Towards Flexible Interior Design:
A system of interior design innovation for cluster housing developments in Taiwan

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Faculty of Design, Swinburne University of Technology

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Signed declaration

This thesis contains no material which has been accepted for award of any other degree or diploma, except where due to reference is made in the text of the thesis. To the best of my knowledge, this thesis contains no material previous published or written by another person except where due references is made in the text of the thesis.

Signed

Kuo-Hsun Wen

Dated
Table of Contents

Abstract  iii  
Acknowledgements  iv  
CD-ROM for PC and MAC  v  
List of Illustrations and Tables  vi  
List of Abbreviations  viii  

Introduction  1  
Chapter 1: Housing design and commercial development in Taiwan  17  
Chapter 2: User-centred design  27  
Chapter 3: Customisation and mass production  40  
Chapter 4: Challenges of mass customisation to Taiwan: Open Source Building and Mobile Architecture  55  
Chapter 5: Housing design and development in Taiwan: exemplifying the issues  64  
Chapter 6: An integrated model of interior design  89  
Chapter 7: Exemplifying with user scenarios  104  
Conclusion: A new paradigm for cluster housing development in Taiwan  133  

Bibliography  137  
Abstract

In Taiwan short-term profitability rather than long-term social sustainability propels housing development, with the result that the interior layouts of individual dwellings do not meet the immediate and changing requirements of occupants. The current inflexibility of Taiwanese housing and interior design can also be traced to the dominance of concrete as Taiwan’s primary construction material and the tendency of Taiwanese governments since WWII to leave design standards in private housing to the market. The inclusion of case studies identifies flaws in the development process as it applies to the cluster housing development sector, showing how these have led to inferior design and the waste of significant financial, human and material resources. In response the research proposes a system of flexible interior design based on a combination of user-centred and participatory design processes, customisation principles from product design and manufacturing and N.J. Habraken’s concepts of Open Building and Open Source Building. Referred to as the ‘base building system’, this innovative approach facilitates sustainable architecture and interior design in contrast to current inflexible, developer-driven approaches in Taiwan. The adaptable interior design and construction system allows ready tailoring of interior design to the needs and preferences of individual occupants while making later modification more straightforward. This is demonstrated in the accompanying CD, which simulates a web-based program prospective home buyers might use to participate in the interior design of a unit in a typical Taiwanese private cluster housing development.
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CD-ROM for PC and MAC
List of Illustrations and Tables

Table 1: Definition of key terms 15
Figure 1: Human-centered design processes for interactive systems 30
Figure 2: Research Methods (Hanington 2003, p.13) 31
Figure 3: QFD and participatory design (Kantio, 1998) 33
Figure 4: Lampel & Mintzberg (1996, p.24) 52
Figure 5: Supply Chain Strategy Management Identification Matrix 53
Figure 6: Womb: work, office, meditation bare, by J. Chou (Mostaedi, p. 23) 61
Figure 7: Vinyl Milford by A. Wexler (Mostaedi, p. 193) 61
Figure 8: Current Taiwanese 'one-size-fits-all' cluster housing unit, Tainan (2006) 65
Figure 9: Current Taiwanese 'one-size-fits-all' cluster housing unit, Jen Tei, Tainan County (2006) 66
Figure 10: Current Taiwanese 'one-size-fits-all' cluster housing unit, Tainan (2006) 67
Figure 11: Demolition and rebuilding of internal partitions, Long-Full display house 69
Figure 12: Plan alteration, Long-Full display house, Tainan (2004) 71
Figure 13: Remodelled interior, Long-Full display house, Tainan (2004) 72
Figure 14: Remodelled interior, Long-Full display house, Tainan (2004) 73
Figure 15: Interior construction, Long-Full display house, Tainan (2004) 74
Figure 16: Interior construction, Long-Full display house, Tainan (2004) 75
Figure 17: Plan alteration, Tzeng house, Tainan City (2002) 77
Figure 18: Remodelled interior, Tzeng house, Tainan (2002) 78
Figure 19: Remodelled interior, Tzeng house, Tainan (2002) 78
Figure 20: Interior construction, Tzeng house, Tainan (2002) 79
Figure 21: Interior construction, Tzeng house, Tainan (2002) 79
Figure 22: Plan alteration (1f~2f), Wang house, Tainan (2002) 81
Figure 23: Plan alteration (3f~5f), Wang house, Tainan (2002) 82
Figure 24: Remodelled interior, Wang house, Tainan (2002) 82
Figure 25: Remodelled interior, Wang house, Tainan (2002) 84
Figure 26: Interior construction, Wang house, Tainan (2002) 85
Figure 27: Interior construction, Wang house, Tainan (2002) 86
Figure 28: Stage 1, Planning and Development 90
Figure 29: Stage 2, Programming and Design Development 91
Figure 30: Stage 3, Pre-Sale 92
Figure 31: Stage 4, Construction 93
Figure 32: Stage 5, Operation and Sale

Figure 33: The application of a user-centred design approach to the housing development process

Figure 34: An example of the width to height relationship of the base building system

Figure 35: An example of the base building system for one unit of a cluster housing development

Figure 36: New integrated process and homebuyers’ engaging points

Figure 37: An example plan of maximizing choice and adaptability in housing design according to Friedman

Figure 38: Friedman’s chart describing alternative designs and components offered to homebuyers under a marketing framework

Figure 39: Friedman’s diagram of different kitchen and bathroom configurations with associated fittings

Figure 40: The four independent building systems: base building, service roughing, full service, interior design.

Figure 41: Flexible response to homebuyers’ needs

Figure 42: Floor grid system 2007

Figure 43: Building stages 2007

Figure 44: Floor grid system 2017

Figure 45: Building stages 2017

Figure 46: Floor grid system 2027

Figure 47: Building stages 2027

Figure 48: Changes to floor and floor voids

Figure 49: Changes to internal walls

Figure 50: Changes to internal plumbing

Figure 51: Changes to interior fittings

Figure 52: Percentage of floor space changed

Figure 53: 3D view of each floor 2007

Figure 54: 3D view of each floor 2017

Figure 55: 3D view of each floor 2027
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact disc</td>
<td>CD</td>
</tr>
<tr>
<td>Compact disk-read only memory</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>Design for assembly</td>
<td>DFA</td>
</tr>
<tr>
<td>Lifetime homes</td>
<td>LFH</td>
</tr>
<tr>
<td>Post-occupancy evaluation</td>
<td>POE</td>
</tr>
<tr>
<td>Quality function development</td>
<td>QFD</td>
</tr>
<tr>
<td>Total quality management</td>
<td>TQM</td>
</tr>
<tr>
<td>User-centred design platform</td>
<td>UCDP</td>
</tr>
</tbody>
</table>
Introduction

In *Towards a New Architecture* Le Corbusier argues that, ‘The problem of our epoch is the problem of the house.’¹ Almost a century after these words were written the aim of transforming society for the better through enlightened housing design and construction has still not eventuated. Leading architects of the early twentieth century sought to reinvent housing through the application of new industrial materials and mass-production. Walter Gropius hoped that industrialized construction processes could ‘meet the public’s desire for individuality and offer the client the pleasure of personal choice and initiative without jettisoning aesthetic unity.’² Current socio-economic realities in a post-modern world suggest the demand for material and aesthetic variability continues. The economic philosophers Michael Hardt and Antonio Negri describe today’s global populations as a ‘multitude fundamentally engaged in the production of differences, inventions, and modes of life, [which] thus must give rise to an explosion of singularities.’³ They recognize that, ‘these singularities are, of course, connected and coordinated according to a constitutive process that is always repeated’, but still regard contemporary societies as existing in a state of ‘paradoxical unity composed only of differences.’⁴ For Hardt and Negri this shift has produced complicated and far reaching political and cultural effects. However, it has practical significance for anyone developing products for the marketplace since these must at once meet mass production constraints but be responsive to the desire for singularities. Globally, striking a balance between customisation and mass production in housing and interior design remains an unsolved issue. This is particularly so for Taiwan.

Issues and challenges in the Taiwanese Housing Industry

The Taiwanese housing industry has shown little interest in the advances in building methods, materials and processes developed by innovative industries that could make construction more flexible and responsive to user needs. In Taiwan houses continue to be built with inflexible materials such as concrete and brick, including internal partitions. Such materials cannot be readily adapted to the changing needs and preferences of occupants. The research revisits the idea that the combination of user-centred design and lessons learned from manufacturing industries could radically improve outcomes for homeowners in Taiwan. The proposed base building system represents an original and innovative combination of user-centred and participatory design.

⁴ Ibid.
processes, customisation principles from product design and manufacturing and N.J. Habraken’s concepts of Open Building and Open Source Building. The research contends that without sacrificing profitability the Taiwanese housing sector could take far greater account of occupants’ needs and preferences while creating housing designed to facilitate modification over the life of a home. Houses that better suit peoples’ needs through their interior design and which can be efficiently adapted to changing needs over time will create less drain on Taiwanese society, have significantly less impact on the environment, and be potentially more commercially viable than existing ones. In addition, the challenge of an ageing population, which will increasingly affect Taiwan, makes the need for more adaptable housing a growing social imperative.

This introductory chapter addresses how resistance to change has generally affected the quality of products offered by the Taiwanese housing industry, with particular reference to cluster housing developments. It concludes with an outline of the overall project.

**Material and construction issues: the power of reinforced concrete**

The Taiwanese housing industry currently creates housing products that have serious material and design problems. The situation in 1996 is described by Knapp thus: ‘Specialists continue to observe in both Taiwan and Fujian that materials are often used wastefully because of lack of experience and poor designs. Multilevel dwellings continue to be built without the benefit of architectural or engineering expertise.’ Knapp also observes the use of two dangerous building materials – radioactive steel and sea gravel – the latter with particular consequences. Sea gravel, he explains, ‘has high salt content that is said to be sufficiently corrosive to cause concrete to disintegrate and crumble, resulting in the collapse of multistorey structures’. This situation is indicative of the state of the Taiwanese housing sector, where construction practices are often left to the market to develop.

Following the 1999 earthquake that killed 2200 and left many homeless, the Taiwanese government has focused attention on structural materials, including wood, which is earthquake resistant. According to Farzad Naeim poor construction techniques contributed to the scale of

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8 Ibid., p.791.
the disaster and judging by current practices the lessons have yet to be learned.\textsuperscript{10} Reinforced concrete is widely used in new dwellings although, as Hsieh and Forster show, the quality of Taiwanese residential construction declines dramatically and consistently at higher production levels.\textsuperscript{11} The implication is that dwelling units from the construction boom of the 1990s are especially at risk. In addition to poor materials, Qiang notes that, ‘It is commonly seen in Taiwan that occupants rearrange the interior or exterior walls and or windows by their own will without knowing the consequence of the change of stiffness of the building’.\textsuperscript{12} Providing for flexible interior construction using materials and frameworks that have been assessed as earthquake resistant, as in this project, may help address this concern at the same time as providing for the singularity or personal style preferences of individuals.

Reinforced concrete construction, which is a labour, power and water-intensive building material, dominates the Taiwanese housing sector and the Taiwanese economy in general.\textsuperscript{13} As a consequence the Taiwanese housing industry is only locally competitive and is increasingly exposed to global shortages of skilled construction labour.\textsuperscript{14} The political and economic influence of concrete construction has resulted in Taiwanese architecture education emphasizing the use of reinforced concrete rather than more innovative environmentally and socially sustainable alternatives such as wood.\textsuperscript{15} There is also limited application of flexible, efficient, technology-driven manufacturing processes from other industries.\textsuperscript{16}

The reluctance to adopt industrially produced building components has been influenced by past problems with such components. The pre-fabrication of building components began in Taiwan in the late 1960s. Sarja notes that in the late 1970s, ‘most house owners were unsatisfied with the prefabricated product.’\textsuperscript{17} The main complaints documented included:

\begin{itemize}
  \item M. L. Farzad Naeim, ‘The 1999 earthquake disasters worldwide: how many times do we have to re-learn the fundamentals of seismic engineering?’, \textit{The Structural Design of Tall Buildings}, Vol. 9, No. 2, pp. 161-182.
  \item According to statistic data of ‘Occupancy Permit in Taiwan and Fuchien Area — By Materials in 2003’, the Total Floor Area is 26,497,263 (sq.m.) The Total Floor Area built by Reinforced Concrete is 19,539,935 (sq.m.) that is about 74% of Total Floor Area. Source is from Construction and Planning Agency, Ministry of the Interior, Taiwan.
  \item The ‘Investigation of Construction Industry Economic Situation in Taiwan and Fuchien Area 2003’ states that the total number of employees of the construction industry in 2002 is about 229,000 persons. Counting by different categories, the percentage of technicians and professionals is about 42.7%. Source: Construction and Planning Agency, Ministry of the Interior, Taiwan.
  \item Ibid., p. 58.
\end{itemize}
1. leakage in joints and roof;
2. noise due to improper joint seals;
3. lack of flexibility to change interior partitions;
4. inefficient interior design; and
5. a sense of low quality due to inconsistent tolerances.

As a result, prefabricated building units languished unsold in the market place and many firms went bankrupt. Sarja also argues that under current conditions developers are generally concerned about how prefabricated housing will affect construction schedules and sales, influence building marketability, meet users’ functional requirements and reduce construction costs. He argues, moreover, that innovative construction methods are widely needed in housing markets around the world, Open Building and Base Building being proposed as one answer to this need. In his most recent writing Sarja proposes a sustainable approach to building construction and remodelling through the life cycle of different architectural structures. This position parallels that proposed in this thesis as a means of addressing issues in the design of cluster housing in Taiwan.

**Demographic and economic issues**

There are numerous reasons for the poor state of Taiwan’s housing sector. For the years 1952 - 2000, Taiwan’s average annual economic growth rate was 8.3%, and GNP increased from US$196 to US$14,126 per capita. As a developing nation experiencing sudden urbanization, the main requirement was to build as much housing as practicable as quickly as possible. During the period of rapid urbanization there was little interest in or research into housing suitability or satisfaction in Taiwan. Similarly, the Taiwanese housing industry did not develop frameworks for tailoring interior design to the requirements of individual occupants. The disparity between housing products and occupants’ needs and expectations is consequently chronic in Taiwan. Thus, it is no surprise that the only consistent finding in surveys of Taiwanese homeowners is that interior design quality is their most significant concern.

In Taiwan post-war economic growth and urbanization have been accompanied by significant social and demographic change. For example, between 1975 and 2004 the average number of persons per household decreased from 5.27 to 3.16, a change driven by a slowing rate of annual

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18 Ibid.
19 Ibid, p. 60.
20 Sarja, *Integrated life cycle design of structures*.
population increase and resulting in an ageing population.\footnote{Table 8 Population by sex, rate of population increase, average persons per household, density and natural increase rate. Available at http://eng.stat.gov.tw/public/data/dgbas03/bs2/yearbook_eng/y008.pdf} Despite the recent introduction of government subsidies for older Taiwanese, family support and co-residence continue to be key characteristics of an ageing population and will be in the mid-term.\footnote{A. Chan, A. E. Biddlecom, M. B. Ofstedal Albert and I. Hermalin, \textit{The Relationship Between Formal and Familial Support of the Elderly in Singapore and Taiwan}, 2003. Also H. L. Jernigan and M. B. Jernigan, \textit{Aging in Chinese society: a holistic approach to the experience of aging in Taiwan and Singapore}, New York, Haworth Pastoral Press, 1992.} For the 1964-1999 period Su, Lin and Wang show that the construction industry has had a significant effect on the economy and that maintenance and repair construction is a growing sector.\footnote{C.-K. Su, C.-Y. Lin and M.-T. Wang, \textit{Taiwanese Construction Sector in a Growing 'Maturity' Economy, 1964-1999"}, \textit{Construction Management and Economics}, Vol. 21, October 2003, p. 719.} The housing sector and the Taiwan economy in general needs to cater to ongoing demographic change through the development of more appropriate housing or suffer economic disruptions that could be significant.

Taiwan has a very high percentage of homeowners who intend to move or renovate to achieve the type of home they require. Census data for 1992-2000 shows that 26\% of householders in Taiwan intended to purchase a new home or renovate an existing one over the next three years, with up to 70,000 households wanting to renovate.\footnote{Taiwanese Census 1992-2000, Department of Statistics, http://www.moi.gov.tw/stat/english/index.asp} According to Tu’s investigation on housing renovation in Taiwan from 1992-1995 more than 26\% of interviewees undertook renovation and among these one third, including owners of new homes, had entirely remodelled their home, indicating the importance of interior quality to householders.\footnote{K.-J. Tu, \textit{The Character of Housing Renovation Needs in Taiwan"}, \textit{Journal of Architecture}, No. 39, February 2002, p. 92.} A significant percentage of new homebuyers will completely remodel the interior of their homes to achieve the living conditions they require.

However, concrete construction makes renovation difficult, expensive and highly wasteful. The cost and regulatory impediments to renovation continue to provoke families to move rather than renovate an existing dwelling. Based on a study in Taipei and 1990 census data, Chang, Chen and Sommerville argue that, ‘Additions to multi-family dwelling are difficult, costly and typically illegal; hence, to satisfy a demand for increased housing services, households must move.’\footnote{C.-O. Chang, S.-M. Chen, and T. Somerville, \textit{Economic and Social Status in Household Decision-making: Evidence Relating to Extended Family Mobility"}, \textit{Urban Studies}, Vol. 40, No. 4, 2003, pp. 733-746.} Forward projections from 1999-2000 suggest more than 420,000 new dwellings will have been purchased within the three years 2004-2006.\footnote{Taiwanese Census 1992-2000, Department of Statistics, http://www.moi.gov.tw/stat/english/index.asp} Such evidence suggests that the provision of an open building renovation process such as proposed in this research could circumvent forced moves and illicit building activity.
Although it is important to provide homebuyers with housing they consider individually acceptable to avoid disruption to individual lives, positive social outcomes are also achievable through better housing design. Given the small average size of houses in Taiwan and the high-density of urban areas, ‘smarter’ housing design could significantly improve the life of the majority of Taiwanese. The poor match of private housing stocks to the present and future needs of the rising number of aged Taiwanese is a looming issue. Flexible, user-centred interior design employing open building methods could enhance the responsiveness of dwellings to individual needs and preferences, as well as the ease and economy of modification.

Cluster housing developments in Taiwan

Housing in Taiwan comes in a variety of forms. Between 1961-1975, the four-storey apartment building and three-storey street house began to replace the well-established Japanese style courtyard house and two-storey dwelling. In the period 1976-1990, cluster housing, both private and public, appeared and grew in popularity. Despite limited land availability, detached and semi-detached houses made up 65.2% of total Taiwanese households in the year 2000, indicating the Taiwanese preference for lower density living.29

In focusing on cluster housing developments in the private housing market this research targets a socially significant segment of Taiwan’s housing supply. Su defines cluster housing in the Taiwan context as ‘a high rise dwelling community, or a cluster of community buildings. The number of buildings varying from two to ten or so depending on the size of the lot’.30 Home ownership, preferably on one’s own piece of land, is perceived as a sound investment for the Taiwanese. Hsueh has shown that even when house prices were high in the 1980s, the expectation of appreciating house values continued to fuel a moderate increase in ownership.31 Since the 1980s the combined effects of increasing housing prices, greater mortgage payments and the expense of more permanent housing in all forms in Taiwan have made investment in housing a considerable economic commitment on the part of individual Taiwanese and Taiwanese society as a whole, underscoring the need for rigorous investigation of practices and principles in the housing sector.32

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31 Hsueh and Chen, pp. 367-388.
When dwellings are built as a group there is a strong leaning to uniformity of design. Identifying design processes and construction methods to overcome the 'one-size-fits-all' mentality typical among Taiwanese developers is the major challenge for the housing industry in delivering products that better fit the needs and preferences of purchasers. While factors such as who owns a dwelling, dwelling age, family life cycle and total household income influence perceptions of the need for renovation in private housing, maintaining housing stocks is important to preserving the value of an individual’s investment. Identifying design processes and construction methods to overcome the difficulty and expense of renovating houses in Taiwan is an equally pressing issue. The research addresses both problems simultaneously.

The importance of the ‘Pre-Sale’ window in Taiwanese cluster housing development

Currently, the four stages of Taiwanese housing developments are ‘planning’, ‘design’, ‘construction’ and ‘operation and sale’. A ‘pre-sale’ window, where homebuyers financially commit to a housing unit, overlaps the design stage. The most open and formative stages of a development are the ‘Planning’ and ‘Design’ stages but these are long past when sample designs are shown to potential homebuyers in a near-site marketing suite. Sample designs are neither flexible nor modifiable in Taiwan because of the influence of construction and marketing factors and their variables over the development process. The ‘Pre-Sale’ window, however, presents an opportunity to offer a measure of customisation in the interior layouts of cluster housing units.

The ‘Pre-Sale’ window developed in Taiwan around 1970 to encourage purchasers with secure employment and stable incomes to sign up to developments as early as possible. According to Lai, Wang and Zhou, the presale system is a risk-sharing arrangement that avoids the potential for bankruptcy on the part of developers. The ‘Pre-Sale’ window involves a set of sequential payments — deposit, construction payment and mortgage — that spread the payment period over a longer time for buyers though its major value is for the developer. Homebuyers pay a deposit in advance, normally ten percent of the total purchase cost. When construction begins, usually after around six months, homebuyers pay another five percent of the total purchase cost as a second payment. Homebuyers normally wait a further eighteen months for a development to be completed and the property to be transferred to them, at which point they begin making mortgage payments to their credit provider. Although some units in a development can remain unsold when construction is completed, the ‘Pre-Sale’ window means that at least two thirds of purchasers are

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committed for much of the development process, since developments do not usually go ahead until this level of pre-sales has been reached.

Currently, developers and builders initiate speculative housing projects using real estate agents to sell units ‘off the plan’ to get a development off the ground. In general, if one third of units are pre-sold construction will proceed in Taiwan. The planning and design stages of a housing development are consequently strongly influenced by the decisions of marketing professionals, whose overriding motive is to maximize profits. This has led to short-term development objectives that rarely focus on the actual needs of homebuyers and which preclude dialogue between designers and homebuyers. Developers do sell units as finished exteriors, allowing homebuyers to determine the interior design and fittings for themselves. However, in such cases architects design the concrete shells with little concern for interior design, meaning purchasers incur great expense in modifying original layouts. The design system proposed in the research leverages purchasers’ early financial commitment to a unit to involve them as participants in the interior design process, transforming the ‘Pre-Sale’ window into an advantage for both buyer and developer.

**Project aims and rationale**

The research proposes that a process of user-centred design be applied as a feedback mechanism to enhance the flexibility of interior layouts in cluster housing developments. The research adapts models of user-centred and iterative design developed in industrial and product design to the specific demands of housing development and interior design in Taiwan. Presently, the most important decisions about interior design are made by developers and marketing professionals at the inception of a development. Through the proposed base building system homebuyers become participants with developers and designers in the design process. The application of Open Building principles to the base building system allows the components of any system in the home to be altered without requiring the replacement of the entire system. Developers become ‘integrators’, offering a process of customisation that tailors housing products to the needs of buyers. Designers become ‘facilitators’, supporting homebuyers in realizing their needs and preferences through the modification of interior layouts for an extended period of the development process.

In product design, products can be shown to potential users prior to manufacture using prototypes. However, full-scale prototypes are not feasible in housing development and in any case tend to give a static picture of design solutions. This research recommends the use of open building principles and user scenarios to offer a form of prototyping to developers and
homebuyers. The application of case and scenario based analysis to housing design in Taiwan has been explored previously but its specific relevance to interior design and cluster housing remains underdeveloped. This research explores these strategies through a multimedia based process of user-centred design.

The research identifies five key ways in which the base building system and associated user-centred approach resolves problems and shortcomings in the design of Taiwanese cluster housing projects. In combination they:

1. promote a design process that is more flexible and takes into account the needs of different occupants;
2. result in more cost-effective customisation of housing developments;
3. provide developers and marketing professionals with innovative housing forms that offer real scope for competitive market advantage and enhanced development strategies for the future;
4. provide architects and interior designers with a design process that better orients their design work to current market demands; and
5. identify a new paradigm of values and principles in respect of Taiwanese housing design.

The research focuses on the scope to design flexibility into the interior component of cluster housing developments. To achieve this in actuality will require substantial changes to current construction methods and materials and the provision of services like gas, water and electricity. Building codes will also need to be modified significantly. While the viability of the new model is supported by construction practices in many countries, a timeline and evaluation of the feasibility of such changes in Taiwan remains to be developed in further studies. The research presents a concise normative model of a design process against which defects and potentials in Taiwanese cluster housing developments can be recognized, not a fully developed and tested design system.

Author's expert knowledge

In addition to drawing on relevant literature this proposal for a reframed interior design process draws on the author's first hand knowledge and experience as an interior designer and tertiary design educator in Taiwan from 1993 to the present. My principal industry involvement has been with residential projects requiring major demolition of new dwellings to better meet clients’ needs and preferences. Under these circumstances I have continually run up against the rigidity of Taiwanese building methods and development processes, the frustration of this experience.

inspiring the present study. This insider knowledge is critical to the feasibility of the characteristics of this innovative proposal while a major goal of the research is to create contextually specific knowledge that can be fed back into the Taiwanese housing development and interior design industries.

In addition to knowledge production, my personal and professional development as a designer and design educator is also an important motivator for the study. This is especially in the sense of equipping me with information and conceptual perspectives that empower me as a designer and which consequently enable me to empower the purchasers of cluster housing developments to achieve better design outcomes. Some of the examples I use below to identify the current issues for housing in Taiwan are based on my own practice. This is another concrete example of bringing my knowledge and experience to this project.

**Structure of the research project**

The research draws on many bodies of thought as relevant to the introduction of flexible interior design in Taiwanese cluster housing. Accordingly, there is no 'literature review' as such. Theoretical sources and relevant design examples are discussed as they relate to the immediate matter under consideration. Consistent with multimodal forms of communication and argument in design, this document employs a number of original diagrams that explore issues and ideas in place of written explanation.

The document is comprised of an introduction, conclusion and seven body chapters. Chapter one, ‘Housing design and commercial development in Taiwan’, reviews housing design and commercial development in Taiwan, focusing on the designer client relationship. Chapter two, ‘User-centred design’, examines principles of user-centred and participatory design as appropriate approaches for overcoming the problems and shortcomings in the current market and developer driven models of interior design in the Taiwanese cluster housing sector, thereby achieving new synergies between interior design and user needs and preferences. Having fundamental introduction to customisation and mass production in chapter three, chapter four, ‘Challenges of mass customisation in Taiwan’, explores the potential of Open Source Building for mass customisation in Taiwan. Chapter five, ‘Housing design and development in Taiwan: exemplifying the issues’, uses actual examples from the author’s experience of interior design and housing development in Taiwan. The case studies highlight 1) the lack of co-operative relations and commonality of purpose between developers, marketers, architects and interior designers and 2) the difficulties that concrete construction and the dispersed disposition of services create when the modification of dwellings is attempted. This chapter serves as a prelude to the integrated
model of open source base building proposed by the research in chapter six. In chapter seven user scenarios are developed as the principal tool for offering customised design for clients. The concluding chapter then draws together the threads of the arguments and examples. It outlines the key elements in reframing housing development and interior design in Taiwan, including the need for Open Source Building that incorporate the user-centred, iterative design processes examined previously.

The examination of a wide range of design models and concepts, such as user-centeredness and mobile architecture, extends beyond the specific principles and practices necessary for an Open Source Building program. Seeing the design innovation in the relevant local context of Taiwan is critical to the full understanding of what is being proposed. In addition, an examination of approaches and models of design research applicable and needed in this setting has not been previously accomplished. As such, the thesis makes a significant contribution to the current deficit in the research literature in interior design. The summary and discussion section of each of the early chapters reviews the issues presented in the chapter and then discusses the issues of application to Taiwanese housing development and cluster housing in particular.

The interactive CD

Langendorf argues that, ‘the interactive, evolutionary nature of exploration and decision making suggests that interactive systems enable more complex problem-solving…Computer-aided visualization may make information understandable and usable to a wider diversity of individuals – groups that previously may not have recognized the relevance of such information.’36 The use of increasingly sophisticated three-dimensional visualization software in design industries is driven by the belief that such imagery is one of the most natural ways to communicate with clients and end-users.37

Accompanying the document is an interactive CD containing scenarios of use that demonstrate the principles of Open Building and the Open Source Building system to prospective homebuyers. Lange argues that architectural innovation demands comparable innovation in methods of architectural representation, architectural models performing, ‘a dual communicative function’ by demonstrating changes in methods, materials, technologies and design philosophies to clients at

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the same time as presenting the case for why the new should be embraced. Attentive to this requirement, the interactive digital visualization performs ‘the combined roles of informant, translator and advocate’ in representing how user-centred design can be incorporated into the housing development process. It demonstrates to potential stakeholders, that is, developers, marketers, architects, interior designers, government officials, politicians and homebuyers, the flexible interior design that can be achieved through the base building system, including its adaptability to occupant’s changing needs and preferences. This is demonstrated through user scenarios that trace how the same occupant might modify their dwelling over time.

Advocacy is critical here, revised regulatory frameworks, changed industry and consumer attitudes as well as the development of a supply chain to provide new, standardized building products being intrinsic to the implementation of the Open Building concept. The animated sequences demonstrate the constitution and value of the base building system, flexible floor system and interior design, including its important assembly and disassembly features. By demonstrating the flexibility of the new system through compelling animated sequences that highlight the application of modular partitions, flexible floor and ceiling systems, the extendibility of the service dock and how the system facilitates flexible interior design, developers, contractors, sub-contractors and manufacturers in the building industry are challenged to consider adopting new construction methods and materials.

Visualizing what the new building system can offer is vital to winning over Taiwanese homebuyers, who show little awareness of the poor interior design the Taiwanese housing industry offers. Typically, they only recognize the shortcomings of the dwellings they have purchased in early occupancy. The dynamic form of the three-dimensional visualization contrasts the limitations of existing housing products to the new flexible system proposed in the research. The animated images describe:

1. the capacity to modify the basic structure of a dwelling;
2. the flexible floor and ceiling system;
3. the nature and advantages of the central service dock;
4. the possibility of applying flexible design as solution to interior design; and
5. the principles of design for assembly and disassembly that are intrinsic to the open building system.

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The animated construction and disassembly sequences demonstrate the variability achievable through the base building system by contrast to the rigidity and uniformity of current Taiwanese house design. The animated scenarios also simulate a process of participatory design as it might occur with actual homebuyers during the pre-sale stage of a cluster housing development. It does this using a limited range of building components only, since to extend the scope and range of components in the visualization would require the creation of a huge data bank of elements to facilitate the potential breadth of user needs and preferences. Nevertheless, the program shows how the base building system operates and how it supports homebuyers to explore different design options.

In the case of housing, where it is not possible to generate full-scale models to support design iteration, three-dimensional visualizations give stakeholders who are not experienced in reading plans and architectural drawings a better idea of a design. King and his co-authors suggest that visualization provides a common language to which all participants — technical and non-technical — can relate, creating a platform where collaboration is feasible and achievable in the building industry. Three-dimensional visualizations are potentially superior to two-dimensional drawings in enabling homebuyers to identify design problems and shortcomings. For Al-Kodmany, the ‘fly-through’ or animated three-dimensional model is the most valuable in identifying design flaws and limitations.\(^40\) He argues that unlike plans, visualization allows the unseen to be seen, fostering profound and unexpected insights.\(^41\) In visualizing change the multimedia program is a more effective demonstration of the philosophy and operation of the base building system than a scale model, stressing the mutability of designs and architecture in a way that static drawings cannot. The 3D visualizations, moreover, can be presented to homebuyers via the Internet at various stages of the pre-sale stage, allowing homebuyers to explore options for an extended time and without the need to be in any one location as presently occurs with the display suite system.

If applied at the pre-sale stage of the development process the prototype tracks patterns of interest and need among homebuyers, including access to demographic, income and lifestyle groups. Such feedback will allow developers and designers to modify the base building system by predicting homebuyers’ needs and preferences so that individual consumers are not overwhelmed by choice. Potential homebuyers can use the dynamic 3D visualization of the base building system to simulate later rearrangements of internal features in line with lifestyle changes and life stages. Whether users purchase a unit or not, the visualization allows them to explore the principles and

\(^40\) Al-Kodmany, p. 14.
\(^41\) Ibid.
possibilities of interior design as a way of spreading the values of flexible, participatory design. If delivered over the Internet the application can be used without selling pressure. However, the data captured from individual users gives developers, marketers and designers the opportunity to track patterns of interest and need with considerable accuracy and detail.

The dynamic 3D visualization of the base building system requires limited knowledge and experience to use. During the pre-sale stage homebuyers can use it as a conduit for interaction with interior designers to explore alternatives in the:

1. positioning of internal partitions;
2. sizing and positioning of bathrooms and toilets;
3. sizing, positioning, conception and designation of most living spaces;
4. location of furniture;
5. application of colors, textures, materials and lighting; and
6. revision of all options as necessary or desired.

Recognizing homebuyers’ lack of design knowledge and experience, the prototype shows floor plans in three-dimensional form while including a standard range of interior layout options with assigned room functions. These, however, can be individually modified as required, the simplicity of the system facilitating design experimentation. Simple tools are available for adding building components, locating internal partitions and determining room functions to help homebuyers engage in actual design activity.

The three-dimensional visualization of the base building system is a tool in a process of user-centered design that allows homebuyers to work with developers, marketers and designers to achieve their needs and preferences. If applied at the pre-sale stage, it supports a high degree of product customisation while giving developers a competitive edge in the housing market through more attractive products as well as more informed and satisfied customers. Developers can use the visualization to review and improve their product offerings through the information gleaned by buyer interaction.

Definitions
The following terms are used throughout the document and defined where first used. Here I provide a brief definition:
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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| Cluster housing development               | The grouping of new homes onto part of a development parcel, so that the reminder is preserved as unbuilt open space.  
| Lean production                           | Optimising the production process through prefabrication and mass production. |
| One-to-one marketing                      | Also called relationship marketing or customer-relationship management, one-to-one marketing stresses personal interactions with customers and increases the value of a company’s customer base by promoting customer loyalty and more specific marketing. |
| Open Source Building                      | Enables new products, services and technologies to come together to create tailored, responsive built environments. |
| Parallel design                           | Parallel design is the simultaneous performance of related activities or tasks in the design process, normally using different design resources. It enables the completion of those activities faster than if they were done in a sequential manner. |
| Quality Function Development (QFD)        | A method of optimizing product and supply processes by incorporating what customers tell you into the planning process. |
| Social sustainability                     | Refers to 'policies and institutions that have the overall effect of integrating diverse groups and cultural practices in a just and equitable fashion.'  
| Sustainable development                   | In 1994, the International Council for Local Environment Initiatives defined sustainable development as, 'development that delivers basic environmental, social and economic service to all residents of a community without threatening the viability of the nature, built and social systems upon which the delivery of these services depends.'  
| Supply chain                              | Is the system of manufacturers, distributors, transporters, storage facilities and retailers that combine to produce a product and make it available for sale. These are typically 'linked together via a feed-forward flow of materials and a feedback flow of information.'  
<table>
<thead>
<tr>
<th>Sustainable housing development</th>
<th>Delivers the housing needs and wants of a current generation without preventing future generations from fulfilling their needs and demands.\textsuperscript{46}</th>
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<tbody>
<tr>
<td>User scenarios</td>
<td>Predictions of use based on the needs and preferences of representative or hypothetical homebuyers.\textsuperscript{47}</td>
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Chapter 1: Housing design and commercial development in Taiwan

This chapter identifies the historical, economic and demographic context for current cluster housing development in Taiwan. It explores how the developer and market driven nature of the sector has led to the marginalisation of designers and homebuyers in the design process. It notes the absence of values of social and environmental sustainability in the Taiwanese housing industry and the need for more direct participation of the user in the design process.

Historical context, government policy and environmental issues

The development of the Taiwanese housing sector was initially driven by the 1949-1953 land reforms enacted by the Kuo-Ming Tang (KMT), the political party that governed Taiwan under martial law from 1947 until 1984. Economic development policies put in place by the KMT made industrialization a priority. Legislative change altered the structure of land ownership, with supporters of the KMT often directly benefiting from speculative involvement in land development. The subdivision of large agricultural landholdings quickly transformed areas into urban and industrial zones, creating a culture of rapid, unplanned development that persists to this day. As agriculture became much less important to the Taiwanese economy a huge migration of people from rural areas to the cities took place. Where extended family structures characterised the largely peasant communities of pre-1950s Taiwan, nuclear families increasingly dominated the expanding cities, contributing to the booming housing sector and cementing the single family dwelling as the main housing type in Taiwan. Under the pressure of urbanization and population growth, the high demand for new housing affected the quality and style of houses with the prevailing approach being the production of houses for quick sale. In the growing urban areas houses changed from horizontal detached dwellings to vertical cluster housing using concrete as the primary building material.

Between 1950 and 1990, the Taiwanese housing market was fertile ground for developers and investors seeking profit. The period 1981-1990 saw a decrease in housing completions for residential use and in the total floor area of residential construction from a peak in the previous decade (1971-1980). However, thousands of similar developments were speculatively built with

51 Table 79. Avail at https://eng.stat.gov.tw/public/Attachment/533017374471.doc
little consideration for the quality of dwellings or their relationship to social needs. During the 1990s poor international economic conditions subdued the Taiwanese housing market. The more difficult market conditions of the 1990s reduced the size of housing developments in terms of the number of units and the size of individual dwellings. However, as Hsieh shows, the 1990s also saw a major construction boom and oversupply of residential housing driven by generous government subsidies to homebuyers. This kept house prices artificially high and prompted much unnecessary developer driven development, which ultimately led to bankruptcies, a significant number of vacant properties and a slump in housing prices into the present.\textsuperscript{52} Su, Lin and Wang note that:

\begin{quote}
Because of overbuilding, the Taiwan area now contains more than 1.2 million unoccupied housing units, according to the population and housing census by DGBAS in 2000, and the building construction output fell to under 50\% of total construction output in the late 1990s … The past unbalanced development, with oversupply of residential buildings and under-investment in infrastructure has seriously affected the competitiveness and productivity of the Taiwanese economy.\textsuperscript{53}
\end{quote}

Significant environmental issues such as air, ground and water pollution affect Taiwan’s densely populated urban areas. Since the later 1970s issues of ecological sustainability have increasingly entered mainstream public policy debates in Taiwan,\textsuperscript{54} influencing the formation of urban development policy.\textsuperscript{55} In the domains of public debate and government policy, environmental concerns are apparent in policies such as ‘green building’ and the strategic environmental assessment policies (SEA) although their implementation remains partial.\textsuperscript{56} The cost of housing and how well it serves the needs of individuals has broad social implications while being critical to the way people live their lives. As Koebel argues:

\begin{quote}
Housing, infrastructure, and other elements of the built environment are not readily part of our throwaway culture. Buildings last. And because the goal of sustainability is to have them last even longer, new approaches are necessary. It will be important, for instance, to understand that longer-lasting buildings will witness multiple occupants and multiple uses,
\end{quote}

\textsuperscript{53} Ibid., p.722
some of which we simply cannot foresee. Sustainable buildings must be designed to be adaptable to change in use.57

**Four demographic trends driving future housing demand**

While Taiwan currently has one of the highest rates of home ownership among developed nations, four demographic trends — declining population growth, an ageing population, smaller households and urbanization — will influence future demand in the Taiwanese housing market. Recent census data shows that Taiwan has experienced a distinct levelling in population growth. The average annual growth rate of the Taiwanese population decreased from a high of 3.7% during the period 1957-1966 to 1.2% from 1981-1990. The 2000 Taiwan census data reveals a further steady downward trend in population growth, with the result that between 1990 and 2000 Taiwan’s population structure shifted from a pyramid shape to a much flatter structure reflecting an ageing population. Moreover, 40.4% of the Taiwanese population over 65 years old are currently in need of special housing because of disability or illness.58 Flexible housing is important for Taiwan’s ageing population.

At the end of 2000, statistics showed a 17.6% vacancy rate in dwellings across the public and private sectors in Taiwan, while home ownership rates stood at 82.5%.59 This vacancy rate is relatively high compared to other developed countries, suggesting a need for conversion of existing housing stocks to manage the oversupply of dwellings. Escalating urban density is also a recognised issue in Taiwanese society. According to latest statistics in the 30 year period (1975-2004) population density/km² has increased from 448.8/km² to 627.0/km². Taiwan’s rapid urbanization has seen the proportion of the population living in the main urban areas of Taipei, Taichung and Kaohsiung growing from 25% in 1951 to 75% in 2000. Changes in population density over the past ten years reveal the population has shifted slightly from the northern region to the middle and southern metropolitan areas where the greater availability of land makes cluster housing developments an appropriate housing solution.

In sum, three issues confront the housing industry. First, existing housing stocks have little scope to be adapted to the changing needs of occupants as they age. The reality of an ageing population has not yet been recognized by the housing development sector through construction considerations like accessibility of doors and staircases and more generally through inclusive design in other areas such as kitchens and bathrooms. Second, unless Taiwanese developers

provide designs that allow for affordable, achievable remodelling to meet occupants’ changing needs over time, the number of vacant homes will only rise, significantly affecting the social sustainability of housing and the profitability of the commercial housing sector. Third, the population density in urban areas means that housing built to reflect occupants’ needs and preferences is of the essence in Taiwan, Yi showing that better interior quality of housing is the most pressing factor for the Taiwanese population. In the uncertain, post-1997 housing market, memories of repossessions and negative equity have meant that many Taiwanese no longer view housing as a temporary investment but rather as a permanent acquisition. The type and quality of lifestyle houses provide is now a more important factor in sales and marketing but this has not yet influenced higher quality or more innovative design, especially that which considers the social and environmental impact of housing. In addition, the lack of effective building regulations and the low professional integrity of developers, builders and architects offer little protection to homebuyers.

Developer and market driven housing

As is the case in many parts of the world, private housing in Taiwan is developer-led, the rapid realization of profit being the main driver in design and development. Marketing involves the public ‘profiling’ of a housing product and includes extensive media advertising, prominent billboards and the establishment of a marketing office and display suites. It is primarily concerned with the artificial stimulation of consumer desire and demand, where buyers choose between stylistically differentiated options provided entirely by the market. Purchasers wanting a dwelling on their own piece of land create the private market for homes in cluster housing developments in urban areas outside Taipei. Since supply currently outstrips demand developers seek to maximize sales through aggressive marketing strategies that stress the latest styling and luxury enhancements like spa facilities or home movie theatres.

Outside the use of glossy promotional brochures and plush show suites developers show little regard for the needs and preferences of homebuyers. Choice is limited to a basic range of alternate floor plans and fittings, denying the growing demand for individuality and personalization in a cultural context that has traditionally promoted the values of social conformity. Culturally familiar but homogenizing paradigms such as principles of Feng Shui constrain the development of innovative layouts and design processes. The uniformity of interior design in Taiwan is

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especially disguised by the use of model interiors where developers manipulate homebuyers’ expectations and perceptions. Taiwanese homebuyers are continually sold the illusion that developments will meet elevated standards of taste, amenity and individuality, the critical tension between unrealistic expectations and actual needs being a primary issue addressed by the research. The main source of information for product development should be prospective occupants.63 However, in Taiwan the high incidence of post-purchase redesign and demolition confirms little real understanding of what homebuyers actually want or need.

Architects and interior designers, who might suggest alternative design objectives to those of developers and marketing staff, have little influence in the development process. Architects’ plans are routinely changed without consultation if developers consider such changes will raise the marketability or profitability of developments. Moreover, in the development process architects mostly focus on the building shell, often having only a cursory interest in interior layouts. Expert interior designers are rarely called on to work with an architect during project planning. As a result houses are routinely completed without much thought about the actual needs of future occupants. Limited scope for customisation of interior design is available during the pre-sale stage and Taiwanese homebuyers typically accept marketer’s emphasis on ‘aspirational’ buying, reflecting Taiwan’s entrenched culture of consumerism.

The past ten years of recession in the Taiwanese housing market have forced architects to replace design values with market imperatives. Today they are more likely to be bit-players in a team of many. The main design decisions are made by developers and marketing professionals and there is little or no contact between designers and homebuyers. Only marketing and sales people work with buyers and then mostly in the pre-sale stage to motivate sales, providing little information to the design process. Developers use established market research methods such as surveys and focus groups to obtain information from potential homebuyers about their needs and tastes.64 These methods may quantify customers’ preferences from existing options but do little to identify qualitative needs people may not yet be able to articulate.65 Patnaik and Becker advise that it is preferable to integrate qualitative criteria into end user surveys using research methods drawn from sociology and anthropology.66

64 C. S. Y. Duh, The Phantom of Urban Landscaping: Reception Centers and Model Houses of the Real Estate ‘Pre-Sale System’ in Taiwan, Master Thesis, Graduate School of Architecture and Urban planning, National Taiwan University, 2000, pp. 32-34.
66 Ibid., pp. 50-57.
Location and Product, Price and Floor Area

In the absence of actual information, the key marketing points of ‘Location and Product’, ‘Price’ and ‘Floor Area’ become default design principles in Taiwanese cluster housing developments. Developers offer limited design options around these parameters, though they typically disregard the relevance of site-specific factors to design, seeing them rather as marketing features, especially as they affect the market value of properties.

Location and Product

In Taiwan, as elsewhere, proximity to and quality of existing infrastructure, neighbourhood status factors and the aesthetics of the location predominate. In terms of the house itself, the suitability of planning, alignment and layout, the quality and types of materials used and the facilities provided are stressed, particularly extra facilities that might enhance the property value, such as swimming pools or spas.

Price

Theoretically, price is divided into three categories: supply price, demand price and market price. Taiwanese developers usually base a property’s supply price on the estimation of total costs, including land price, building costs and profit margin while using the average price of existing housing in the area as a reference point. Demand price, on the other hand, arises from homebuyers’ demand for a housing product. The market price of a property represents the compromise reached through negotiations between developers and homebuyers. The market price reflects the actual value a property can fetch in the market. Marketing professionals carefully monitor trends in housing prices to establish a suitable price because price, along with flexibility in payment and mortgage arrangements are the key factors in influencing homebuyers to commit to a property. Developers also have to balance price against current interest rates since these have a strong influence on the affordability of housing products to homebuyers.

Floor Area

Maximizing space and providing the greatest range of amenities within that space within a price significantly affects the marketability of units in Taiwanese cluster housing developments and is consequently a central driver of design. This is despite the fact that floor space requirements — the relationship of area to function — shift according to changes in the circumstances of occupants, especially as they relate to life cycle.

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Designer client relations in Taiwan

According to Lawson, relationships in housing development revolve around the different combinations of four primary players, these being between client/developers, legislators/building regulators designers and user/homebuyers. These relations represent constraints that need to be confronted to improve outcomes for all involved in the development process but they also identify key intervention points where outcomes could be improved. In Taiwanese cluster housing developments decision-making is currently skewed towards developers. The traditional image of the architect establishing a personal relationship with a client who is the future occupant of a home does not apply in this sector, where many architects provide little more than a drafting service that converts developer demands into plans. Developers control the ‘lead’ companies in the construction industry and their decisions and preferences dominate both the design and construction process. Their control makes the architect’s task of understanding user needs and preferences inherently difficult.

Architects are seldom involved in project planning or recommending design options even though three separate parties — developers, architects and homebuyers — have a stake in the design process. Lawson argues that worldwide, ‘The vast majority of design … is commissioned by clients who are not themselves the users.’ For Michael Wilford, this creates inherent issues for design outcomes, since:

Behind every building of distinction is an equally distinctive client, not necessarily high profile, but one who takes the time and trouble to comprehend the ideas of the architect, is supportive and enthusiastic, who is bold, willing to take risks and above all can hold their nerve during the inevitable crises.

Wilford identifies the client as a creative partner in the design process but in Taiwan architects continually defer to developers while the future purchasers and likely eventual occupants of units in cluster housing developments never come into contact with architects. Ziesel calls this the ‘gap’ between the ‘paying client’ and the ‘user client’, arguing that it can cause fundamental problems even when there is good communication between designers and those directly paying

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72 Ibid.
73 Lawson, p. 108.
74 Tzeng and Haung, p. 24.
for their services. User-centred design demands direct interaction between designers and end-users through the institution of communication and design processes in which meaning is created and shared. Ideally, the design stage is where user clients express their needs and preferences to designers. If this were to occur in the case of Taiwanese cluster housing developments it would allow designers to then liaise with developers and marketing professionals on homebuyers’ behalf.

Building regulations

The authority of professionals is changing in Taiwan, their word no longer being taken for granted. Architects certainly no longer enjoy an unquestioned position of power within their area of expertise. As has occurred elsewhere, best practice guidelines have been established in Taiwan but are often devised and administered by outsiders to the housing industry, resulting in some transfer of power from individual developers, designers and homebuyers to a centralized, bureaucratic system that applies general standards. The rigidities imposed by legislative constraints are a real obstacle to the implementation of innovations including user-centred design to cluster housing developments in Taiwan. However, if the bureaucracy were enlightened to the benefits of user-centred design legislative frameworks could be an important mechanism in introducing innovation to the Taiwanese housing industry.

Most Taiwanese developers and architects view building regulations as a burden. There is persistent criticism of Taiwanese building regulations on the grounds that they are a cumbersome, bureaucratic and inflexible system that inhibits variety and imposes unnecessary costs. A raft of standards, codes of practice, guidelines and recommendations regarding safety, utility and appearance have to be satisfied for housing developments to meet conventional trade descriptions and gain permission to commence construction. Compliance with regulations concerning fire safety and structural integrity represents a level of standardization that restricts buyer choice and innovation in housing products. Moreover, current construction lead times cannot readily accommodate customised designs in Taiwan due to the allegiance to traditional building systems and construction methods, which are far too fixed to allow alterations at different stages of the development process.

Taiwanese building regulations also mean that if a new homeowner is dissatisfied with their dwelling, remodelling is an extremely complicated process requiring re-assessment of the entire

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building application. This usually occurs without the architect receiving additional remuneration, making them reluctant to become involved. Private interior design firms working under the instructions of owner-occupier clients are then typically called in to redesign the style and layout of new housing units to better accommodate homebuyers’ needs and preferences. Yet design possibilities are still limited by Taiwan’s rigid building codes. For example, fire safety regulations and rules governing a property’s required facilities or floor-space must be strictly observed when modifying a building. Remodelling of interiors by the addition of partitions different to the original interior partitions is closely checked before a usage permit is issued to homeowners. While interior design consultancies offer a client-focused service their approach overlooks socially and environmentally sustainable design values. In essence, these firms have colonized the market space created by developers’ inflexible and ill-informed housing designs. Rather than addressing the weakness of interior design standards in cluster housing developments by engaging in user-centred and participatory design approaches such consultancies reproduce these limitations through their own inflexibilities.

Summary and discussion
As has been outlined, the complex of historical and contemporary issues constitutes the present context for cluster housing development in Taiwan. A major disjunction exists between homebuyers’ needs and wants and what the Taiwanese housing industry currently offers purchasers. This disparity is maintained through the lack of consensual practices between developers, builders, marketers and architects. In this loose network of professionals interior designers are largely excluded from the process of housing development. Existing Taiwanese housing developments would be improved by adopting a flexible design process that could adapt to potential buyers’ needs and preferences. To facilitate improvement, units in cluster housing developments require the structural flexibility to facilitate change. To achieve this Hanington argues that end-users should be included at all important stages of design and have real power over decision-making.78

The drive for quick profits and the inflexibility of construction methods and materials are the major obstacles to the successful involvement of homebuyers in the development process for Taiwanese cluster housing projects. For a range of reasons already explored these combine to make developers and marketing professionals inherently uninterested in establishing homebuyers’ needs and expectations. This is despite the fact that the ‘Pre-Sale’ window offers a perfect opportunity to interact with prospective buyers and future occupants of a development before the

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nature of its interior design is fixed. Recognizing how developers and marketing professionals have largely usurped the role of designers in Taiwanese cluster housing developments establishes both the source of many future problems for occupants of such developments and the possible solutions. Only when architects are well-informed about homebuyers’ needs and expectations can they become sensitive to these needs and take responsibility for meeting them.

As a partial solution to the design of cluster housing developments in Taiwan qualitative occupant surveys would assist in bridging the gap in knowledge and understanding between marketers, designers and homebuyers, acknowledging the needs and opinions of occupants as central to the commercial success of the housing development sector and its standing in public opinion. For example, feedback can be gathered after a percentage of homebuyers have moved into a development or after potential homebuyers have visited reception centres and show suites. Proactive sampling of the spectrum of consumer needs and expectations would open up design possibilities, it being difficult for development teams to predict the needs of unidentified buyers. Traditionally, this means direct communication between designers and homebuyers and frequent, face-to-face meetings between all members of the design and development team. In chapters five to seven the research broaches more innovative approaches grounded in information and communications technology.

The following chapter examines user-centred and participatory design as the most relevant models for a new approach to Taiwanese cluster housing development. The value of user-centred and participatory design strategies are illustrated using a case study approach. Ultimately, user-centred, participatory design is combined with the concepts of Open Building and Open Source Building to enhance the flexibility and modifiability of developments without resorting to open-plan designs that fulfil no-one’s needs.
Chapter Two: User-centred design

This chapter reviews theories of user-centred design as a source of design principles relevant to the overall research aim of maximizing the flexibility and scope for modification of interiors in Taiwanese cluster housing developments. Where cluster housing developments in Taiwan are currently developer-led and profit-driven, user-centred design perspectives challenge developers and designers to directly acknowledge user needs and preferences in the design process in order to arrive at more appropriate and sustainable outcomes. After examining relevant principles of user-centred design, including the important subsidiary concepts of participatory design and user research methods, the chapter discusses current processes of interior design as they occur in Taiwanese housing developments. The aim here is to establish what is problematic about current approaches and the benefits of applying user-centred design methods.

A user-centred design paradigm

As Redström argues, designs are unlikely to gain approval and acceptance from users if based on “insufficient knowledge about people, their capacities, needs and desires.” Krippendorff notes that since the start of industrial modernism users of technology have been regarded as functional elements in a systems-type process where values of efficiency and productivity dominate. The idea of user-centred design has grown from debates in interaction and industrial design on product development, which as Hanington argues, is both human-focused and design-centric. Donald Norman coined the term ‘user-centred design’ at his computer research laboratory at the University of California, San Diego, in the 1980s, disseminating the idea of designing from the user’s standpoint through a string of publications, beginning in 1986 with User-centred System Design: New Perspectives on Human-Computer Interaction. Norman’s influential 2004 book Emotional design: why we love (or hate) everyday things restates his opposition to the approach of designers who regard the industrial, stylistic or technological aspects of products as their main design value, and who treat users as functionaries of a product or technology.

81 Hanington, pp. 9-10.
Norman’s general intention was to challenge product developers in the computer industry — where the use of products typically required specialist knowledge — to think carefully about who users actually were and to create products based on their perspectives, designers assuming the responsibility for ensuring users’ ability to employ products as intended after expending a minimum of effort on mastering their use. However, although Norman’s position on user-centred design appears enlightened his writings largely maintain the situation where end-users are objects of the design process and product developers remain the primary decision makers. In one text, Norman specifically cautions against soliciting users’ perspectives on how actions within a computer environment should take place. He limits the end-users’ role in product development to testing the performance of prototypes through a process where their capacity to complete tasks is observed. The limited participation of users in the design process and the continuing concentration of control over design decisions in designers’ hands remains a weakness in Norman’s program.

Today, user-centred design is increasingly concerned with humanizing products through greater contact between designers and end-users, countering the emphasis the computing industry places on user and usability testing to check the effectiveness of products in facilitating tasks. In supporting the idea of an interactive cycle of design, Hannington argues that user participation must begin as early as possible, ideally before any design has taken place, to develop an adequate perspective on users’ needs and preferences. For Hanington, this makes user-centred design very different from the late-stage testing routinely applied in new product development to evaluate prototypes or finished products but at a point where economic imperatives and manufacturing processes mean there is little scope to change designs in a significant way. There is a mounting argument to include users in the very early stages of design, including pre-ideation stages and extend participation to all relevant people who can contribute to the generation and evaluation of design concepts, O’Neill and Johnson arguing that, ‘knowledge about users’ practice and future use situations can only be obtained through cooperation with users’ and is the best way to achieve ‘better products.’

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86 Hanington, p. 2.
87 Ibid., p. 4.
User-centred participatory design

Participatory design — also known as cooperative design — emerged in Scandinavia, being born out of labour unions’ general push for workers to have more democratic control of their working environment and participation in workplace decisions.\(^9\) Participatory design can be seen as a particular form of user-centred design in which representative members of user groups collaborate with designers to propose design ideas and make design decisions.\(^9\) Luck represents participatory design as a social process that facilitates the transfer of user knowledge to the designer, who can then incorporate this knowledge for the user’s benefit.\(^9\) However, in affording power to users participatory design challenges the designer’s role in the design process, being potentially problematic in commercial design contexts for the time, expense and lack of control it builds into the design process.

Participatory design was formally acknowledged as an international design standard in 1999 through the promulgation of International Standards Organization Standard 13407: User-centred design Process for Interactive System or ISO/DIS 13407. ISO/DIS 13407 is strongly connected with the design of interactive computing systems but its positive validation of user participation challenges all designers and product developers to consider user participation as a core feature of a progressive design practice. ISO/DIS 13407 supports the philosophy of user-centred design with a body of research and literature on methods for implementing a user-centred design as an ‘Iterative Design Cycle’ that unfolds over five stages:

1. an awareness of the need for such a process;
2. an understanding of the contexts of use of the design product;
3. a set of requirements, especially those relating to usability is drawn up;
4. a design solution is proposed; and
5. that solution is evaluated.

This cycle is repeated through successive iterations until the product, system or service fulfils user requirements and matches the context of use. The application of parallel design and iterative development to the process of product design typically involves the use of mock-ups and user scenarios to model design directions.

Collecting feedback from actual or representative end-users early and often in the design process is the key to matching designs to users’ needs and preferences, avoiding unwelcome surprises at the end of the design process. However, there are currently no widely accepted methods for incorporating user input. Hanington argues that design needs its own integral methods to allow users to contribute ideas and knowledge about their needs and expectations to design. He categorises current user research methods into traditional, adapted and innovative categories, arguing all are more productive if those conducting the research avoid imposing their own values on the ideas and information people offer. The model of user-centred participatory design proposed in this project fits into the category of ‘innovative design’ while also incorporating adapted methods in the use of visual imagery as shown in the scenarios and product development process prototyped in this project.
Hanington’s analysis of adapted user research suggests how information about users’ needs, preferences and practices can be partly achieved through observation of users’ interaction in the real world with similar products. However, he challenges the usefulness of such empirical methodology in a user-centred design process on the basis that observation without consultation with users can simply reinforce designers’ assumptions about product use as well as user needs and preferences. Hanington thus argues that design needs its own innovative methods of conducting user research, which are oriented to design processes and appropriate to the characteristics and parameters of the design project for which information is being sought.\(^9^4\) His examples of innovative user research methods include having people produce visual diaries or involving them in design workshops, where activities like annotation of design prototypes, card sorting, cognitive mapping, collage and Velcro modelling are used to elicit ideas and opinions.\(^9^5\)

For Hanington, creative activity has better potential to get participants thinking and contributing high quality information to the design process than conventional activities like filling out surveys or taking part in interviews.\(^9^6\) An additional benefit of such practices is that information is

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\(^9^4\) Hanington, p.16.

\(^9^5\) Ibid, pp. 15-16.

\(^9^6\) Ibid, p.15.
configured as clusters of themes and ideas, often in visual form, the value of which should be evident to designers who as visual and spatial thinkers will recognize its greater relevance to the design process.

Participatory design and Quality Function Development
A comparison with an established product development framework known as Quality Function Development (QFD) may help illuminate the design stages and user participation in user-centred participatory design. Day notes that ‘quality function development … is one of a number of methods employed in manufacturing and service delivery to incorporate customer feed back into product development in order to optimize product and supply processes.’ In QFD customers’ satisfaction is the measure of product or service quality. Applied to the context of Taiwanese cluster housing, examining homebuyers’ opinions of previous products can be instituted both prior to and during the initial stages of a new housing development. The various approaches to QFD can be located on a scale that indicates both their participatory potential and relevance to product design stages. Kaulio clarifies this in providing the following definitions in which the relationship between designers and end users and the agency of both in the design process are indicated by the prepositions ‘for’, ‘with’, and ‘by’:

1. **Design for**: denotes a product development approach where products are designed on behalf of customers. Data on users, general theories and models of customer behaviour are used as a knowledge base for design. This approach often also includes specific studies of customers, such as interviews or focus groups;

2. **Design with**: denotes a product development approach, focusing on the customer, utilizing data on customer preferences, needs and requirements as in a ‘design for’ approach, but, in addition, includes displays of different solutions/concepts for the customers, so the customers can react to different proposed design solutions; and

3. **Design by**: denotes a product development approach where customers are actively involved and partake in the design of their own product.

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Participatory ergonomics provides perhaps the closest parallel to the kind of ongoing user participation QFD approaches could contribute to the design of Taiwanese cluster housing developments. The principle of ‘Lead User’ design is equally relevant here to the extent that those clients who commit to a dwelling during the pre-sale window can become ‘lead’ or representative users, providing feedback to designers about necessary modifications or the range of options a dwelling should facilitate to equate this with the needs and preferences of its target market.99

As the broken line in Kulio’s diagram indicates, in product design QFD is not considered a participatory method since engineering takes over prototype development following product specification, notwithstanding the fact that users’ needs are kept in mind. Ozaki recommends four strategies that developers and marketing professionals could apply to QFD to enhance product and service quality, these being, ‘good to talk’ (dialogue with client), ‘solicit needs and expectations’, ‘develop more individualized housing’ and ‘learn from failures.’100 Participatory and

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user-oriented product development remains on the agenda for housing development in Taiwan. The cases in the following section illustrate the inherent failure of current approaches to housing design and development in Taiwan, which range across the full spectrum from design and construction methods, to marketing strategies and communication with customers.

**User-centred housing and interior design**

User-centred design approaches have been applied to housing development under various names. In housing construction a common technology is the creation of user-driven selections within a flexible 3D virtual environment. However, initiatives such as the UK-based Lifetime Homes (LTH) described by Milner illustrate some of the gaps between policy and practice. Howes argues that internationally, ‘Construction has not followed other industries in applying advances in technology and management concepts to improve the quality of its products and value to its customers. Instead it has relied on outdated practices which have been more concerned with the process rather than the product.’ Certainly, the housing industry has tended to focus on cost structures and stylistics rather than the flexibility of interior layouts in its products. Carmon sees this as a consequence of mass housing being regarded as serving general functional requirements rather than specific personal needs. For Carmon, the reality is that in most developer-driven housing the interior elements of homes are completely standardized to the extent that there is almost no scope for user-controlled processes of interior design, where homebuyers participate in determining the nature of their living environment.

There is, of course, no sense of predetermined needs in the interior elements and organization of a home. Needs vary and can be accommodated in a variety of ways as suits individual occupants. There is also considerably more to housing design than its functional aspects. Forrest and Murie note that homeowners invest a large proportion of their time, energy and financial resources in creating and maintaining a desirable home. Houses must satisfy occupants’ requirements of privacy, intimacy, repose and even seclusion, design and decoration also representing their emotional investments, creative expression, personal values and perhaps even the spiritual aspects of occupants’ being. Kristensen and Groenhaug point out that, ‘spatial structures, including the dimensions of peoples’ homes and the containments of objects, artifacts, including also services

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and systems where applicable, affect people cognitively and emotionally.\footnote{T. Kristensen and K. Grønhaug, ‘Designing Total User Experiences: design, value creation and physical space’, The 5th European Design Academy conference Barcelona 2003, pp. 10-11.} On this basis they characterize design as being ‘concerned with planning and executing the design of total user experiences’ making ‘knowledge of users and their experiences seem primary.’\footnote{Ibid., p. 10.}

Nonetheless, addressing user experience through participatory, user-centred design to housing design is not without challenges. Barlow and Ozaki highlight the difficulties in applying user-centred design principles to ‘a multi-purpose, complex product [like a house] in which there is an infinite possible range of variations in size and shape, space and layout, amenities and finishes.’\footnote{J. Barlow and R. Ozaki, ‘Achieving “customer focus” in private house building: current practice and lessons from other industries’, \textit{Housing Studies}, Vol. 18, No. 1, 2003, p. 91.} They see this difficulty multiplied by the fact that, ‘Identifying user requirements and adding value to increase ‘satisfaction’ pre-supposes that people know what they want and that their needs can be captured and translated into realizable products.’\footnote{Ibid.} This challenge needs to be acknowledged in any approach to participatory design. In this research the exchange between designer and user client is mediated by multimedia scenarios.

Another issue is the duration of the participatory window over the stages of design and construction. Principles of participatory design acknowledge occupation as a stage in the design process. The need to evaluate occupation is already addressed through post-occupancy evaluation (POE), which I incorporate below in the base building model proposed in this research. A POE typically focuses on assessment of client satisfaction and functional ‘fit’ with a specific space, the criteria for judgment being the fulfilment of the functional criteria and occupants’ needs.\footnote{A. Zimmerman and M. Martin, ‘Post-occupancy evaluation: benefits and barriers’, \textit{Building Research and Information}, Vol. 29, No. 2, 2001, p. 169.} The POE process aims to make the design process more empirical and research orientated, as well as more cyclical in nature and responsive to feedback.\footnote{J. Zeisel, \textit{Inquiry by Design: Tools for Environment-Behaviour Research}, Cambridge, Cambridge University Press, 1981, pp. 14-16.} Zimmerman and Martin argue that, ‘A proper POE will provide real information on which to base decisions, and real information is the key to informing and improving the next project.’\footnote{Zimmerman and Martin, p. 169.} Currently in Taiwan many design decisions are based on the assumptions of developers about market preferences. POE can manage design approaches in parallel with traditional marketing strategies to better accommodate homebuyers’ various needs. More holistically, this point is acknowledged by Hill’s contention that people’s simple presence in an interior environment changes the properties of the space through the very
act of occupation. Hill also cedes to the design process the fact that occupants will seek to create their 'own' space through their alteration and personalization of a residence through interior decoration and the character and distribution of furnishings and personal effects. For Hill, occupation should be understood as an extension of the design process, one that is enacted by the homeowner and which interior design should support.

One way then to perceive design decisions is to chart a path through the process from beginning to end, using a sequence of activities that Roozenburg and Eekels describe as 'analysis', 'synthesis' and 'evaluation'. Applying a user-centred design approach to housing development adds extra complexity to the process by adding a parallel sequence of considerations for designers. Building on the user research principles set out by Hanington, this project suggests that the design process follow these steps:

1. needs Analysis
2. user and Task Analysis
3. functional Analysis
4. requirement Analysis
5. setting Usability Specifications
6. design
7. prototyping
8. evaluation

A design conceived around these steps is ideally an iterative process that assists designers to arrive at a more appropriate, inclusive approach for end-users where certainty of design direction is established through repeated user involvement. Iterations expressed as quick diagrams, sketches, collages or models assist designers to develop the final design, which the user client is asked to validate or critique by imagining their uses and experience of it. As indicated above, the iterative participatory process should also include space for POE. This is addressed below.

Summary and discussion
This chapter has argued that the application of a user-centred design paradigm properly extends from the initial evaluation of product parameters throughout the process of design development to the delivery of a completed design. However, despite growing interest in user-centred design its application remains problematic in many respects, including its potential application to housing

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development in Taiwan. The dominance of concrete construction in the Taiwanese housing sector is an example of technology over-riding user-centred design perspectives. If a user-centred design approach were to be applied during the construction stage of such developments it would encounter problems with current time-to-market and construction schedules, return on investment demands and the fluctuating availability of resources. Such obstacles challenge the implementation of end-user participation in the Taiwanese housing sector, especially where projects are developed speculatively. In Taiwan, architects and interior designers could advocate for the objectives of user-centred design but up until now they have usually seen the importance of design values eclipsed by economic pressures from developers, regardless of the promise for better housing products and more satisfied customers.

Taiwanese developers’ current control over design and construction in private housing development means there is no opportunity for an interchange of ideas between architects and homebuyers. Commercial risk encourages developers to close off the design process as soon as possible and exercise tight control over project briefs, which typically conform to market tested principles. The situation where developers hold the majority of the power in the development process means generational change may be necessary to reorient design and construction processes. Certainly, to involve homebuyers in design makes a process in which architects and interior designers already have little influence even more complex. Given the perspectives of Taiwanese developers, it would most likely only be possible if buyers committed financially during the pre-sale or early construction stages of a development. However, any buyers who commit early to a development are in fact an important information resource for other buyers and for a development as a whole, identifying the most up to date needs and preferences of end-users and making these available to the design process, thereby increasing the possibility of commercial success.

However, there is no cultural experience of designer-client relationships in Taiwan, and the involvement of user clients in the interior design process is restricted to a few wealthy and design literate individuals. Eliciting user knowledge and perspectives as a resource for the design process in Taiwan would have to be carefully approached, it being the cultural disposition of the Taiwanese not to question the expert knowledge that designers would be assumed to possess. More generally, Krippendorff argues there is direct evidence of consumer resistance to product innovation. He contends that consumers are cautious about change and may not want to have new approaches tried out on them, especially in a major purchase like a home:

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115 Due to high percentage of home ownership in Taiwan, there exists the tendency of demanding housing with high quality also indicating the needs of interior design.
http://www.realeaste.org.tw/realestate/result/pdf/lc1999_2A.PDF
The vast majority of people [he writes] are pragmatic and conservative. They are the late adopters who take a more realistic view of the world … They wait until the product is truly capable of meeting their needs, wait for firm evidence that it brings economic value without disruption of their existing way of doing things. These buyers want convenience, reliability, and value. They do not want disruption.116

Dedicated strategies will be needed to overcome such resistance, though I have postulated that the availability of an on-line program to explore design options, especially one disengaged from direct selling pressures, may be the answer to this hurdle.

The primary objective of participatory design is to reduce the distance between designers and users and to transform users into designers in certain respects.117 The highest level of participatory design involves collaborative partnerships between users and designers, where there is full communication between the two. This involves repositioning designers from a group that sees its role as acting for others to a position of accepting end-users as agents of their own values, knowledge and outcomes. While actual outcomes are not always identical to those modelled, in the context of this research the inclusion of feedback mechanisms that 1) allow homebuyers to express their needs and preferences and 2) make developers aware of the changing nature of those needs is vital to the improvement of interior design flexibility in Taiwanese cluster housing developments. The research argues that initial and ongoing feedback between the end-user and the development process could begin during the pre-sale window, allowing developers to check design strategies before beginning construction. The approach I am urging might be termed a holistic one, in which all parties would work co-operatively in an integrated way to better meet immediate buyer needs, while acknowledging the fact that the life circumstances of occupants will change. Active homebuyer participation in the design process using innovative, design oriented approaches could do more than provide designers and developers with better information about user needs and preferences. It could reduce resistance to change in the conservative Taiwanese housing market.

In *How Buildings Learn*, Brand shows that buildings change as different occupants find their needs are no longer met, at which point structures are often dramatically altered by occupants to meet their new needs, or to add personal value and meaning.118 This process often intersects with the

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117 Ibid.
fashion cycle in consumer design, which effectively manipulates the social need for self-identity into opportunities for more, and more individualized consumption. These considerations point to the need to consider the dual processes of customization and mass production, which I take up in the following chapter. These considerations are a prelude to the base-building proposed below.
Chapter 3: Customisation and mass production

The degree of material affluence in Westernized societies is historically unparalleled. However, the generators of that affluence, including mass production, have fostered escalating homogeneity and conformity, leading to the growing importance of symbolic, expressive, identity-oriented values around the world. The logic of mass-production is aimed at realizing economies of scale but this cost-efficiency is achieved at the expense of providing variation to match individual needs and preferences. In this sense, it is somewhat debatable whether human values can be integrated into mass industrial products.

Housing development and construction has been positioned within a discourse of mass production and individualized customization. Thus, it has been claimed that housing design and product design are not comparable in terms of mass production. The house, including its interior design, is seen as unique and personalised while product design is seen as intrinsically linked to mass production. Cluster housing and the model of mass customised interior design proposed in this research contest this separation between housing and product design. Through an examination of the principles of mass customisation, this chapter considers how to bridge the gap between architectural conventions and the implementation of a readily customisable interior design practice for Taiwanese cluster housing developments.

Housing design versus design for mass production

In the majority of instances around the world building industries consider every house a unique product. However, in his 1998 article ‘Rethinking Construction,’ Egan demonstrates that many buildings, including houses, are essentially repeat products, which furthermore can be continually improved through the process of design. Most significantly, Egan contends that the process of construction is repeated in essential ways from project to project, although site-specific make exact duplication difficult. The possibility of applying aspects of mass production to housing in a beneficial way is thus broadly argued, though others would seek to preserve housing as a ‘special case’ product.

For example, in contrast to Egan, Gunn argues that ‘constructed products’ differ from other manufactured goods in several respects that affect the extent to which new and innovative

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production processes can be employed. In comparison with conventional product design, these differences include the facts that houses are large and usually immobile; there is a higher degree of complexity in the number and range of component parts; and production on site introduces varying degrees of uniqueness. Gunn points out that housing products are usually more expensive than other manufactured goods, contributing to the accepted wisdom in the construction industry that new homes are ‘different’ from other consumer products and that innovation carries far greater risks. Gunn argues it is not possible to directly transfer lessons from the industrial (product) design process and mass production to the housing sector.

In reality the differences between residential construction and other industries are exaggerated and often used as an excuse for complacency and a lack of innovation in design methods, processes and philosophies. This position is strongly supported by Barlow, who suggests it is both possible and useful to consider the entire process of housing development as similar to the process of product or industrial design development.

**Prefabricated housing**

The most obvious example of a house being treated as a product is that of prefabricated housing. Since the late nineteenth century a number of important architectural thinkers have sought to reinvent the design and delivery of housing for the masses. Noting the time and cost efficiencies and rationalised product ranges that occurred through mass-production, many considered whether these advances might be applied to housing. For example, Le Corbusier argued for the general benefits of mass production in housing. He believed mass-produced housing would demonstrate an aesthetic and functional rationality similar to that achieved within the automotive industry through advances in engineering and manufacturing. Le Corbusier saw the automobile as the key to future housing, arguing that:

> If the problem of the dwelling or the flat were studied in the same way that a chassis is, a speedy transformation and improvement would be seen in our houses. If houses were constructed by industrial mass-production, like chassis, unexpected but sane and defensible forms would soon appear, and a new aesthetic would be formulated with astonishing precision.

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121 *Ibid*.

122 Barlow and Ozaki, pp. 89-90.

Le Corbusier also had a firm belief that standardisation was improved by the laws of natural selection and was an economic and social necessity. He concludes his discussion on housing and mass production with his canonical statement where he describes a house as a machine for living in. Yet Le Corbusier also observed that mass production was not necessarily seen as a good thing by architects and lay people, both reacting against the depersonalisation of mass production.

Other designers made more practical attempts at mass produced housing. Buckminster Fuller’s 1927 Dymaxion House — named by combining three of Fuller’s favorite words, dynamic, maximum and tension — experimented with mass production as a means of providing economical housing to the masses. Fuller believed that every human should be afforded the benefits of new technology. The Dymaxion House had a central mast that held up the hexagonal-shaped building and the capacity to be disassembled and transported to a new site. Despite its flexibility and scope for mass production the house was not widely adopted due to market resistance. Its failure shows that under the conditions of industrial capitalism, where freedom of choice is a central logic of consumption, a single housing style will not be successful for its ingenuity and function alone.

By contrast to other products, modernism’s utopian ideals of achieving timeless and durable housing design through prefabrication and mass production were unsuccessful. The gap between the logic of modern production and the ethos of modernist design was recognised early. In 1930 the social historian Lewis Mumford wrote a telling article called ‘The Modern as a Trade Article’ for the Deutche Werkbund’s Die Form magazine. The essay identified the gulf between the economic role of modern commodities and modernism’s vision of an economical, functional, universal and timeless design based on abstraction of form and rational design. Mumford’s commentary opened with a discussion of the fate of American Arts and Crafts mission-furniture, which sought to appeal through its simple but contemporary, utilitarian styling. Mumford argued it was not only mission-style's heavy proportions and lack of stylistic diversity that limited its commercial success. Mission-style was bound to fail because durability and timelessness contradicted capitalism’s laws of production and marketing, short-circuiting the commodity cycle.

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124 Ibid., p. 148.
125 Ibid., p. 240.
126 Ibid., p. 232.
Mumford’s position grew out of a 1927 visit to Grand Rapids, the hub of the American furniture industry. There he saw the enormous productive power of American industry and its dizzying range of products. Mumford recognised that manufacturers’ goal to quickly turn over their capital by selling new domestic furniture to every American family on a six-year cycle had clear design implications, ensuring poor quality materials and production while demanding stylistic novelty:

Both [he wrote] are extremely harmful for the development of a genuine modern style. In the United States there is the great danger that in the place of real modern conviction, which makes its way from the bathrooms and kitchens to the rest of the house … exactly the opposite [occurs], namely a so-called modern art, which in view of the sales will have nothing to do with the care of purpose and use...130

Mumford recognised that the promotion of sales by quick style changes and limiting costs conflicted fundamentally with modernism’s principle of the absolute coherence of form and function, casting doubts on whether modernist design and U.S industry and commerce could ever form an alliance. Designers, however, kept working on the problem.

In contrast to the one-size-fits-all logic of the Dymaxion House was Walter Gropius’ development of the Package House in Germany in the 1940s, a factory-based mass production building system that resulted in highly customisable homes.131 Unfortunately, it was quickly discovered that the system was not economically viable. Under the conditions of Gropius’ experiment, personalised homes took too long to design while custom manufacturing created a logistical nightmare. Industry of the 1940s was ill prepared to manufacture a customised product and the manufacturing company that supported Gropius’ venture was forced to retreat to the production of a few standard models that looked cheaper than a conventional home but cost more and offered less scope for personalisation.132 Other post-war industrialised housing projects were similarly unable to overcome the inherent contradiction of personal preferences in mass produced products and the practical problems of broadly applying mass production to housing. Manufacturers either did not have the resources and designs to produce a sufficiently flexible product system, or design and manufacturing was made so complicated by the need to allow for customisation that it was not economically feasible.

130 Ibid., p. 62.
131 Herbert, pp. 32-39.
132 Ibid.
A prime example is John Entenza’s Case Study House Program, which was launched in the Southern California area in 1945. Entenza saw the need for well-designed model houses that used new technologies and modular components. He developed the program through his magazine *Arts & Architecture*, in which Ray and Charles Eames, Richard Neutra, Craig Ellwood and Ralph Rapson were also involved. Rethinking the American house was at the basis of their campaign and progress was reported monthly by the magazine to its readers. The range of designs grew from eight to 28 cases and many were built, the most well-known being Case Study House No. 8 in 1949 designed by Ray and Charles Eames. The house was based on standard steel framing and sought to provide a model of rational, low-cost housing design for ordinary people in response to the perceived poor state of American housing by demonstrating the combined benefits and superiority of modernist design and mass production.

Like Le Corbusier and Fuller, however, those involved in the Case Study House Program misunderstood the socio-economic paradigm in which they were operating. Increased production rates in capitalist society enabled by the rational organisation of labour and the introduction of machines was driven by the profit motive not the aim of beneficial social outcomes. Moreover, mechanisation and the rational ordering of production soon became fundamental values in capitalist societies, many writers including Marx, Weber and Lukacs blaming them for the scourge of commodification and material values in modernity as well as the deepening separation of people from each other and from the basic necessities of human existence.

**Mass customisation and personalisation**

The myth that consumer products address human need has seen the technological and functional complexity of consumer products increase markedly over time, creating demand for newer and different products. Similarly, many manufacturers have tried to overcome the sameness of consumer products by offering customers the opportunity to ‘customise’ products. Since the early 1990s, efforts to introduce ‘mass customisation’ — that is, the supply of customised products at costs comparable with mass production — have grown in many mature manufacturing industries. The idea underpinning mass customisation is that customers seek certain basic standards and components, but also hope for ‘some individual reorganization and custom treatment.’ Technologies enabling mass customisation now permeate a vast number of

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133 Johnson, p. 28.
manufacturing and service industries, from automobile, furnishings and grocery shopping to insurance and personal investing.\(^{136}\)

Primarily, mass-customisation requires a flexible product with in-built potential for the tailoring of product styles and their range of features to suit the needs and preferences of individual consumers. Norman points out the paradox behind the ideal of mass-customisation, arguing that:

> There is a tension between satisfying our needs by purchasing a ready-made object versus making it ourselves. Most of the time we are unable to build the objects we need, for we lack the tools and expertise, to say nothing of the time. But when we buy someone else's object, seldom does it fit our precise requirements. It is impossible to build a mass-produced item that fits every individual precisely.\(^ {137}\)

Yet many writers suggest we are witnessing the dawn of a new age of customisation in which new technologies, increased competition and more assertive customers will see industries develop great scope for the personalisation of their products and services.\(^ {138}\) Mass customisation aims to produce goods and services that best meet individual needs with near mass production efficiency, offering genuine differences in spite of component standardisation and prefabrication. Davis argues that mass customisation means ‘the same large number of customers can be reached as in mass markets of the industrial economy, and simultaneously they can be treated individually as in the customized markets of pre-industrial economies.’\(^ {139}\) From an industry perspective, mass customisation allows enterprises to capitalise on their own core business areas while responding to the additional opportunities created through new and improved interfaces between configurable modules and sub-components of the desired end product.\(^ {140}\)

Most design and production industries seek to implement an appropriate level and method of customisation to keep up with markets. As has already been suggested in this manufacturers and retailers stand alongside their customers, Forty arguing that today’s consumers are increasingly disposed to becoming ‘customizers,’ if there are models that allow this to occur:

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\(^{137}\) Norman, *Emotional Design*, p. 223.


Until a few years ago, it was possible to identify clear-cut groups in society whose members could all be expected to show the same behaviour in a variety of respects. However, we now see that the customer’s behaviour is often quite unpredictable. People are adopting a flexible, pick-n-mix approach to their life styles and habits. And there is little pattern to the variety that occurs.\footnote{A. Forty, \textit{Objects of Desire: design and society since 1750}, New York, Thames and Hudson, 1992.}

Esslinger argues that customisation is now a conventional social technique that almost everyone uses, claiming that as a ‘reaction to the homogenization of styles and tastes the desire to personalize our universe’ is not only strong but expressed in the very way ‘we embroider our jeans, paint our walls, dye our curtains… or have others do it for us.’\footnote{Quoted in F. Sweet, \textit{Frog: Form Follows Emotion}, London, Thames and Hudson, 1992, p. 12.} Personalising consumer products like mobile phones with accessories, some purchased, others privately improvised, is a common activity of contemporary consumers. In fact, Pantzar uses the idea of the chameleon to describe recent consumers, whom he describes as a third level of consumers in history, engaging in consumption virtually as an art.\footnote{M. Pantzar, ‘Consumption as Work, Play, and Art: representation of the consumer in future scenarios’, \textit{Design Issues}, Vol. 12, No. 3, Autumn 2000, pp. 14-15.} Moreover, customer involvement in product design has become an accepted part of the development and marketing processes in many industries. Examples such as Apple’s experience with desktop publishing shows how companies and customers work together to create new applications and new markets.\footnote{R. McKenna, ‘Marketing in an Age of Diversity’ in Gilmore and Pine, p. 27.}

One particular manifestation of mass customisation of products is self-service shopping, which has expanded dramatically in recent decades, with warehouse style stores for automotive accessories, hard ware, software, sporting goods, and many other products seeing minor and major purchases offered for sale in circumstances with limited personal assistance.\footnote{J. Kathman, ‘Brand Identity Development in the New Economy’, \textit{Design Issues}, Vol. 18, No. 1, Winter 2002, p. 31.} The Internet is also becoming an exemplary self-service selling environment, spreading a model of interactive shopping where the scope for customisation is greatly enhanced and the consumer explores groups of items and ranges of product features at their leisure and convenience to create their own products on the basis of aesthetic preference and lifestyle.\footnote{\textit{Ibid.}, p. 34.} Kathman argues that in the self-select selling environment of the Internet the designer’s role ‘is transformed because of the newly empowered consumer’ to that of creating ‘a menu of options’ from which the consumer can choose.\footnote{\textit{Ibid.}} This echoes the role of designers in relation to the flexible interior design system proposed in this research.

\footnote{141 A. Forty, \textit{Objects of Desire: design and society since 1750}, New York, Thames and Hudson, 1992.}
\footnote{142 Quoted in F. Sweet, \textit{Frog: Form Follows Emotion}, London, Thames and Hudson, 1992, p. 12.}
\footnote{144 R. McKenna, ‘Marketing in an Age of Diversity’ in Gilmore and Pine, p. 27.}
\footnote{146 \textit{Ibid.}, p. 34.}
\footnote{147 \textit{Ibid.}}
Self-service shopping and retail sites on the Internet selling customised products are a training ground for homebuyers using the open building system, familiarising them with the idea of working in collaboration with designers and developers. Today, many products and services are market-researched and tested to the point where if consumers are dissatisfied with one product the marketplace offers an abundance of easily available alternatives, whole societies being transformed into unsuspecting focus groups predicting individual needs. The Taiwanese housing industry is yet to appreciate that the social and commercial context for housing has been transformed by a multitude of producers and merchandisers targeting consumer design in this way. The Internet is teaching consumers to be increasingly comfortable with researching products for themselves, making independent product choices and ultimately developing their own products. In many ways the hyper link models a contemporary psychology attune to open possibilities, intuition and relative thinking by connecting browsers and users to an almost infinite range of information and end points. The growth of self-service shopping and the Internet will surely create homebuyers more comfortable with choice and not only far more assured about participating in the design process but demanding input.

A true customer focus, however, is not possible if an organisation is not information intensive. Intensive information resources are required mainly because mass customisation offers potentially millions of variants in products, especially, as has already been flagged, in a product as complex as a house. Mass customisation also creates a fluid design environment in which participating people, processes and technology must reconfigure quickly to provide customers with what they want from the many available options. Mass customisation can only respond to the needs and wants of individual customers by reducing product development and life cycles, minimising cost structures and production times, fragmenting market homogeneity and employing new processes. Womack, Jones and Roos see it as building on the idea of ‘lean production’, an approach to assembly-line manufacturing developed initially for the production of automobiles at Toyota, and accordingly sometimes referred to as the Toyota Production System. Lean production aims to supply the production process with the necessary components only at the exact time and place they are required, reducing waste and the need to build up stocks of components, the latter opening the production process to product change. Taiichi Ohno, the Toyota engineer acknowledged as developing the lean production concept, found that the innovation also

148 Ibid.
improved product quality and the continuity of the production process.\textsuperscript{152} By the 1980s lean production principles had transformed mass production into ‘a more efficient, responsive system.’\textsuperscript{153} Elsewhere lean production has been specifically suggested as a model for addressing inefficiency and poor quality in building industries.\textsuperscript{154}

An example of mass customisation: the automobile industry

At this point it is useful to examine more closely recent attempts at mass customisation in industries other than housing, especially those in which classic strategies of product differentiation are no longer sufficient for market success. One such industry is the automobile industry where increasingly globally interconnected markets offer marginal leverage for improving the operating results of multinational companies. The general business hypothesis is that enterprises that manage to build individual and enduring relationships with their employees, customers and the end-users of their products and services can achieve strategic advantages in the face of increasing global competition by offering customisation. However, the application of customisation in various industries has encountered difficulties that should be heeded if such principles were to be introduced into the Taiwanese housing industry. For example, in the mid-eighties, Toyota launched an all-out effort to offer buyers individually customised automobiles.\textsuperscript{155} Initially, the company seemed well on its way to accomplishing its goals but by the mid-1990s production costs began to soar, forcing Toyota to abandon the effort.\textsuperscript{156} Other Japanese automobile companies that followed Toyota’s example ran into similar problems. Nissan, which at one time boasted that customisation meant it could produce, ‘any volume, anywhere, anytime, of anything for anybody,’ retreated from customisation when it became clear that buyers did not want to choose between eighty-seven different steering wheels.\textsuperscript{157}

In theory, mass customisation aims to create products that meet customers’ individual orders and has been a primary ambition of the manufacturing industry for many years. It has remained elusive in reality, although the car industry provides a model long predicted to become commonplace in other industries in the future.\textsuperscript{158} Most relevant for this study, especially given the

\textsuperscript{152} Search CIO.com, http://searchcio.techtarget.com/sDefinition/0,,sid19_gci810519,00.html


previous failure of pre-fabricated housing, is the fact that Toyota has provided increasing levels of
customer choice for different model options by minimising the number of parts in a new model
and by pushing some of the production complexity out of the assembly plant and down to dealers,
who install customer’s options as bundled dealer-installed packages.\footnote{Gann, ‘Construction as a Manufacturing Process?’, p. 442.} This has resulted in closer
supplier involvement in the design and engineering of sub-assemblies with direct benefits for
consumers.

**Mass customisation applied to housing**

The model of mass customisation offers the best possibilities for building flexibility into interior
design since it does not depend on quantity to be cost effective and is driven by the production of
pertinent to housing because the customer determines what the options will be by participating in
the design process from the start rather than deciding among the options produced by industry.
Nonetheless, translating this model from the manufacturing sector to housing is made somewhat
problematic by the life cycle of the house as a product. Houses are not cars. They are far more
complex in their functions, both utilitarian and social, and typically new houses are only
transformed into individual homes as occupants discover what they need by living in them,
sometimes over a number of years. By contrast, the average life span of a car is about ten years
and they are seldom modified, other than in minor customer-specific ways.

Norman argues that personalisation cannot be designed for ahead of time and in fact runs
contrary to the logic of mass production. ‘To make something personal [he argues] means
expressing some sense of ownership, of pride. It means to have some individualistic touch. We
make our homes and places of work personal by the choice of items we place in them, how we
arrange them, and how they are used.’\footnote{Norman, *Emotional Design*, p. 220.} Mass housing can only be ‘personal’ at the structural
level if this capacity is designed into it. Conversely, a residence can become too personal and not
easily adaptable to others. Barlow argues that a house built with user-centred principles and
enhanced flexibility adds value for buyers since it is more attractive to subsequent purchasers than
conventional stock expressly because of its ready convertability.\footnote{Barlow and Ozaki, p. 91.} In Taiwan, progressive
developers might achieve a significant market advantage by offering flexible housing options that
are able to adapt to changing needs, giving greater choice to purchasers. Mass-customisation

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\footnote{Gann, ‘Construction as a Manufacturing Process?’, p. 442.}
\footnote{Norman, *Emotional Design*, p. 220.}
\footnote{Barlow and Ozaki, p. 91.}
offers a user-centred approach to housing design that would allow homebuyers the opportunity to personalise their homes.\textsuperscript{163}

While each housing development creates its own challenges in applying the model as a result of site-specific factors and the market segment it caters to, valuable lessons can be drawn from attempts at mass-customisation in the Japanese building industry in the past three decades. Since the 1970s, the Japanese building industry has undergone extensive innovation in its interaction with customers and in relation to the way it manages its supply chain and production processes.\textsuperscript{164}

The term ‘supply chain’ is normally used to describe the flow of goods from the very first process undertaken in the production of a product culminating in the final sale to the end consumer.\textsuperscript{165} It has been defined by Lummus and Vokurka as ‘the network of entities through which material flows.’\textsuperscript{166} In building industries these ‘entities’ includes builders, suppliers, carriers, manufacturers, distributors and homebuyers. Normally, the supply chain consists of links between firms and their customers, connected through distribution methods onto customers.\textsuperscript{167}

The changes in supply chain and manufacturing processes in Japan have allowed the industry to more easily provide customised products for homebuyers where factory-based companies produce homes pre-assembled from standardised components or modular systems. Toyota, although one of the world’s three largest car manufacturers, arguably provides the best examples of how the housing and automotive industries might learn from one another, producing 2800 factory-made houses each year in Japan.\textsuperscript{168} Toyota Homes produces a range of ready to assemble homes, based around individual room modules provided to specific customers via a franchised dealer network.\textsuperscript{169} Their approach provides customers with greater choice even though the houses are essentially designed and built without any significant input from the customer. The application of mass-customisation to housing also includes guaranteed speed in the fulfilment of orders while ‘open building’ design and flexible building processes allow for the late configuration of each housing product to homebuyer’s choices.\textsuperscript{170} This flexibility in design and construction is


\textsuperscript{164} Ibid, p. 134.

\textsuperscript{165} R. Cooper, M. Bruce, A. Wootton, D. Hands and L. Daly, ‘Managing Design in the Extended Enterprise’, \textit{Building Research and Information}, Vol. 31, No. 5, September-October 2003, p. 368.


\textsuperscript{168} Ibid, p. 134.

\textsuperscript{169} Ibid, p. 139.

\textsuperscript{170} Sarja, \textit{Open and Industrial Building}, pp. 7-8.
supported by sales and service functions. Different market segments, such as detached housing, cluster housing and apartments, require different modules due to varying space constraints and alternative uses for living spaces. To achieve this, the interior spatial schema is described in terms of an area of living space instead of the number of bedrooms as is typical in Taiwan, signifying a different concept of the nature and use of a house.

**Customisation as a Tailoring Industry**

In Taiwan, currently only the single-detached, architect designed house offers a process of ‘Pure Customisation’ that extends to all stages of design, fabrication and assembly. The creation of such houses also sees the entrenched distance between architects, builders and clients replaced by a consultative decision making process involving all participants and deeply focused on the needs and preferences of a building’s future occupants, providing a model of user-centred product development for the whole Taiwanese housing sector. On the surface it would appear that pure customisation, where housing products are created around the specific needs of individual buyers, is not applicable to cluster housing developments because of time and cost factors. Yet if housing development were approached as a tailoring industry, in which a relatively standardised core design were adapted to the needs and preferences of individual customers, the potential for mass-customisation would become more feasible.

In the marketing activities of mass customised industries, companies seek to develop a direct relationship with the individual customer. Products can be ‘made to order’ or ‘tailored made’ in production, although the potential degree of customisation varies markedly from industry to industry. Lampel and Mintzberg offer a means of bridging this variability by establishing a manufacturing production chain with four distinct stages, these being, design, fabrication, assembly and distribution. At each stage the customer’s specific needs are taken into account, Lampel and Mintzberg arguing that, ‘Individualization is an important factor in tailoring industries, such as residential housing and mainframe computers, where a relatively standardized core design is adapted to individual customer needs.’ They posit five different approaches to customisation: ‘Pure Standardization’, ‘Segmented Standardization’, ‘Customized Standardization’, ‘Tailored Customisation’ and ‘Pure Customisation’. According to Lampel and Mintzberg, ‘Pure Standardization’ is where there are no distinctions between different customers so that the buyer has to adapt or else switch to another product. ‘Segmented Standardization’ is where basic design

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174 Ibid., p. 27.
is modified and multiplied to cover various product dimension but not at the request of individual buyers. ‘Customized Standardization’ involves products being made to order from standardised components but the assembly is customised. ‘Tailored Customisation’ is where a product prototype is presented to a potential buyer who then adapts or tailors it according to individual needs or wishes. ‘Pure Customisation’ is the bespoke product that is truly made to order.

A Continuum of Strategics

![A Continuum of Strategics](image)

Summary and discussion

Given such examples, the risks of introducing mass customisation principles to housing in Taiwan through an industrial design process must be recognised. Moreover, in those industries where the logic of customisation is pervasive and successful very specific forms of marketing, production and product development tend to dominate. Such procedures contrast with current marketing approaches and development practices for Taiwanese cluster housing, which emphasise limited stylistic difference but almost no structural customisation of homes and certainly no industry systems to support this. Currently, Taiwanese housing products provide only fixed living areas and amenities, which offer limited choice to homebuyers. Products are neither concerned with achieving the goals of a user-centred design nor adaptability if the need for future interior remodelling arises. The application of mass customisation principles and methods from manufacturing to housing seems in many ways inevitable since it is argued that mass
customisation will be as important to business in the twenty-first century as mass production was in the twentieth century.175

The example of Toyota homes, discussed above, shows that mass customisation where supply chain and product interactions are well developed is possible. The discussion of customisation as a tailoring industry provides a particularly appropriate framework for locating the model of open sources building to be proposed below. The following diagram (figure 5) is extrapolated from Lampel and Mintzberg’s five strategies of customisation and can be applied to housing development in Taiwan. The five by five matrix equates the various supply-chain strategies and customer requirements more effectively by trading-off levels of customisation against construction lead-times and costs.

![Figure 5: Supply Chain Strategy Management Identification Matrix](image)

Of the five versions of customisation named by Lampel and Mintzberg, ‘Tailored Customisation’ is the strategy most applicable to Taiwanese housing developments. To demonstrate the concept of ‘Tailored Customisation’ they explain how a traditional men’s tailor will present a customer with standard fabrics and cuts to be adapted to their preference for wider lapels than normal or

175 Gilmore and Pine, p. ix.
adjustments to accommodate an unusual physique. Later, the customer will return for a fitting, more tailoring and adjustments. This open-ended design process provides a model for customised housing development through Open Building in Taiwan. In Open Building homebuyers are provided with a structural system, design support and in-fill possibilities from which to tailor a house to their needs and preferences. This argument is developed below.

The following chapter exemplifies the current challenges to mass customisation in Taiwan, prior to the positing the models of open source building and mobile architecture as most appropriate to meeting these challenges.

177 Lampel and Mintzberg, pp. 25-26.
Chapter 4: Challenges of mass customisation to Taiwan: Open Source Building and Mobile Architecture

Learning from other industries could be the most appropriate way for Taiwanese housing developers, marketing professionals, architects and interior designers to recognise the value of offering radically new housing forms to homebuyers by re-formulating production. However, introducing a system of housing development and supply chain management as exemplified by Toyota homes will be challenging for Taiwan, even though Taiwan has an established sympathy for what is perceived as the 'efficient' Japanese 'way of doing things' following the period of Japanese colonisation. While it is technically difficult to make a consumer product customisable and a percentage of customisations fail to satisfy and succeed financially the market advantage of configuring products to consumer's individual tastes and needs is evident. In the following chapter I explore Open Source Building and Mobile Architecture as approaches that can address current shortcomings in Taiwanese cluster housing development.

Open Building

An Open Building approach harnesses improved building technologies to facilitate mass customisation, protecting resale value while allowing for ease of later modification. Indeed, an Open Building approach could see customisation become an ongoing process over the life of a home with greatly improved scope for modifying interior design to suit changing family structures and tastes while having the additional effect of making homebuyers feel more adventurous and confident in their initial housing choices. Taiwanese developers, supported by architects and interior designers, could provide personalisation for their customers through a process that is dynamic, adaptable and human-centred while homebuyers could see remodelling as a routine activity, periodically changing their home environment to reflect shifting needs and interests.

According to Dekker, Open Building is a systematised approach to design and construction that combines building components in such a way as to give optimal freedom of layout and installation. Dekker shows that when applied to housing Open Building can improve the quality of residential architecture in relation to exterior and interior character and the surrounding neighbourhood while achieving environmental and social responsibility in the housing sector. For the purpose of this research Open Building is considered in its capacity to give buyers greater choice in their interior living conditions while increasing a home's capacity to meet changing

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178 Norman, Emotional Design, p. 223.
requirements, thereby adding significantly to its long-term value. Specifically, Open Building allows the components of any system in a home to be altered without requiring the replacement of the entire system or impacting greatly on other systems. For example, gaps in floors, walls and ceilings can be readily opened and closed without the need for major structural change as currently happens in Taiwanese cluster housing units. This flexibility and efficiency is achieved by clearly demarcating the building shell and in-fill elements while making in-fill elements readily alterable, thereby enabling occupants to reconfigure the interior layout of a dwelling by altering in-fill elements only.

The Open Building model brings together many diffuse strands of innovation in architecture, construction and the industrial production of building parts that have emerged around the world over the past thirty years. These include systems approaches to building, modular and dimensional coordination, computational support for design, industrialisation in the building industry, rehabilitation of existing buildings and principles of user-centred design and sustainable design. In the research each is incorporated to ensure that design and construction enables interior flexibility and diversity within mass housing, while increasing the participation of homebuyers in the design of their dwellings and facilitating the immediate and long-term adaptability of interior architecture to the changing needs and interests of occupants.

To be effective Open Building requires innovative design methods, new building products with improved technical and interface qualities as well as different installation skills and procedures. New construction procedures are also required to match the high level of variety possible if material wastage, construction times and costs are to be kept to a minimum and lean construction principles enabled. The flexibilities it can achieve in initial design and through the scope for alterations over time suggest it is worth the considerable effort of introducing it to a housing market, especially when the outcome is a far more socially and environmentally sustainable housing product.

Specifically, Open Building is concerned with the quality of the interior environment for individual occupants and facilitates diversity from the conception of a project and throughout the design, construction and real-estate management stages. The first requirement of Open Building is to establish ways of ordering and combining sub-elements of a building to minimise any interference issues between them. This creates efficient building and permits the

reconfiguration or replacement of elements of a building without having to redesign or rebuild the whole building. In contrast to current approaches to housing construction methods in Taiwan, the central tenet of Open Building involves separating the individual component systems of a building to allow them to be reconfigured in a variety of ways and the systems to be mixed, matched and replaced to match occupant’s individual needs without requiring the demolition or replacement of other elements, especially elements of another component system. In Open Building both design and construction are achieved by a layered approach to building. The positional and dimensional co-ordination of building parts and their interfaces allows for the industrial manufacturing of components, resulting in a leaner construction process. Many non-residential buildings are already constructed according to an open approach. Commercial buildings, for example, are regularly built without predetermined interior layout, regardless of their style, function or construction. Rather, interior partitioning is added to suit the individual tenant when a building is leased. However, subsequent remodelling for later tenants typically creates a huge and unsustainable waste of materials if inflexible building methods have been used and thoughtful recycling not applied.

One of the most influential figures in the development of Open Building is N. J. Habraken, whose book *Variation: The Systematic Design of Supports* proposed dividing the home into two clearly defined parts that he called ‘support’ and ‘in-fill’. The supports are the common structural elements and utility services in a building. The in-fill elements are those segments tailored to the individual and changing needs of occupants. All in-fill elements, such as partitioning and service components in kitchens and bathrooms, are capable of being installed or removed without requiring structural change. Cuperus argues that the division of design and construction into shell and in-fill elements can clarify decision-making for the various parties in a housing development. It also allows for the transfer of parts of the building process from on-site construction to off-site manufacturing while reducing waste by coordinating dimensions and positions:

Open Building and Lean Construction can complement each other, what they have in common is the sympathy they feel towards lean thinking. Open Building is concerned with the quality of the built environment and the way it is established, from initiative, via decision making, design, construction and real estate management.

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184 Ibid., pp. 10-17.
185 Cuperus, (http://www.obom.org/DOWNLOADS/MCinHousing.pdf)
186 Ibid.
Developers applying Open Building achieve cost efficiencies and scope for customisation by distributing utilities centrally while separating them from each other as well as from internal partitions and the building structure. Currently, these innovative approaches are in their early stages of application and have not made significant inroads in the international building industry though some successful examples will be discussed later in this chapter.

**Open Source Building**

Open Building would be a noteworthy addition to design and building practices in Taiwan in allowing the base building component to be as generic as possible to increase the capacity for customisation and future change but Larson and others argue that its extension to ‘Open Source Building’ offers a further customisation model for the building industry. Open Source Building allows independently developed building modules to come together within the context of construction to create a larger system built around mutually agreed principles. At the most basic level Open Source Building design separates the support system or ‘base building’ from the parts that occupants interact with and are much more likely to want to change. Integrated elements, some constructed on site, some manufactured away from it, provide the basic structure and services. Mass-produced in-fill components complete the dwelling, creating cost efficiencies while providing for customisation and change. In fact, Open Source Building enables an almost infinite number of economical in-fill types to respond to different homebuyers’ needs and preferences while freeing up funds that can be spent on other aspects of a dwelling, now or in the future.

A useful analogy for the Open Source Building model is the Linux operating system for computers. By creating standard interfaces or ports and dividing systems into modules, Linux has proved that a complex, open source, modular operating system can successfully evolve and function in a stable way without the control of a single design ‘authority’. Linux can be modified and augmented without disrupting its core elements. In fact, the personal computing hardware and software industries are exemplars of the ‘open source’ principle in that hundreds of device and systems manufacturers develop new products that successfully integrate with other independently developed products.

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Paralleling developments in the automobile, ship building and electronic industries, Open Source Building offers responsiveness to the individual housing needs of homebuyers by using modular components rather than the labour-intensive, craft-based approach of conventional construction.\(^{190}\) It separates a building into a base building (chassis) that provides structure and services while the interior fit-out and exterior façades, including electrical fittings, are developed as mass-customised modules. Unlike previous experiments in prefabricated building, Open Source Building is not limited to standardised, repetitive building elements constructed largely off site. Rather, Open Source Building enables the integration of new products, services and technologies such as the Internet, wireless communication, high-performance materials, new design, fabrication and supply-chain technologies to create tailored, flexible and responsive high-performance environments.

Admittedly, for these changes to be fully implemented within the global or any local housing industry sophisticated, cross-industry relationships need to be developed, these being the major hurdle to its implementation in Taiwan. Open Source Building represents a fundamental challenge to the current generic and speculative housing developments that fail to fulfil homebuyers’ preferences. It demands some intrinsic shifts in roles, attitudes and approaches to be viable, whereby:

1. Developers become integrators and alliance builders, offering tailored solutions to individual buyers;
2. Architects devise design approaches to efficiently create distinctive environments;
3. Manufacturers agree on interface standards and become tier-one suppliers of components, producing systems that share common interface characteristics with those of all other manufacturers. In seeking to meet individual consumers’ needs and preferences as well as to secure market share manufacturers can independently develop their products with confidence without affecting the way they integrate with other company’s products;
4. Builders become installers and assemblers; and
5. Customers become designers at the centre of the construction process by contributing personal information about needs and preferences at the point of design.

Thomke and von Hippel enlarge on the last point by framing customers as potential design innovators if suppliers provide them with the means to ‘design and develop the

\(^{190}\) White Paper, MIT Open Source Building Alliance, p. 2.
application-specific part of a product on their own. In their view Open Source Building has the scope to effectively reposition the ‘supplier-customer interface’ to the extent that ‘the trial-and-error iterations necessary for product development are now carried out by the customer only with the resultant benefits of greatly increased speed and effectiveness of design.

The customisation of a dwelling is inevitably more challenging than the mass-customisation of small consumer products. A home is a complex mix of elements, some standard, some customised, all of which must serve a very broad range of potential occupants in vital, multifaceted ways. The Open Source design approach also requires a design interface that allows individuals to make informed decisions and not be overwhelmed by choice. Fortunately, maturing markets and manufacturing processes, often in combination with new information and communication technologies, have dramatically altered the way in which products are designed, manufactured and marketed, typically by bringing together the following three concepts:

1. the principles of modularity (where interfaces between systems are standardized);
2. a form of Open Source (where designers and engineers at many different locations and organizations share knowledge and details and agree on common design rules); and
3. Customization (where products are tailored for the specific needs and values of an individual).

Mobile architecture

The last component of the integrated open source base building model proposed below is the principle of mobile architecture. Since the early twentieth century vanguard architecture has often endeavoured to increase the adaptability of interior design by conceiving a ‘mobile architecture’. Two strategies have emerged to this end and are often used in conjunction with each other. The first is the use of flexible floor plans characterised by flowing room sequences that adapt to multiple uses. The other is the development of detached, multi-functional interior objects that can be moved around interior spaces as required. Mobile architecture is an option for Taiwanese housing developments, though its application in vanguard architecture has raised as many issues as it has solved, not the least being consumer resistance to its sometimes extreme qualities of impermanence and mutability (see figures 6 & 7 below), which have often been developed as a philosophical challenge to conventional concepts of domestic space rather than to address practical problems or affective aspects of human habitation.

192 Ibid.
Figure 6: Womb: work, office, meditation, base by Johnson Chou

Figure 7: Vinyl Milford by Allan Wexler

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In Taiwan, the growing prevalence of mobile, unconstrained and flexible lifestyles is leading to a demand for living options that are independent of fixed patterns and predetermined locations. The utilitarian demands on Taiwan’s small, interior spaces are also high. When most people commit to a dwelling it is with the thought of the present and the future. This ‘future’ may include disruptive effects like changing family structures and life situations that connect the purchase and interior configuration of a home to financial issues like saleability and renovation costs. A mobile interior architecture could effectively meet these concerns by designing flexibility into Taiwanese cluster housing developments with minimal risk. Open Building and Open Source Building can be seen as a kind of mobile architecture in offering high level flexibility and ease of modification in interior architecture though without being instantly movable. This is explored in the following chapter.

**Global precedents and examples of Open Building in Asia**

The broad adoption of the Open Building system depends on the availability of a variety of interchangeable building components, and has been slow in coming internationally. Component manufacturers require a large market but a larger market requires a greater variety of components. While this appears to be a Catch-22 situation, developments based on Open Building principles are beginning to move into the residential housing sector. Globally, many thousands of residential units have been constructed on Open Building principles in Europe, Asia and North America, where they are leading to a general reorganisation and re-conception of housing design and construction. By contrast, traditional housing industry practices have continued to produce a relentless monotony in housing products, with little or no design input from homebuyers and a disregard for the potential cost and design benefits of industrialisation. Most notably, the post-war housing boom in The Netherlands saw base building and fit-out being treated as separate entities with different life cycles, producing housing stocks better able to respond to the individual needs of occupants. Those parts of buildings relating to local building styles and regulations typically remained constant but interior elements were conceived for a more rapid cycle of change.

In Asia, Open Building principles have been applied with varied success. Zaman and Lau discuss the difficulties of applying open building to mass housing in Hong Kong, arguing that in this context, ‘open building and customisation of mass housing flats is determined according to the furniture layout and the minimum dimensions required for a limited number of layout

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195 Ibid., p. 159.
198 Kendall and Teicher, p. ix.
Even though its application is government ordained and controlled, its use is only partial and in essence a simple response to the limited space standards that the Hong Kong Housing Authority allows in public housing. It does not empower occupants to exercise greater choice in interior layout. Hur, Chung and Yoon discuss open apartment building in Korea, noting similar difficulties to the Taiwan market in terms of the unsuitability of construction materials and processes and general industry intransigence.

Summary and discussion

The traditional measures and parameters of successful housing development in Taiwan are inadequate. Conditioned over time, they have seen homebuyers settling for something much less than what they want and need, homebuyers’ general dissatisfaction with products substantiated by the high rates of demolition and redesign of the interiors of newly purchased units in Taiwanese cluster housing developments. The time for Taiwanese developers to identify design and construction strategies that create better value for homebuyers is long overdue. Mass customisation principles are an obvious place to start. However, the potential for product diversification and customisation must meet a variety of economic determinants and potential applications, contemporary lifestyles creating a wide range of needs and preferences among user clients. A more innovative approach to housing development sees homes as personalised commodities, generated through a new, user-centred design paradigm that accommodates extensive customisation. The realisation of customisation through mobile architecture as modelled in Open Building theory and practice is one answer to customisation for Taiwanese cluster housing. The next draws on Open Building theory to develop a model of housing products as an interface, comprised of a building shell, or base building, and a fully prefabricated and adaptable in-fill system capable of accommodating different homebuyers’ needs and wants. The chapter discusses how an Open Building approach can leverage the user-centred design principles described above, outlining the inherent principles of Open Building and Open Source Building before explaining their implications for management of supply chains in the Taiwanese housing industry.


Chapter Five: Housing design and development in Taiwan: exemplifying the issues

This chapter considers how the current housing development process in Taiwan can be made more user-centred and flexible through the introduction of ‘Open Building’ and ‘Open Source Building’ principles and user scenarios. First, I consider issues concerning modular design in Taiwan, particularly the obstacle to mobile architecture that fixed internal partitions represent. This is followed by a more holistic analysis of three case studies demonstrating the general issues facing development of cluster housing. This chapter is a prelude to the three user scenarios advanced in the final chapter, which illustrate the flexible interior design processes central to the base building system proposed in this study.

Exemplifying current practice in Taiwan

In the first instance, modular and standardised ceiling, floor and wall systems designed for easy assembly and disassembly would greatly increase the efficiency of the Taiwan housing industry. Such modular systems would not be difficult to introduce in respect of supply chain management. The great challenge, however, is to go beyond the modularisation and standardisation of individual building parts and offer variation and flexibility at the level of the total dwelling since this is where the real choice arises for homebuyers. At present, mass-customisation of housing products is impossible in the Taiwanese housing sector because of the restrictions imposed by concrete construction. The use of this single material means developers offer homebuyers only a very limited range of products, typically conceived around architectural style and the number of bedrooms. Even within these limits there is latent and under-exploited potential for customisation if only the Taiwanese housing industry could develop more integrated design, production and sales functions framed around the customer-centred performance criteria of facilitating choice. Until buyer needs and preferences become an imperative for the sector the scope for widespread customisation will remain a distant possibility and a lost marketing opportunity for developers, since a primary effect of customisation is to decrease what prerequisites a customer gives up to purchase a particular product. Gilmore and Pine in fact argue that the ideal for manufacturers is to have the level at which customers sacrifice personal needs and preferences low enough to woo them away from competing offerings and lock them into their own customised alternatives.202

Developers, working in association with architects and interior designers, especially need to devise more open interior layouts that facilitate alteration over the life of a dwelling. Currently in Taiwanese cluster housing products interior walls are not designed for easy modification or

removal, giving buyers almost no scope to make alternations to a dwelling if purchased at completion stage. The figures below demonstrate how the construction of fixed internal partitions makes alterations and renovations expensive, difficult and time-consuming while highlighting the standard nature of interior and exterior finishing in developments.

Figure 8: Current Taiwanese 'one-size-fits-all' cluster housing unit, Tainan (2006)
Figure 9: Current Taiwanese ‘one-size-fits-all’ cluster housing unit, Jen Tei, Tainan County (2006)
Open Building and Taiwanese cluster housing

The flexibility of the base building system is a more sustainable approach to housing since it addresses architectural and interior design in the context of the complex social system of Taiwanese society. It is also a tangible example of sustainable design contributing changes to interior design and housing development by considering lifestyle consumption and production. Open Building likewise meets Kendall and Teicher's criteria as an approach to sustainable architecture since its processes, 'accommodate new technologies and also allow for changes in the organization of work, in the life-styles of building occupants, and in the shape of households those occupants form.' The opposite of the positive characteristics of Open Building is demonstrated in the following case studies.

Tainan case studies

The analysis of the following three cases is intended to highlight the cascading and interdependent weaknesses inherent in Taiwan’s cluster housing industry while framing the flexibility created by the use of the base building system. In all three cases I was engaged by the owners to redesign each property as the need arose, at significant expense and with considerable difficulty and waste due to the dominance of concrete in the construction of each dwelling. Reflecting on these examples has enabled a greater understanding of my previous practice as an interior designer while challenging me to conceive a plan of action to address inadequate design strategies, construction methods, industry structures and regulatory frameworks in the Taiwanese housing industry in order to improve what is currently happening.

All the properties to be analysed are located in Tainan, the former capital of Taiwan but now its fourth largest city. The city has a population of around 740,000 people, many colleges and universities, small and large-scale factories and a world-class science park. Patterns of home ownership in Tainan are representative of urban areas in Taiwan, and, as elsewhere in the country, residential building is very important to the city economy. Fluctuations in this sector strongly influence the general economic performance of the city as well as the overall living standards of its residents. Of all Taiwanese cities, Tainan has the intellectual and technological resources to re-conceive medium-density housing developments but at present there is not the interest, mechanisms or knowledge to do so. As in many dimensions of Taiwanese society, economic imperatives and perceived insecurity continually drag practitioners back to the conventional, the norms and values of the housing system being so pervasive as to be largely taken for granted and, as such, almost beyond challenge. The lengths determined home owners have go to in individual instances to compensate for a flawed system and achieve the home they want are demonstrated in the following examples.

Case study one - Long-Full display home

The Long-Full display home demonstrates how concrete construction can be a difficulty for developers as well as their customers. The display unit is used to market the Long-Full company’s cluster housing developments. The remodelling was implemented to revive buyer interest in the company’s developments, the renovation revolving around a new interior layout. The remodelled display home is intended to encourage those living with ageing family members to relocate to a new home, highlighting the pervasive but unsustainable practice of moving house in Taiwan to solve problems of lifestyle and life stage. In remodelling the display home the majority of its existing interior was torn out and a new design concept applied to achieve a more powerful expression of luxury and somewhat clichéd, life stage appropriate features, showing how appeals to lifestyle and high social status dominate practicalities, these being the needs of elder dependents and affluent, middle aged purchasers.
The expensive unit can hardly be seen as representative of the type of homes the majority of Taiwanese homeowners occupy. Nevertheless, the remodelling exercise exemplifies the fundamental problem of inflexible interior layouts and construction materials in Taiwanese cluster housing developments while indicating the mix of marketing and design strategies real estate development companies use to stimulate interest in housing projects. As the Long-Full display home demonstrates, it is typical that a larger, more lavishly appointed and decorated unit is used by developers to sell dwellings in their less expensive developments, believing that homebuyers will be won over by the illusion or reflected prestige.

A lift was installed in the display house to aid the mobility of ageing family members while the developer requested a separate living area be set aside to maintain their privacy. The new design also provided a fully appointed master bedroom cum retreat for the primary homeowners, incorporating sleeping, working, entertaining and relaxation areas. The remodelling likewise added spa facilities for other family members and guests, a guest room, tea room and prayer room. All new rooms were constructed in brick, compartmentalising the interior of the unit into a new fixed
sequence of specific spaces offering little flexibility of interior design if the occupant’s lifestyle, life stage or family structure changed or the unit were sold to new owners with different needs and preferences (see figures 12-16 below).
Figure 12: Plan alteration, Long-Full display house, Tainan (2004)
Figure 13: Interior construction, Long-Full display house, Tainan (2004)
Figure 14: Interior construction, Long-Full display house, Tainan (2004)
Figure 15: Remodelled interior, Long-Full display house, Tainan (2004)
Case study two: Tzeng house

A family of six family members previously living in an apartment purchases an existing, five-storey detached house that requires substantial remodelling to accommodate the family's needs and preferences. Mr. Tzeng (age 48), owner of a shoe factory and his wife (age 46) have five children at various stages of work and schooling. Their eldest daughter (age 23) works part-time at Mr. Tzeng's office and lives at home while their second daughter (age 21), studying abroad, needs a bedroom in Taiwan for temporary stays. Their third daughter (age 18) is studying at high school, and needs a bedroom and quiet space for preparation for her university entrance examination. Their youngest daughter (age 11), a 4th grade student in a primary school, needs her own bedroom and a common study room together with sisters and brother. Their youngest son (age 11) also a 4th grade student in primary school, needs his own bedroom to display toys and the common study room together with sisters. They engage an architect to make the changes. Following disappointment with the architect’s design, Mr. Tzeng hires the author to redesign the internal layout of the house to better accommodate the owner’s specific functional and stylistic requirements such as the separation between living areas for parents and children, the provision of common studying area so that the elder sister can take care of younger sisters and brother. They also require a buddhist prayer room and Japanese tea room to be located on different floors.
In the original house and the architect’s plans, interior space was highly compartmentalised, being comprised of fixed and discrete spaces linked into a linear sequence. The general aim in seeking a second design for remodelling the house was to open up the interior space to provide view linkages between internal and external spaces, including the living area and front garden, tea room and rear garden, master bedroom and internal garden balcony (see figures 17-21). A multifunctional ‘Japanese’ room and balcony was added for use as a guest room or for audio and video entertainment. Two separate living areas were requested, to maintain privacy and avoid interference between concurrent activities in the busy household.
Figure 17: Plan alteration, Tzeng house, Tainan City (2002)
Figure 18: Interior construction, Tzeng house, Tainan (2002)

Figure 19: Interior construction, Tzeng house, Tainan (2002)
Figure 20: Remodelled interior, Tzeng house, Tainan (2002)

Figure 21: Remodelled interior, Tzeng house, Tainan (2002)
Case study three: Wang house

A family of five purchases a unit in a cluster housing development off the plan but after the time when design changes are allowed by the developer. Disappointed with the unit’s interior layout in early occupation, the owner, Mr. Wang, initially considers selling and building a new home elsewhere so the family can be involved in the design process to arrive at a home that meets their specific needs and preferences. However, when the possibility of purchasing an adjoining unit arises Mr Wang decides to remodel it and his existing unit to create a single dwelling.

The family members are all involved in a design and manufacturing business that specialises in women’s shoes. Significant business activity will be conducted in the family home. Mr Wang (age 50) directs the company. Mrs Wang (age 48) works as its accounting manager. The eldest daughter: (age 25) is single and works as the company’s chief designer. She needs her own room for developing her design work and meeting friends. The elder brother (age 24) is preparing for marriage and works as a business manager for the family company. He is hoping for a suitable room to be included in the remodelled dwelling to accommodate him and his wife, as they will initially live with the family. The youngest male member (age 21) works as a general manager for the company. Thus, a key consideration for the redesign work was the dual considerations of business and living needs, as well as Mr Wang’s pastimes of gardening and physical fitness.

Initially Mr. Wang hired an architect to provide a design for the remodelling of the two units but in judging the architect’s approach to be lacking Mr. Wang hired a specialist interior designer, the author, to develop a more tailored design. The revised interior design was accepted and the units remodelled to facilitate the client’s wishes for a unit that could accommodate both business activities and privacy for his adult family. Other requirements of the interior design were a sense of openness and visual penetration through the dwelling and a relaxed lifestyle with plentiful provision for leisure and personal entertainment. The author conceived an interior with a garden setting, including an artificial waterfall located at the centre of the interior providing views to living, dining and kitchen areas. A minimalist teahouse was included for relaxation and business meetings. A lift was provided for easy access to the four upper floors and with an eye to future needs. Most internal spaces opened onto the garden. The addition of gym, spa and bath facilities responded to the client’s interest in relaxation and fitness while sleeping areas were designed to include living and working areas to accommodate the specific lifestyle of family members (see figures 22-27). The reconstruction of the dwelling in response to these particular needs underlines how the inflexibility of Taiwan’s building codes and construction materials results in dwellings that are too specific for future buyers, requiring them to accept what exists or take on expensive major renovations — such as that already undertaken by the Wangs — to achieve what they need and want in a home.
Figure 22: Plan alteration (1f–2f), Wang house, Tainan (2002)
Figure 23: Plan alteration (3f–5f), Wang house, Tainan (2002)
Figure 24: Interior construction, Wang house, Tainan (2002)
Figure 25: Interior construction, Wang house, Tainan (2002)
Figure 26: Remodelled interior, Wang house, Tainan (2002)
Summary and discussion
The Tainan case studies illustrate the difficulties faced by homebuyers in seeking to achieve their needs and preferences in conventional Taiwanese housing developments. They highlight a range of design constraints, as well as the failure of the important communicative and advocacy roles of the designer in serving the needs and preferences of homebuyers and in bridging the gap between developers, architects and homebuyers during the design process. The cases also illustrate how constraints occur at different stages of the development process, such as Long-Full’s misleading marketing strategy for potential homebuyers and internal layouts so misconceived or unacceptable to purchasers that they are remodelled immediately on completion, creating huge waste.

The Long-Full display home indicates the extent of demolitions required to remodel a completed cluster housing unit, even though the commercial purpose of the exercise was to show how the company’s products could be dramatically reborn. For example, all internal partitions on the ground floor were removed and new partitions in different locations rebuilt in cement blocks to create different interior spaces, allowing for the provision of a larger garage and a new
multifunctional room equipped with spa facilities. The same construction methods were required on the third floor, where two original bedrooms with en suite bathroom were remodelled to create a communal bathroom with more features and better space orientation. Only on the second floor was a light partition able to be used to create a separated living area. The Long-Full unit, while never occupied, nevertheless illustrates the need for Taiwanese cluster housing to offer more scope for reconfiguration during the development process while incorporating strategies to avoid major demolitions when the need or desire for interior changes arises post-occupation.

The Tzeng and Wang houses exemplify how a user-centred design approach should allow purchasers higher potential to tailor their houses at the early stages of housing development. From an interior designer's viewpoint both houses demonstrate the lack of communication between architects and clients, the remodelling work requiring a thorough reconsideration of failed architectural plans after it was recognised that the interior layout essentially ignored the needs and preferences of individual family members and the family as a whole. Moreover, the provision of amenities for the Tzeng family’s three elder daughters had to be carefully considered since each was of an age where they might soon leave home. Taiwan’s current building regulations require permanent internal walls to be constructed in concrete or brick where the life stage of the Tang family predicted that the role of whole sections of the house could be in flux in the near future. These two examples highlight the need for flexible, user-centred approaches to design and construction methods to support easy remodelling, where in conventional Taiwanese cluster housing units the building fabric is almost completely resistant to later remodelling.

These three case studies suggest that without inbuilt flexibility in the design process developers gamble on the existence of 1) homebuyers whose needs and interests approximate those reflected in the design of their developments, 2) homebuyers who are prepared to accept a sub-optimal home or 3) homebuyers who don’t recognise that they are purchasing a sub-optimal home. Furthermore, it is necessary that new innovative construction methods are embraced in the Taiwanese housing sector to achieve sustainability concerns over time. Indeed, all three cases reveal near identical problems in achieving a desirable quality of life and an increased degree of personalisation. If developers do not examine the conventional processes of housing development and replace them with more appropriate housing forms, the issues of lack of social sustainability in housing developments will remain in the Taiwanese housing market. The following section considers how the above considerations for reframing interior design for cluster housing developments in Taiwan can be achieved through user scenarios.

The interior design industry can take the up the need for greater human-centeredness and customisation in Taiwanese housing developments. Interior design projects can be completed by a designer working directly with a client to better control design and tailor it to client needs and preferences. In this process, only the interior designer and the client determine design outcomes.
The case studies and scenarios have enabled me to more precisely locate the gaps, obstacles and issues that confront the application of a user-centred design platform (UCDP) and customisation to the Taiwanese cluster housing market. An open-ended design approach, applied at any stage of the development process, would allow homebuyers to modify the configuration of their dwellings during construction and throughout the time of their use. The aim of the following chapter is to propose such an open-ended model to meet the needs of the current Taiwanese market. If mass-customisation of housing products were adopted in tandem with one-to-one marketing strategies, interaction with homebuyers would not only demonstrate a new openness to their needs and opinions but also provide Taiwanese developers with a valuable new source of market knowledge. In fact, one-to-one marketing has the potential to forge a learning relationship between homebuyers and developers. Developers would become smarter in their provision of housing products and associated services as well as in their directions to designers, formulating these to meet needs and interests directly explained to them by buyers, an experience with high potential to overcome developer resistance to housing innovation.

206 One-to-one marketing ‘is an approach that concentrates on providing services or products to one customer at a time by identifying and then meeting their individual needs. It then aims to repeat this many times with each customer’ from http://www.managingchange.com/onetoone/overview.htm

Chapter 6: An integrated model of interior design

At present in Taiwanese housing developments interior design is tied to minimum standards of living and the conventional distribution of living space into basic functional areas. The needs and expectations of those buying into Taiwanese cluster housing developments can be better fulfilled through an ‘open’ rather than ‘closed’ design process, drawing on the multi-adaptive subsystems of the Open Building model and the flexible principles of the chassis-concept interface contained in the Open Source Building system. As significant as these practical innovations are for this design research, what is more important is the conceptual emphasis these models place on the openness of all the processes of development, design, construction and interior design.

This section introduces a model process of development and design for Taiwanese cluster housing developments, which integrates the remedial principles and strategies outlined above based on actual scenarios of use. The model contends that treating design as an integral process is essential to establishing appropriate housing outcomes for the Taiwanese housing market. In other words, developers and marketing professionals should relinquish their current dominance of this process to reclaim their proper function as the managers of an integrated development process. Where currently the first stage of Taiwanese housing development only involves developers, marketing professionals and designers, my alternative system also involves homebuyers, reducing the need to revise designs during construction or after completion.

An integrated model process for Taiwanese housing development and design

The future of housing development in Taiwan requires the introduction of user-centred design approaches at specific stages of the development process in order to establish new housing forms that better accommodate purchasers’ needs and expectations over the life of a dwelling. The scenario method introduced here is built on the premise that those who can directly control the details of the housing product, including developers, marketing professionals and designers, must interact with potential homebuyers. Scenarios of use can lead designers and developers to a deeper commitment to the actual needs of potential homebuyers, greatly enhancing the practical implementation and ‘workability’ of the UCDP examined in the next section.

Stage 1: Planning and Development

A new housing development normally begins with Land Development and Evaluation, which relates to the marketability of a development and has its own iterative cycle that influences later
design decisions. The addition of an UCDP at this stage links marketing objectives to the process of obtaining a real understanding of homebuyers' needs. It should include census data related to the Taiwanese housing market, the monitoring of feedback from previous housing developments, learning from other housing developers’ experiences, QFD and the subsequent creation of hypothetical homebuyer scenarios. Post-occupancy evaluation (POE) is perhaps the source of the most valuable information in planning a new housing development, enabling rapid orientation of product characteristics to buyer needs and preferences. In terms of the proposal for user-centred design in this project, a POE should form part of the overall participatory design process as diagrammed above in the section on QFD. The integration of existing development and evaluation processes of housing construction and design, such as QFD and POE, forms part of the overall strategy in this project in the development of a participatory design process.

Figure 28: Stage 1, Planning and Development
**Stage 2: Programming and Design Development**

This stage is central to the entire housing development and is comprised of ‘Concept Development’ and ‘Design Implementation’. Here the UCDP encourages designers to overcome the problem of not knowing who potential users are by employing user scenarios to predict the needs and preferences of future homebuyers.

![Diagram of Stage 2](image)

**Stage 3: Pre-Sale**

The ‘Pre-Sale’ window in Taiwanese housing developments normally overlaps the latter period of design development. Sales people are in the ‘front line’ at this stage, having plentiful opportunities to talk to potential homebuyers and to better understand their needs and preferences. In Taiwan, specially constructed reception centres and display homes are usually prepared to attract buyers to a development. They provide a context where responses, opinions and ideas from potential buyers could be collected and fed back to designers to revise working drawings and final plans. Here, market feedback can be seen as a kind of outsourcing of market intelligence. The value of the
information that is exchanged between sales people and potential homebuyers if channelled into the design process as part of internal iterative cycle in producing better, more competitive and sustainable housing products cannot be emphasised enough.

Stage 4: Construction

This stage normally comprises a series of sequential construction stages for housing development. Currently in Taiwan, this stage is the least flexible and demonstrates that design rigidities increase as the development process progresses.
Stage 5: Operation and Sale

The last stage is generally the sale stage of the completed housing development. In this stage, the UCDP is entirely constrained by the great rigidity of conventional housing forms. Conventional development practices impose very limited scope to apply a user-centred design approach at this stage, where achieving homebuyers’ specific needs and preferences usually requires demolition of the building interior.
An overview of a user-centred design approach for housing development and design in Taiwan is shown as Figure 33. Three main stages are characterised and demonstrated as responding to this approach. In Stage 1, user-centred design is achieved by identifying homebuyers, identifying and understanding their needs, and then achieving those needs through relevant methods such as participatory design. In Stage 2, ‘User Testing’ and ‘User Involvement’ are employed as positive methods to fulfil homebuyer’s needs and preferences. Stage 3 encompasses the construction process where a user-centred design approach is not applicable.

Figure 33: The application of a user-centred design approach to the housing development process

Based on the role each of the five stages play in adapting user-centred design to housing design and development, this design research incorporates a further three levels into the process to more effectively accommodate homebuyers’ needs. The first level includes ‘Housing Development’ and ‘Programming and Design Development’, where the UCDP is of most benefit to future homebuyers. This occurs through the more informed decisions made by developers, marketing professionals and designers. The second level includes the ‘Pre-Sale’ window where homebuyers...
can still benefit from UCDP through designer-initiated alterations. The third level contains the 'Construction' and 'Sale' stages where changes are currently limited by the rigidity of building construction and UCDP inputs cannot be catered for. Clearly, then, to optimise the implementation of a user-centred design practice in Taiwanese cluster housing projects it is necessary to introduce the user-centred design approach from the outset of the development. The Tainan case studies previously discussed illustrate the importance of this strategy.

**Prototyping the base building for Taiwanese cluster housing development**

As argued previously, the provision of UCDP at different stages of the housing development and design is also informed by Open Building and Open Source building principles combined with customisation strategies from manufacturing. Open Building was developed to give the greatest possible freedom of interior layout and construction. It also reflects the growing focus in the architectural profession and building industries on the life cycle of materials and components in the light of sustainability issues, changing established views of architecture. Moreover, as previously outlined, the new design and construction strategies the research recommends for Taiwan use ‘support’ and ‘in-fill’ concepts from Open Building to facilitate easier remodelling of interior layouts according to needs. However, the Open Building system can not be directly transposed without addressing the issue Taiwanese building regulations, methods of construction and radical new approaches to supply chain management, which all need attention to maximise the possibility for ‘free’ interior layout options to be broadly introduced to the cluster housing development sphere.

For instance, the traditional width of buildings in cluster developments may need to be increased to extend interior layout flexibility. Current building widths would make it difficult to provide modularised approaches such as floor grid systems. In turn, this restriction prevents the provision of alternative configurations of vertical connections such as plumbing and electricity (see figure 24). It is equally important to increase the storey height to improve the layout of plumbing installations, particularly to allow for additional horizontal connection to replace the conventional vertical connection of electricity, water and gas. For example, a method for accommodating additional horizontal connections is to use a suspended floor system, creating an extended floor and ceiling cavity. The base building system advanced in this research includes a suspended, modular floor system with a lift-up components for upper floors. Currently, a concrete floor is mandatory for the first floor of Taiwanese cluster housing developments. When applied to

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Taiwanese cluster housing developments, the base building system is superior to other approaches due to the scope to adjust interior layouts during construction. Such adjustability includes altering spaces horizontally and vertically, and making internal structural changes to the elevation and extensions.210

The application of modularised building components and interior in-fill to the base building demands a building width with a fixed mathematic multiple relationship to building height. For example, in Figure 34, the width and depth of the modularised floor system is set as 60 cm. Therefore, the width of base building can be multiplied to 540 cm or 600 cm to preserve the interrelationships discussed above and enable modularity.

![Figure 34: An example of the width to height relationship of the base building system](image)

In addition, revised building regulations are required to successfully apply an open building system. At present, every new home owner has to provide building authorities with copies of the floor plans submitted with the application for a construction permits, these plans being strictly checked against the completed house before a permit of building usage is issued. This makes it impossible

to alter interior layouts during the construction stage of a housing development. Moreover, the stipulations of the building permit are a major obstacle to altering buildings in Taiwan, since floor plans are kept as a record to prevent alteration without the issuing of an additional building permit. According to the system proposed in the research, the permanent base building elements would be the part of the building checked off against plans. Internal partitions would be regarded as transferable and exchangeable.

The base building system is described in Figure 35. It is composed of external structural walls, floor voids, and a single service dock for connecting floors vertically and locating services like electricity, gas and plumbing, or for feeding them out through floor/ceiling cavities. The base building does not include any internal partitions or other internal in-fill elements such as doors. The incorporation of services for the building is divided into two stages, service roughing and full service. The stage of service roughing involves only the central distribution of plumbing and wiring. In the full service stage, services are extended throughout the home according to homebuyers’ decisions about the final interior layout and the points where services are needed. To facilitate such flexibility in Taiwan, the permit of building usage issued by the building authority needs to accommodate both the base building stage recording only the completed building of exterior shell while documenting the final interior layout, if the latter is still thought necessary.

Figure 35: An example of the base building system for one unit of a cluster housing development
To support the base building system and make customised housing products feasible in Taiwan will require a well-established and linked supply networks in associated building industries, especially across the oblique relationships between customers and suppliers in the external supply chain beyond the immediate process of delivering components to builders and subcontractors to construct a building. This approach can be understood as an extended network, whereby the housing and building industries facilitate the scope for customisation by coordinating their products. To implement the Open Source Building system discussed in this research, the building industry must in reality achieve the quality and responsiveness of a ‘one-off’ architect designed house with great efficiencies, something that is currently beyond the capacity of traditional speculative housing developments in Taiwan.

The integration of the principles of a user-centred design into the Open Building system to provide a more customised housing product is shown in Figure 36. It documents the points where the important strategies of ‘Identifying User Groups and ‘Identifying Users’ Needs’ must occur in the early stage of building development process, and where ‘Participatory Design’, ‘User Involvement’ and ‘Collaborative Design’ intercede in the subsequent stages. The idea of the ‘Extended Design Stages’ (see figure 36) advanced by the design research potentially allows homebuyers access to an alternative form of housing development, which avoids rigid characteristics that can be very difficult and expensive to alter at a later date if needs and preferences change. For example, at the stages of full service, the base building allows homebuyers to engage in participatory and collaborative design at various points in the design and development process and to freely implement design alterations at a later time with minimal cost and disruption. At the interior fit-out stage in particular, the flexibility of base building system allows for the implementation of what could be called ‘continuous’ interior design to arrive at genuinely user-driven interior layouts.

Following this argument a new, flexible, tripartite process for homebuyer involvement in housing development emerges for Taiwan, the stages of which I have titled ‘Options from Developers and Architects’, ‘Interior Design and Designer’ and ‘Self-Management’. Each option provides homebuyers with a different set of circumstances of increasing scope to fulfil their needs. Moreover, as the flexibility of housing developments in Taiwan expands even more alternatives would most likely be offered by developers. ‘Options from Developers and Architects’ retain the customary approach of standard alternative designs being offered to homebuyers if they prefer traditional models. The alternative of ‘Self-Management’ allows homebuyers to fully determine interior layouts prior to occupation and over the life of a home. It is predicted that implementing a continuous interior design process to arrive at tailored interior design will achieve greater
satisfaction for homebuyers, reflecting Friedman’s idea of designing for adaptability as a ‘growing process’.211

In order to ensure success in the application of flexible, user-centred interior design in Taiwan, the research recommends dividing the development process into two parts (also see figure 36). The early stage allows the development team to target design’s more precisely to the needs and preferences of potential homebuyers. The introduction of the base building system to the process informs the second part of the development process, transforming it into an extended design stage that allows homebuyers to be directly involved in the design process.

Figure 36: New integrated process and homebuyers’ engaging points

Building costs for traditional and alternate cluster housing form

The design of a housing development is not only determined on appearance and performance. Cost is also a critical factor in most projects. Costs in the housing industry are difficult to establish given the complicated process of on and off-site labour and production that creates a house.212 By contrast, the automobile industry can extrapolate costs once the processes and conditions of

production are known. The form of a building is also be influenced by many interrelated factors from location and planning constraints to the availability of building components, materials and skilled labour and technical support. The knowledge and skill of the designer to specify the most appropriate methods of construction also impinges on costs.\textsuperscript{213} When the complexities of user needs and preferences are introduced through customisation production costs become even more unpredictable.

Besides factoring these concerns into the true cost evaluation of a building, building costs include more than capital cost alone, designers, developers and owners needing to become more aware of life-cost considerations for different buildings.\textsuperscript{214} From the designer’s viewpoint, reducing building costs has generally been regarded as the most important factor in creating value for both purchasers and developers. The diagram above roughly demonstrates the cost of a traditional Taiwanese Cluster housing unit by calculating land cost plus building cost. By adapting this basic calculation to the base building, the estimation of a homebuyer’s total cost for a new cluster housing unit can be approximately estimated as follows:

\[
\text{Total cost of a base cluster housing building} = \text{land cost} + \text{building cost},
\]

that is, building shell and exterior material, needed internal floors, central distributing points of service dock.

Compared to current Taiwanese cluster housing developments, the cost of the internal parts can be reduced considerably if the development is not constructed with traditional methods. This also avoids further high costs if houses are remodelled. In dividing the process of housing construction into two stages — base-building and in-fill — homebuyers have their needs and preferences accommodated while time and money is saved in initial construction and over the life of a dwelling.

Based on the standard estimation of building costs in Tainan County, the cost differences between traditional cluster housing developments and the proposed base building system for cluster housing development can be established according to the process set out below.

\textsuperscript{213} The true cost evaluation of a building should involve a close examination of viable alternative acquisition, running and optional costs. \textit{Ibid}, p. 102.

It is difficult to estimate the exact cost of the internal components of a dwelling due to the varied needs and preferences of individual homebuyers. However, the proposed base building system will always reduce expenditure on internal materials and finishing when compared to traditional cluster housing development. According to Porter, buyers must be willing to pay a price for a product that exceeds its cost of production. In the context of this argument, the reduction can be derived by proper implementation of integrated supply chain management by related housing industries, creating cost leadership that can be transformed as a benefit for homebuyers by minimising costs (capital cost, occupancy costs and maintenance costs) and/or increasing performance. Establishing the value created through alternative building forms for both developers and homebuyers is vital in agitating for revised standards and systems in the Taiwanese cluster housing sector.

Certainly, when discussing the value of a building there are many factors apart from basic supply and demand questions to be considered, just as perceptions of satisfaction are not only captured by price alone. In the context of the housing market, Best and De Valance identify three types of value — exchange value, use value and esteem value. They define exchange value as the open market price of a building, which is of primary interest to property developers. In general, developers create profit by successfully executing exchange value with homebuyers. They describe use value as the value of a building to those performing activities within it, principally owner-occupiers while esteem value is the attractiveness or desirability of a building, that is, the subjective estimations formed by those influenced by, but not using, the building. These two values are, of course, far more abstract than aspects of profit value, such as cost reduction for example. Therefore, in influencing a homebuyer’s view of a property, cost value is linked with use value, which is very different from the meaning of exchange value for housing developers.

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216 Ibid., pp. 131-140.
Most homebuyers want to minimise building cost as much as possible when purchasing a new home while developers typically want to reduce building cost as much as possible to achieve the maximum profit after exchange with homebuyers. On the other hand, to achieve certain expectations of use value, including the scope to make flexible alternations later on, building costs are not openly reducible. T. C. Fowler recognises that a product must fulfil a user’s need to have value, summarising the relationship through the formula:

\[
\text{Value} = \frac{\text{worth}}{\text{cost}}. \tag{218}
\]

However, he also recognises the problem of measuring worth objectively in a product or service and suggests an alternative expression through the formula:

\[
\text{Value} = \frac{\text{user’s initial impression + satisfaction in use}}{\text{(first cost + follow on costs)}}. \tag{219}
\]

Fowler regards user acceptance as a direct measure of worth and user perception of worth as composed of first impressions plus experience. Cost, on the other hand, is not simply the initial price, but must also include follow-on costs during the life cycle of the product. In construction, Dell’Isola presents a more objective view in his definition of value in the stage of construction:

\[
\text{Value} = \frac{\text{function + quality}}{\text{cost}}
\]

Where:
- \text{function} = The specific work that a design/item must perform.
- \text{quality} = The owner’s or user’s needs, desires, and expectations.
- \text{cost} = The life cycle cost of the product. \tag{220}

In depth, an adapted definition of value is:

\[
\text{Value} = \frac{\text{benefit (what you get)}}{\text{sacrifices (what you put in)}}. \tag{221}
\]

This broad definition captures the value component of providing a product or service at the right time, with the right construction, to the right customers. \tag{222} For housing development this definition of value can respond to the specificity of a housing development regarding time,

\footnotesize
building and actual purchasers for both the developer and homebuyer. In the case of perceivable value, the new design system outlined in this design research could be provided at a lower price and with a shorter construction period than existing ones; an attractive outcome for developers on the basis of profit and productivity, both of which result in competitive advantage. This advantage can also create tangible and intangible benefits for homebuyers. Cost reductions are a measurable benefit to homebuyers. While the enhanced qualities of the building are harder to quantify they are still real for the homeowner. Implementing human-centred design may also offer very real cost advantages for developers and homebuyers during both the construction and post-construction stage through the avoidance of expensive demolition, redesign and reconstruction.

Summary and discussion
This section has considered the key elements needed to reframe housing development and interior design industries in Taiwan. It concluded with an overview of the key elements needed for scenario-based user-centred design. This approach is exemplified in the following section where three scenarios are proposed for adapting interior design processes within an Open Source Building context to the changing needs of clients.
Chapter 7: Exemplifying with user scenarios

A user-centred design approach to housing development requires definitive processes to predict homebuyers’ existing and future needs. One method is to avoid designing spaces for only one function, as in the Long-Full, Tzeng and Wang houses.\textsuperscript{223} The scenarios of use offered here establish parameters for design when the actual situation of future occupants is not known, thereby modelling the attitudes and responses of potential homebuyers throughout design and construction. To develop the highest level of customisation to meet homebuyers’ specific requirements and changing needs over time, the vertical and horizontal relationships between the different stages of housing development is especially considered.

In this section I advance three scenarios for the ‘use’ and according reconfiguration of the base building in a single cluster housing unit to accommodate homebuyer’s individual and changing circumstances, needs and preferences. Following the concepts of ‘support’ and ‘in-fill’, each interior configuration is presented at two stages — service stage and interior fit-out stage — during which detachable interior modules are organized to create rooms, storage, partitions, cabinets, and water supply and drainage facilities, electrical wiring, communication lines and gas piping is distributed from the service docks to the structural envelope of the building shell. The representation of the dwelling at the interior fit-out stage indicates the lifestyle and life stage of residents and the flexibility of interior design that can be achieved through the base building system. The transition from one scenario of use to another shows that all interior walls are reconfigurable, highlighting the ability of the home to be altered over time.

User scenarios

Scenarios of use based on the needs of representative homebuyers are a way of reconfiguring the design process to allow greater flexibility and relevance in design outcomes.\textsuperscript{224} Currently, Taiwanese developers often complain that homebuyers’ needs and preferences are too variable and conflicting. The limitations of using consumers as contributors in product development are well recognized. Ciccantelli and Magidson argue that, ‘Even when consumers are aware of what they want and are willing to reveal it, their wants are likely to be conditioned by what is available … when the product or service available is basically unsatisfying to them, they are unlikely to reveal startling new desires or concepts.’\textsuperscript{225} This assessment may reveal more about the

\textsuperscript{223} Friedman, p. 14.
\textsuperscript{224} Schneiderman, pp. 127-129.
inadequacies of the mechanisms for investigating user’s attitudes and ideas, especially when they are framed around marketing messages.

Integrating a user-centred paradigm into housing development involves basic practical challenges when only a percentage of purchasers of a future development are knowable. Yet effective channels for soliciting product feedback are vital to product developers and users, suggesting user research methods need to be continually developed and refined. In this opening section of chapter four I use three related examples to show how scenarios of use can be developed for this purpose. These scenarios reflect the practical difficulties in offering customisation when developments are market and profit-oriented. Scenarios of use are a widely recognized problem-solving tool and analytic model in other design fields. Website developers frequently create ‘hypothetical archetypes of actual users’ known as user ‘personas’ to help designers better conceive their target audience and thereby develop the best features and qualities for a site. Cooper argues that detailed projections of the needs and characteristics of individual members of a target audience allow designers to deliver products that fulfil the needs and interests of many others, who are likely to have related preferences and backgrounds. If designers create profiles and scenarios of use to reflect a greater range of hypothetical users, one for each main group of user clients.226 A particular precedent for the use of user scenarios in interior design is Friedman’s work on housing adaptability.

**Friedman’s model and user scenarios**

Friedman sees housing adaptability as ‘providing occupants with forms and means that facilitate a fit between their space needs and the constraints of their homes either before or after occupancy.’227 Today’s accelerating social and technological changes increase the need for developers and designers to provide even more adaptable housing forms. Friedman argues there is a process to providing adaptability, reasoning that, ‘to maximize choice and adaptability in the unit design, an appropriate floor plan had to be created.’228 He reasons that this entails, ‘Locating all the unit’s wet functions and services along one of the walls proved to be suitable strategy, as it frees the rest of the space for interior partitioning that fit the occupants’ needs and budgets.’229 (Figure 37)

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227 Friedman, p. 1.
Friedman employs user-scenarios to show how this model has been applied to track housing developments (see figure 38). He notes that housing developers have generally adopted a marketing strategy when it comes to the interior design of housing products, offering homebuyers the opportunity to purchase the number of floor levels they desire and then assisting them to arrange the interior according to their budget and preferences from a limited number of options.
In Friedman’s work the user-scenarios, which he based on representative homebuyers, create a menu that features, for example, different kitchen and bathroom configurations, with different options in how fittings relate to each other to meet the varied needs of different homebuyers.
Friedman’s approach shows how mass customisation adds value to products by focusing on the
details of products and their responsiveness to customer needs.

Applying user scenarios in Taiwan
Developers and marketing professionals usually identify a target group of buyers for a
development at the outset of the development process, attributing specific needs and preferences
to them. Yet the motivation for predicting potential buyers can significantly diminish benefits for
a development’s eventual buyers. As I have argued, presently in Taiwan framing the target market
can be a cursory and uniform procedure, with developers and marketers captive to the fantasies of
need and desire they later use to lure buyers to a development. Predicting who buyers are and
their needs and interests in respect of a housing product should transcend the development of
simulated subjectivities and lifestyles framed around marketing perspectives, especially in the face of mounting environmental and demographic challenges.

While scenarios of use are an established approach in product design for creating specific designs by predicting the needs and interests of end-users, they can also be used to forecast consumer trends and create generalised design perspectives. Seybold argues that, ‘By defining … broader customer scenarios’ — and then managing them meticulously — companies can deliver much more value to buyers and reap much greater loyalty in return.’ Taiwanese developers have been so focused on fine-tuning their offerings for the market around symbolic values of prestige, luxury, buyer identity and lifestyle that most have failed to consider how their products fit the actual lives and preferences of potential homebuyers. By building detailed scenarios of use into the design process and continually updating and refining these scenarios, developers can expand the quality of their offerings by predicting what homebuyers really need and want at a practical, aesthetic and emotional level, thereby expanding sales and deepening customer loyalty. Scenarios of use can also identify new housing forms and business opportunities, which are sorely needed in the Taiwanese context at a commercial, social and environmental level.

However, Seybold cautions that in creating scenarios of use stakeholders must think beyond their company’s immediate commercial objectives and customary marketing processes. She argues that at a practical level this involves selecting a target customer set; selecting a goal that customers need to fulfil; envisioning a particular situation for the customer; determining a start and an end point for the scenario; thinking of the individual activities the customer performs and the information needed at every step; using your marketing, distribution and service channels to support and streamline the customer scenario. Currently in Taiwan, designs are framed around the perspectives of developers and marketing professionals. Brand argues that designers are better suited to lead scenario development, their well practised facility with concept development allowing them to envision multiple scenarios of use as if they were potential homebuyers, designers’ graphic skills enabling them to map out these various possibilities.

To address the issue of the unknown user, Norman has recently argued for a design process that emphasises the coordinated, integrated activities that unfold around a product as opposed to the

232 Ibid.
233 Brand, p. 184.
isolated tasks that products can perform, believing this is the key to all successful products.\textsuperscript{234} However, where designers rely on their own understanding of the activities to be performed rather than considering user perspectives Norman believes users will always struggle to conform to designers’ intentions and be limited in their own patterns of use. To extend this argument to housing design and development, a house can be seen as facilitating an integrated pattern of activities that grow out of occupant’s needs and preferences through their interior layout and services, or alternatively it can impose a performative lifestyle on occupants that grows out of the combination of developers, marketers and designers’ perspectives.

von Hippel characterises homebuyers who commit at the pre-sale stage as lead users, who give developers access to market information months or years ahead of the point at which a product hits the market thereby establishing scope for substantial product innovation.\textsuperscript{235} The information they provide allows designers to offer all buyers into a development alternative design options, their participation initiating an open-ended design process facilitating the flexibility and extendibility of design solutions. In the context of developer-driven housing, the Construction Stage generally offers the least scope to adapt interior layouts to the needs and preferences of specific buyers. Concrete construction means there is little opportunity to change floor plans in Taiwanese cluster housing units, leading to the idiosyncratic Taiwanese practice of demolishing and remodelling the interiors of newly completed buildings to accommodate personal requirements. The exception is the small percentage of developments where internal partitions are not linked to external structures, suggesting some hope for attitudinal change in the housing development sector.

**Scenarios of use for cluster housing development in Taiwan**

To achieve customisation in cluster housing developments necessarily involves the standardisation of dimensions in both the base building and interior fit-out elements. Standardisation within the same housing project enables the reuse of forms and supporting scaffolds, reducing construction errors and imprecision while increasing the quality of repeated building items within a project. The standardisation of construction methods is likely to shorten construction time, including by minimising the cost of communication among parties. Also, the application of standardised building materials and fixtures simplifies both design and related construction technologies.\textsuperscript{236}

The scenarios of use demonstrate how the base building system facilitates flexible interior design over the life of a property. To gain the maximum advantage from this, Design for Assembly


\textsuperscript{235} von Hippel, pp. 791- 805.

\textsuperscript{236} Sarja, *Open and Industrialised Building*, p. 65.
(DFA) principles are central to the design process. At the interior fit-out stage, the application of DFA to interior components to the base building reflects the concept of systemised furniture that has been broadly used in office furniture and kitchen wares to enable the use of standardised products to create different outcomes. In the context of interior design, DFA offers homebuyers the flexibility of design to achieve the level of actual personalisation both at the time of purchase and the changing needs over time. The research proposes a four stage design process, comprised of base building, service roughing, full service and interior fit-out (see figure 40). At the stage of service roughing, homebuyers are provided with an open-ended plan. Traditional plans have fixed internal partitions, which are completed through wet construction methods at construction time. Open-ended plans have a central service dock and modular floor system that in combination extend the location of utilities and internal partitions. The interior fit-out stage is based on the degree of potential for disassembling, particularly in developing unique interior design for different homebuyers.

Figure 40: The four independent building systems: base building, service roughing, full service, interior design.
The building system shown in Figure 40 exemplifies the sequential routes of the conceptual idea of assembly to be applied to three most common objects — wardrobe, cabinet and shelves in interior design projects. Additionally, the use of sliding and movable interior objects maximises flexibility of interior layouts initially and over time. Figure 40 exemplifies how predictions about suitable floor area and functional requirements can be extrapolated from demographic and other data. The first function of the scenarios of use is to demonstrate how potential homebuyers participating in the design process can have their individual needs and preferences met. The second function is to show how the base building can change over time according to the changing, life style or circumstances of a single occupant. The combined application of the base building system with design for assembly and disassembly, enables the scenarios of use while suggesting how the design innovation advanced in the research achieves social sustainability and flexibility to various homebuyers’ needs, as Figure 41 illustrates and Figure 42 demonstrates the construction process.

The cluster housing unit in the scenarios of use is typical of southern Taiwan. It is a five-storey building with a parking lot occupying the front half of the 1st floor and a small courtyard located at the back. Three decadal benchmarks have been set in the scenarios: 2007, 2017 and 2027. The unit’s hypothetical continuous occupant is a male in his early thirties when he purchases the newly
built unit in 2007. Initially, the unit is configured as a home-office and remains as such for the first ten years. Ten years later, in 2017, it is remodelled to accommodate a family, since the original occupant is now married and has two children. By 2027, his two children have left for university. He is divorced but has the new responsibility of his elderly parents, who have come to live with him. He also intends to rent out the 2nd floor of the unit to increase his monthly income. The flexibility of the base building system allows him to readily add a lift to the internal layout of the unit, improving accessibility for his elderly parents while providing individual living spaces for the three separate sets of occupants now living in the unit. I have chosen to spread the scenarios of use over three decades to demonstrate the openness of the base building system to remodelling but they could also describe the configuration of three separate units in a development at purchase.

**Scenario A: 2007** (figures 42-43)

The occupant is a single man acquiring a unit in a five-storey cluster housing development to use as a home-office. Specific requirements:

- **Office (1st and 2nd floor):** working area for two staff and himself as manager; a seminar room; a kitchen and toilet.
- **Home living area (3rd, 4th and 5th floor):** master bedroom; living area; dining area; kitchen; guest and Japanese tea room; spa, bath and toilet; gym.
Figure 42: Floor grid system 2007
Figure 43: Building stages 2007
Scenario B: 2017 (figures 44-45)

The occupant is now married and his business office has been relocated to separate premises. The unit has been altered to accommodate family life and three new occupants, his wife and two children.

Requirements (using all five floors):

- entrance lobby; guest and Japanese tea room; living area; dining area; kitchen; toilet;
- master bedroom with bath and toilet; two bedrooms; bath and toilet; study and entertainment areas.
Figure 44: Floor grid system 2017

- Concrete floor and major structural beam
- Void
- Permanent secondary steel beam
- Removable floor/ceiling modular support
Figure 45: Building stages 2017
Scenario C: 2027 (figures 46-47)

The occupant’s children have left for university, he is now divorced and his elderly parents have moved in with him. In addition, the 2nd floor has been let out.

Requirements:

- 2nd floor: sectioned off for rental, separate entrance, bedroom, living and dining area; kitchen; bath and toilet.
- 1st, 3rd, 4th and 5th floor for home living: separate entrance lobby; living room; internal lift, dining area; kitchen; studying area; master bedroom with bath and toilet; guest and entertainment room.
- 3rd floor: bedroom for elderly parents; bath and toilet for elderly parents,
Figure 46: Floor grid system 2027

- Concrete floor and major structural beam
- Void
- Permanent secondary steel beam
- Changeable secondary steel beam
- Removable floor heaving modules
Figure 47: Building stages 2027
Figures 48-55 demonstrate the diversified interior layouts possible when Open Building principles are applied to cluster housing development. For Scenarios A, B and C the figures show changes to floor and floor voids, changes to internal walls, changes to internal plumbing, changes to interior fittings, percentage of floor space changed, and 3D views of each floor in 2007, 2017 and 2027.
Figure 48: Changes to floor and floor voids
Figure 49: Changes to internal walls
Figure 50: Changes to internal plumbing
Figure 51: Changes to interior fittings
Figure 52: Percentage of floor space changed
Figure 53: 3D view of each floor 2007
Figure 54: 3D view of each floor 2017
Figure 55: 3D view of each floor 2027
Summary and discussion
As the scenarios of use suggest, future housing in Taiwan needs to respond to the nation’s changing demographics, particularly the trend of an ageing population. According to Hansen and Gottschalk’s ‘life cycle model’, frequency of mobility, that is changing homes, increases in connection with changes in life stages such as marriage, children leaving home or retirement. Their findings demonstrate that for people in the age groups 52 - 57 and 62 - 67 years, good accessibility in a dwelling is a better determinant of whether people will move than how long they have lived in a dwelling. In current Taiwanese housing developments accessibility is not considered at all. Certainly, all age groups need to be able to access all areas of their homes easily and safely but the trend to an ageing population underscores the need for readily adaptable homes to meet the changing needs of different age groups if Taiwan is to avoid an even greater percentage of unwanted and unsuitable housing stocks.

As this trend gathers pace, homebuyers will increasingly demand more control in the design of their homes, rejecting the inflexible housing types that currently dominate the Taiwanese market. Greater customisation for housing developments must occur through the availability of variations. Recently, in an response to this issue in the United States, the OPEN Prototype — a real example demonstrating the concept of base building led by the MIT Open Source Building Alliance (OSBA) and Bensonwood Home — has announced that it will work with a roundtable of industrial leaders to develop a new model for creating more responsive, adaptable, high quality and cost-effective homes. The central goal of the OPEN Prototype is to create personalised residential environments that can be highly mass-customised. In Taiwan, such a demonstration is sorely needed in order that new approaches for housing design and development based on user-centred design and mass-customisation can be promoted first and foremost to Taiwan’s housing industry and to the public. To change the conservatism of the housing industry in Taiwan, homebuyers will be an important driver of changes when they recognise the benefits of Open Building.

Conclusion: A new paradigm for cluster housing development in Taiwan

Based on the Open Building and Open Source Building principles, the research has advanced a new approach to cluster housing development for Taiwan, where the separation of structural, service and interior fit out systems in a building addresses the traditional design constraints in this sector of the Taiwanese housing market. The challenges in introducing Open Source Building, however, are high, though information technology would significantly support the integration and coordination of suppliers of building systems and relations between developers and suppliers. The research recommends these flexible processes of housing development to produce the base building system through which homebuyers’ needs and preferences can be better accommodated. It is a system where each homebuyer independently derives their own value from the housing product, new approaches to design and construction enabling multiple permutations to a standard but customisable housing unit. It then becomes the design of the housing unit itself, rather than the developer or market, that individual homebuyers interact with at a very personal level. While there has been considerable apathy in the introduction of housing innovation in Taiwan, customisation is a dramatic but inevitable trend in housing due to demographic change, urbanisation and environmental pressures and the current level of vacant housing in the public and private housing sectors.

This design research aims to place these ideas in a contemporary context, and to orient them to the needs of today’s housing developments in Taiwan. Consequently, examples of choice and flexibility provided by the design research demonstrate that housing design and developments should be marketed in a new way to satisfy all stakeholders. This is particularly so if Taiwan obtains greater diversity in housing types, increasing the involvement of homebuyers in the design of houses and resulting in superior housing products for all Taiwanese to live in. Future research should aim to experiment with the base building model presented here and evaluate its usefulness for the housing market in Taiwan.

In the reformed design process posited in the research, developers become highly informed clients to designers, bearing increased responsibility for representing the interests of end-users to other participants in the development process. Their role can be regarded as that of integrators, who gain the required information from representative homebuyers and ensure it is successfully incorporated into the design process. Initially, designers should act as facilitators, leading

homebuyers through the complex decision making process that tailors homes to actual needs and preferences. Research by Franks demonstrates that when designers act as project managers they become, by and large, the principal point of contact between clients and all others associated with a housing project, acting to ensure clients’ needs are satisfied. 241

This approach has clear benefits for developers. Cova and Hoskins argue that, ‘Companies that function in terms of projects or business relationships operate in a unique, complex, and irregular way.’242 For Mahmoud-Jouini the process of operating projects or business relationships includes a high level of uncertainty with respect both to strategy (who will be the next client and what will the product be?) and context (when will the next project take place, and under what conditions?).243 Such uncertainty suggests developers should listen to potential homebuyers and adapt their offerings to buyers’ needs and preferences. In cluster housing developments potential homebuyers also need to better consider their needs and preferences in relation to what a housing developer is offering. Both issues rely on adopting a relational strategy to the market, though the first is resolved by an ability to respond to homebuyers’ requests whereas the second is resolved by an ability to develop ‘creative market offerings.’244 However, as I have demonstrated, responding to the diversity of homebuyers’ preferences and requirements introduces a high degree of complexity into the design process. The traditional design brief is inadequate to this task, especially when, during the early stages of a development, the actual buyers of a development are unknown or when units are not sold during the pre-sale period.

Development involves many parties who have insights and expertise to share, suggesting the need for a facilitator to mediate between them. The role of such a facilitator is a shifting and multi-faceted one, requiring a multidisciplinary background and high-level communication skills. For example, when communicating with users, the facilitator assumes the role of the designer. When talking to the designer the facilitator becomes the user’s representative, contributing customer-related, contextual information to the design process. Successful design teams exploit their diversity to create richly effective products. In Taiwanese housing developments, possible points of interchange between developers, designers and homebuyers already exist though any potential to improve housing outcomes for future homeowners is not exploited.

A crucial step in multi-disciplinary, participatory design is the initial prototyping stage, which can significantly enhance marketing potential at the predevelopment stage. Day argues that, ‘no matter how effectively a company meets the initial needs of its customers; it must remain constantly alert and responsive to its customers’ continuing want and needs.’ In Taiwanese housing developments determinations made from sales and marketing input are usually based on limited survey projections that emphasise quantitative criteria rather than involving the consistent line of questioning needed to produce qualitative frameworks. As a result, there is no ‘learning’ in the system and the homeowner’s voice cannot find its way effectively back into the design and development process to influence the generation of subsequent developments. The solution offered by this design research is for developers to continually update their knowledge of potential homebuyers’ wants, needs and levels of satisfaction. These can be cross-checked against Taiwanese census data relating to the housing market and data collected from other relevant housing developments. These feedback processes and the information they provide would help predict the needs and preferences of unknown homebuyers for future housing developments, needs and preferences, which could be readily accommodated if combined with Open Building and Open Source Building approaches.

Applying user-centred design to cluster housing development in Taiwan requires improved understanding of homebuyers’ needs, thorough and ongoing research into the cluster housing market to develop appropriate user scenarios to define design parameters to accommodate the original and future expectations of homebuyers, as well as the routine shifts in the housing market. The flexible design and development program proposed would clearly benefit homebuyers, individual developers, the Taiwanese housing market in general and Taiwanese society as a whole. The rise of innovative housing companies, products and services will influence customer dissatisfaction with existing offerings. However, the first step is to support their entry into the market, though the willingness of traditional housing developers and designers to understand the importance of meeting end users’ needs will be a key to changing design standards and approaches. It is to be hoped that emerging scope for high-level customisation of some products in the mass market for housing will demand that all companies offer products capable of being tailored to meet the specific needs of individual customers or risk business failure.

Despite the increasing move towards customisation and user-centred design in other areas of industrial design, these approaches will not be adopted in the Taiwanese cluster housing sector until a number of difficulties are confronted. First, Taiwanese homebuyers must be encouraged to overcome their reluctance to make demands on developers, especially in relation to possible

future needs. Currently, homebuyers are far more likely to be swayed by the immediacy of developers’ offerings and their promotion of social status, stimulation of consumer desires and simulation of unrealistic luxurious lifestyles than driven by their own long term interests, which they have difficulty in any case in understanding since there is no precedent in Taiwan for flexible interior design or ease of remodelling. To expect consumers to envisage something product developers cannot see is improbable. This is evidenced by the proliferation of new homes for sale with little capacity to meet the genuine and changing needs of occupants.

My research predicts that, in the future, units in Taiwanese cluster housing developments will be custom-specified from the outset and possess the capacity to be easily upgraded. The building ‘shell’ will remain intact while interior modular components — either uniquely designed by interior designers or supplied through mass production — will be removed, remodelled or replaced in a wide variety of combinations. As new occupants move in, houses can accommodate a new set of needs via the (re)design flexibility already built into the dwelling. The idea of design for assembly and disassembly allows the base building to be flexible if supported by well-structured supply chains. This is the reverse of current conditions, where users are forced to adapt to new surroundings rather than the built environment adapting to them. Factors such as changing family structures and the desire for personalisation will likely become more significant forces in the Taiwanese housing market. Solutions do not only depend on the provision of new flexible processes for housing design, the development of innovative housing forms but also overhauling current, restrictive building regulations to establish building codes that are more socially, environmentally and economically sustainable, housing designed through user-centred processes being more sustainable by avoiding or minimising alterations.

The research addresses these issues by commencing with changes to interior design processes while addressing these in the context of all stages of the housing development. It suggests that interior design, which represents the practical crux and manifestation of a web of social and industry inadequacies for individual homeowners, can be the driver for general change. In this way, the research represents a significant contribution to progressive housing development in Taiwan. Applying the principles of user-centred design to cluster housing developments requires new design methods, improved installation skills and procedures, and new products with improved technical interfaces that allow for streamlined inspection and review processes during construction. To make such approaches more applicable to the Taiwan building industry, further research needs to investigate the technical supports of the building methods discussed here. Likewise, suitable building facilities and equipment need to be examined to enable increased modularisation for building construction.
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