +ve and –ve values. However, these results do not reveal the extent to which such individuals exist in the population. An alternative is to calculate the partworth for each individual using their age and opinions, and then plot the distribution. This is shown in Figure 1 below.

Figure 1: Distribution of Partworths for Steel Frame for the sample (125 individuals)

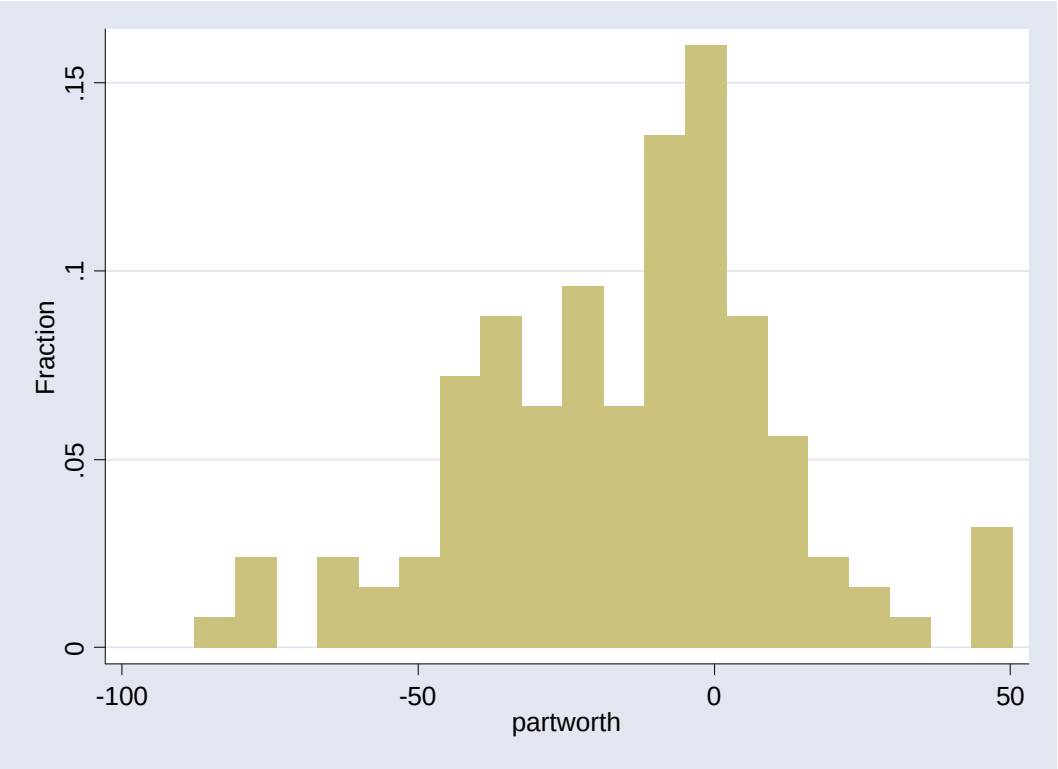

Table 7 gives the summary statistics for the sample partworths, including mean and percentiles.

Table 7: Summary statistics for the sample partworths

Percentiles		Observations	125
1%	-81.4	Mean	-15.0
5%	-60.8	Std. Dev.	26.1
10%	-44.76	Variance	680
25%	-33.0	Skewness	-.1.7
50%	-8.7	Kurtosis	3.4
75%	0.8		
90%	12.0		
95%	24.6		
99%	50.2		

Within the sample there are a small number with extreme aversion to steel frames, but a small number who are positive about their characteristics. If the sample is representative of the general population, this gives a perspective on the size of the market that would accept this technology without the need for any discount in price: approximately 25%.

One can also identify the partworths associated with reduced and increased house sizes. As noted above, these are equivalent for 10 and 20% changes. For reductions in size the value is -27.6k, and for increases in size, 28.0k. Because no individual characteristics are identified as modifying the parameter associated with the size of the house, these can be considered as sample estimates.

Explaining Opinions.
As noted above, few of the individual characteristics of the respondent are found to be significant in the conditional logit model. However, the inclusion of the opinion index may already have captured these effects: e.g. education or income may be associated with a perspective on steel frames, and hence including these variables in the model does not improve the explanation of choices. Although the current model may be of value in identifying the impact of the diversity of opinions on the corresponding diversity of values associated with steel framed houses, as yet we have no model of the source of those opinions.
Because there are two versions of the survey, it is possible to conduct some tests of consistency in responses to the opinion questions. As presented to the respondents, the order of the responses is changed: in Version A "definitely the concrete block house" appears first in the options, through to "definitely the steel frame block house". In Version B the order is reversed. It is possible that this change may have influenced responses, and if it has, this would be of concern. Responses to the questions are coded ordinally ("definitely the steel block"=1, "probably the steel block"=2 etc) A two-sample Kolmogorov-Smirnov test for equality of distribution functions is conducted across the two samples to see if the distribution of responses varies by survey type. In all cases one cannot reject the hypothesis that the distribution is the same.

Statistical analysis has been conducted on the opinion questions themselves, at the individual and the aggregate index level using ordered logit and multiple regression analysis respectively. The results indicate that there are no significant predictors of opinions, other than individuals with no reported qualifications, who consistently rate the concrete block design above the steel frame, and those whom are older, who also rate the concrete block system higher. However, the level of significance and overall explanatory power of the regressions was low. The source of the diversity of opinions that people hold is correlated with the choices they make in the choice modelling stage, (its internally consistent) but we do not really know what is forming those opinions, nor do we have strong proxies for what might predict them.

Discussion

The analysis above establishes the existence of a preference for 'traditional' construction over steel framing. Whilst concerns of housebuilders, lenders and valuers about consumer resistance are, to a certain extent, confirmed, the analysis also reveals that attitudes are not uniform across the population; in fact a significant minority value steel frame on a par with, or more highly than concrete block. Though a certain proportion of house buyers might be strongly opposed to steel frame, the resistance of the majority might be overcome by offering relatively achievable incentives in terms of price or room size, or a combination of both.

It did not prove possible to conclusively establish predicting factors for attitudes and preferences in relation to steel frame, and further research is clearly required in order to understand the underlying values held by respondents. This might be achieved, for example, through a series of follow-up interviews. Coolen and Hoekstra (2001) describe a promising laddering interview technique used to construct 'means-ends chains'; these link attributes (for example 'garden') with consequences ('gardening') and values ('creativity'). Sadalla and Sheets (1993) use symbolic interactionist theory, attaching a social meaning, and ultimately a 'personality', to the choice of house building materials. Steel was not specifically included in the materials they studied, but it would be relevant to examine notions of steel as a 'cold', 'hard', 'precise' etc. material and establish whether the holding of such ideas is a predictor of attitudes toward steel frame housing.

Finally, the effect of experience and knowledge on attitudes towards steel frame might be investigated. A survey of visitors to British Steel's light steel frame show house at the 1994 Future World exhibition revealed that "91% expressed no concern at all about buying a steel frame house"- after "the interviewer had explained the benefits of the SureBuild system" (Burling 1995). If these results were to prove replicable in follow-up interviews with the respondents, this might suggest that negative attitudes towards steel frame are vulnerable to a positive marketing strategy. This would be at odds with the current prevailing approach, which involves telling the customer about the steel frame only after they have purchased the house.

References

Ball, M. (1996) **Housing and construction: a troubled relationship.** Policy Press, Bristol

Bowley, M. (1960) **Innovations in building materials: an economic study** Duckworth, London

Burling, P. (1995) **Attitudes of Potential Home Buyers in the United Kingdom** in **Steel in Housing: Meeting Tomorrow's Marketing Challenges.** International Iron and Steel Institute, Brussels

Coolen, H. and Hoekstra, J. (2001) **Values as determinants of preferences for housing attributes.** Journal of Housing and the Built Environment, 16, pp.285-306

Edge, M. Craig, A. Abott, L. Hargreaves, A. Scott, J. Scott, S. (2002) **Overcoming client and market resistance to prefabrication and standardisation in housing.** Robert Gordon University, Aberdeen, September.

Egan, J. (1998) **Rethinking construction: report of the Construction Task Force.** HMSO, London.

Herbert, G. (1978) **Pioneers of Prefabrication.** The John Hopkins Press Ltd, London

Greene, W. H. (1997) **Econometric Analysis** 3rd Ed. Prentice Hall; Englewood Cliffs, N.J.

Housing Forum (2002) **Homing in on excellence: a commentary on the use of offsite fabrication methods for the UK housebuilding industry.** The Housing Forum, London.

Jones, W. (2003) **Roll your own** RIBA Journal Vol 110 No 7, July, pp.62-64

Louviere,J.J. Hensher,D.A. and Swait,J.D. (2000**) Stated Choice methods: analysis and application.** Cambridge: Cambridge University Press

Molin,E. and Timmermans, H. (2002) **Accessibility considerations in residential choice decisions: accumulated evidence from the Benelux**. Paper presented at the Annual Transportation Research Board Meeting, January 2003, Washington D.C.

Molin, E. Oppewal, H. and Timmermans, H. (1996) **Predicting Consumer Response to New Housing: A Stated Choice Experiment.** Netherlands Journal of Housing and the Built Environment Vol. 11 No. 3, pp.297-311

Sadalla, E. and Sheets, V. (1993) **Symbolism in building materials: Self presentational and cognitive components** Environment and behavior, 25, No. 2, pp.155-180

Smit, J. (1996) **Steeling a march** Building Homes No 1, March 1996, pp. 23-24

Stokdyk, J. (1988) **Outsider in the frame** Building Vol 253 No 34, August 19, p.30

Swenarton, M. (1981) **Homes fit for heroes: the politics and architecture of early state housing in Britain.** Heinemann, London

Vale, B. (1995) **Prefabs: a history of the UK temporary housing programme** Spon, London

Walker,B. Marsh,A. Wardman, M. and Niner,P. (2002) **Modelling tenants' choices in the public rented sector: A stated preference approach,** Urban Studies Vol.39 No.4, pp.665-688

Appendix A: Survey instrument

How should new houses be built?

About the survey:

- There are 39 questions over 4 pages
- It should take about 10-15 minutes to complete
- You do not need any technical knowledge to answer the questions

Key issues

The key issue of this survey is the choice between steel frame and concrete block as the main structural material for new houses.

Houses in England are conventionally built with cavity walls made up of two layers. The inner layer of concrete blocks does the main structural work of holding up the floors and roof, while the outer layer (usually of bricks) governs the appearance of the house.

There are alternatives to the use of concrete block for the inner, structural layer. One of the alternatives is to use structural steel framing, which is then enclosed by an outer layer of brick or another cladding material. This method has been in use in other countries for many years and in some places is very common. More recently, it has been introduced to this country, and an increasing number of houses are being built this way every year.

This survey is designed to reveal whether there is a preference for either concrete block or steel frame structures among homeowners and buyers.

Section 1: Choice situations

In the first section of the survey, we ask you to imagine that you are trying to buy a newly-built house. Imagine that you have been given a mortgage limit of £135,000, and you could still afford to live if you buy a house at this price. However, remember that buying a cheaper house will give you extra money to purchase other things, like a new car, holidays etc.

We will present you with a series of situations in which you can choose between 3 different houses.

In each of the situations, one of the houses has a concrete block structure, has average sized rooms and is priced at £120,000 (an average price for houses in its location). The other houses vary in the structural material used (concrete block or steel frame), in the size of their rooms and in price.

We would like you to choose between the 3 houses in each of the following situations. Look at the characteristics of each house and tick one of the boxes. There may be another alternative that you would prefer over the options that are presented, but for the sake of this exercise please simply choose between the 3 options that are presented. Please assume that all the houses have the same number of rooms and are in the same location.

Please turn over to begin answering the questions.

(1) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Steel frame	Steel frame	Concrete block
Room size:	20% smaller than average	10% smaller than average	Average size
Price:	£120,000	£130,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

(2) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Concrete block	Steel frame	Concrete block
Room size:	20% larger than average	20% larger than average	Average size
Price:	£130,000	£105,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

(3) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Steel frame	Concrete block	Concrete block
Room size:	Average size	10% larger than average	Average size
Price:	£135,000	£135,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

(4) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Steel frame	Concrete block	Concrete block
Room size:	10% larger than average	10% smaller than average	Average size
Price:	£130,000	£135,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

(5) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Steel frame	Concrete block	Concrete block
Room size:	10% larger than average	Average size	Average size
Price:	£110,000	£110,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

(6) If the following 3 houses are the only ones available, which do you choose?

	House 1	**House 2**	**House 3**
Structural system:	Steel frame	Steel frame	Concrete block
Room size:	20% smaller than average	20% larger than average	Average size
Price:	£105,000	£120,000	£120,000
Which house do you choose? (tick one box)	❑	❑	❑

Section 2: Opinion survey

The following questions will help us to understand a wider range of consumers' opinions about steel frame and concrete block houses. There are 22 questions in this section.

For this exercise you are asked to compare two houses of similar size, price and location. One is being built with a steel frame and the other with a concrete block structure. Please answer the following questions by ticking the box that best indicates your opinion.

Building and purchasing: **In your opinion, which house is likely to…**	Definitely the steel frame house	Probably the steel frame house	Both houses probably about the same	Probably the concrete block house	Definitely the concrete block house	No opinion offered
(7)…be easier to get a mortgage for?	1☐	2☐	3☐	4☐	5☐	☐
(8)…be easier to get insurance/guarantees for?	1☐	2☐	3☐	4☐	5☐	☐
(9)… be completed more quickly, ready for moving in?	1☐	2☐	3☐	4☐	5☐	☐
(10)…have fewer defects on moving-in day?	1☐	2☐	3☐	4☐	5☐	☐
(11)… have a higher quality of finishes?	1☐	2☐	3☐	4☐	5☐	☐
(12)… have a higher quality of construction?	1☐	2☐	3☐	4☐	5☐	☐
Design and occupation: **In your opinion, which house is likely to…**						
(13)…have a more attractive appearance from the outside?	1☐	2☐	3☐	4☐	5☐	☐
(14)… have a good layout of rooms internally?	1☐	2☐	3☐	4☐	5☐	☐
(15)… be more secure (difficult to break in to)?	1☐	2☐	3☐	4☐	5☐	☐
(16)… have sufficient storage space?	1☐	2☐	3☐	4☐	5☐	☐
(17)…have lower maintenance costs?	1☐	2☐	3☐	4☐	5☐	☐
(18)…be easier to keep at a comfortable temperature inside?	1☐	2☐	3☐	4☐	5☐	☐
(19)…be quieter (have better sound insulation)?	1☐	2☐	3☐	4☐	5☐	☐
(20)…have lower heating bills?	1☐	2☐	3☐	4☐	5☐	☐
(21)…be safer in the event of a fire?	1☐	2☐	3☐	4☐	5☐	☐
Making changes and the long term future: **In your opinion, which house is likely to…**						
(22)…be easier to extend (build on to)?	1☐	2☐	3☐	4☐	5☐	☐
(23)…be easier to adapt (change the internal layout of rooms)?	1☐	2☐	3☐	4☐	5☐	☐
(24)…allow easier wall hanging of furniture and pictures?	1☐	2☐	3☐	4☐	5☐	☐
(25)…be easier to maintain and refurbish using DIY methods?	1☐	2☐	3☐	4☐	5☐	☐
(26)...be easier for its owner to sell quickly if he/she needs to?	1☐	2☐	3☐	4☐	5☐	☐
(27)…maintain its value better (have a higher resale price)?	1☐	2☐	3☐	4☐	5☐	☐
(28)…have a more permanent structure?	1☐	2☐	3☐	4☐	5☐	☐

Section 3: Your housing

Please give us some background information about the houses you have lived in and your future house buying intentions by answering the following questions. All information you give to us is confidential and will not be revealed to anyone else.

(29) What is the structural system of the house you are currently living in? (Please tick one box)

Solid brick or stone walls❑ Cavity walls with block inner layer❑ Timber frame❑
Steel frame❑ Don't know❑ Other❑ Please specify _____

(30) What type(s) of house have you lived in previously? (you may tick more than one box)

Solid brick or stone walls❑ Cavity walls with block inner layer❑ Timber frame❑
Steel frame❑ Don't know❑ Other❑ Please specify _____

(31) Have you ever bought a newly-built house (where you were the first occupant)? (Please tick one box)

Yes❑ No❑ Don't know❑

(32) Have you bought a house in the last ten years? (Please tick one box)

Yes❑ No❑ Don't know❑

(33) Do you think you might buy a house sometime in the next ten years? (Please tick one box)

Yes❑ Maybe❑ No❑

(34) Would you consider buying a newly-built house in the future? (Please tick one box)

Yes❑ Maybe❑ No❑

Section 4: Personal information

This final set of questions will allow us to ensure that the people taking part in the survey represent a cross-section of the community. All information you give to us is confidential and will not be revealed to anyone else.

(35) What is your age?

Under 18❑ 18 to 25❑ 26 to 35❑ 36 to 45❑ 46 to 55❑ 56 to 65❑
Over 65❑

(36) What is your sex?

Female ❑ Male❑

(37) What is your current employment status?

Self employed❑ Unemployed❑ Retired❑ Employed full time❑
Employed part time❑ Student❑ Other❑

(38) What is your estimated annual household pre-tax income?

£0-10,000❑ £10,001-£20,000❑ £20,001-£30,000❑ £30,001-£40,000❑

£40,001-£50,000❑ £50,000+❑

(39) What is the highest level of educational qualification for which you have received a certificate?

Degree, or degree equivalent and above❑ Other qualifications❑ No qualifications❑

Thank you: You have reached the end of the questionnaire.
Please return your completed survey AS SOON AS POSSIBLE using the postage-paid envelope.

Thank you for taking the time to complete this survey. Your responses are greatly appreciated and will make an extremely valuable contribution to our research.