Open Source Building Alliance Ecology
The Internet Framework for Consumer Driven Participative Design

By

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Submitted to the Department of Architecture
In Partial Fulfillment of the Requirements for the Degree of

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Abstract

Open Source strategies have become powerful tools for the development of innovative products in various industries (Von Hippel, 2006). Success stories in computer and clothing manufacturing signify that the adoption of Open Source practices may improve service standards and productivity (Clayton, 2001; Thomle & Von Hippel, 2002). Although Open Source strategies have been adapted in many design industries for satisfying customer demands in customized products, no one has successfully implemented an effective process for integrating Open Source into the building industries (Herbert, 1981, Larson et al., 2004). In an attempt to overcome many of the same barriers to product maturity such ineffective collaboration, lack of data management (Shah, 2003; Rothfuss, 2002), and limitations of product distribution channels, a new participative Open Source platform for transforming building design processes and economics is suggested (Larson et al., 2004).

This thesis reexamines the basic assumptions of how building products are distributed through the Open Source environment. By analyzing the impact of e-Business and Internet technology driving community participation, the integration of (1) four online Business models: Dell, Open Source, iTunes, and eBay, and (2) the advent of mass- customization through the revolution of Internet technology, Computer Aided Design (CAD), and Computer Aided Manufacturing (CAM) for architecture and architectural product design and development will be established. The results of this evaluation identify the effective factors for the Internet augmentation framework to achieve the usability of Open Source for the design-build housing industry, and reinforce the changing relationship between homebuyers, architects, and manufacturers prior to making a final housing product.

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My parents, grandmother and brothers for their love and support over the years.

and God for his grace, love and strength.

"The future is [here] now; it's just not evenly distributed."

-William Gibson

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CHAPTER 1: **INTRODUCTION**

1.1 Situation

Japanese housing production is one of the biggest international industries. It is the second largest in the Asia-Pacific region, generating 32.4% of the region's homebuilding revenue, which is 94.8% dominated by the private homebuilding sector (Datamonitor, 2006). In the past decade, the industry has changed dramatically from craftsmanship to mass production manufacturing in order to accommodate housing demand for the middle-income market (Hagerty & Dunham, 2005). Fierce competition among leading housing production companies such as *Sekisui House*, *Shimizu*, *Teisei* and *Misawa House*, and the entering of automobile and electronic manufacturers such as *Toyota* and *Mitsubishi* forced small scale building industry companies to find a new way of designing, building and integrating technologies into housing products (Datamonitor, 2006).

Figure 1.1 Professional design in all cost-range housing projects

As a result of market and societal pressures, the combination of architects, manufacturers and suppliers arises in the form of an industrial system. This new form of collaboration can be found in some architect firms such as *Tokyohouse* changing architects to a construction experts with knowledge of production, and inviting aggressive business organizations to take over the market of architectural services. Industry participants do not confine themselves to a single role or work individually. For example, most *prefab*[1] providers, the largest share of the middle-income market, are designed by architects who work for or collaborate with manufacturers. Many of these

[1] See section A. in Appendix.

providers engage in some of their own production to develop their own brand and direct purchasing method such as *Toyota* and *9-tsubo house,* a new chain for mail order operation house. This *merchant-builder* industry is very service-oriented, which normally prepares custom products and provides arranging services.

During 1960s to 1980s, Japanese housing can be can be found in either 'one-off' model, a tailored solution to a unique problem by architects, or 'generic' model, an optimized for lower cost solution by merchant builders or developers. The monotony and inflexible mass housings are the result of the lack of meaningful involvement from architects and the reductive manner of manufacture production. Customization and service are sacrificed in order to reduce the complexities of the design detail and the production cost, and increase the production quantity. Economic efficiency is treated as primary to user needs, leaving homebuyers with no alternative selection (Kurokawa, 1983).

Figure 1.2 'generic' model. Left: Generic housing. Centre: *Mini-Kaihatsu,* small development housing in Japan. Right: Mass-housing development in Toyota city, Aichi Prefecture.

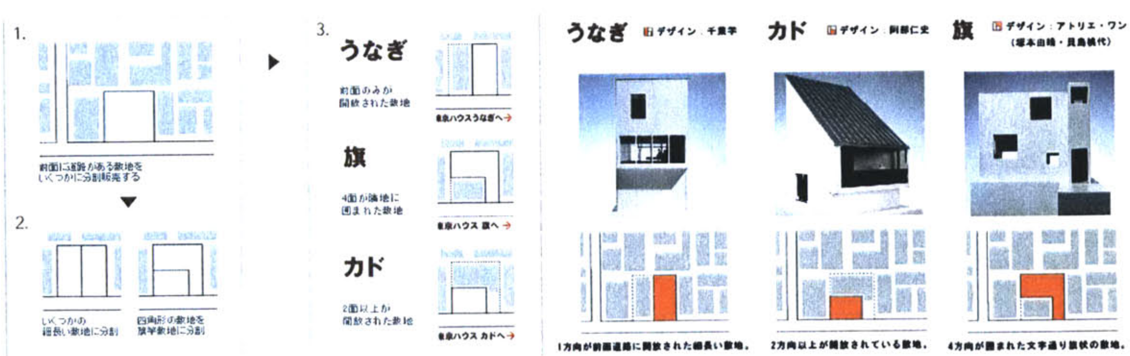

Figure 1.3 'one-off' model. Left: Design Solution diagram for irregular lots by *TokyoHouse*. Centre: Three designs: *Unagi* (Eel) for a narrow strip land, *Hata* (Flag) for a zigzag shape, and *Kado* (Corner) for a triangular and small plot. Right: Detailed design model done by Manabu Chiba (*Unagi*), Hitoshi Abe (*Kado*), and Atelier One (*Hata*). [Resource: tokyohouse.jp, businessweek.com]

Today, housing problems in Japan have shifted from the issue of quality and quantity to responsiveness and efficiency (Noguchi, 2003; Freeman, 2004). The generic development housing are rarely found nowadays since Japanese housing industry has successfully prevailed over "the inferior image of industrialized houses" and achieved a high-quality standard of manufacturing (Noguchi, 2003). However, the industry is still facing many of the same barriers to satisfaction of the diverse demand and product maturity such as ineffective collaboration, lack of data management (Shah, 2003; Rothfuss, 2002), and limitations of product distribution channels.

Moreover, most of Japanese homebuilders such as *Sekisui* are proprietary manufacturers that provide consumers with specific range of options and pricing on housing products. Even though the beneficial for proprietary systems can be found in compatibility installation and maintenance service (Dutton, 1995), the system are not flexible enough to satisfy diverse demand of consumer preferences. A poll taken in 2000 by the Ministry of Construction revealed that 40% of users were not satisfied with their housing and desired improvements that respond to their change in lifestyle, the surrounding environment, earthquake resistance, and energy efficiency needs. Moreover, the fragmented development within the industry results in an inefficient distribution system, which makes it difficult to gather information for developing responsive products in the building industry.

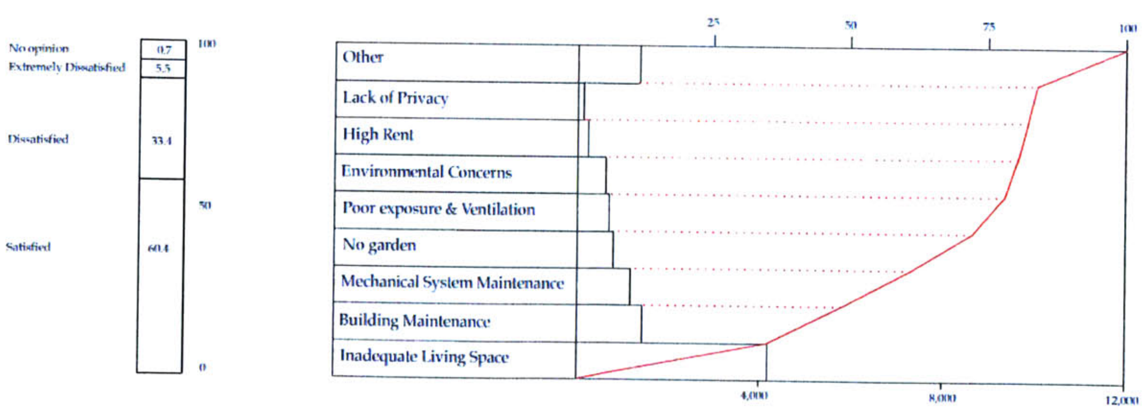

Figure 1.4 Statistics of User's Housing Requirements. Left: Percentage of Families Not Satisfied with Their Housing (N=32,092). Right: Reasons for Dissatisfaction with Current Housing (N=12,482). [Resource: 'Statistics of User's Housing Requirements', Japanese Ministry of Construction, 2000]

1.2 Problem Statement

To increase the flexibility and reduce the customization constraint of the housing production, the industry requires responsive customization processes and marketing strategies to satisfy homebuyers' needs and values. An alternative is a solution system with open access that allows consumers to directly interact with designers, manufacturers, and other consumers, and allow architects to specify their housing product for customized production. Such a system is essential to increase response time and diversify efficient design of housing products.

1.3 Purpose

This thesis proposes HOU.SYS, an online community for the *Open Source Building,* as an alternative approach for a participative platform in mass customization of small housing and its related products, technologies, and services. The proposed HOU.SYS system attempts to take full advantages of inexpensive computation, fabrication, and e-business strategy. This alternative system may transfer innovations from other industries to building design and technology, and provide tailored solutions in housing.

HOU.SYS is developed under the comparative study between the proposed "*Open Source Building Alliance*[2]" model, and the proprietary system in Japan. The difference between both systems is the configuration process. While the proprietary configuration system allows users to select and customize their housing product from one manufacturer, the Open Source system offers consumers the open and standardized components that enable them to integrate products from different manufacturers. The differences of both systems will identify the critical factor for the development and implementation of a *Japanese Open Source Building Alliance.*

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2 See section A in Appendix.

The primary purpose of this thesis is to apply a theory of Open Source to building industries, and illustrate how the augmentations of Internet services can improve the usability of Open Source for the design-build architecture. By bringing together diverse areas of research and existing systems available in the market, the online community for the *Open Source Building* will facilitate the design and deployment of a new participative design workspace, and expose industry to a new way of designing buildings.

HOU.SYS focuses on developing an empowering tool that may allow architects to specify their housing products for customization and may be an appropriate tool for smaller infill builders. By implementing a strategic business model using electronic commerce and Internet to replace the existing design organization structure, HOU.SYS enables architects to get involve in the mass housing production offering affordable and predictable process. Allowing homebuyers to customize their utilitarian yet responsive housing products through their preferences, the system reinforces the collaboration among all building industry stakeholders[3] prior to making a final product.

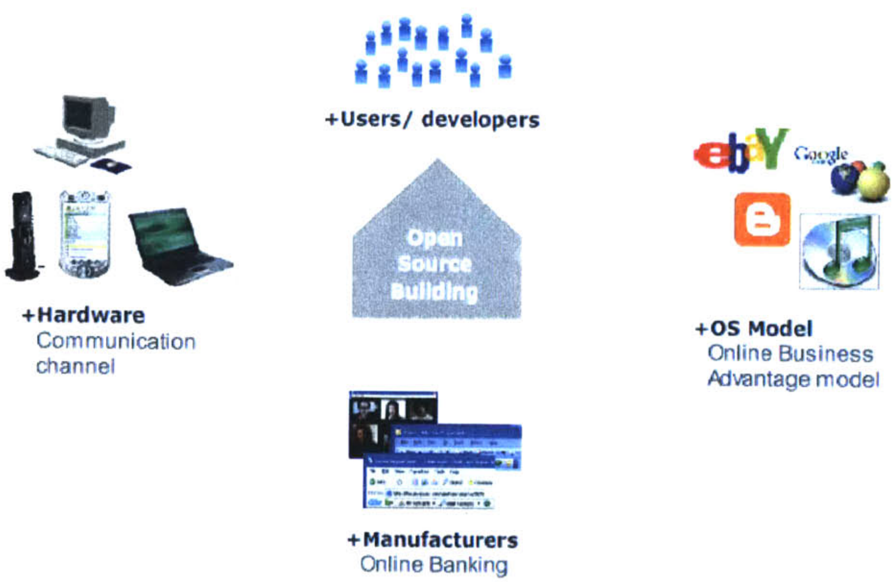


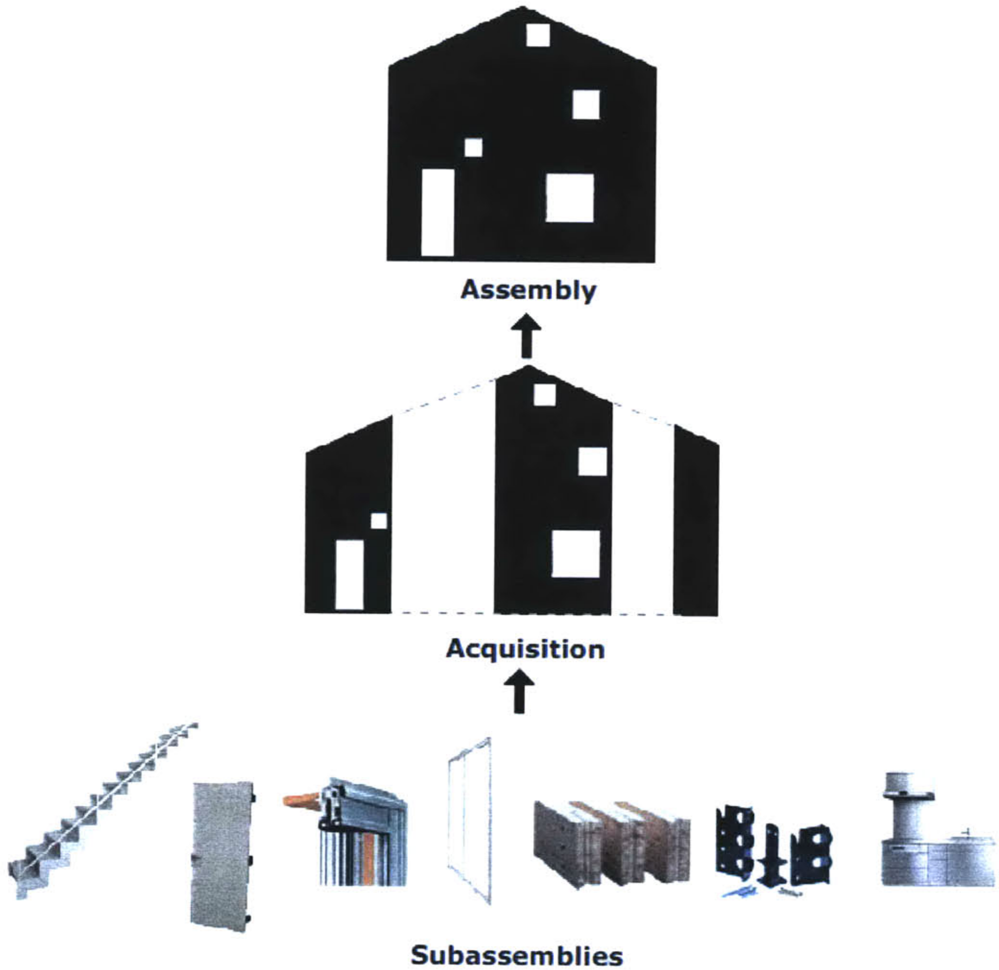
Figure 1.5 The Open Source ecosystem that reinforce the collaboration among stakeholders.

[3] The collaboration among all building industry stakeholders includes prospective owners, architects/ designers, builders/contractors, materials vendors, property developers, city planners, lenders, insurers and various commentators.

1.4 Scope

The development of Open Source Building Community is a very large topic and requires intensive cross-disciplinary collaboration among users, building industry participants and many others. The scope of this thesis is not to complete the online community system but to propose a framework for the building industry. Actual problems are studied to further the analysis of e-business and Internet technologies that drive community participation. The integration of knowledge management, designer tools for non-experts and feedback systems for housing design and development will be established in the online community for effective data collection and customization. The key point of the Open Source building is customization method and housing industry standard. This thesis approaches this matter by developing the decision-making tool using dialogue and interactive image as mediator for non-expert. This method enables homebuyers to visual search, interact with design configuration, and customize their housing product with regards to their urban context, lifestyles and preferences.

The implementation of compatibility and standard web-based applications may help explore developments in the modernist prefab marketplace in Japan. An experimental participative design interface for the non-designer is built based on the well-established principle of modularity that parallels recent e-business strategies in the automobile, apparel and electronics industries. To demonstrate and test the viability of this approach to help influence future products and service offerings, this online community is programmed with Macromedia Flash MX, Java applet, html and PHP to place the consumer in the center of the proposed system. Evaluations from various disciplines will identify the underlying factors for establishment of the online community, providing necessary input to formulate the framework. The approach will reinvent the industry by changing the role of architects, homebuyers and manufacturers in developing responsive housing products and powerful innovation incentives.



Builders become installers and assemblers.

Developers become integrators and alliance builders, offering tailored solution to individuals. Architects design design-engines to efficiently create thousands of unique environments.

Homebuyers become designers at the centre of the process by receiving personalized information about design, products, and services at the point of decision.

Manufacturers agree on interface standards and become tier-one suppliers of components, producing systems that share common sensing and communications infrastructures.

Figure 1.6 Visions

"What shall replace it?"

-William J. Mitchell

CHAPTER 2: **E-BUSINESS FRAMEWORK MODEL**

"The language of business at its core depends on metrics. It is often said that a truly great design cannot be judged until it has proven its success in the market. Design creates and maintains brands through people's interactions with solutions that fulfill the promise of the brands. Many people make a personal, emotional investment in the company or group that brought the product to them. This is innovation used to its most powerful effect, resulting in great designs and even greater companies."

Mark Dziersk, FIDSA

2.1 4 e-Business Strategies for Open Source Building Alliance

A business model is a description of how an organization functions, a general template that describes its major activities. According to Lucas (2002) and Malone (2006), adopting an e-business model requires the understanding of the model and the organization capabilities. This understanding is significant in order to obtain and synthesize efficient advantages, ensuring effective coordination and moving the traditional business to the Internet. An understanding of business constitution and process is necessary, and the model chosen needs to be justified to suite the building industry's business core and clients' demands. This chapter examines and discusses four e-business models, *Dell*, Open Source, *iTunes* and *eBay*, and demonstrates how aspects may be applied to an HOU.SYS, the Open Source Building Online Community.

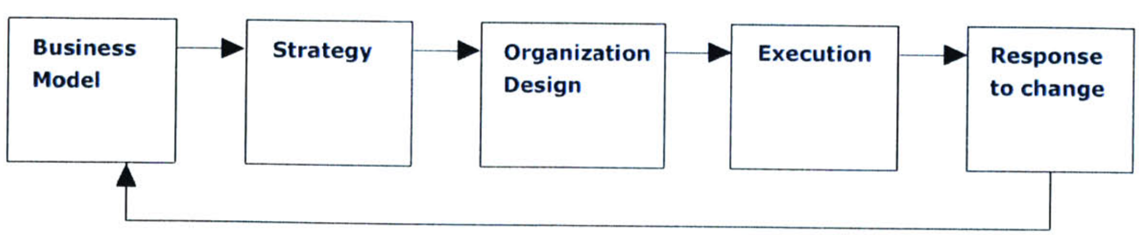


Figure 2.1 Strategy formation and execution [Resource: Henry Lucas, Strategies for electronic commerce and the internet]

2.1.1 Dell Model

The *Dell* model is an illustration of an integrator's business collaboration with partners or suppliers. This model successfully uses standardization and the Internet to reach customers directly by offering them a web-based configuration and decision-making tool for customization (Larson et al., 2004). This build-to-order provides customers a cost-effective solution, and is response to their needs through easy custom configuration and ordering (Lucas, 2002).

As shown in the figure, the essence of this model is the exploration of commodity component standardization through the collaboration among manufacturers and integrators. Larson (2004) noted that the building manufacturers might apply this model with integrators who are responsible for bringing together products and services to create branded lifestyles offerings. As a result, this lean production model operates with little inventory, allowing organizations to generate unique solutions in response to individuals' preferences (Larson, 2004).

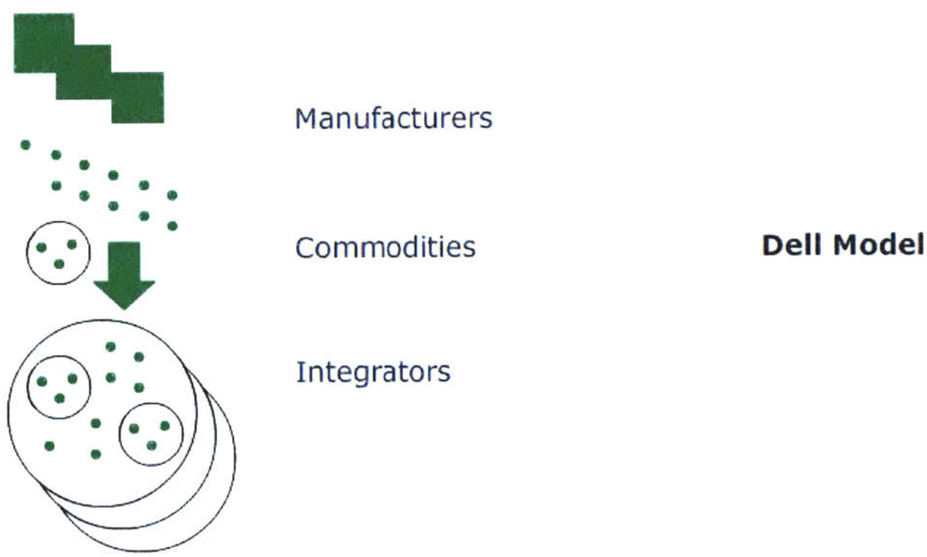


Figure 2.2 *Dell* Model [Resource: House_n group]

2.1.2 Open Source Model

Open access to the production and design process for products or resources describes the principles and methodologies of Open Source. This model allows a distributed commodity to iteratively build new solutions ("Open Source", 2007). Figure 2.2 illustrates the Open Source model and demonstrates how integrators may benefit from industry standards. The available fixation allows integrators to connect and create final products in different ways using design and configuration environments evolved for both professionals and consumers (Larson, 2004).

Open Source has grown significantly in size and scope during the past decade. In order to fully extend the benefits of Open Source and strategically utilize this model in the building industry, the development of new protocols and algorithms is essential to meet changing operational requirements. Application of the Open Source model will allow the building industry to find an efficient framework for integrating construction, building process and Internet advancement into conventional practice. Examples of specific areas that can be improved by use of Open Source are quality of design components, service support, security, networking, and policy management.

In response to the practicality, one key feature of the proposed Open Source model is that it may be used for either professional or consumer applications. The differences between professional design tools and consumer configuration tools are significant for the implementation of the system. The flexibility of the design products and complexity of the design and configuration environments are keys to distinguish those systems. Professional design tools are generally made for architects and are more open ended, while consumer configuration tools are more constrained to integrators' solutions.

2.1.3 iTunes Model

iTunes is positioned as a major distributor in the music industry. It is one of several various music-downloading services that are competing in the marketplace, and is pursuing various business models. The processes that allow users to locate and purchase music, publicize and share offerings, and adjust their music collections to their preferences are the key to its business model. By evolving rapidly and generating a higher profit from the revenue off of its downloads, *iTunes* can differentiate the product and provide opportunities for artists (Rappa, 2006).

This model may be implemented in the building process as a solution in terms of intellectual property and design incentive, as designers or consumers who contribute the design to the database can be paid royalties when their designs are requested. A database of design solutions submitted by architects, consumers and manufacturers could grow exponentially. This database is linked directly to manufacturing and product specifications, taking advantages of online services to create environments for customers to find and buy information (Larson, 2006).

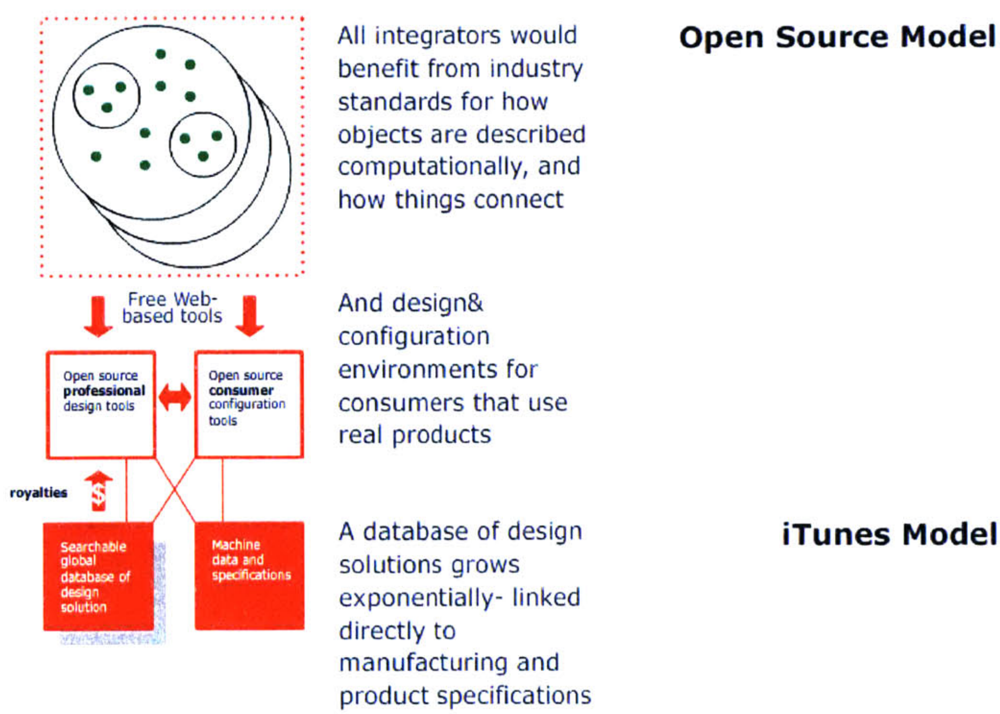


Figure 2.3 Open source and *iTunes* Model [Resource: House_n group]

2.1.4 eBay Model

eBay is the world's largest online auction business model in which participants bid for products and services over the Internet. This model is positioned as a new way of market transactions, and a new domain for consumer decision-making. *eBay* facilitates the process of listing, displaying, bidding, and purchasing based on consumer preferences and satisfaction to assess the true values of products ("Online auction", 2007).

The *eBay* Model can be applied to the final stage of the building design and construction process. When consumers finalize their housing design or post their assembly specifications on a bid site, they can find suitable assemblers or manufacturers for their projects through *eBay*'s feedback system. This value assessment is another advantage that allows you to evaluate and determine your project collaborators. Moreover, the pricing system might be more suitable than an auction system for this online community since the lowest price or highest price might not correlate with the product quality.

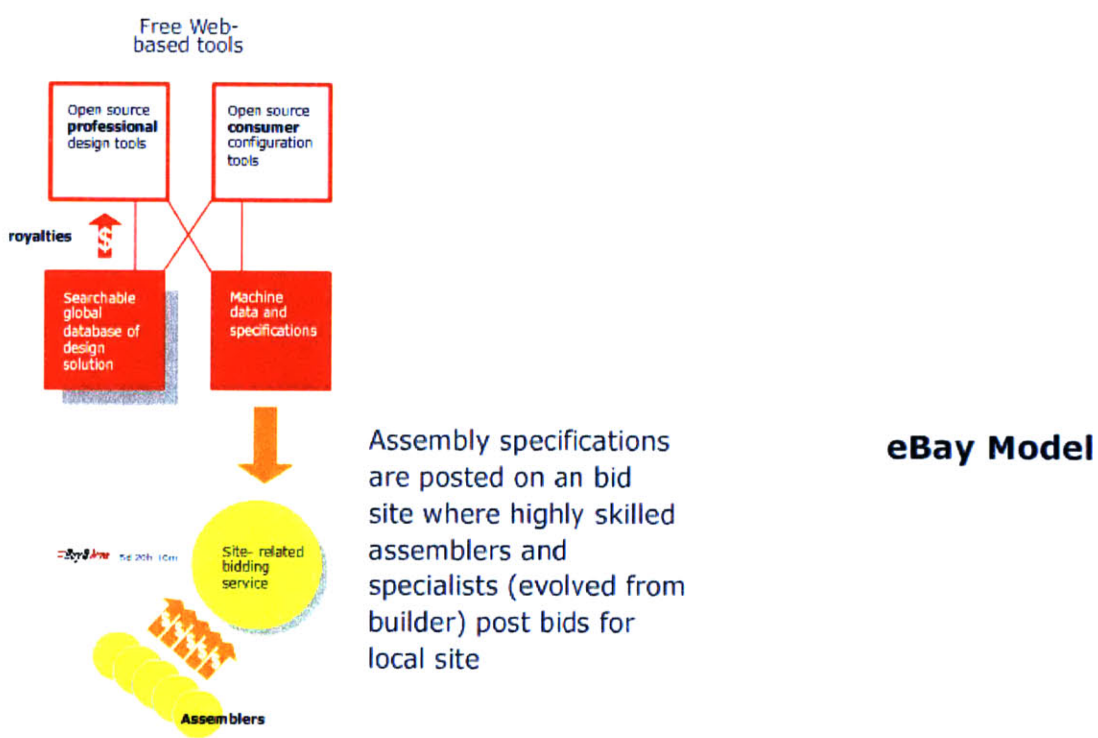


Figure 2.4 *eBay* Model [Resource: House_n group]

2.2 Application for Future Housing Industry

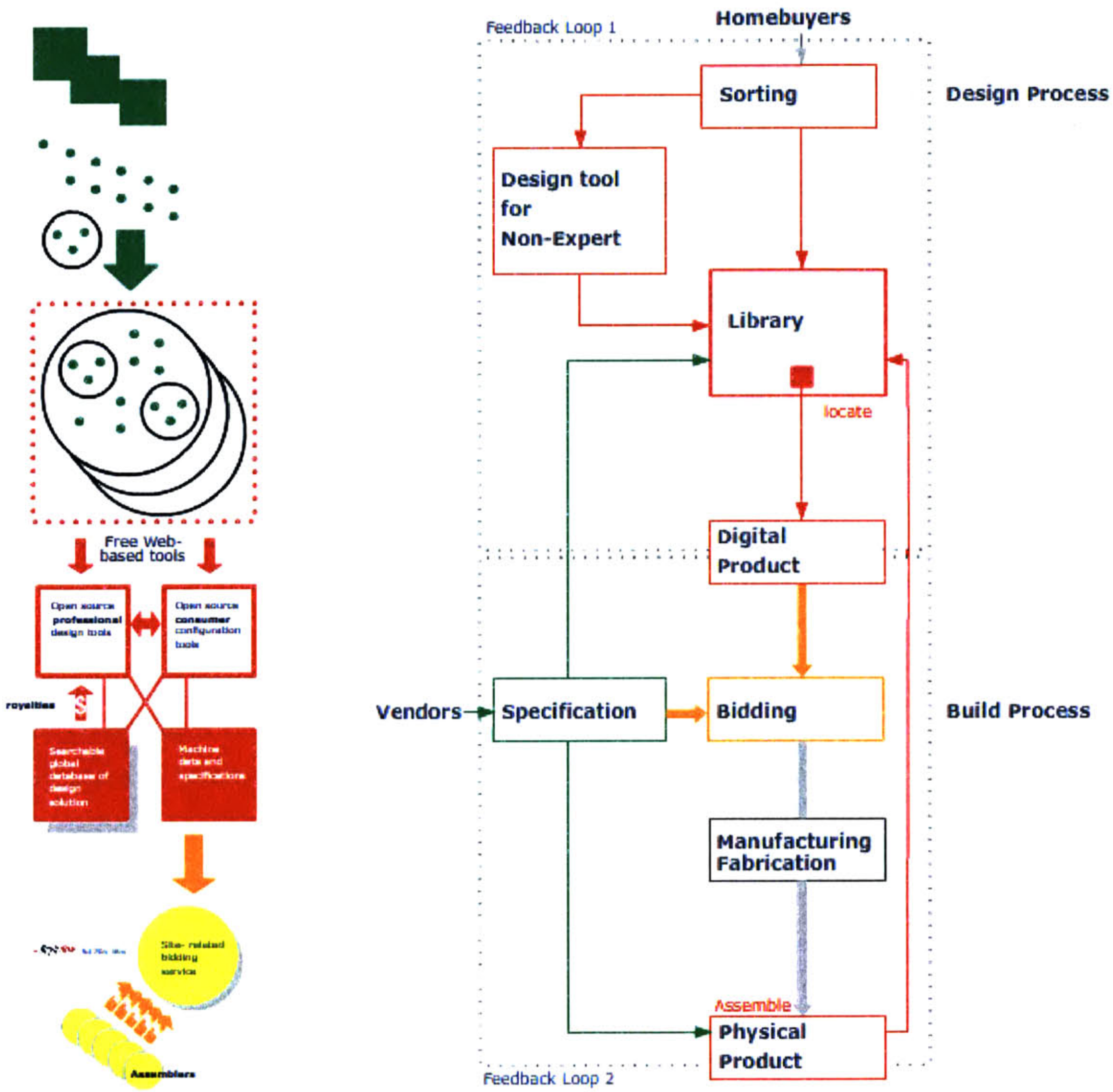


Figure 2.5 Application for future housing industry

CHAPTER 3: **CASE STUDIES**

In search of innovation, today's technology quickly and continually moves through incremental developments. The study of cases from different disciplines is essential to gather solutions that might already exist in another field. This chapter investigates how design tools can be applied to practical use of the real market and existing customers. It also examines the related factors that drive participation and growth of the Open Source strategies in an attempt to identify opportunities and problems. The best qualities from this case analysis can then be extracted and utilized to develop strategic alliances and reinforce user to participate in the design system.

3.1 Current Prefab Housing Market

Prefab housing is a predominantly mass-market housing that has been developed to satisfy individual's needs in a modernist design aesthetic. Since not many people can financially afford the custom-designed modernist architecture, the *prefab* building emerged from a design and production ideology that has the potential to deliver affordable modernism. Current *prefab* housing can be categorized into three models based on customizable level: fixed model, customizable finishing, and customizable plan. However, *prefab* houses available in the marketplace are often presented as an aesthetic solution, varied by either "*traditional*" or "*alternative*" forms (Noguchi, 2004). Most of them rarely respond to the modern living style (Ryu, 1982).

A second consideration in prefab housing is cost and profit. Manufacturers of prefab products are exploring various fabrication methods in design and construction to minimize expenses by reducing system complexities. As a result, according to Sylvester (2003), many *prefab* housing products are not available for immediate purchase, and is under development process to minimize housing system complexities and maximize profits to the manufacturer.

However, to successfully market a turn-key *prefab* dwelling, design aesthetic and inexpensive housing are not the only considerations for success. An understanding of product distribution and consumer satisfaction is equally important to structure design. As Sylvester has noted, "Commercialization is traditionally the domain of speculative builders and property developers rather than design professionals". The collaboration among designers, builders, property developers, and consumers is necessary and critical for commercializing and delivering prefab housing products to the market. The customizable models mentioned previously consider the Internet as a medium to approach their consumers and gradually implement customization strategy to satisfy a variety of customer segments. Each is discussed in more detail below.

3.1.1 Fixed Model

The fixed model is an illustration of *prefab* housing product that cannot be changed from the original design. This product sector dominates the proprietary industry, representing 50% of Japanese homebuilding revenues. The primary essence of this model is the design variation and aesthetic that expresses architect's signature and concept. This stylish model ranges widely in design, quality, price and feature, and only uses the Internet as an advertisement channel. This model is normally developed by architects and is less responsive to the needs of the consumers and existing site conditions.

3.1.2. Customizable Finishing Model

The customizable finishing model is a *prefab* housing product that allows consumers to make a minimal change for the design finishing such as materials and colors. Most manufacturers use this model to deliver *prefab* houses designed based on existing modular products or systems and standard materials. This model focuses on design aesthetic with a high concern for manufacturing costs and processes. The product websites range from a basic static informative webpage, which informs consumers about their products and available choices, to a more interactive website that allows consumers to simulate their selections and submit their design online.

3.1.3. Customizable Plan Model

A minority of housing products falls into the customizable plan model. This is the most recent strategy and the most advanced model applied in online business for developing *prefab* housing products. Developers and homebuilders currently adopt this model and develop design tools that allow consumers to "design" their residence. This product is more responsive to the design function and consumer's lifestyle than other models. However, most of the design tools attempt to simplify the complicated professional design tools, and are difficult for a non-designer to comprehend. A lack of constraint and guidance requires the customer to possess design knowledge and skills to avoid impractical and illegal solutions and successfully produce a high-quality solution (Larson et al., 2004; Mcleish, 2003).

Toll Brothers, one of the leading U.S. homebuilders, has introduced a web-based home design tool that can be run in any web browser. Toll Brothers' designyourownhome™ is another approach for practical customizable housing design tools available in the market. Even though this tool is more flexible and responding to the users' lifestyle and functional usages than the former model, it is limited to design and component constraints provided by Toll brothers. The tool is divided into two sections, offer user-friendly development and appropriate solutions for the non-expert. The first set of design tools assists consumers to sort available products by number of rooms, and total area. From the resulting list of potential housing products, consumers can select a best match and proceed to the design step.

The second step allows prospective homeowners to customize the floor plan of their selected house. Unlike professional design tools that allow users to freely manipulate space, surface and detail components, this system uses a series of simple 'yes-no' questions interface as a guideline for users to rearrange their room from the pre-designed layout. The result is displayed in finished floor plan and pre-photo still images rather than an overloaded 3D solid modeling system. The final design can be stored or printed for further evaluation and to proceed to the construction process.

The Toll Brothers' designyourownhome™ design system has introduced consideration of outlets and fixtures, partially provided a communication channel for design and a support system for the consumer, and allows users to modify their design and consider various options. However, even this first step toward consumer design can be improved. Necessary additions include many features that most users would find essential, such as evaluation of design solutions, solutions for the existing site condition, and feedback on how a particular design might meet a specific consumer need. Moreover, the system should fully integrate data management, purchasing, an immediate communication channel, appropriate data display and information on fabrication of a design.

To establish an effective online participative design community, the investigation of the existing online application and alliance system for non-expert designers is substantial. Supply chain management, common strategies and standards and participative design are the underlying involvement of these cases. The studies are divided into three areas to illustrate the online application development for customizable design products, the open source strategy for online distributors, and the sustainable solutions for online communities.

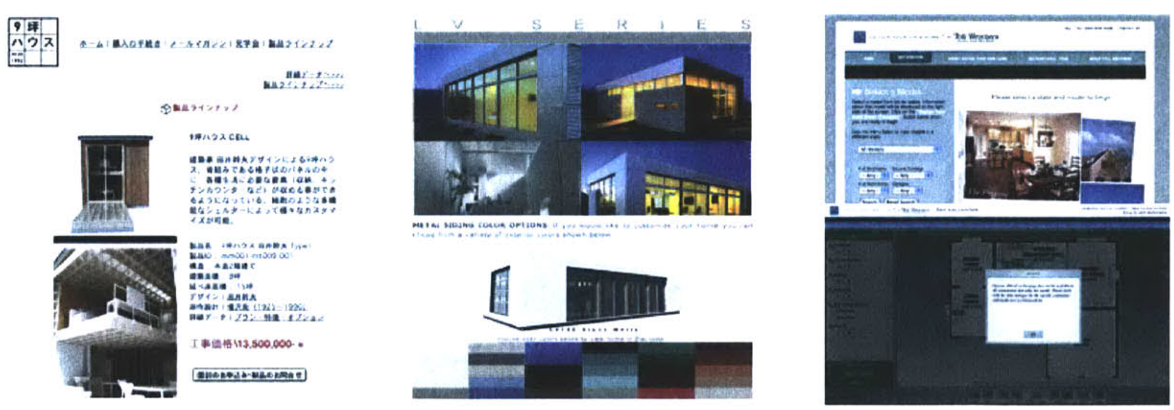


Figure 3.1 Current *prefab* housing products. Left: The *9-tsubo* house project is 'the absolute minimum house' designed by Makoto Masuzawa. This simplicity yet necessity house is an example of the fixed model product that 'anyone can built anywhere'. [Resource: http://9tubohouse.com] Centre: The LV series done by Rocio Romero allows users to change material color of the designed model. [Resource: http://www.lvseries.com] Right: Toll brother's web-based home design tools. [Resource: designyourownhome.com]

3.2 Customizable Design Products

Customizable design products provide a mass production output of Computer Aided Manufacturing (CAM) that meets individual consumer's needs (Tseng & Jiao, 2001). This product strategy can be found widely in industries that need maximum differentiation and low-cost production, such as the electronics, automobile and apparel industries. The build-to-order product requires extensive market research and configuration systems that tie consumer's interaction to the company's production ability. The design and configuration environments for these products are developed in the form of decision-making tools to assist non-expert designers. These products can be categorized into three types based on the customization purpose: function, look-and-feel and optional constraints.

3.2.1 Function

Dell computer is an example of product customized by function. Buyers select the model most suitable to their expected usage and price range. This is followed by a sequential process that assists buyers to build their own computer, add accessories and buy software. The system automatically updates buyers' selections, calculates the price, and fully integrates a purchasing system and delivery service. There is no design or visualization tool for this product interface.

3.2.2 Look-and-Feel

While product customized by function can be found in electronic devices, look-and-feel types can be found in apparel and automobile products. Apparel manufacturers, such as *Nike* and *Camper*, developed an illustrative design tool that allows buyers to customize their own product using digital printing, standard processes and sizing with options in style, style details, color and fabric (Anderson, L.J., Brannon, E.L., et. al, 1995). The hierarchical structures and sequential navigation flows guide buyers through the design process. The selected result can be displayed in a 2D still image from different angles.

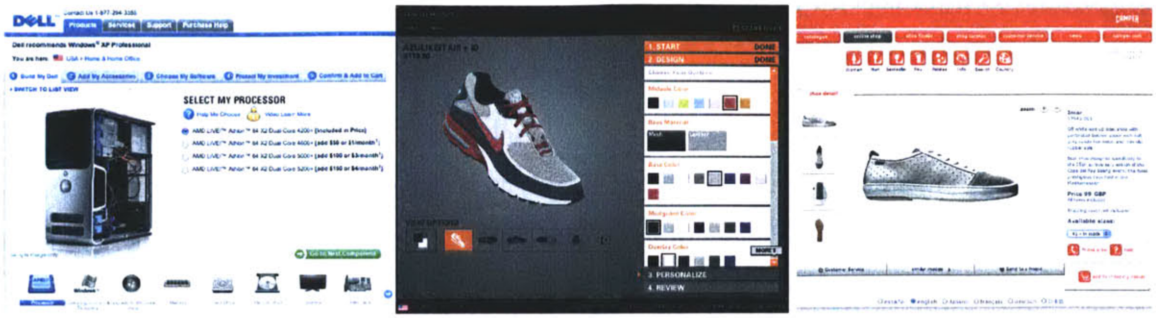


Figure 3.2 Functional and Look-and-feel design interface. Left: *Dell* [Resource: dell.com] Centre: Nike. Right: Camper [Resource: nike.com, camper.com]

3.2.3 Optional Constraints

The mass customization of automobile industry allows customers to tailor car body parts, finishes and accessories to improve quality and enhance the flexibility of the production. Automobile producers, such as *Maserati*, also use the Look-and-feel approach by providing all the color and fabric options upfront. The features and color selection are fairly unconstrained, and there is no feedback for the design solution. *Lexus*, on the other hand, developed a more adaptive design system that provides some selection constraints between material and color and also offers color palette suggestion for the consumers.

Figure 3.3 Optional Constraint design interface. Left: *Maserati*. Right: *Lexus*. [Resource: Lexus.com, Maserati.com]

None of the design tools for these customizable design products use a complicated CAD tool or parametric 3D solid modeling, but instead use a data management system to simulate the design solution.

Table 1 Comparative diagram of customizable design products

	Customization constraint level	Products	Solution Method
Function	High	Electronic devices	Consumption behavior
Look-and-feel	Mid	Apparel, Automobile	Users' preferences
Optional Constraints	Low	Automobile	Design suggestion

3.3 Online Distributors

Online distributors are the result of popularity in consumer broadband that has been growing and increasing within the past decade ("Digital distribution", 2007). Taking advantage of digital information and knowledge management, online distributors approach consumers by strategically providing products or services in different forms of catalogs or databases through channel management and logistics. These service providers can be categorized into three types based on how they organize and exhibit product availability, allowing users to navigate and interact with what they want. All of the online distributor approaches require software agents that provide a combination of search engines, data management, and comparative and participative systems using different strategies to stimulate users' traffic and responsiveness.

3.3.1 Personalizable Database

iTunes is an example of an online distributor that uses a personalizable database strategy. It is the most well-known music distribution system that allows users to organize and personalize music files based on their preferences. This successful popular collector culture run by *Apple Inc.* is an example of extensive, flexible and interactive services that link the music industry, *iTunes* Music Store, to many individuals. *iTunes*, working with computer and portable media players, provides a software, current release *iTunes* 7, that can be downloaded directly or automatically from the *Apple* website. This software is installed onto user computers working as a library and purchasing channel.

Expanding the potential of sound and visual, this interactive interface library offers database organization solutions, allowing users to visually and verbally navigate, personalize, track, and organize a variety of formats of digital files based on individual criteria. This software also provides a purchasing channel with search engine that links users' database directly to music or digital media providers for commercial activities and advantages. Moreover, the extensive activity channel of this system allows users to participate in the music industry, not only as buyers but also as creators and presenters. The major limitation of *iTunes* is the lack of two-way communication.

3.3.2 Matching Information

Matching information is a data filtering method in which a set of data is responsively selected from certain information, and forwarded the result back to the user. This service system is mostly used in lifestyle-related business such as Internet dating services, real estate, and the travel business. Users are asked to provide their preferences or information via a set of qualitative and quantitative questions to find solutions that match user requirements and preferences. Many systems integrate visual images to increase the responsiveness, and offer additional services such as online chat or message boards, which sometimes require a service fee ("Net dating service", 2007). Most of the available matching information system is found to be tedious, time consuming and inflexible. Because this system requires an adequate amount of information in order to generate an effective result, users are forced to go through extensive fill forms and frustrating routine operations.

3.3.3 Exchanging Incentives

The system of buying and selling incentive is one of the most successful online distribution methods. According to Guttman and Maes (1998), this alternative experience of market transactions is generally found in the form of software agents to facilitate the automation of electronic commerce (p. 1). This system is successfully influenced by consumer preferences, decision processes and satisfaction, and blurs the boundary limitations of cross-merchant offering comparison. By allowing consumers to compare price and some range of value based on customer consideration, this agent-mediated integrative negotiation offers a more suitable approach to retail electronic commerce.

The practicality of this system is based on the value assessment and automatic monitoring. These factors are important for strategizing service and quality incentives and decision dynamics. As users can be both buyers and sellers in this system, they can use the provided software agents to compete and increase product values, and use feedback systems to evaluate the reliability of products and providers. Another advantage for this system is that it eliminates geographical limitations and enables people to participate in the buying and selling process using asynchronous bidding to provide flexibility for consumers and providers.

Figure 3.4 Online distributors. Left: iTunes. Centre: Net Dating Service. Right: eBay. [Resource: apple.com, americansingles.com, ebay.com]

However, this system requires a high level of participative network, databases and transactional systems in order to provide effective responses to user requirements and a high standard of quality and program management. Furthermore, an understanding of buyers and sellers incentive factors is essential for software agent development and system strategizing.

Table 2 Comparative diagram of online distributors

	Sorting and Selection	Products	Solution Method
Personalizable Database	Manual	Digital media	Activity channel bridging customers and providers
Matching	Automatic	Information, product	Qualitative retrieval and analysis
Exchanging	Democratic	Product	Democratizing and evaluation system

3.4 Online Communities

An online community is an Open Source collaborative platform using social software and communication media to regulate the activities of participants via the Internet ("Virtual community", 2007). Most of these online communities can be found in the form of knowledge-sharing resources tied together by one or more specific types of relationships or interests in order to establish their own unique culture. In order to increase the strength of motivation for contributing, the size of the community is a significant indicator for the growth and sustainability of an Open Source Community. Membership lifecycle, accessibility, and a collaborative platform that enables individuals' knowledge evolvement are the critical factors that drive online knowledge sharing infrastructures. The individual or organization collaborative platform that allows participants to evaluate and respond to contributions can be categorized into three types based on the purpose of the participation.

3.4.1 Education

OPENSTUDIO is an illustration of provisional online system for pedagogical communities. According to Tierney (2006), OPENSTUDIO is an ongoing experimental ecosystem done by John Maeda from the Physical Language Workshop at MIT Media Lab. This web-based mathematical drawing system organized in the Open Source environment is an attempt to introduce computer programming to visual artists. It offers the fundamental principles of coding software that allow users to create, collect and sell digital art or data via the Internet. This system allows users to design in different scenarios and trace the interactions through an Application Program Interface (API) (p.42-43).

Another example of an online community for educational purposes is Ben Fry's and CEB Reas' Processing. It is, as Tierney (2006) noted, "the alternative proprietary software tool and the integrative process result of programming language, development environment and teaching methodology that unifies structure for learning as a radical departure from traditional programming languages and commercial software". This computation medium was designed to simplify programming syntax such as C, C++ and

Java, enabling visual designers to create responsive images through a text programming language environment and learn fundamental coding concepts (p.43).

Ben Fry's and CEB Reas' pedagogical community is the result of established long-term research that users gain from the discussed material. This community system mostly develops under the specific purpose of learning, and focuses on exhibiting and sharing technical resources for the growth of data collection. The graphical user interface is the simple combination of text editor, tool bar and mouse-based applications to enable users to respond to the code.

Figure 3.5 John Maeda, OPENSTUDIO & Processing, Physical Language Workshop, MIT Media Lab, ongoing. [Resource: *Architectural Design,* 76(5).]

Most of the educational online community use interactive graphical interface to replace lengthy verbal information. Josh On's *theyrule.net* is another illustration of educational purpose for online communities. Josh's website provides a visual database of various companies and institutions, enabling users to map connections and explore relationships of companies' and institutions' executives and investment (Tierney, 2006).

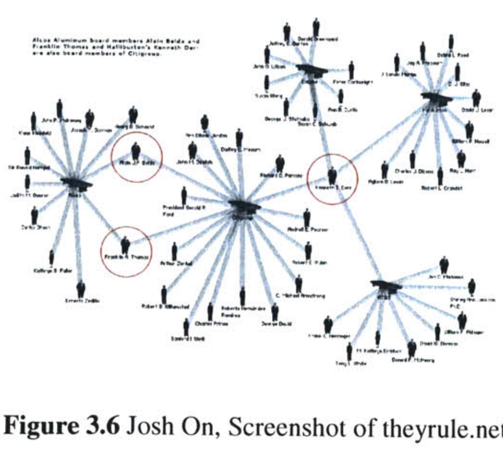


Figure 3.6 Josh On, Screenshot of theyrule.net website. [Resource: theyrule.net]

3.4.2 Lifestyles

A *blog*, a short term for *web log*, is an example of an Open Source lifestyle-based community that can be found widely in a reverse chronological journal style ("Blog", 2007). This user-generated website provides an interactive format of commentary or news on a specific subject using knowledge management, multimedia sharing and a communication system to establish an asynchronous Open Source platform.

> *"Most blogs are primarily textual although some focus on photographs (photoblog), sketchblog, videos (vlog), or audio (podcasting), and are part of a wider network of social media ("Blog", 2007)."*

The primarily purpose of this knowledge-sharing resource system is to express personal thought, interests and lifestyles. Its interface enables users to make entries and contributions through comments or community posting by combining text, images, and links to other related resources or media. This textual graphical interface is generally similar to the pedagogical community's but is more complex in terms of data and media management. Furthermore, the embedded asynchronous communications channel not only extends the flexibility but also increases responsiveness of the community systems.

3.4.3 Entertainment

Entertainment is the most addictive form of online community purpose. It is the combination of real time computer networks, Internet access and user interfaces which can be found mostly in the online gaming industry. The rising of this social activity is the result of multimedia-authoring platforms such as Flash and Java. This technology advancement enables websites to engage multimedia contents, such as streaming video and audio, and other embedded devices for developing an integrated interactive environment.

The interfaces of this system range from textual based to a high level of graphics and virtual simulation. They successfully eliminate language resistance and communication constraint of the participative platform. Moreover, this system primarily relies on a transparent interface that effectively persuades users to buy and use the service available in the community. As a result, this online gaming community currently is the most profitable business for an interactive entertainment industry ("Online game", 2007).

> *"This system successfully shifts from an information management domain to also offer on-demand entertainment and allows providers to gain profit from a service fee or advertising revenues from on-site sponsors ("Online game", 2007)."*

Figure 3.7 Lifestyle and Entertainment online communities. Left: Blogger. Centre: Second Life. Right: Habbo hotel. [Resource: treehugger.com, secondlife.com, habbo.com]

The intensification of the various forms of media coverage, collective cognition and social software are essential for the development of online communities. All of these systems require an adaptive *K-Log*, a Knowledge management *weblog* that allows users to tag, classify and develop directories of resources according to various descriptors in the environment, in order to enhance the efficiency of data collection and management.

Table 3 Comparative diagram of online communities

	Communication	Products	Solution Method
Education	One-way	Knowledge	Exhibition
Lifestyles	Asynchonize	Information	Personal interest and data management
Entertainment	Synchonize	Product	Interactive experience

CHAPTER 4: **DESIGN FRAMEWORK MODEL**

"While the new design and fabrication tools deployed by the Gehry team are useful for singular buildings like the Stata Center, they are not directly applicable to housing. We argue that next generation computational tools that place the individual (customer) in the centre of design process, if mated with a more rational approach to construction and fabrication, can enable a democratization of excellent design and technology in housing. These new processes must scale to mass market."

Kent Larson, Open Source Building

4.1 **Open Source Building Alliance Infrastructure**

The premise of customization and relationship marketing is a key to shift building industries' culture from command-and-control to coordinate-and-cultivate (Malone, 2004). This change in building industries' culture will distributively transfer design authority from dictatorial architects to users and building industry participants. The cumulative information will play a big role in this system and alters mass marketing into relationship marketing, improving the operational and constitutional intelligence of the business processes (Kelly, 2006). This process, dealing with capabilities, incentives and connections, enables users to make efficient decisions, and encourages building providers to share their resources and develop their products. To develop an effective alliance framework for the Open Source design community, critical factors for the design-build collaborative process were extracted from the case study analysis.

This alliance framework follows Sean Kelly's 4Es, engaging, enabling, exchanging and extending, as a guideline to attract and engage providers and customers, and develop process architectures for interchangeable organizations. In an attempt to foster relationships among building stakeholders, the suggested framework facilitates a communication process among industry participants, and utilizes customers' information to satisfy and discover their needs (Malone, 2004; Kelly, 2006). This system gives industry participants the right incentives regarding their goals, providing the activity maps or other infrastructures they need to manage their own interaction (Malone, 2004).

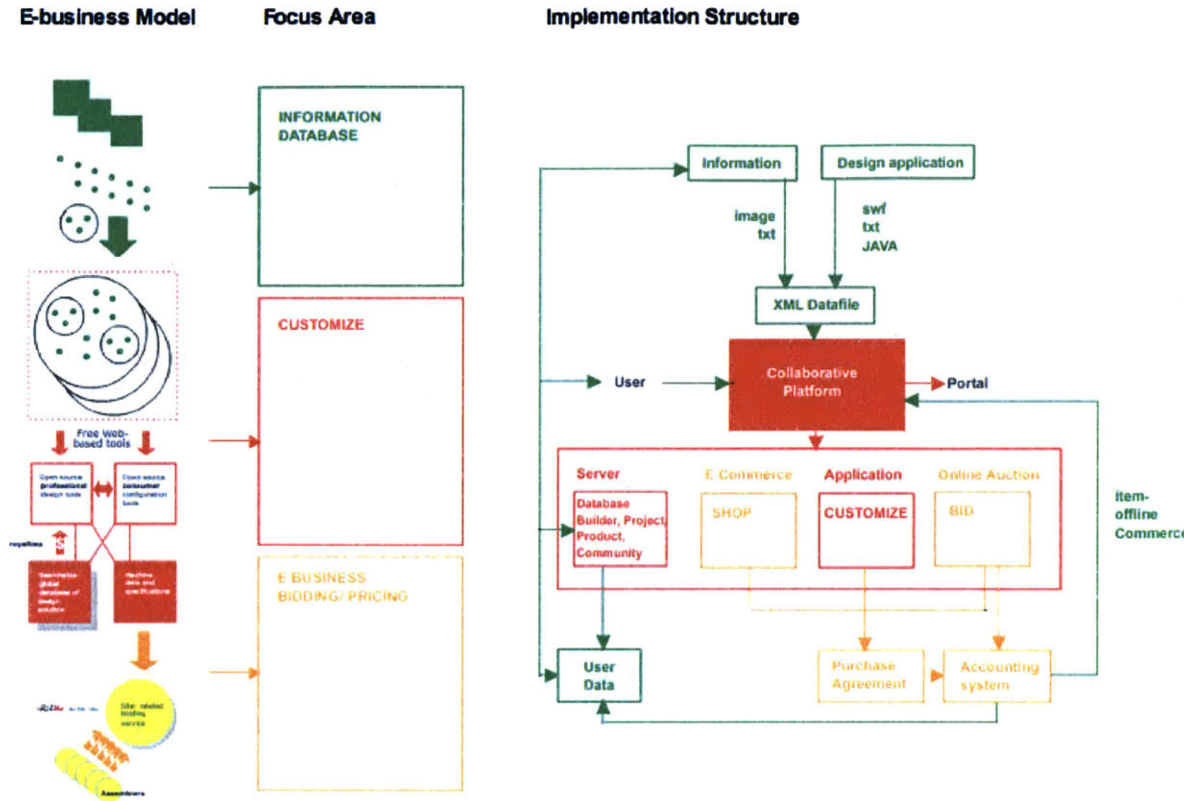


Figure 4.1 The e-Business model. Left: the e-Business model outline for this online community can be categorized into three components: information database, customization, and bidding (Centre). Right: The implementation infrastructure illustrates the relationship between these components in the online community system.

Larson (2004) noted "The Open Source Building Alliance is essential to overcome barriers to innovation. This high-level of 'systems architecture' integrates leading research and industry agreement on design principles and industry standards to trigger an explosion of creativity resulting in high-performance, cost-effective environments by (1) standardizing approaches to a building 'chassis' and the interfaces between elements and (2) developing an agile methodology for unlimited variations of elements that people see, touch, and interact with or 'infill'. This will involve industry agreement on standards related to data, electronics, software, and physical component connections, etc., which could lead to the democratization of good design and engineering (Larson et al., 2004)."

This chapter addresses the components of design application and provides information about how to implement the design application and open source service into Japan's speculative *prefab* industry. This study examines the effect of the quality-oriented production approach on the delivery of prefabricated homes in Japan, and highlights the interrelationship between the quality-oriented industrialized productions. A demonstration of the collaboration techniques using this system to design and construct finished prefab housing from the design application is also included.

4.2 Architectural Implementation and Network Design

This section provides a suggestive framework for architectural implementation and network design. This system is enabled by technology but centered on enduring human values to effectively utilize the benefits of loose hierarchies, democracies, external markets and internal markets. This system is comprised of a combination of centralized and decentralized organizational structures to achieve the purpose of this system and to develop a sustainable environment for building processes and products. Each of these organizational structures is used regarding the purpose of the process to establish its constitution. The use of a decentralized organizational structure encourages motivation and creativity, allowing participants to work simultaneously on the same problem, and accommodating flexibility and individualization (Malone, 2004).

This thesis selects Japan as a potential market to develop design and configuration for building '*chassis*[4]' and '*infill*[5]' and to demonstrate the methodology of this proposed framework. Homebuilding in Japan has been internationally valued by mechanization of construction and mass production technologies in the past decade (Noguchi, 2005). The potential standardization of production, and available consumer behavior analysis are key factors for the development of Japanese housing manufacturers, enabling the Japanese homebuilding market to grow in size and expand to the Asia Pacific region (Datamonitor, 2006).

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[4] *The standardization and utilities of the building* (Larson et al., 2004).
[5] *Elements that are customized by the individual and connect in standard ways to the chassis* (Larson et al., 2004).

This Open Source alliance infrastructure is divided into three parts, design, bid, and community, in order to implement this network design in the architectural process, and to further study:

1. Open Source design system and online technological integration.
2. Business transformation emerging patterns of service, architectures and architectural products.
3. Perceptions of social responsibilities and developmental role for sustainability and efficient infrastructure.

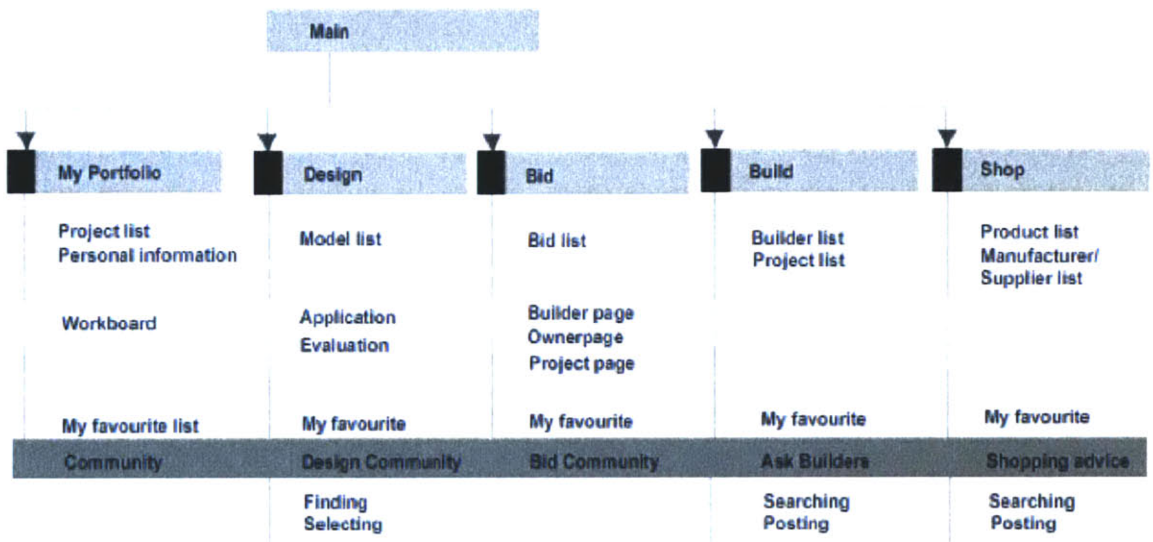

Figure 4.2 Logistic Layers for Architectural Implementation and Network Design.

The logistics of this system can be categorized into three layers of traffic networks; physical networks, operational networks and service networks.

The physical network is the actual path that users use for navigating, customizing and achieving their housing products. It is a guide way to introduce components, scenario, and choice of selection. It is a terminal for community, personal or public database, and a system control for online public workspace, allowing people to post product and log in to private workspace.

The operational network (Vertical) is the provided system of decision points that is adaptive to a specific response with costs and processes, enabling simulation, visualization, sorting, and tagging.

The service network (Horizontal) is a series of communication paths or specific tasks through the network for assisting and reinforcing the industry participants from origin to destination. Each represents a complete option and summarizes the operational decision: movement in common design, financial and performance terms- used for trade-offs.

4.2.1 Design

The Open Source design system introduces a new approach and design economy to utilize the provided resources like plug-and-play product components for restructuring organization. This new business model for home building industries makes use of current digital design tools and fabrication research and development to scale complex design to a mass market (Larson et al, 2004). The proposed customization design tool for non-experts reflects the way designers seamlessly engage in the design process. Converging opportunities of modularity, Open Source, and customization, this system provides interface for standardized system, participative platform for sharing knowledge and common design rule agreement at different locations and organizations, and process for tailoring product that responds to individual's value and specific requirements (Larson et al., 2004).

The study of design systems includes how to incorporate media technology to convey look and feel to customer beyond a virtual model or showroom display, and to implement design computational method sensitive to existing constraints for customizable products. The building industry's online system will be a critical component of this evolution. An understanding of customers indicates how to lead and assist homebuyers through the building design process, and seamlessly retrieves their information to make design tools and architectural products go beyond the limitation of customization and product distribution.

4.2.2 Bid

Democratic decisions are becoming feasible in many situations because of technological advancements (Malone, 2004). The Open Source design system uses all kinds of electronic tools to constantly solicit and respond to the opinions of buyers and sellers (Reichheld, 2001). The strength of this process, dealing with capabilities, incentives, and connections, enables customers to evaluate and validate the providers, establishing a new value and access for homebuilding providers. Taking advantage of *Building Information Management* (BIM) and eBay's bidding strategy, the primary purpose of this online democracy is to find suitable collaborators for customers. A collaborative platform for homebuyers and manufacturers to work and deliver the final products is also provided after the bidding process.

This system focuses on the decision-making, financial structure and project management after the design process. The first phrase of this system uses opinion polling to analyze accumulated information to find new collaborations. The second phrase uses *web logs*, or *blogs*, as a communication channel and participative platform during the fabrication and construction process. This system chronicles building participants' daily activities, discoveries, and problems to explore and keep track of project collaborators' work, finding issues that needed further discussion. These *blogs* also help building participants document working papers and processes, and provides criteria for customers to evaluate their collaborators and determine their satisfaction.

4.2.1 Community

Nissanoff (2006) claimed that one of the keys to eBay's success is how it evolves to serve a community of users and offer them liquidity in both buying and selling. The growth of alliances is significant for community development to go beyond communication channel infrastructure and achieve sustainable competitive advantages. This framework requires clusters of knowledge exchange to increase external visibility, enhance reputation and support different individuals through the online process. The community provides internal coordination facilitating intervention and accountability of the whole system (Brynjolfsson & Urban, 2001; Lucas, 2002; Malone, 2004).

Adopting strategy from online communities and collective intelligence, this process focuses on bringing market opportunities to the building industry, taking care of people (Malone, 2004) and utilizing shared resources provided by different individuals' within the system. Community is served as *Computational critics* of the design system to provide practicable feedback from experts while users explore a design solution (Larson et al, 2004). The groups, formed by interest, disciplines, or problems, distribute gathered information of diverse interests and independent knowledge in provided collaborative environments. Their mutual involvement would be an incentive for community members to share their knowledge, decrease direct assistance demand from the expertise, reinforce the network relationship, sustain the growth of the system, and maximize their profits.

Moreover, Malone (2004) noted that the community is a dependent network that depends on various kinds of infrastructure and services. It is necessary to identify key parameters that facilitate the exchange of knowledge in specific topics such as technical issues or geographic locations to assist the design and bid process. The community enables individual members to propagate the information network and act as new access points, allowing users to track, share and generate content information. Furthermore, the strengths of the community process are not only information exchanges, system managements and data collections, but also the ability to share human assets. Information from professional expertise and experienced users leads new customers to coherent decisions and develops an effective solution approach for the market.

4.3 Application and Implementation

The application and implementation of this framework are constructed in order to demonstrate the practicality of the proposed process as follow:

- Sorting and Selection
- Bidding
- Design Process

4.3.1 Sorting and Selection

This iterative learning implementation focuses on how homebuyers sort and select the available prefab products in the market regarding to their preferences, value, and priorities. The selected result is used to generate design configurations for the design process. The evaluation process is divided into three steps as follows:

Step 1: Interview and Questionnaire

This process focuses on finding purchasing decision factors for homebuyers. Fifty Japanese people, who live in the Boston and Cambridge area, and want to have their own homes when they go back to Japan, were interviewed and answered the questionnaire[6]. The results indicate that Japanese homebuyers consider purpose of use, number of residents, individual priorities such as aesthetic values and range of activities, purchasing budget, and building area as their primary concerns prior to making purchasing decision.

Figure 4.3 Sorting and Selection. Left: List of products and detailed information. Centre: Each image provides a direct link to provider's webpage. Top-Right: Interface for **Build page** where users can manually find their products and builders. Bottom-Right: Computational sorting and selection method.

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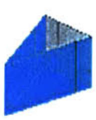
6 See section D. in Appendix

Step 2: Interface and Database Development

A list of available prefab products was assembled and organized into a database accessible via a web interface generated with PHP. Instead of designing a conventional Internet store with hierarchical structures and sequential navigation flows, this pre-design stage is developed in form of dynamic webpage that can present results responding to the user input. It is an open space that allows manufacturers, suppliers or developers to provide their company and product information, presenting customers an access to different sets of products. There are two accesses for this system. One is for providers and the other is for customers.

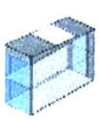
The access for the providers consists of a fill form that allows providers to post their products on the website. The fill form requires providers to give a short description of their companies and products as shown in the figure. These company and product descriptions are stored in the categorized database, helping customers to effectively sort and select the product they need.

```
purpose          $purpose_live, purpose_lease, $purpose_office, $purpose_storage, $npeople,
priorities       $focus_1, $focus_2, $focus_3, $focus_4,
budget           $cost,
urban context    $site_1, $site_2, $site_3, $site_4);
```



```
// test for "PET"
    if ((int)$npeople <= 3 && $focus_3 == "" && $focus_4 == "" && $cost == "less than 2M"
    && ((int)$site_2 < 4 || (int)$site_3 < 4))
        echo "You select PET type\n";
```

```
// test for "INSTANT"
    else if ($purpose_live != "" && $purpose_lease == "" && $purpose_office == "" &&
    $purpose_storage == "" && (int)$npeople <= 3 && $focus_3 == "" && $focus_4 == ""
    && $cost == "less than 2M" && (int)$site_2 < 4 && (int)$site_3 < 5 && (int)$site_4 < 4)
        echo "You select INSTANT type\n";
```



```
// test for "TALL"
    else if ($purpose_live != "" && $purpose_lease == "" && $purpose_office == "" &&
    $purpose_storage == "" && (int)$npeople <= 3 && $focus_2 == "" && $focus_3 == "" &&
    $cost == "10m-15m" && (int)$site_1 == 36 && (int)$site_2 == 6 && (int)$site_3 == 6 &&
    (int)$site_4 == 9) echo "You select CUT type\n"; else if ($purpose_live != "" && $purpose_lease
    == "" && $purpose_office == "" && $purpose_storage == "" && (int)$npeople <= 3 &&
    $focus_2 == "" && $focus_3 == "" && $cost == "10m-15m" && (int)$site_1 == 49 &&
    (int)$site_2 == 7 && (int)$site_3 == 7 && (int)$site_4 == 10)
        echo "You select TALL type\n";
```

Figure 4.4 PHP

Customers can choose to sort and select products automatically or manually. The automatic access asks for information from customers regarding the above critical factors in order to match the customers' answer to the providers' product information database, and return the product result back to customers. Figure 4.8 illustrates how the manual access allows users to search the available products through different categories and the preliminary constraints for the automatic access.

Moreover, this web system allows customers to compare the product in which they are interested and bookmark their favorite products in their "**Portfolio**" section. This function is served as an evaluation measurement that informs users of the popularity of the providers and products, helping customers making their decision. Furthermore, providers can create their information page to serve as an advertising channel to provide their information and approach their potential customers.

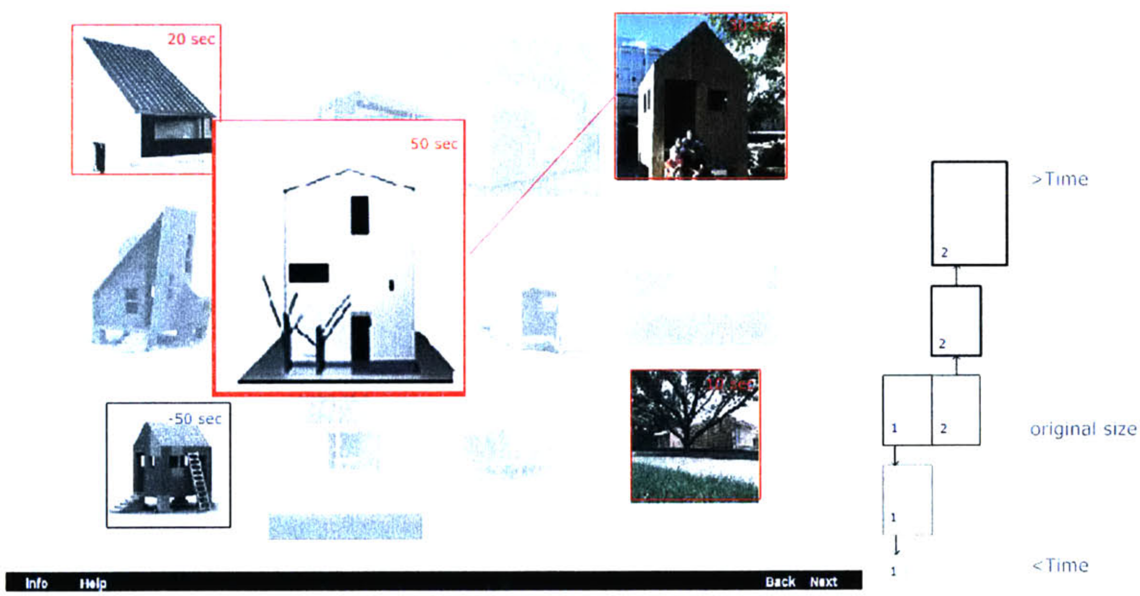


Figure 4.5 Manual sorting interface

Step 3: Evaluation

This interface is evaluated by the same set of interviewees. The evaluation indicates that more than 75% are satisfied with their product results. 20% of the interviewees stopped at the preliminary question page. The flow of traffic shows that the fill form process is one of the shopping constraints, and must be seamlessly embedded in the system. The *scattering retrieval method* will make the information gathering system more transparent, and effectively reduce customer barriers to the system. The interviewees also suggested a sorting system that enables customers to search projects and providers based on the skill matrix, features, and release date. Moreover, the system requires more information input to evaluate the effectiveness of the database categorization.

4.3.2 Bidding

This implementation focuses on how housing product is delivered from the beginning to the end of the process. This section describes the overall structure of the website and explains how users select, design and share their design houses, find builders, and place bids. This system has not been evaluated by users since it is requires real world collaboration, manufacturing testing, and a complicated programming system, such as auction management and software tools, to be able to evaluate the practicality of this system. The demonstration of how the bid process is implemented in the system can be seen in four steps as follows:

Step 1: Design Process

This section uses *Pet architecture* as an illustration for the design process since it is a smallest structure with a certain limitation regarding site and personalization. *Pet architecture* refers to the buildings that exist in unused urban openings, especially in Tokyo. According to Tsukamoto (2004), this characteristic pet like building can be observed in areas with a one-meter opening between buildings, subdivided small land, narrow ground yield from gaps between geometric designs of roads, railroad tracks and rivers, and street corners. The design tool is developed based on this building's physical constraints and considerations.

First, this system allows the customer to select from four types of *Pet Architecture* typology (Figure 4.6), depending on their site constraints. Customers are directed to a list of available digital products, and can review the digital file to determine whether to make a purchase from the top sellers or develop from scratch. Users can choose to personalize their building by downloading a free file, representing a generic building design, or purchasing the file that the creators request the royalty fee for their initial design. The purchase files are not only unique designs of housing model but also additional features such as a new designed façade and room arrangement, which can be applied to the free generic designs. Moreover, the users can get more information and feedback from previous customers who used the file by looking on the community page or in the file's comment section.

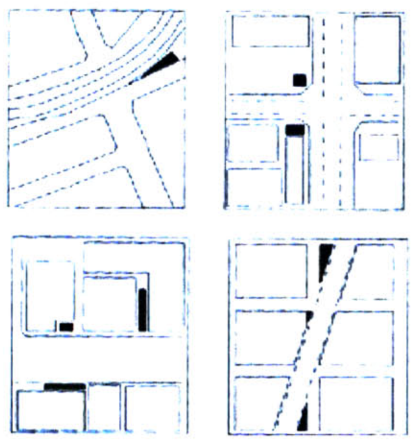


Figure 4.6 *Pet Architecture* Typology
[Resource: Yoshiharu Tsukamoto, How to utilize Pet Architecture]

Second, the design interface introduces users to a set of questions asking them about their preferences, purpose of using this building, site detailed information and preliminary constraints[7]. After that, the system guides users to personalize their products by using an interviewing method. These series of adaptive questions modify the products according to user responses, guiding them through the planning, space design, decorating and material selection process. Moreover, the system also provides personalized recommendations based on prior purchases. For instance, the system can provide

[7] See application 3 in Chapter 4.3.3.3.

suggestions on color to fit customer preferences based on their buying behavior or their information from the *scattered retrieval method.*

Third, before users submit their design online, the system provides a summary page that allows users to review and finalize their selections. The system also provides an evaluation page that is linked to the professional community, through which users can receive suggestions from community members or a default evaluation from the system.

Fourth, after users submit their design products, their personalizations are stored in two locations: the **product page**, if they prefer to publicize their file, and in their **portfolio page**, if they are a registered user which will allow them to access and modify their files anytime.

Figure 4.7 The **product page.** Left: Completed product. Right: Digital design, prototype or finished example of the dwelling constructed.

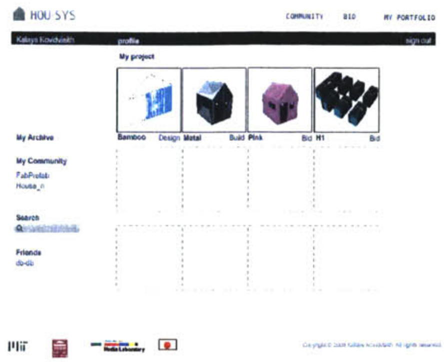


Figure 4.8 The **portfolio page**

Moreover, users can sell their design files or continue to the bid process in order to build their designed building. The pricing system for these digital files has not yet been defined. According to the observations through the 3D stores on the Internet, the price range for this type of product is normally around $10-$300 depending on the creators' performed costs associated with the designs. File previews will show only one or two single shot screens with rough information until users purchase the file, which will allow them to gain access to all the details. Moreover, users can access the community, in order to discuss about their design problems, or ask opinions from other community members that available online at the moment throughout the design process.

Step 2: Bidding Process

If the user decides to continue and build their design projects, there are two methods to find building collaborators: manual or bidding. The manual system will use the same process as the sorting and selecting system, focusing on the builders' skill matrix. For the bidding, followed and modified from eBay bidding system, users have to submit their projects, indicate their budget cost and provide the date ended on the website. The information will be listed on the **bid page** where manufacturers, suppliers, contractors, or homebuilders will find their jobs and start bidding for the project. The submitted budget cost will not show on the bid place, but will be used as one of the criteria to select builders.

Figure 4.9 The **build page**

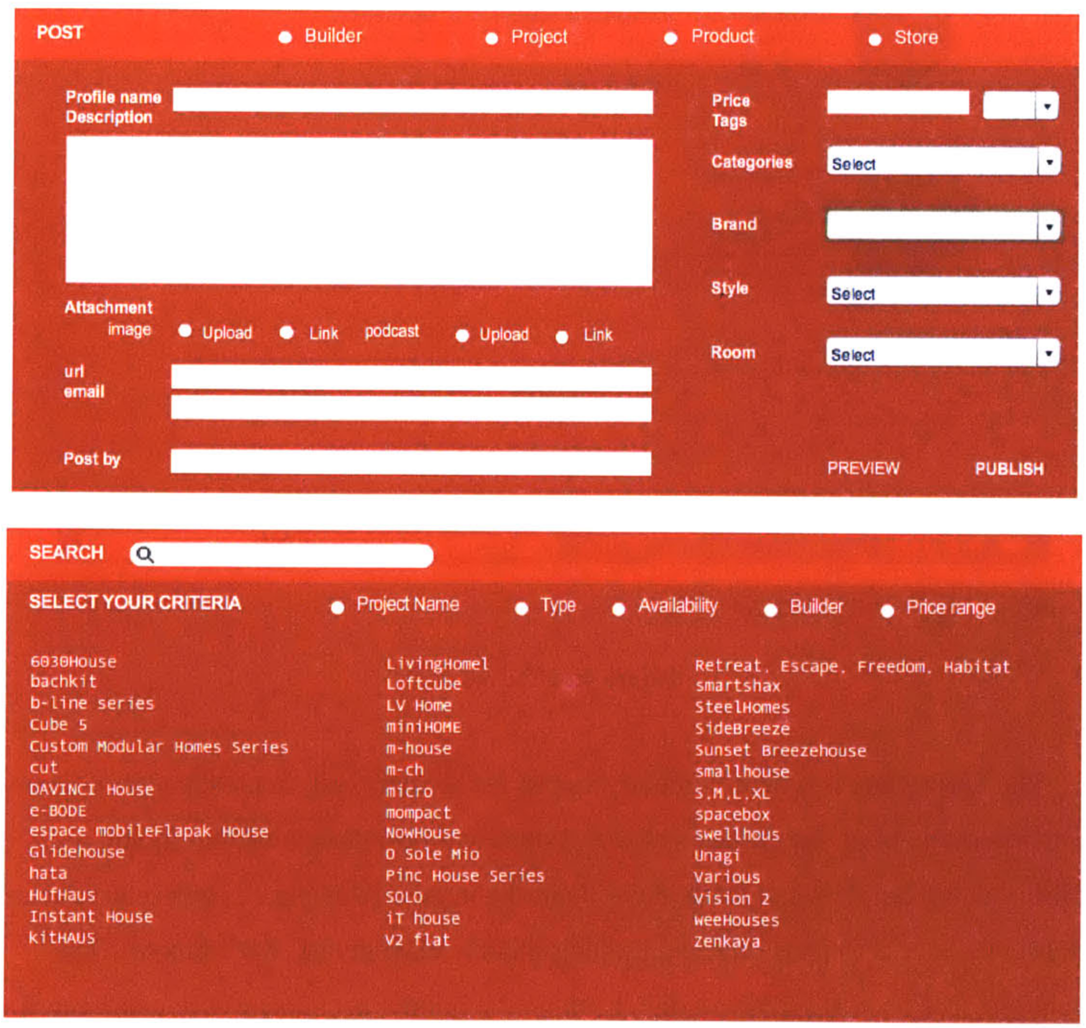


Figure 4.10 Post form and search engine. Top: Post form. Bottom: Sorting interface

The web page can be categorized into four types based on their functions: Bid page, User page, Builder page, and Dashboard.

The **Bid page** is the main page where every bid is posted and viewed. This page is a 'hub' for customers and providers that shows all the activities such as posting, selling and bidding.

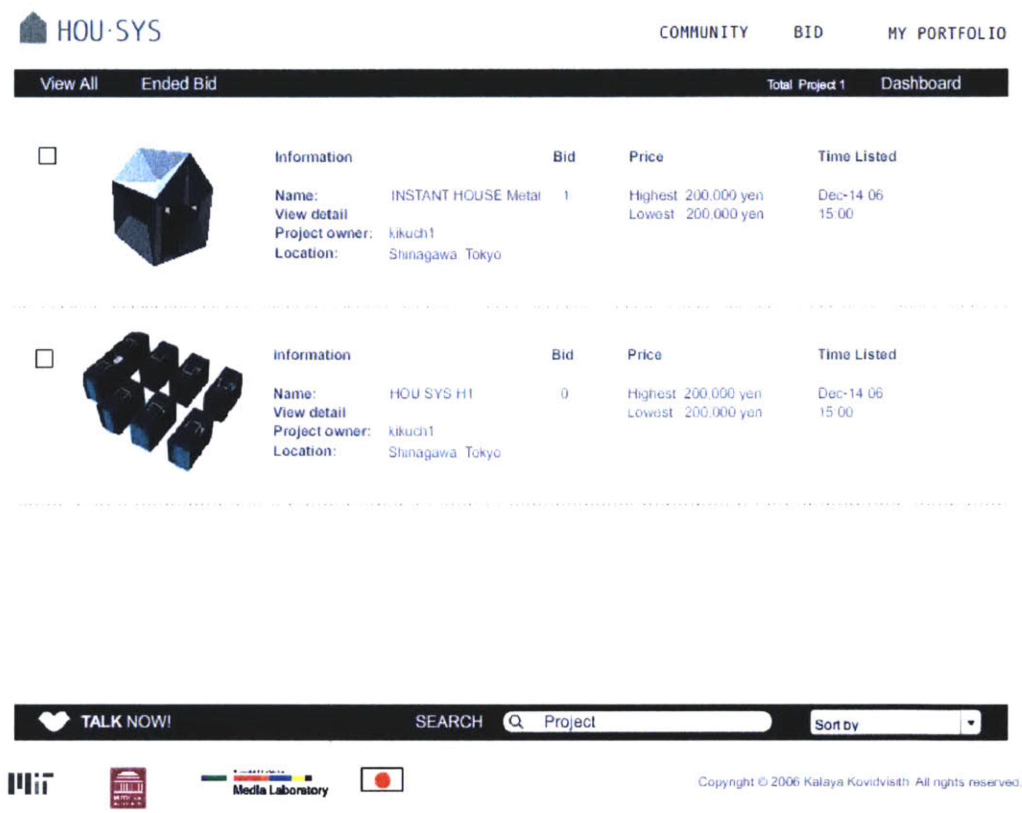
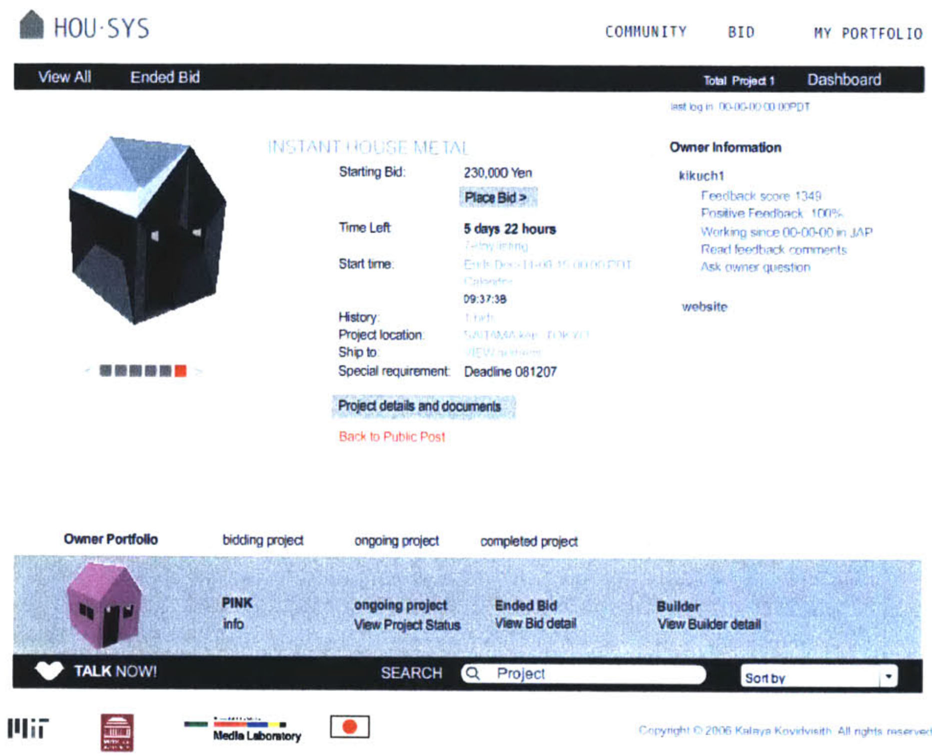


Figure 4.11 The bid page

The **User page** is where homebuyers can refine their system presence. It contains the information about bid project summary, owner information, evaluation, and a portfolio where builders can learn about their client. Also, this page is where users can have private access to their ongoing projects and the current bid of the project. The current bid section will provide a direct link to the builder account, where users can find builders' detailed offers and conditions regarding the project. Moreover, the system allows users to track listing view, leave feedback, and communicate with the builders.



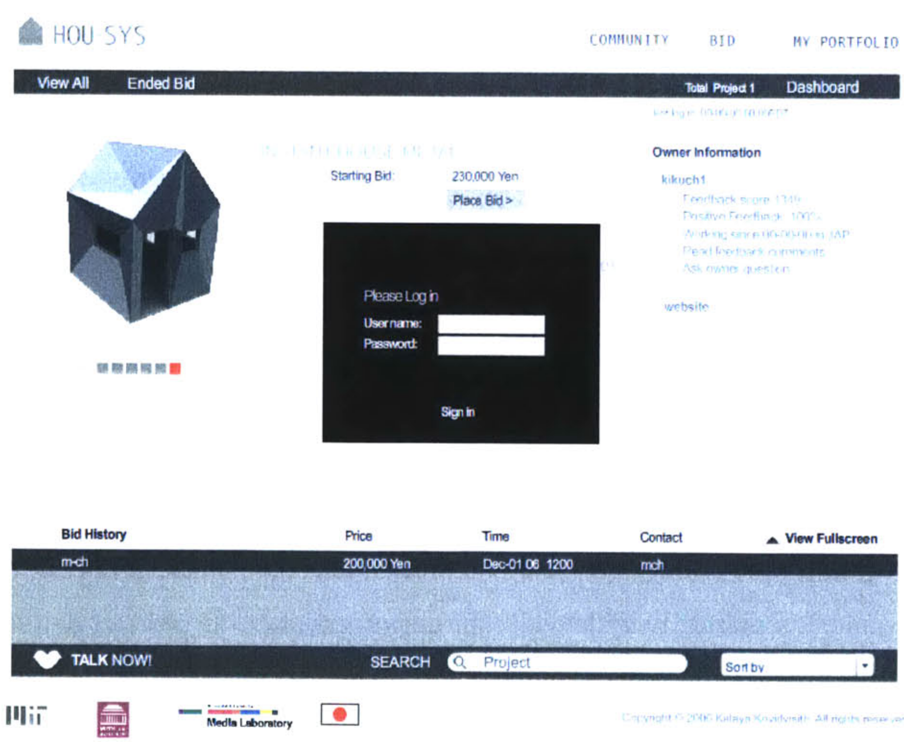


Figure 4.12 The user page. Top: User page. Below: Login to view current bidders.

The **Builder page** is similar to the user page but focuses on the builder's profile such as their project history, company information, policies and expertise, and evaluations from their previous customers (Figure 4.13). This page allows customers to inquire about their question regarding the builder's offers and their company performance before bidding. This method will assure customers about the builder's responsibility and responsiveness. Moreover, the evaluation will help customers to select suitable builders for their projects. Builders can be evaluated by expertise or by feedback rating in this system (Figure 4.14).

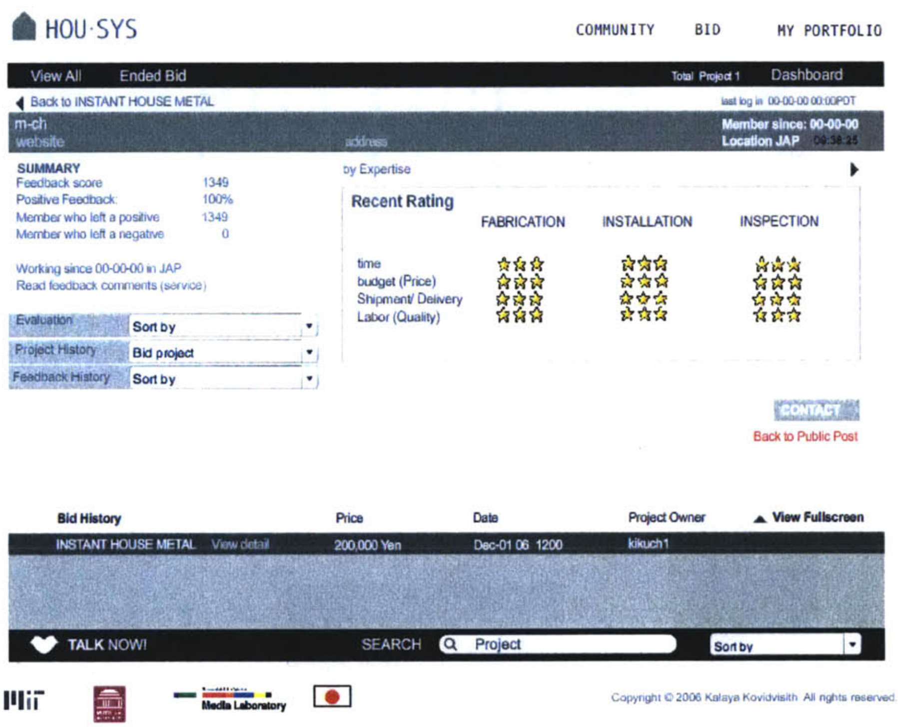


Figure 4.13 The builder page

The feedback rating uses the same principle as *eBay*'s positive and negative feedback regarding the builder's service and transactions. Feedback can be viewed chronically and automatically updated by the customers after the product delivery. The evaluation by expertise is feedback rating based on builder skill performance and previous collaborator satisfaction. Builders can be evaluated by time, price, project delivery, and labor quality during the fabrication, installation and inspection processes. The evaluation method will be described in step 3.

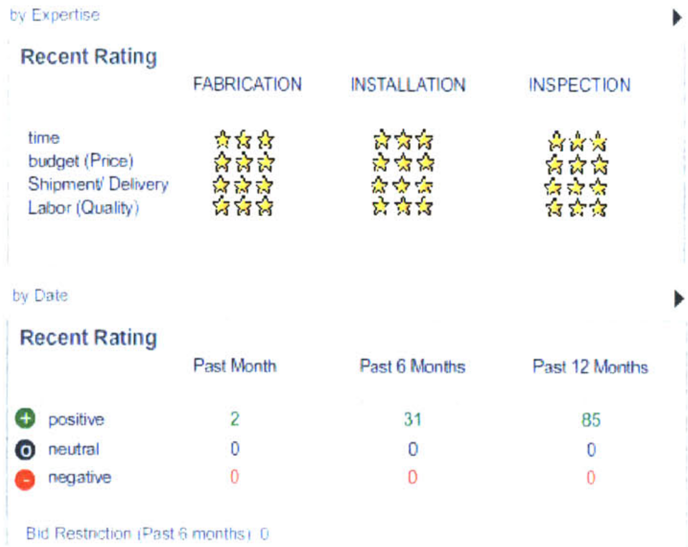


Figure 4.14 Capability evaluation by expertise or by feedback rating.

Dashboard is where visitors, users, and building industry participants can view the activity and statistical summary of the website such as number of members, users and visitors, number of digital and physical products, and the quantitative and qualitative evaluations from previous users. This section will link users to the **community page**, and provide message boards, online tutorials for system functionality, and the latest news and announcements of the website.

At the end of this process, the builders who offer the closest cost to the homebuyers' budget will be selected. However, customers can choose to accept or negotiate their conditions. Users also allow to decline and select other builders by using eBay's *Second chances offers system* (Elms, Bellomo & Elad, 2005) if their conditions are more acceptable to customers.

Step 3: Fabrication and Construction

To fully integrate this online system to the building production, this page is a private section only accessible to project collaborators to view and work on their project. Building on Project management and BIM software such as e-Builder™ and *Primavera*, this collaboration platform contains all the necessary functions and related documents required for the project such as certified blueprints, specifications, contract agreements, estimation spreadsheets, and building permits. This page is a web-based construction project management and collaboration platform simplified for non-experts to comprehend and collaborate with builders and manufacturers.

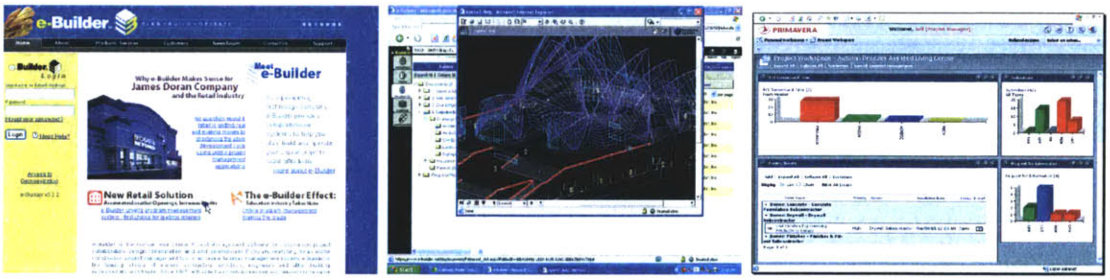


Figure 4.15 Project management software. Left: e-Builder™. Centre: Drawing document. Right: *Primavera*. [Resource: e-builder.net, primavera.com]

This page will download all the collaborator information, and serve as the worksheet, *Transaction processing system*, and *Decision support system* for both customers and builders. Manufacturers, suppliers and contractors can download, transact and evaluate the digital file via the Internet before directly sending the data to the *CNC*[8] or millwork machines for fabricating and manufacturing.

Figure 4.16 Project management page

[8] Computer numerical control

The process is divided into seven sections, contract, fabrication, delivery, assembly, inspection, service, and account/finance. Each section contains detailed information and processes that require to be updated regarding to the topic and project schedule. In order to finish the project, both homebuyers and builders have to submit their evaluation as an agreement to verify their progression. Each section might be overlapped, and need to be verified at the same time. For example, if the contract indicates that customers need to make a payment after each section is finished, collaborators might have to certify the transaction in the account/finance section and also verify the progression in the fabrication section. The same idea applies to the builders when they receive material from the supplier. The builders and suppliers have to verify the transaction and project progression as part of the delivery and fabrication process. The evaluation will automatically update in the calendar and project management schedule and be document as a reference for the next project. Moreover, the evaluation will not only be gathered from collaborators' opinions but also records the time at which each participant submits their evaluation. These resources will be analyzed as the evaluation for their responsiveness and time criteria, and will be collected in their personal page and used as their references. This page also provides communication channels such as *blogs* or *skype*, a calendar for scheduling and project management, confidential documents that tag information, useful resources, and special topics that require further discussion.

Step 4: Comments

Regarding to Elms, Bellomo and Elad (2005), the bid system requires quick response from both customers and providers. This system also needs a lot of communication so that users can be informed enough to evaluate intelligently. Moreover, everyone's opinion count equally in evaluation, even though those provided by experienced users or professional experts might have more value than others (Malone, 2004). This managerial applicability requires a multiply interactive system for multi-tasking operation level, and it might be necessary to create a small interactive team to monitor and cooperate during the design or manufacturing and construction process.

4.3.3 Design Process

"The difference that makes the customization of homes more challenging than other mass-customization products is the wide range of users' age, interests, skills, and cognitive ability (Larson et al, 2004)." This implementation focuses on how homebuyers can customize and personalize houses in response to their preferences and lifestyles. Building on the House_n group research, this section provides a detailed outline of the design process with an emphasis on design tools for non-experts. The demonstration can be divided into three sections, data collection and analysis procedure, development process and implementation, and the interface for non-experts.

4.3.3.1 Data Collection and Analyses Procedure

This section investigates Japanese housing design, and analyzes criteria critical to the development of a design configuration and systems that capture design knowledge and values. Freeman (2004) noted that housing design in Japan is focused on the solution for compact living. Contrary to the western ideal, where larger is better, Japanese design is about how to efficiently utilize the geographical limitation, and create a harmonious approach to the surroundings (p. 6-7).

The traditional Japanese house originally is a multi-functional one-room house that can be divided into series of compartments by *Shoji*, sliding screens that separate the inner from the outer space, and *Fusuma,* sliding screens that separate the inner space (Figure 4.17). However, Japanese houses have gradually changed through time resulting from changes in social order, urban infrastructure and lifestyle (Ryu, 1982). After World War II when Japan decided to open their country, the rush of Westernization has tremendously affected Japanese lifestyle, transforming Japanese housing production, the use of material, and room arrangement.

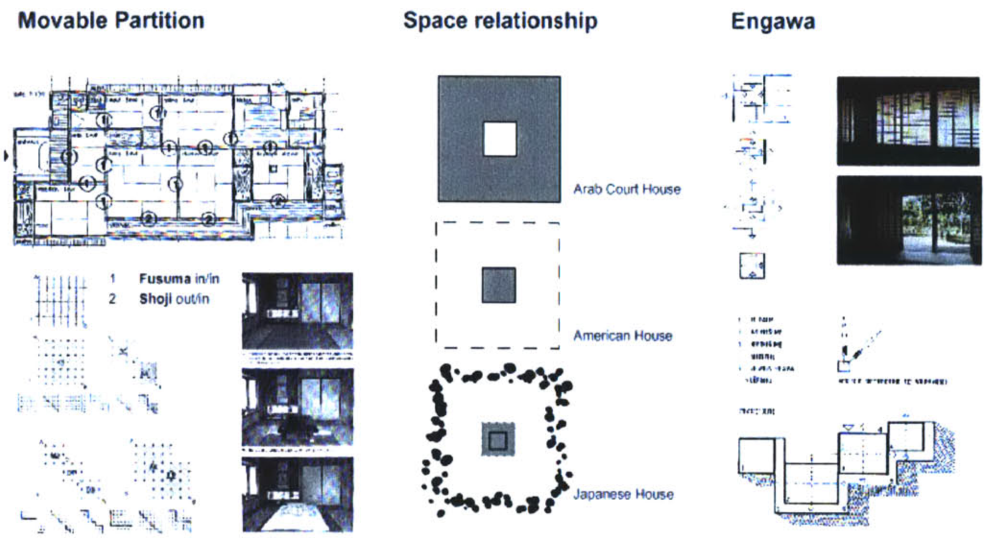


Figure 4.17 Japanese housing characteristics. Left: (A) Moveable partition. Centre: (B) The comparative study of housing enclosure, hierarchical of space and the use of garden. Right: (C) *Engawa* or corridor position.

A. Freeman (2004) noted, "Long before Le Corbusier's famous Modular, Japanese were working with *Tatami*, a human-proportioned mat unit that informs the dimensions of homes and rooms and indicates the sense accommodate and living behavior." *Tatami* is an essential item making Japanese house multi-functionality possible through the difference between numerical diversity and flexibility of the Traditional Japanese room arrangement system. [Resource: Yositika Utida, The Open System of Building Production 10 August 1977.]

B. Japanese housing has more layers than Arab courts and American houses. Each layers of Japanese garden is meaningfully used as a shield to ensure the residents' privacy and identify territorial boundary rather than exposing it to public or only using it for leisure purposes. Freeman (2004) stated that the key component of Japanese spaces is lightness. Contrary to openness concept that can be found in window façade of the contemporary housing, Japanese houses visually borrow significant natural or built features from the surrounding context to form lightness boundaries of hierarchical spaces, maintain a sense of place and connect residents to the natural environment around them (Nute, 2004).

C. While most of the Asian and Western countries position corridors towards the south, Japanese corridors are positioned towards the north.

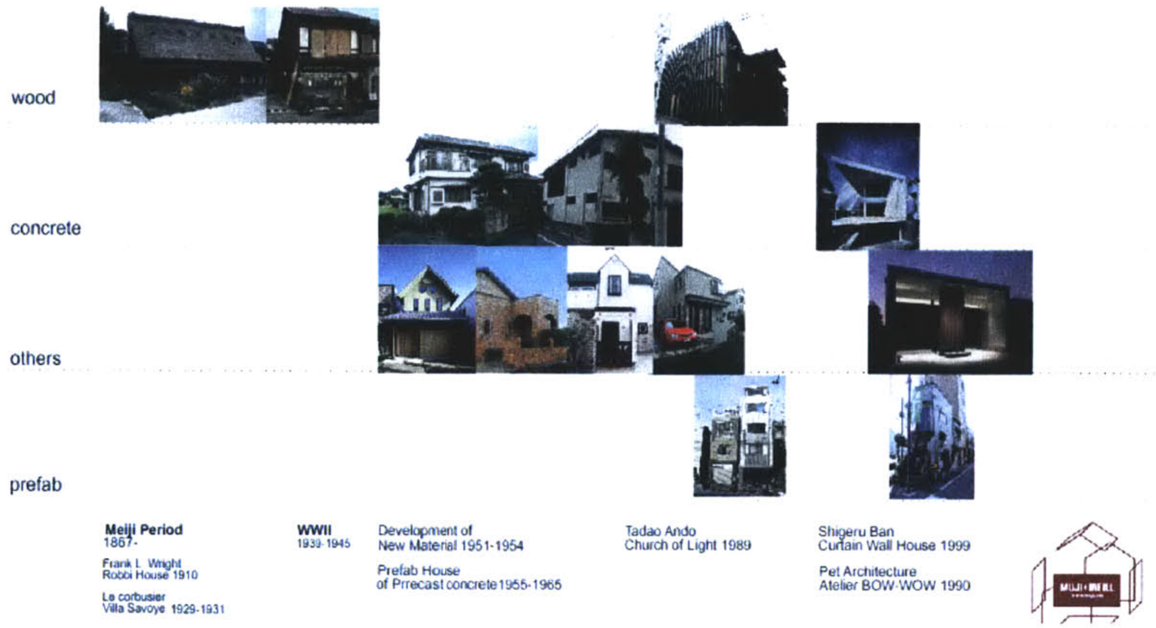


Figure 4.18 Japanese housing transformation. This figure illustrates how Japanese housing has changed from craftsmanship to industrialization, natural material to manmade material, and vernacular shape to geometric form.

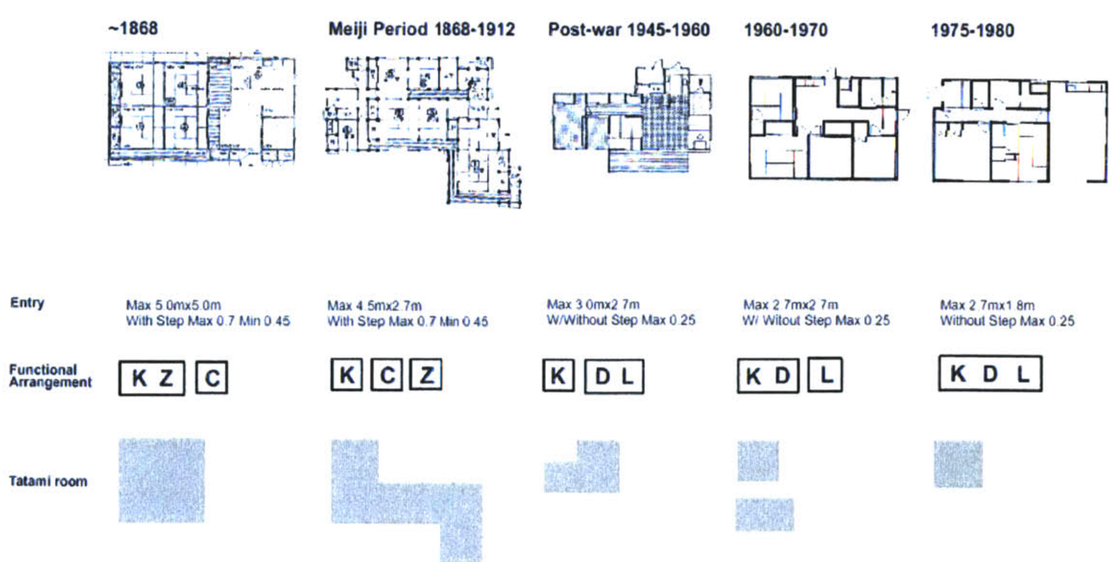


Figure 4.19 The transformation of middle-income single-family house in Japan. This figure illustrates how a middle-income single-family house has been changed through time. [Resource: Yoshiko Ryu: Alternative housing designs for changing life-style in Japan, Suzuki Naribumi: Collective Houses]

The adaptation in housing not only distinguishes a traditional Japanese house from a modern Japanese house, but also reflects how changing in lifestyle affects housing design and development in Japan. While the traditional arrangement is multi-functional and adaptive, a modern arrangement is purposeful and less flexible. This figure is a comparative study of a Japanese entry, a functional arrangement between kitchen, dining, and living areas, and size and expansion of *Tatami* room. Besides these physical transformations, there are other parameters that represent the essence and responsiveness of Japanese design. Nute (2004) claimed that the uniqueness of Japanese buildings is how they can respond to place, time or user existence. These responsive characteristics can be expressed in the housing design as follows:

Table 4 Summary of the principle finding

Intangible	**Tangible**
Place	Integration of natural phenomena Architectural shape and exterior envelope
Time	The visual framing of significant features in a building's surrounding environment The use of material and Japanese elements
Being	Room size and usage The use of garden Expression of the inherent patterns of materials
Flexibility	Spatial organization of LDK[9], living, dining, and kitchen room

These principle findings will help Japanese homebuilders to develop practical configurations assuring a high standard housing. These tangible and intangible parameters are essential in order to sustain environmental and cultural identities against the homogenizing effects of industrializations.

[9] ***LDK** is an abbreviation in Japanese real estate to describe apartments. It stands for Living, Dining and Kitchen area, and is preceded by the number of rooms. For example, 1LDK is one room apartment with a living, dining and kitchen area.* [Resource: www.japan-guide.com]

4.3.3.2 Development Process and Design Configuration

The development and implementation of this framework is constructed in order to demonstrate the practicality of the design tools for non-experts, which involved

- Design prototype and market research scenarios
- Analytical envelope
- Design configuration
- Library infill and components

The implementation offers different configuration strategies based on homebuyers' preferences, lifestyles and practical limitations to designs such as HVAC[10] for developing well thought products. These design configurations are generated by the user profile from Sort and Selection process, which will be refined by the users through design interface.

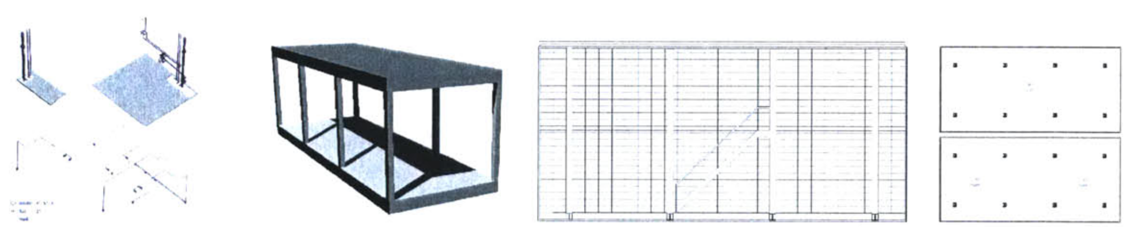


Figure 4.20 Design prototype

A. Chassis detail showing integrated HVAC units.
B. Volumetric chassis modules designed to be twenty feet by fifty-two feet in dimension. The volumetric for main structural module is thirteen feet by forty feet, which can be transported over the highway (maximum size of containers is sixteen feet by sixteen feet by forty-three feet) The floor area is approximately 32 *tsubo*, Japanese area unit that commonly used in discussing land pricing, which can be fit into the Japanese landfill (see Appendix A).
C. Floor plan and section of the residential development illustrating a variety of room configurations.

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10 The abbreviation for heating, ventilating and air conditioning system

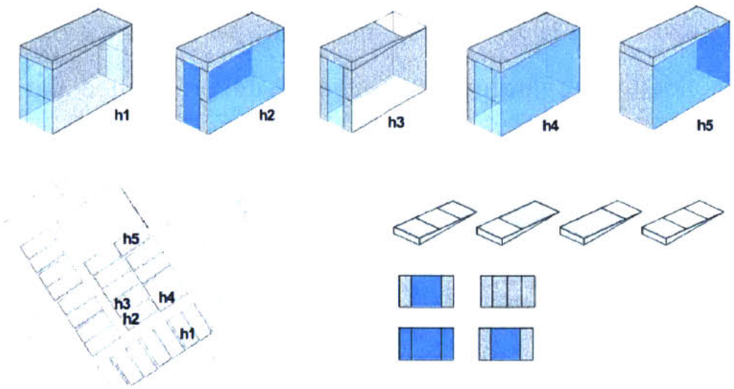


Figure 4.21 Analytical envelope and planning suggestion. Alternative solutions for 6 housing prototypes with regard to their site and surrounding constraints; Site location and layout, Shinagawa, Tokyo.

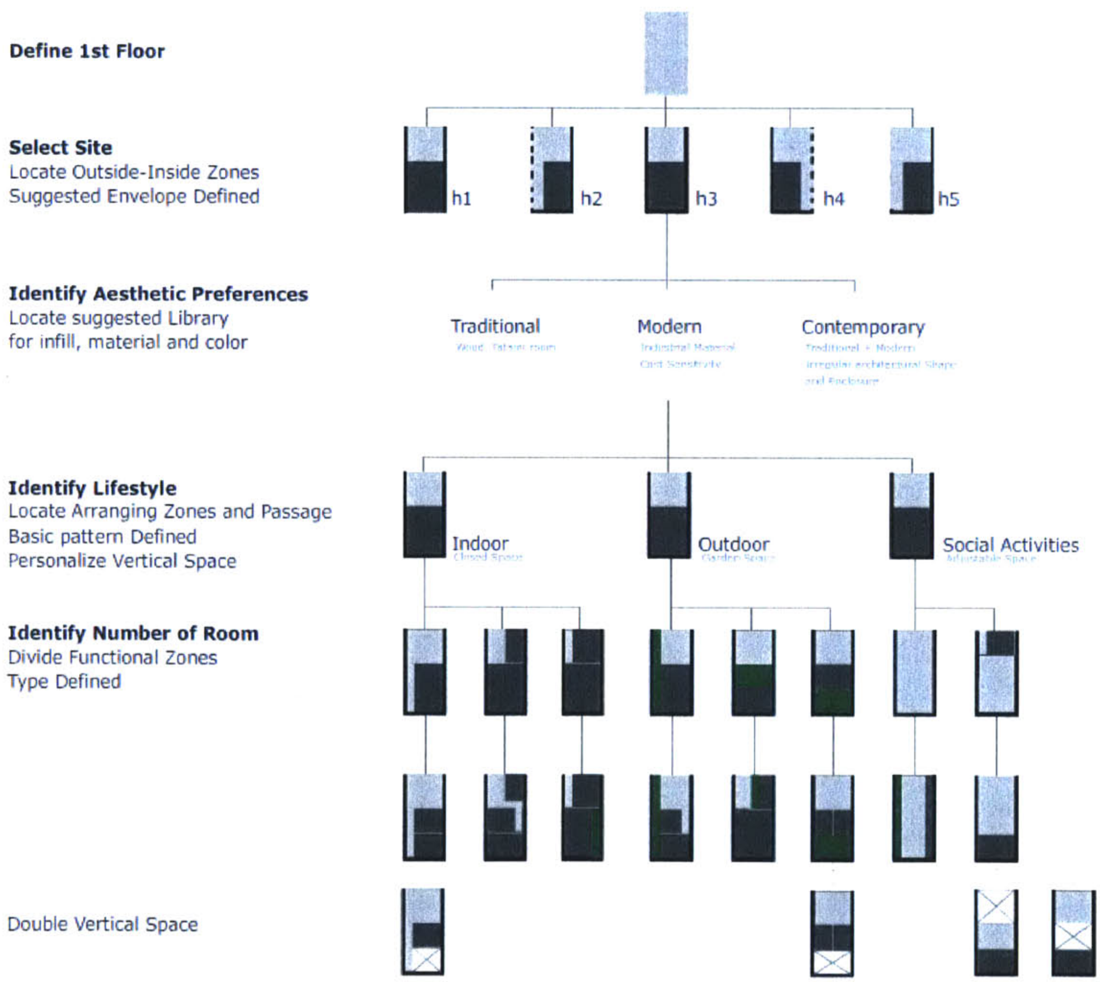


Figure 4.22 Design configuration

Spatial organization of LDK, access, and open space, and the parameters for schematic generation regarding homebuyers' site, preference and lifestyle. The arrangement of the vertical space is to emphasize the room priority and differentiate users' lifestyle.

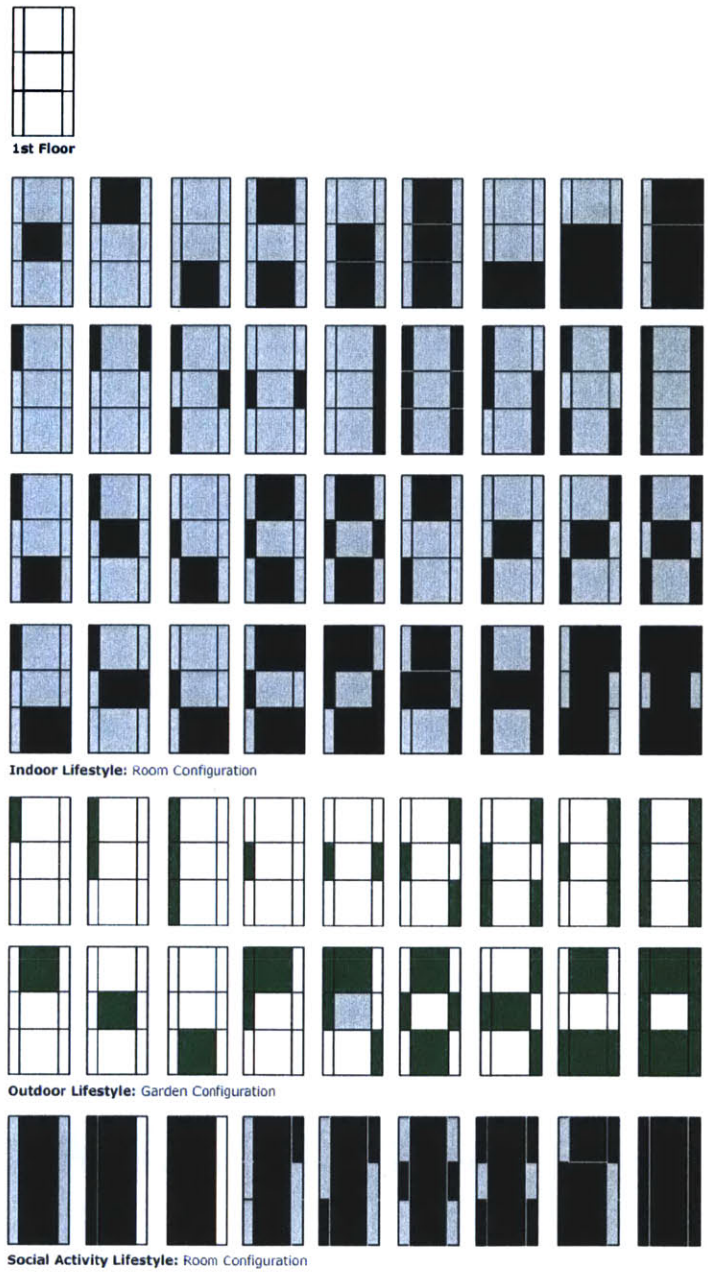


Figure 4.23 Diagrammatic housing types and their transformations. The schematic design of the prototypical floor plan regarding personal criteria such as recreation lifestyle: social activities, outdoor, and indoor.

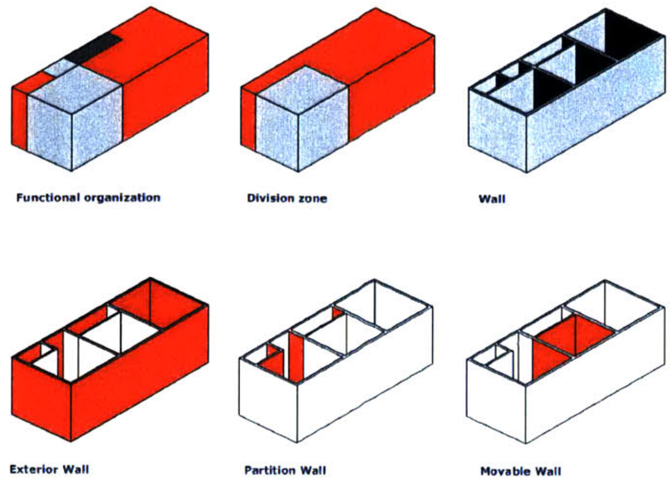


Figure 4.24 Correspondence between functional organization and structural system

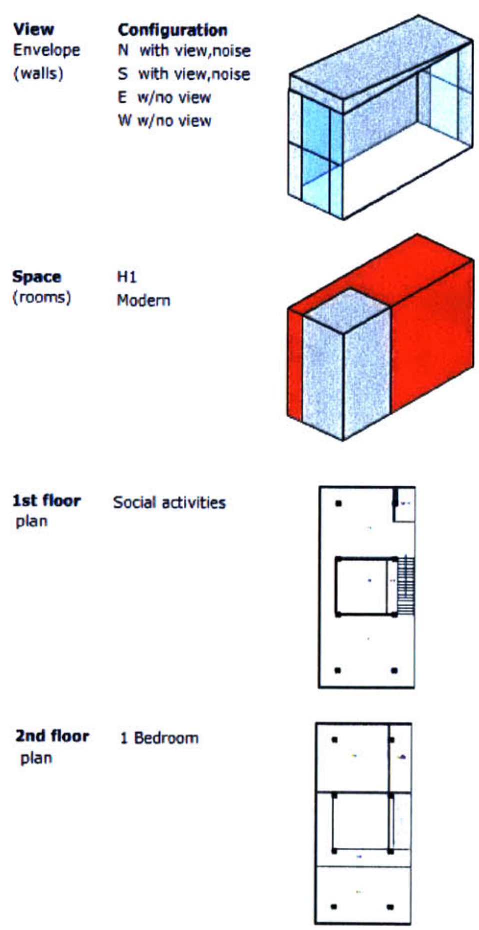


Figure 4.25 The illustration of the design process and chassis design for housing prototype.

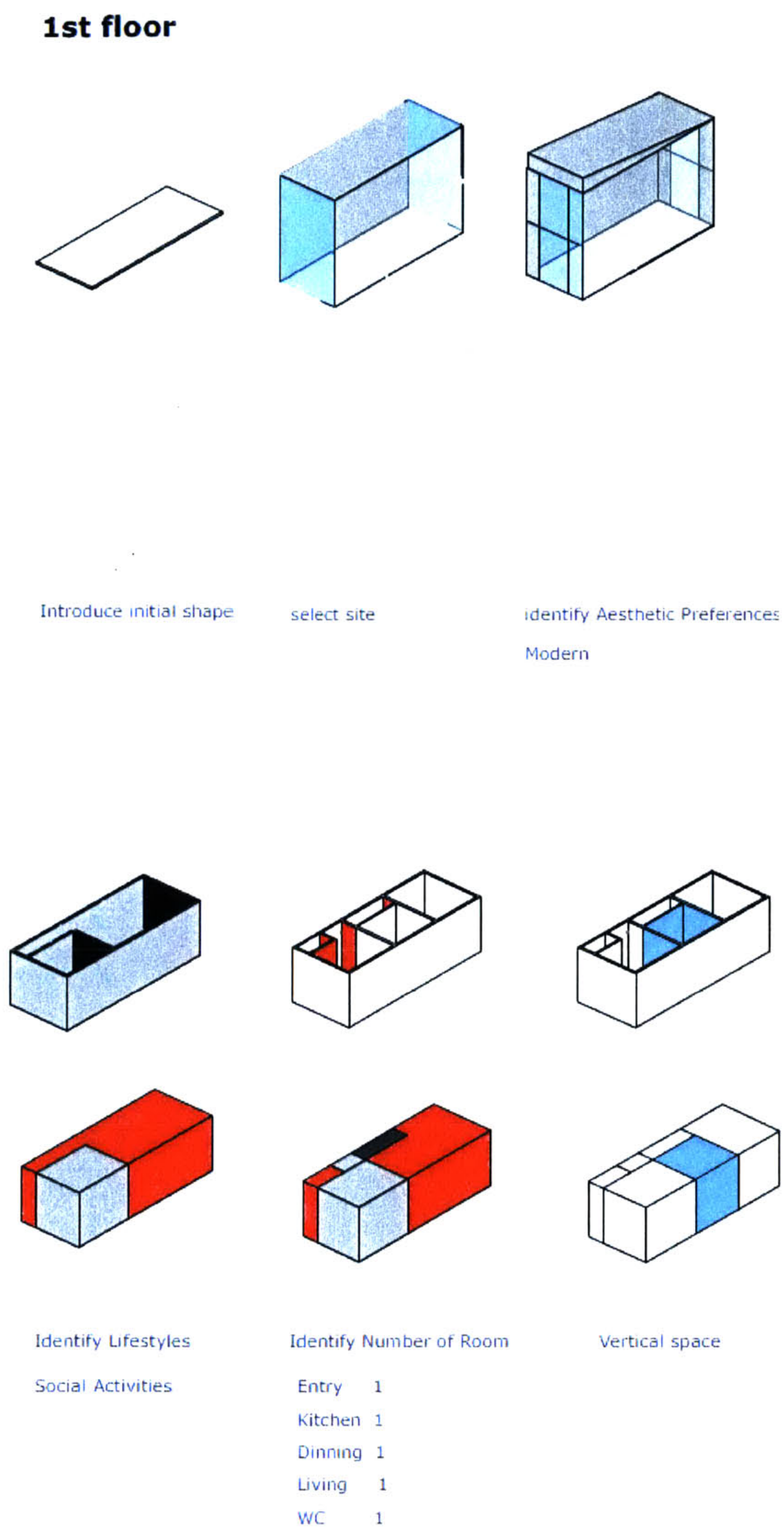
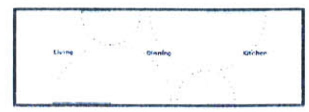


Figure 4.26 Derivation of new design for h1 housing type.

Table 5 Design of a Library of infill components

	Traditional	**Modern**	**Contemporary**
Function			
Aesthetic	Vernacular shape and craftsmanship elements	Cubicle and simplicity	Geometric form
Color	Wooden and natural	Monotonous and plain	Artificial and metallic
System and Material	Steel frame, wooden and paper panel, *Tatami* mat	Steel frame, concrete and glass panel	Steel frame, concrete, glass, wooden and paper panel, *Tatami* mat

The difference between aesthetic value: Traditional, Modern, and Contemporary categorized for design parameter, infill library, configuration development. Left: Traditional style is a wooden based material component that is consisted of *Tatami* rooms and moveable partitions to support space formulation for multi-functionality (L/D). Centre: Modern style is a price sensitive model. Its functional based model is partly constructed of concrete component. Homebuyers can choose between *Tatami* or western style living room. The living is isolated while the kitchen becomes the integral part of dining area (K+L). Right: Contemporary style is a mixture of Japanese and Western living style. It is composed of open plan room (L+D+K) and has a wide range of exterior finish material and color database.

Following the research done by Mcleish (2003), the library of infill components is developed and documented for the design tool's database. These documentations are produced using AutoCAD and Rhino. These components are exported to Macromedia Flash MX, and associated with tags to be used in the online interface.

4.3.3.3 Interface for Non-Expert Designers

This section focuses on the development of a Design iteration interface[11] that utilizes the above information and analysis, enabling non-experts to design and explore their design alternatives of housing products and guiding them through complex design and decision-making problems (Larson et al, 2004). These implementation interfaces are conducted in order to illustrate, compare and investigate user interaction, especially in regard to how the system can retrieve information and display the data, and how users interact with the design methods and configurations.

Using an interactive interface to replace the passive system, there are four applications, programmed entirely by Macromedia Flash MX that are developed and evaluated. The success and failure of the previous interface will identify the groundwork for the next development of the design interface. The evaluations for first, second and third design application were done informally by Japanese people who reside in Boston and Cambridge area. However, the fourth application is formally evaluated by selected people from different disciplines, which will be described in detail in chapter 5.

Application 1: Design Perception

Purpose:

This exercise focuses on how users perceive and process architectural design information and utilize the design tools to achieve their final design products.

Implementation:

The first application is a visual-based interface that allows users to select rooms and furniture from the visual component library, and place them in the provided space. After users go through *Sort and Selection* section, a series of design configuration, provided based on user profile, is displayed on the system interface. This drag and drop application provides a positional constraint by assigning tags to each configuration. Tags

[11] See section A. in Appendix

can be snapped to a certain number of suggestion areas. This method helps users locate their configuration, design their plans, and experiment with design alternatives. Using the drawing tools approach, this interface also provides other design tools that allow users to rotate, change color, and cut and paste material.

Evaluation:

Twenty users who are not in the design field, were asked to use this tool to design apartment. After a demonstration, eighty percents of the users claim that the system is too complicated and ask for assistance and guidance during the design and selection process. In summary, this system requires design knowledge in order to understand architectural drawing symbols, and determine which suggested configurations and positions are suitable for the users' conditions.

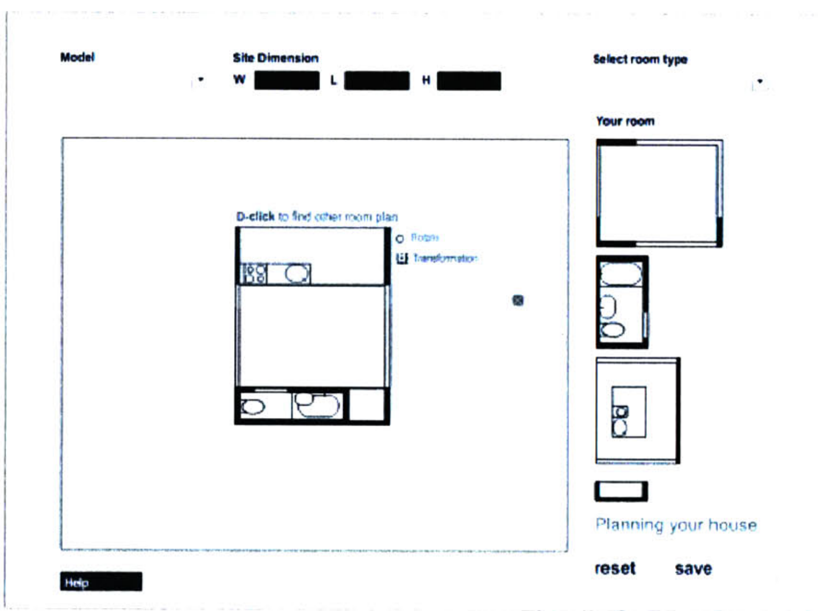


Figure 4.27 Application 1: Interface and design result

Application 2: Sequential guiding process

Purpose:

This interface focuses on how to lead users through the design process and use three-dimensional visual images to illustrate users' selection.

Implementation:

Adapted from an interface strategy from an online apparel store, this system enables users to customize their selected model through the professional design process. This illustrative interface provides visual simulation on the left side and customization tools on the right side. The visual simulation allows users to view their design product in five perspectives: 3D, plan, front, back and section, and enables them to zoom in on the visual image. The design process is divided into five sections as shown in figure 4. Users are required to finish each section before going to the next step.

Start: Users are required to provide project description, site information and number of floor requirements.

Planning: This step asks users to select their rooms using the tag system from the previous interface.

Design: This stage allows users to arrange their space by dividing room using wall or furniture, or adjusting their interior circulation.

Personalization: Focusing on decorating, this section enables users to select their furnishing and furniture, providing direct links to supplier online stores such as *IKEA, Muji* and *Nippon paint.*

Evaluation: This is a summary page that allows users to review their design selection.

Figure 4.28 Application 2: Interface and design result

Evaluation:

This system is developed from the professional perspective which constraint and suggestions are required during the design process. Moreover, the interface is too graphical and complicated for some users to comprehend. The same users from the previous evaluation are requested to use this interface to modify the provided housing model. Sixty percent of the users noted that this interface helps them understand the design process, and the 2D and 3D visual images help them understand their selection. However, many users are still not satisfied with their design result and complain that they cannot decide which choice to be selected.

Application 3: Design Decision-Making Tool and Selection Constraints

Purpose:

This application focuses on how to use users' preferences as a tool to modify their design products.

Implementation:

Using the sequential process to guide users through the design system, this interface retrieves users' information through the decision-making procedure. This system provides a series of questions that allow users to manipulate interior space and furnishing. These questions are adaptive to the answer from previous questions. This method allows users to generate a more result that is more responsive to their contexts.

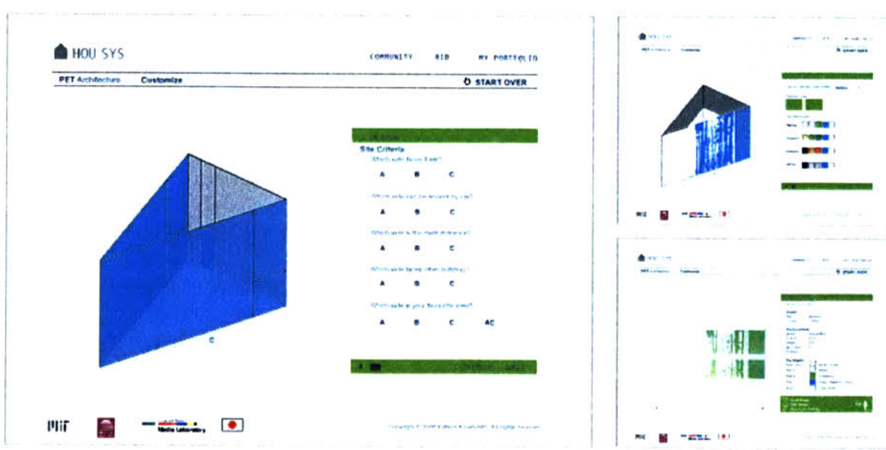


Figure 4.29 Application 3: Interface and design result

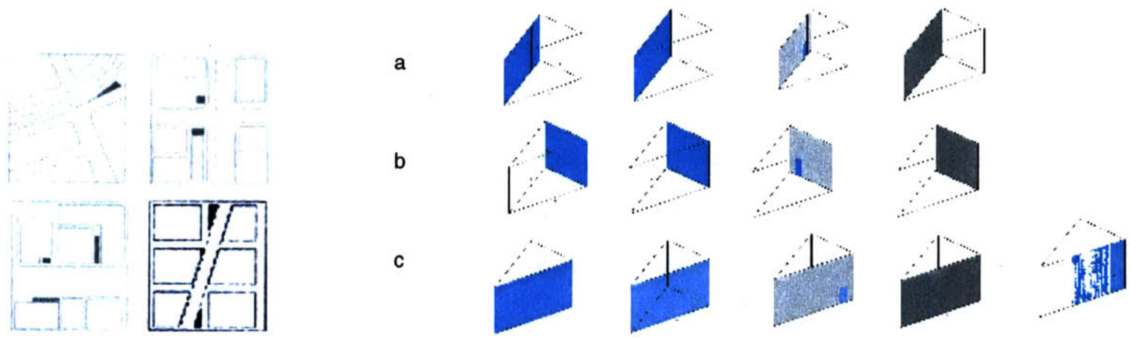


Figure 4.30 Site and façade typology. Left: Select model based on site shape. Right: façade parameters based on site accessibility, surrounding and utility connection.

Figure 4.31 Prototype model and variation. Left: Prototype model modified from *Billboard building, KDArchitects*. Centre: Façade alteration interface. Right: The variety combination of the screen façade and interior wall.

Evaluation:

The same users from the previous evaluation are requested to use this interface to modify the provided housing model such as the previous apartment unit or the *instant house*[12] originally designed by Marcel Botha. This method provides responsive results that fit to users' preferences and criteria and successfully eliminates complicated tool for non-experts. However, many users suggest that the system should provide visual images that simulate design ambient rather than a solid model. Moreover, the design results from this interface are very limited in variety due to the lack of design configuration.

[12] Botha, M. (2006). *Customized Digital Manufacturing: Concept to construction methods across varying product scales.* MS Thesis, Massachusetts Institute of Technology, Cambridge, MA, June 2006.

Application 4: Design Output Simulation

Purpose:

This application focuses on computational design system, design experience and how to incorporate visual and verbal interface throughout the design process.

Implementation:

Building on Duarte's and Ma's *Design engine*[13], this section developed a design system of mass housing in Shinagawa, Japan. This computational design system uses database of Japanese design typologies and users profiles from the above analysis for devising shapes, functional arrangements and parametric rules for the design configuration. This Tailor to Fit system is programmed entirely by Macromedia Flash MX and PHP, encoding design rules for the design configuration, and incorporating users' needs for customization into design process.

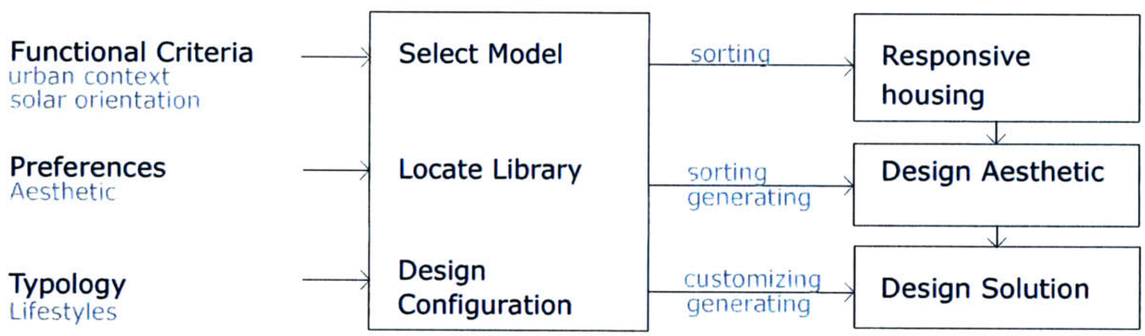


Figure 4.32 Design constraints

Interface: This computational design tool leads users through design process enables them to refine and explore designing and functional issues through the *scattered retrieval method.* This system develops a new way to retrieve the information by allowing users to provide their information by responding to decision-making questions and selecting preferred images.

[13] See section A. in Appendix.

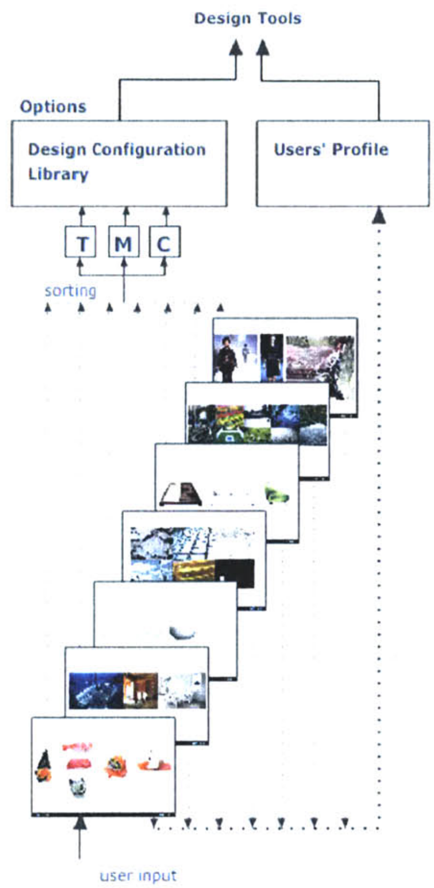


Figure 4.33 Preference sorting process. User selections identify design configuration library: traditional, modern, and contemporary, and are stored in the users' profile to be used during the design process.

This method helps create an incentive for users to follow the sequential step of the design process. This system allows respondents to manipulate visual image of the selected model as a means to express their taste and preferences and generate their design solutions. The tool is comprised of a decision-making interface with an extensive database layer that handles the library of design infill and configurations. The database correlates information to visuals and generates adaptive questions based on users' responses.

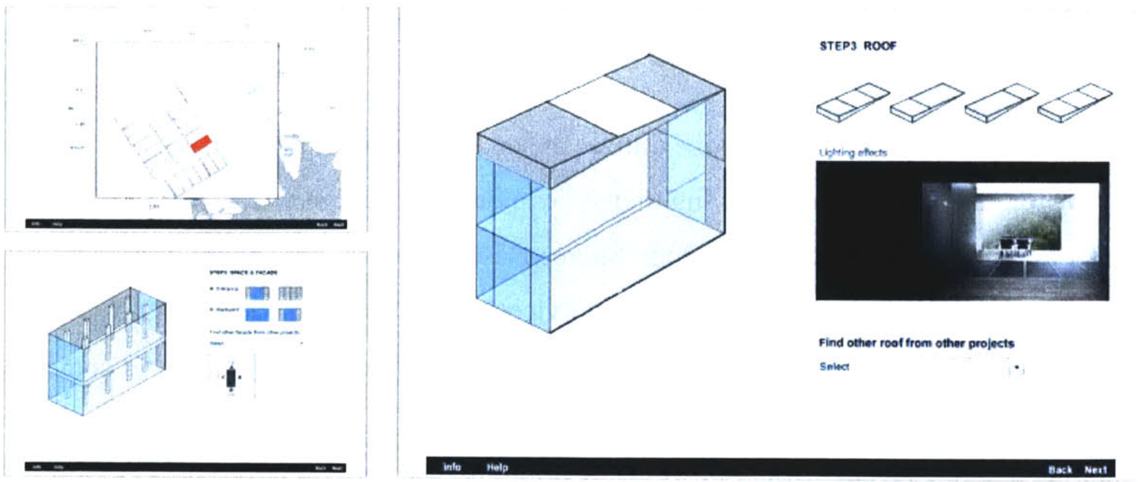


Figure 4.34 Decision-making design tool interface

Visualization: This application doesn't use 3D simulation system, but uses stilled images to show relationships and information. The simultaneously updated of the perspective view illustrates how the users' selection would be perceived through architectural shape, space, and furnishing. The application contains a custom design interface that directly links to the module library and communication channel.

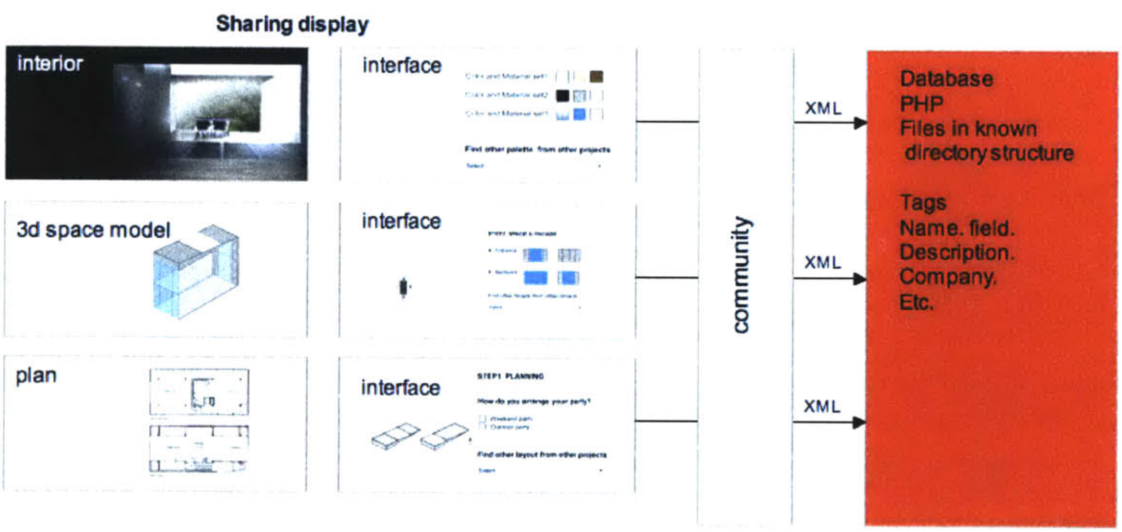


Figure 4.35 Interface Development and data and media management system

Evaluation:

This *Design iteration interface* utilizes the architectural components generated by user profile and preferences allowing them to explore their design alternatives. This application is a formulation of the Open Source Design Ecology that changes data to dialogue, and connects users to web based services and a shared resource infrastructure. The subject for the evaluation is divided into two groups: general audiences and control group. The general audience is a mass online user whom this system focuses on quantitative data deriving from observing the usability and accessibility of the system. The study of control group, homebuyers, manufacturers, architects, homebuilders, and interface and software engineers, focuses on verifying the core function of the system and collecting detailed qualitative feedback. The HOU.SYS system is put online for the user study and the elevation on December 10, 2006 (http://web.mit.edu/~kalaya/www/housys/). The evaluation of this application, done by both subjects, will be described in the next chapter.

**"Customers do not want choice.
They want what they want (and generally now)."**

Joe Pine, Markets of One

CHAPTER 5: **EVALUATION**

5.1 Evaluation

In order to transform this prospective resource community into a multiply generated platform for vendor access and democratic participation, this framework requires a full implementation from different professional practice industries. The collaboration among building experts and stakeholders, such as developers, commercial companies, corporate users, software engineers, private users, will establish a system that provides security, reliability, reusability, compatibility and standards for the future of the homebuilding industry. Moreover, the implementation of an economic model collaboration like that of *eBay* and *Paypal* is necessary to successfully motivate investors and providers to share their information database developing an effective and complete full service purchasing system.

The evaluation process for the fourth application consists of the qualitative and quantitative feedback from individual interviews with Japanese users, experts and developers. The interviews were conducted in three parts. After the brief discussion about an evaluator's background, experience and perception of the homebuilding industry, the embodied framework and website structure were presented through the slide show. After the demonstration, the evaluators were required to use the system with the assistance of others regarding their discipline and scenarios for the housing design. The *StatCounter*[14] embedded in the system tracked the flow of users and the final comments given by evaluators helped focus the discussion on strategy implementation, practical requirements and interfaces. The summary of the quantitative evaluation from different professional practice participants can be found as follows:

5.1.1 Customer
5.1.2 Manufacturer
5.1.3 Architect
5.1.4 Homebuilder
5.1.5 Interface and Software Engineer

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[14] *StatCounter is a web tracker for configurable hit counter and real-time detailed web stats.* [Resource: statcounter.com]

5.1.1 Customer

Table 6 The Summary of the Customer Evaluation

	Comments	Suggestions
Context	Informative online community for building industry	Strengthen the service, reliability, security reputation and trust
Design tool and Interface	Practical tool for the Japanese urbanize system such as cooperative consensus planning for local community development	Integrate more interactive system to enhance shopping experience such as *QR Code*[15]
		Explore building design and product solutions related to cost and practicality
	Benefit to tenant providers and mass volume buyers more than individual home owners	Develop scenario beyond lifestyles and find ways to categorize emotional value and product complexity
	Collaboration platform for landowners and leaseholders	Leverage the learning curve Providing instruction, tutorial
		Provide channel for real estate transaction and rent

Resource: Interview information from Kakeru Takenaga, Chieko Kudo, Minoru Ishigawa and Realtokyo estate (n=4) Image taken from barcodemobile.com

[15] *QR Code is a 'Quick response' two-dimensional bar code. It is commonly used in business cards and advertisements, and the most popular code for consumer oriented applications in Japan. Mobile telephone operators include QR Code reading software in camera phones for users to photograph QR Code decoding, manipulating and storing the information.* [Resource: barcodemobile.com, denso-wave.com]

5.1.2 Manufacturer

Table 7 The Summary of the Manufacturer Evaluation

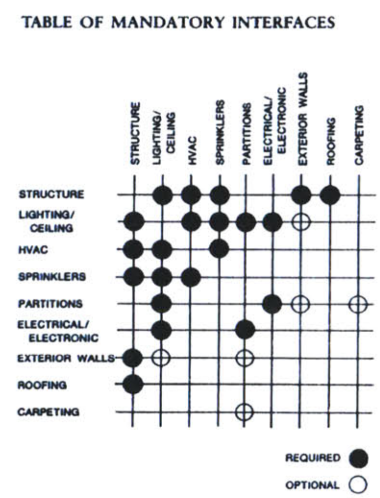
	Comments	Suggestions
Context	Standardization Database for building industry	Capitalize on different participants
Design tool and Interface		Provide analytical and provision service such as proactive dashboard for quick navigating and evaluation activities and products
Bidding and Manufacturing		Develop detailed outline for fabrication and manufacturing process such as installation sequences from hard structure and soft structure to connection component such as the connection of wiring or piping, partitions, and electrical appliances. 
		Develop a share platform for manufacturer database and component integration
		Diversify products and service interface for manufacturers and suppliers

硬い hard	軟らかい soft
木材 wood material	畳み・布・紙 *tatami, cloth, paper*
木材 wood material	塗り仕上げ plastered finish
金属建具 metal fitting	固まる前のモルタル・コンクリート mortar/concrete before hardening
現場で形が変えにくい difficult to change shape on site	現場で形が変えやすい easy to change shape on site
固まったコンクリート hardened concrete	木材 wood material
丁寧に仕上げられた材料 carefully finished material	仕上げをしていない材料 unfinished material
現場加工がしにくい difficult to work on site	現場加工がしやすい easy to work on site
敷居・鴨居 sill, head	和風の建具 Japanese-style joinery
サッシュの枠 window-frame	引き違いサッシュの障子 sliding *shoji* panels
量産されている既製品 mass-produced ready-made product	注文生産の部品 part made to individual order
製作期間が長くかかる部品 part requiring long manufacturing period	製作期間の短い部品 part with short manufacturing period
現場加工に応じない部品 part that cannot be worked on site	現場加工を強いられる部品 part that must be worked on site
現場調整のできない部品 part that cannot be adjusted on site	現場調整ができる部品 part that can be adjusted on site
強い strong	弱い weak

Resource: Interview information from Muji Ryohin-keikaku (n=1). Image taken from Yoshitika Utida, The Construction and Culture of Architecture Today: A View from Japan.

5.1.3 Architect

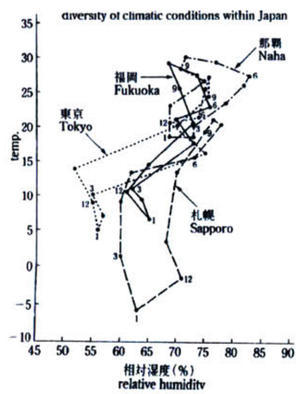
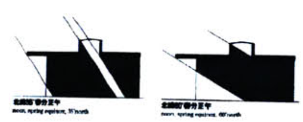
Table 8 The Summary of the Architect Evaluation

	Comments	Suggestions
Context	Career opportunity especially for freelancing benefits Can be the next development for 9-tsubo moving from mail order service Promote selling and purchasing	Increase autonomy, motivation, and creativity
Design tool and Interface		Develop complex customization logic Move from layout planning to space and system configuration  Decrease constraints and enhance creativity Go beyond brand and fashion architecture to reputation and pricing strategy

Resource: Interview information from Manabu Miyake (n=1). Image taken from Yoshitika Utida, The Construction and Culture of Architecture Today: A View from Japan.

5.1.4 Homebuilder

Table 9 The Summary of the Homebuilder Evaluation

	Comments	Suggestions
Context	Modularity	Create coordinating mechanisms such as contracts,
	Understand customers' buying objective and cultural integration	Understand the potential value of customers and prompting firms to learn more about the patterns of individuals or groups of customers.
	Expand distribution opportunity	
Design tool and Interface		Establish testing and quality assurance
		Geographically group Japanese residential homebuyers to develop products regarding difference in climate and natural features
		
Bidding and Manufacturing	Establish system for performance and construction evaluation	
	Establish future relationship with other building stakeholders for a practical network	
	Increase sales and help offset the direction for product design and development	
		Develop product line and catalogs for change in taste, renovation or seasonal celebration
		Develop detailed construction management tied with existing software to increase the practicality of the system

Resource: Interview information from Misawa (n=1). Image taken from Yoshitika Utida, The Construction and Culture of Architecture Today: A View from Japan.

5.1.5 Interface and Software Engineer

Table 10 The Summary of the Interface and Software Engineer Evaluation

	Comments	Suggestions
Context	Adopt authentication services and embedded technologies	Develop transparency, flexibility, and playful interface
Design tool and Interface	Easier to navigate the structure content and express the minor trend of the new designers' practicality approach	Develop a platform for different initiators: individual, group, and institute
	An alternative housing market and implementation for building design and performance evaluation	Efficiently integrate community for peer production: not only provide an access but detail on how to assist
	Decision making tool (dialogue) enables non-experts to decide quickly and efficiently	Study *MONEYKit* by Sony Bank, an online service specifically developed for different interests. Its tool kit consists of service section for investors, enabling them to visualize numerical data, do the interest calculations, and track balances of incoming and outgoing project accounts
		Study *CUUSOO* system, a participatory design development visualizing the intangible element of consumer preferences. This system enable users to monitor their preference and dislikes for making purchasing decision
Bidding and Manufacturing	Enabling homebuyers and building participants to solve design conflicts online	Develop interface from other participants' approaches such as financial progressive system for manufacturers or homebuilders

Resource: Interview information from IIDj Institute of Information Design Japan (n=1). Image taken from Yoshitika Utida, The Construction and Culture of Architecture Today: A View from Japan.

5.2 Open Source Building Alliance Constraints and Considerations

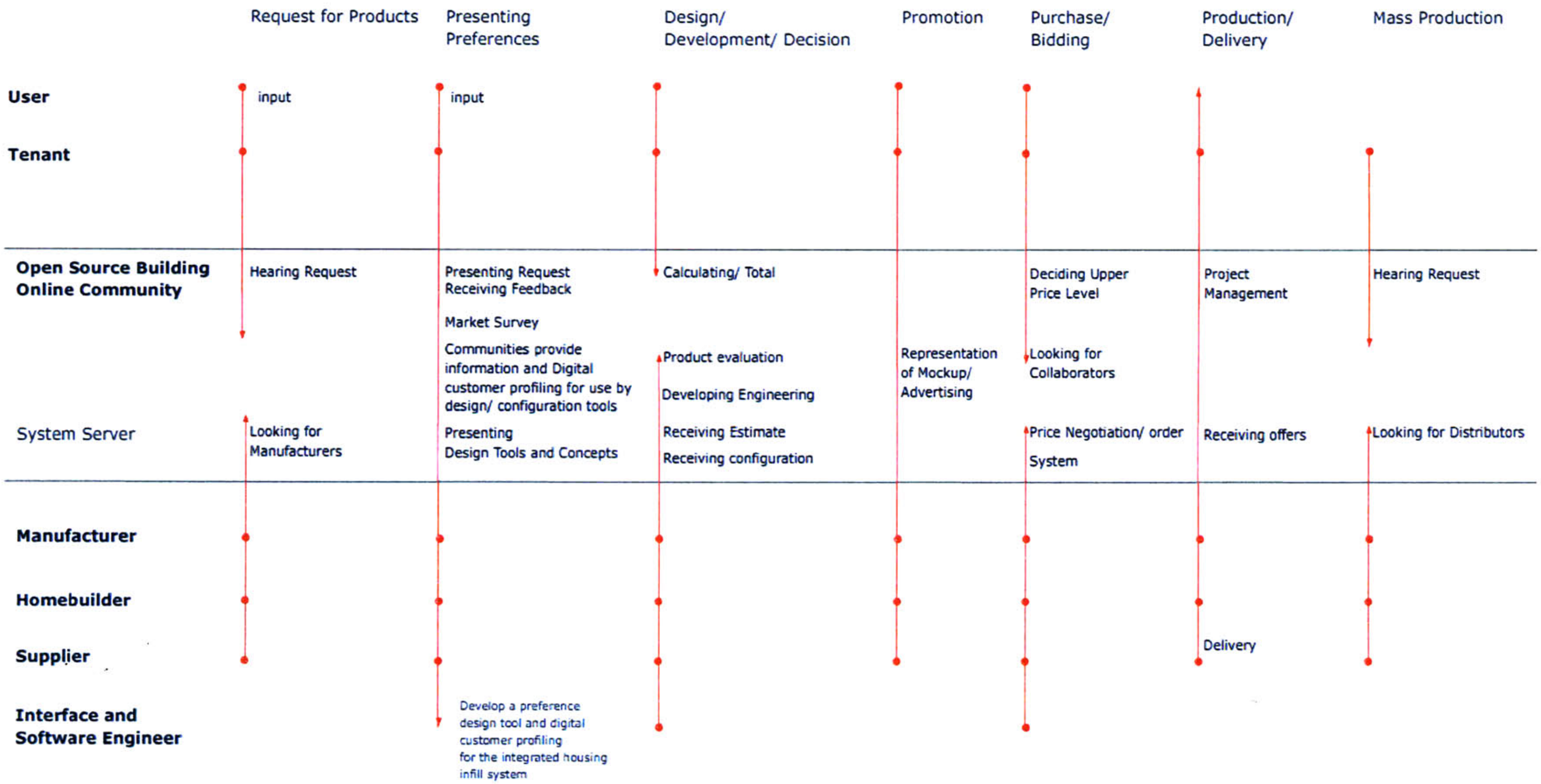


Figure 5.1 Open Source Building Alliance constraints and considerations

5. 3 Success and Failure

This interdisciplinary online platform is still at the early stage of development. It requires extensive collaboration and data collection to test the usability of the system and successfully implement this system to the real world practice. There is yet a detailed outline for the bidding and project management process, or a detailed outline for the community page specifically developed for homebuyers and building industry in order to share standardization, knowledge, and information, and initiate creativity. As a result, most of the users end up using this online community as a web-based resource, and cannot evaluate the collaboration or the efficiency of the system. However, this system can evaluate users' interest and how to develop a platform regarding their discipline by using *Statcounter* to track users' traffic. This method numerically visualizes users' responsiveness to this online environment by analyzing users' navigating behavior and how they utilize this community.

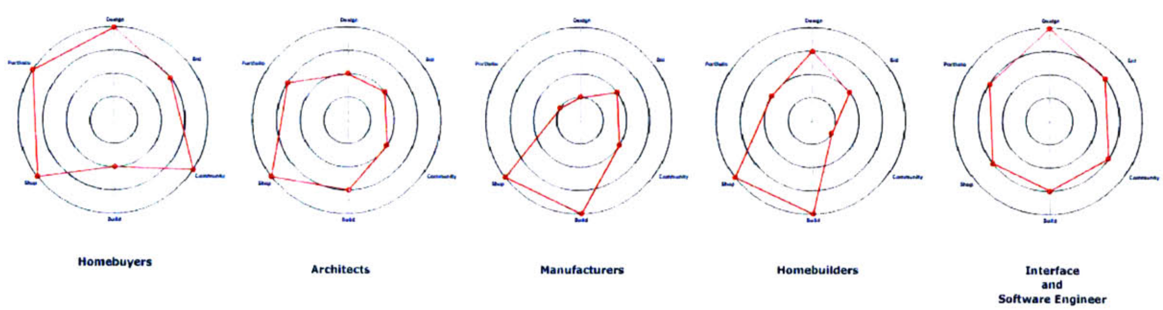


Figure 5.2 Quantitative accessibility analysis. Data retrieving from *Statcounter*

The quantitative evaluation result identifies individuals' interest from different perspectives. Homebuyers spend one hour to explore the whole web-based service while manufacturers only spent 15-20 minutes. Figure 5.2 illustrates the comparative result of navigation behavior from different disciplines through the main structure of the online platform: design, bid, build, shop, portfolio, and community. Homebuyers' navigation behavior is more spread to every section and they are more willing to participate and explore the system. All of them prefer to use the bid page to find their collaborator rather than using the build page to manually find builders for their designed project. Homebuilders are more concerned about choice and alternate criteria: feasibility, service standard, size, product characteristics, and lifestyle.

Architects use this online service as their design resource. They enter the **shop page** to find and buy products such as furniture or material for design specifications, and enter the **build page** to find information about builders. Unlike homebuyers, 75% of architects who use this system prefer to find their collaborator through a manual system. Moreover, architects only browse the **design page** to get design ideas rather than go through the design process and utilize the design tool.

Manufacturers and homebuilders are interested in trade-offs between service and cost, and manufacturing and assembly. Typically, 90 % of manufacturers and homebuilders are interested in the practicality of the system. They visit the **shop page** and **build page** to gather information for their product development, and use the **bid page** to find jobs and approach their potential customers. Manufacturers and homebuilders are more concerned about market surveys, promotions and advertising, and are less interested in the design and community section.

Interface and software engineers' behavior is also spread throughout the system. However, unlike homebuyers, they are interested in the practicality of the interface development rather than designing and building the product. The evaluators also suggest additional developments of choices for system, structure, material, and delivery.

In conclusion, this system successfully guides homebuyers to go through the design process even though they are not convinced enough to use this system to design and built their real home. Furthermore, manufacturers and homebuilders show a lack of interest in the system service, which can be solved by developing a platform regarding their interests and the applicable system for their existing organizations.

CHAPTER 6: **CONCLUSION**

6.1 Conclusion

This thesis presents a new practice environment for mass-customized housing industries. It introduces a system framework comprised of four influential e-business models- Dell, Open Source, *iTunes*, and *eBay* - for support of individual and collaborative activities. These models provide the foundation for revising perceptions of customer interaction and redefine the relationship that exists between the building industry and participants. The augmentation of four e-business models not only helps assist consumers through the design-build process enabling Internet technology, design and construction advancement to meet changing of the individual needs, but also initiates the marketing channel from providers to customers. Moreover, the analysis of the art in agent-mediated retail electronic commerce suggests a new integrative negotiation approach to the Open Source Building Community to satisfy customers' individual needs resulting in efficient home design and buying experiences.

The value of information, the role of technology, the advancement of fabrication and production, and the customer initiative are the critical factors for individualization. Demonstrations were used to illustrate the mechanism and generate housing design variation. The result of the interface experiment indicates that the design application interface is merely a dialogue between consumers and providers to gather information and transform it into an architectural knowledge representation. Consumers do not require comprehensive Computer Aided Design (CAD) systems, but rather interactive interfaces with communication channels to simulate and explore selected features of the product in response to information input and geographical constraints. The result also reflects that the integrated business framework can help housing businesses to efficiently and effectively acquire the information they need for architecture and architectural product design and development providing an appropriate method for carrying previous experiences and expertise into new design practices.

6.2 Future Work

The proposed framework was developed to demonstrate the integration of suggested e-business models and illustrate the flow of information and activities by various users. This project framework, which ties together roles processes and tools to introduce a new way of marketing buildings, is still in an abstract level, and does not provide descriptive detailed procedures for this online community management. The design application only focused on product interface differentiation and how to retrieve information that is critical to the design process. To expand the capacity of the system, this interdisciplinary system requires real world collaboration and extensive data collection to be tested by representatives from a variety of disciplines.

This extensible framework is designed to offer advices beyond this online community aspect for studying housing industry behavior through online processes. Future opportunities for this new process speculation can be investigated in many different prospects to explore its potentials and limitations such as:

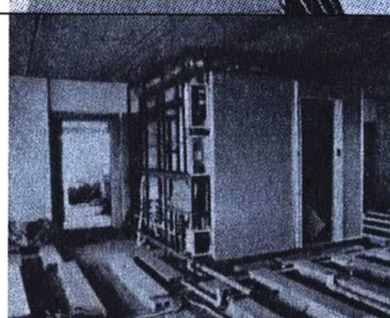
- The development of intelligent agents and detailed outlines from other building participants' approach that reinforce collaboration, creativity, and enable users to effectively iterate and modify product options offered,
- The development of non-expert computational design mechanism that capture design intention and physical conditions that designers encounter in the design process,
- The development of structural design and performance analytical function,
- The integration of bidding systems, communication services, and available software such as BIM, *QR Code* and auction software, making this framework practical, profitable and seamlessly enhancing shopping experience,
- The geographical implementation expanding this system to other potential homebuilding industries in the Asia-Pacific region such as China, Korea and Thailand.

These features will enhance usability and distinguish the Open Source Building Ecology from a conventional website, and will establish a social platform for operational standardization that connects the digital to the physical world.

APPENDICES

APPENDIX A: **GLOSSARIES**

Japanese Housing Technology

	Image	Purpose	Description
ECP		Developed for urban housing	Composed of sub-systems such as interior walls, exterior walls, and storage units. Provide Open components such as the kits of components and parts limited to particular project **Advantages** Efficient use of site, freedom of design and lower cost
SK		Developed through the association of volumetric unit makers, PC panel makers, and steel makers	Provide various designs by the provider **Advantages** Fast construction
SAP		Developed for high-rise housing developments	Composed of closed component of kits and parts system **Advantages** Utilize new building technology such as GRC walls and panels, and prefabricated core units
KEP		Developed for public housing projects	Composed of sub-system development by different manufacturers under the authorization of the KJ and BL (Buhin nintei seido) **Advantages** Efficient for repetitive production
ASTM		Developed for high-rise public housing	Composed of closed component of kits and parts system Concrete prefabrication

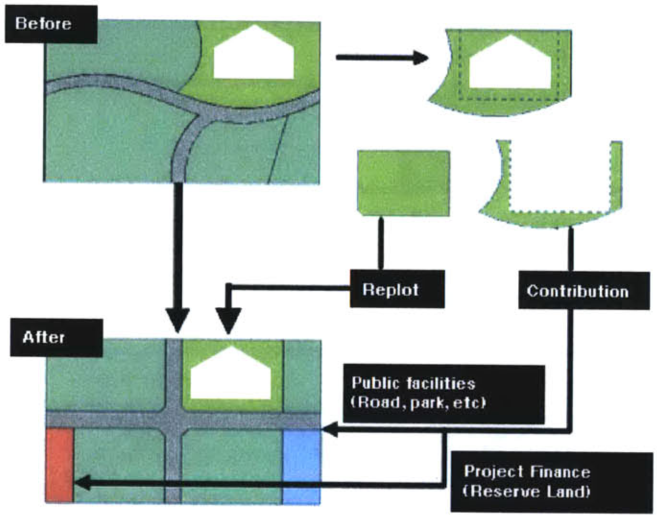
Resource: Yoshiko Ryu, Alternative Housing Designs for Changing Life-Styles in Japan.

Japanese Leading Companies Comparative Diagram

Company	Segment	Service
Shimizu Corporation	Construction and development of real estate	The group's operations are divided into three business categories: construction, real estate development, and other businesses. Other business includes sale and leasing of construction equipment and the provision of financial services
Kajima Corporation	Construction company	Ranging from builds offices, industrial plants and various infrastructures
Taisei Corporation	Construction and civil engineering firm	Ranging from corporate offices, airport terminals and sports arenas to dams, bridges and power plants, as well as homebuilding
Daiwa House Industry	Construction company	Construction of apartment, office buildings and large-scale residential developments. The company also involved in construction of barrier-free housing for elderly and disabled, wooden housing, and medical and nursing care facilities. Daiwa also manufactures, sells, and distributes construction materials.
Sekisui House	Largest homebuilders in Japan	Construction, sale, purchase and administration of residential properties: the design, execution, contracting and supervision of construction projects: real estate brokerage; and landscaping
Misawa Homes Holdings	Homebuilder	Engage in various forms of home building, including both custom and lot- subdivision builds.

Resource: Datamonitor, Homebuilding in Japan.

Japanese Landfill
Japanese landfill become more regular shape and easier to utilize and equip with the necessary public facilities due to the Japanese land readjustment project (Kikaku-Seiri). This urban development project uses an urbanized technique that aims to improve public facilities and community by dividing and exchanging land parcels for altering lot shapes and land conditions.



Resource: Hohn, U. (2000), Stadtplanung in Japan: Geschichte – Recht – Praxis – Theorie.

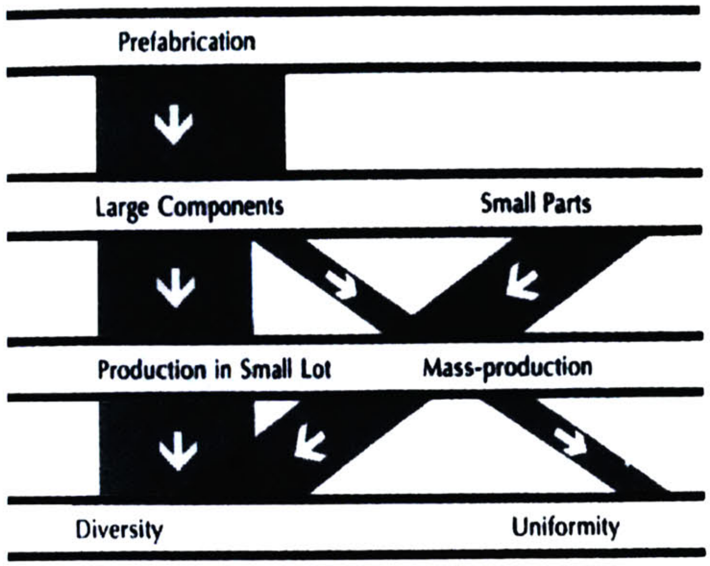
Open Source Building Alliance

OSBA is part of the Open Source Building projects developed by House_n research group and changing places consortium at MIT's school of Architecture and planning. OSB takes advantage of the inexpensive computation, almost-free electronics, the Internet, wireless communication, high-performance materials, and new design, fabrication, and supply-chain technologies. This approach will lead building industry to the new way of building, chassis, infill, and integrated technologies, and designing, tools for non-expert designers. OSBA establishes a pre-competitive forum at MIT for a broad range of industrial stakeholders and academic researchers to develop key elements of an "Open Source," modular component approach to creating high-value, responsive, and mass customized. The goals of OSBA are:

1. *Develop Open Source Building as a model for cross-industry participation in mass-customization of places of living and its related products, technologies, and services.*
2. *Establish a bridge between MIT/ national laboratory research and industry in the area of next generation building design and technology.*
3. *Exploit existing process/ technology transfer opportunities form other industries that relate to building design and technology.*
4. *Develop the Open Source Building model as a pathway for companies outside and inside of the building industry (technology companies, new material manufacturers, etc.).*
5. *Focus on solutions that address multiple problems simultaneously (i.e. a common sensing and networking infrastructure for energy management as well as proactive, preventative healthcare-solution that scale from commercial to residential buildings)*
6. *Expose industry and the public to next-generation building design and technology concepts. (through publication, broadcast media, exhibitions, etc.)*

Taken from MIT Open Source Building Alliance White Paper, House_n research group and Open Source building- reinventing places of living, Larson et al., 2004

Prefab
Prefab is a short form for prefabrication. It is the construction method that the building is pre-assembled in the factory or manufacture and transport to the site rather than constructed on-site by conventional methods. This industrialized building method provides economically products and transforms housing construction and development adapting to diversification.



Prefabrication and mass production diagram
Taken from Yoshitika Utida, The Construction and Culture of Architecture Today: A View from Japan.

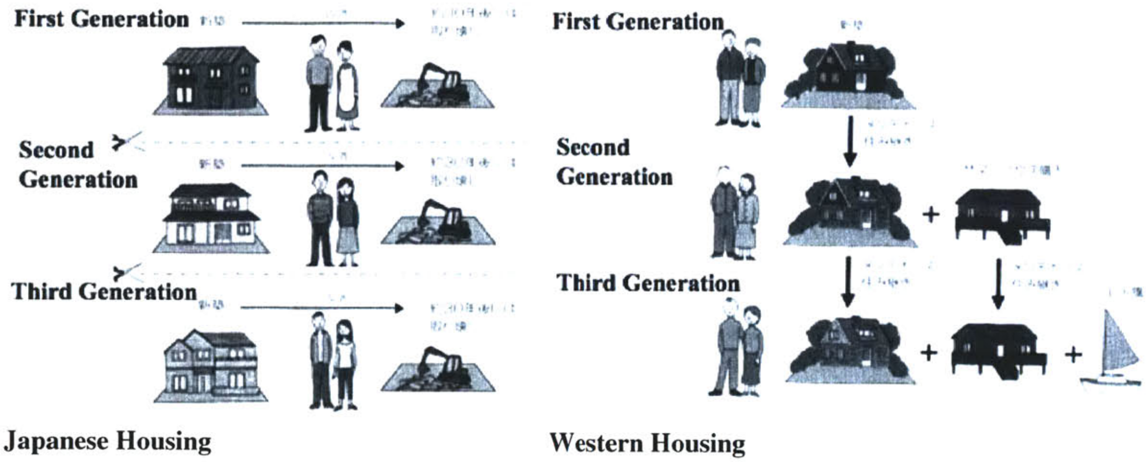
Prefab in Japan
Prefab house is statistically popular among single-family homebuyers because its inexpensive cost, fast and reliable construction, and design variation.

Japanese Housing Types in Private Ownership Related to Acquisition and Construction Types

Type	**Housing Type**		**Acquisition**		**Construction Type**	
	Occupancy	**height**	**House**	**House with site**	**Prefab**	**Conventional**
Condominium	Multi-family	More than 4 stories	Yes	Occasionally Yes	Yes	No
Spec-house	Single family	1 or 2	No	Yes	Yes	Yes
Prefabricates house	**Single family**	**1 or 2**	**Yes**	**No**	**Yes**	**No**
Conventional house	Single family	1 or 2	Yes	No	No	Yes

Resource: Yoshiko Ryu, Alternative Housing Designs for Changing Life-Styles in Japan

Moreover, The nature conditions in Japan such as earthquake, and limited land cause the demand in impermanent building resulted in Japanese housing construction behavior and value.



Housing construction behavior and value in Japan compare to western
Resource: Ministry of construction.

Tools for Non-Expert Designers
House_n research group's approach to design decision making for non-expert designers involves four integrated components.

1. Preference engine
This takes people through a series of exercises or games to uncover needs, preferences, values, and reasonable trade-offs. The preference engine builds a user profile that includes family size, budget, aesthetic values, and range of activities.

2. Design engine
The architectural program generated by the preference engine is used to create a starting point design that the 'designer' (i.e. the future homeowner) then refines.

3. Design iteration interface
Using one of many possible design iteration interfaces, customers can experiment with design alternatives, and evaluate a complex mix of attribute including form, finishes, light, cost appliances, performance, durability, technologies, and services.

4. Computational critics
While iteratively exploring a design solution, most non-expert designers will require feedback from experts related to best practices, building codes, and design integrity. Computational critics can provide feedback to the user as incremental changes are made to the design.

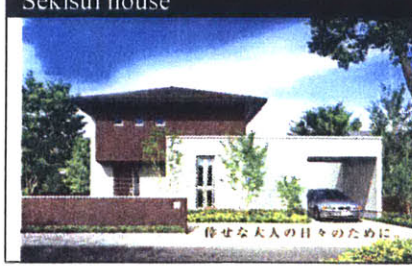
Taken from MIT Open Source Building Alliance White Paper, House_n research group and Open Source building- reinventing places of living, Larson et al., 2004

APPENDIX B: **CONTACT INFORMATION**

This is the list of Japanese prefab products that are available for purchase and are actively marketed as a product solution by vendors or architects.

Vendor/Designer	Project name	Contact information
9tubohouse		
	9-tsubo house Tall NUDE (2006) 9-tsubo house kinoco (2005) 9-tsubo house basic (2004) 9-tsubo house kyoheya (2004) 9-tsubo house CELL (2004) 9-tsubo house Tall (2002) Garage house (2002) 9-tsubo house Senior (2002) Collector house (2002) FUZEI (2002), more	http://9tubohouse.com Boo-Hoo-Woo.com 03.5765.5300
Actus		
	ACTUS LABO reform SEKISUI HOUSE x ACTUS Asobu house	http://www.actus-interior.com
Asahi-Kasei		
	Hebel Haus™ Hebel Maison™	http://www.asahi-kasei.co.jp/hebel 03.3344-7115
Bigfoot		
 	BIGFOOT	http://www.bigfoot.jp/ 03.3462.7000

Daiwa		
 	EDDI's house	http://eddishouse.com 0120.590956
Sxl		
 	MINCA New Authent Vit	http://www.sxl.co.jp/ 0120.58.5501
Misawa		
 	Magic house HYBRID BLANC Chikyujin house MACHIYA	http://misawa.co.jp/ 03.3349.8088

Sumitomo Forestry		
 	MyForest	http://sfc.jp/ie/ 0120.21.7555
Muji+Infill		
 	Wood house	http://www.muji.net/infill/ 0120.196.404
Sekisui heim		
	bj plus Connect unit	http://www.sekisuiheim.com 0120.369.816
Sekisui house		
	Natura IORI (2006) IS ORDER series Be ECORD series SHEQAS	http://www.sekisuihouse.com 03.5575.1740

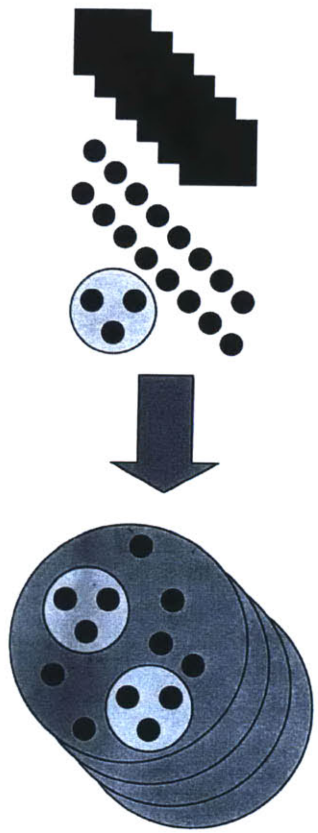
Sustainable Design Laboratory		
 	PAPI (Toyota) Euhouse (Panasonic)	03.5575.1740
Toyota		
	PAPI (2005) SINCÈ series ESPACIO series	http://www.toyotahome.co.jp/lineup/index.html 0561.64.2612
Panasonic		
	Euhouse (1990)	http://panasonic.co.jp/euhouse/ 03.3599.2600

For prefab product in USA, UK and Europe, please visit:

Fablist http://www.fabprefab.com
Housing Prototypes http://housingprototypes.org/

APPENDIX C: IMPLEMENTATION PROCESS (Enlarged Diagram)

House_n MIT Open Source Building Alliance



Manufacturers

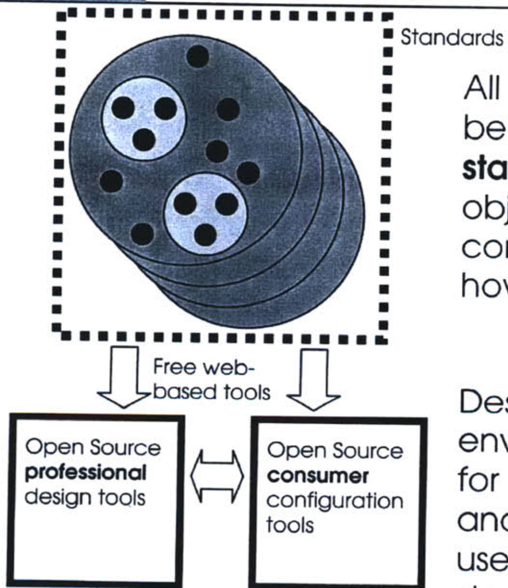
Make products
(mostly commodities,
but some assemblies)

In the future, you will
have many integrators
that bring together
products and services
to create branded
lifestyle offerings
(Virgin Homes??)

Dell Model

APPENDIX C: **IMPLEMENTATION PROCESS** (Enlarged Diagram)

House_n MIT Open Source Building Alliance



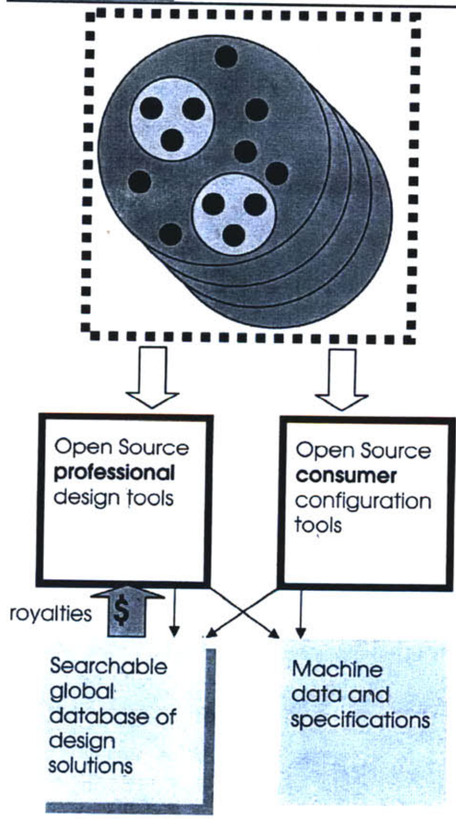
All integrators would benefit from industry **standards** for how objects are described computationally, and how things connect

Open Source Model

Design & configuration environments evolve for both professionals and consumers that use real products described in standard ways.

APPENDIX C: IMPLEMENTATION PROCESS (Enlarged Diagram)

House_n MIT Open Source Building Alliance



All integrators would benefit from industry **standards** for how objects are described computationally, and how things connect

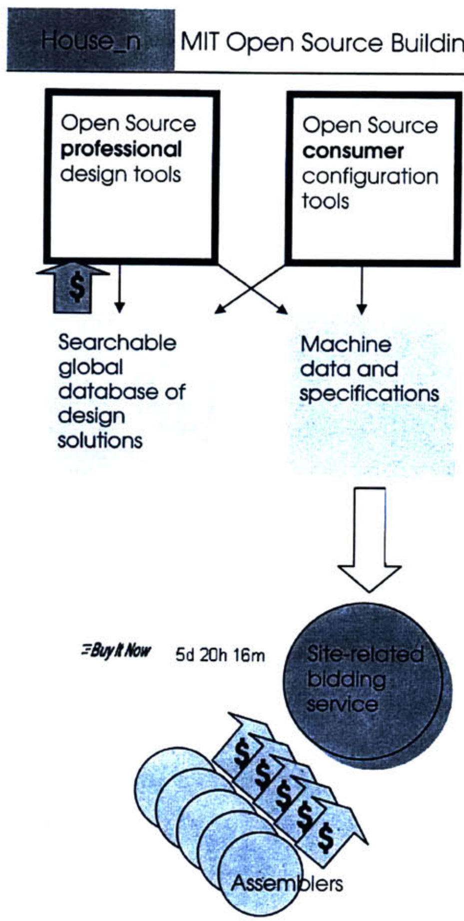
Open Source Model

And design & configuration environments for consumers that use real products

A database of design solutions grows exponentially – linked directly to manufacturing and product specifications

iTunes/Napster Model

APPENDIX C: IMPLEMENTATION PROCESS (Enlarged Diagram)



Assembly specifications are posted on an bid site where highly skilled assemblers and specialists (evolved from builders) post bids

for local site work/assembly/testing/ etc.

(Reverse) eBay Model

APPENDIX D: **QUESTIONAIRE**

MIT 建築計画学部
このアンケートはオープンソースアライアンスのウェブサイトのために役立てられます。

セクションA： プロフィール

1．国籍
- ☐ アメリカ系日本人 ☐ 日系アメリカ人 ☐ 日本人

2．性別
- ☐ 男性 ☐ 女性

3．既婚/未婚
- ☐ 未婚であり、誰とも交際していない
- ☐ 未婚であり、交際している人がいる
- ☐ 既婚

4．年齢
- ☐ 20歳未満 ☐ 20-29歳 ☐ 30-39歳 ☐ 40歳以上

5．職業
- ☐ デザイン関連 ☐ その他

セクションB： 行動

1．将来的に自分の家（マンション含む）を持ちたいと思いますか？
- ☐ はい ☐ いいえ ☐ たぶん持つ

2．もち持ちたいのならば、いつ持ちたいですか？
- ☐ 今年中に
- ☐ 2-5年以内に
- ☐ 5年後以降に
- ☐ まだわからない

3．どのようなタイプの家を持ちたいですか？
- ☐ マンション、アパート
- ☐ リフォーム済み中古物件
- ☐ 新築一軒屋
- ☐ その他______________________________

4．どのようにしてその家を手に入れますか？
- ☐ 住宅メーカーの建売のものを買う
- ☐ 不動産業者から買う
- ☐ 個人的に建築家に依頼する
- ☐ その他______________________________

5．家のサイズ、場所、また土地代以外で、以下のどの要素が家を買うとき一番重要ですか？
- ☐ 業者の顧客に対するサービスの質
- ☐ デザイン
- ☐ エネルギー効率への配慮
- ☐ 機能性、質
- ☐ 価格
- ☐ 時間
- ☐ そのた＿＿＿＿＿＿＿＿

6．家を買うのにいくらくらいのお金を使いますか？（土地代を除く）
☐ 25万ドル未満　☐ 25万 -50万ドル　☐ 50万ドル以上　☐ わからない

7．どのくらいの期間で家が完成してほしいですか？
☐ 3-5日　☐ 1-2週間　☐ 1-3ヶ月　☐ わからない

8．プレハブハウスについてきいたことがありますか？
☐ はい　☐ いいえ　☐ 多分

9．そのようなスタイルの家が好みですか？
- ☐ 伝統的な日本風
- ☐ シンプルで清潔な現代風
- ☐ 欧米風
- ☐ ハイテクを用いたスタイル
- ☐ その他＿＿＿＿＿＿＿＿

10．あなたは以下の企業を知っていますか？
- ☐ 清水建設株式会社
- ☐ 鹿島建設株式会社
- ☐ 大成建設株式会社
- ☐ 大和ハウス工業株式会社
- ☐ 積水ハウス株式会社
- ☐ ミサワホーム株式会社
- ☐ その他＿＿＿＿＿＿＿＿

11．あなたは建築家によって自分の家をデザインされたいですか？
☐ はい　☐ いいえ　☐ 多分

12．もしそうであれば、あなたは以下の建築家の名前を知っていますか？
☐ 青木淳　☐ 隈研吾　☐ 妹島和世
☐ 坂茂　☐ 安藤忠雄　☐ 伊東豊雄
☐ その他＿＿＿＿＿＿＿＿

13．家を買う、または立てる場合、以下のうちどのような要素があなたを左右しますか？
- ☐ 同僚や職場の勧め
- ☐ 住宅メーカー
- ☐ 仲介業者、不動産業者
- ☐ ショウルーム
- ☐ 雑誌やカタログ
- ☐ あなた自身で決める

オンラインショッピング

1. あなたは普段オンラインショッピングをしますか？また、それはどのサイトですか？
   □ はい　　□ いいえ　　サイト：＿＿＿＿＿＿＿＿＿＿

2. 今までオンラインショッピングで買った一番高いものは何ですか？またそれはいくらでしたか？
   ＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

3. あなたは今まで、自分のためのカスタマイズをしてくれる商品（コンピュータ、車、服等）を扱っているウェブサイトに行ったことがおりますか？
   □ はい　　□ いいえ　　□ わからない＿＿＿＿＿＿＿＿

4. もし住宅業者が家をオンラインで売り出したら、あなたは買いますか？
   □ はい　　□ いいえ　　□ 多分＿＿＿＿＿＿＿＿

5. もしオンラインオークションで家が売り出されたら、あなたは買いますか？
   □ はい　　□ いいえ　　□ 多分＿＿＿＿＿＿＿＿

6. もしあなたの家をオンラインでカスタマイズでき、その家の請負業者を探してくれるウェブサイトがあれば、あなたはそのサイトを家を作るために使ってみたいですか？
   □ はい　　□ 多分　　□ いいえ＿＿＿＿＿＿＿＿

7. 上の質問で、「はい」か「多分」と答えた人は、そのようなサイトについて、以下の要素をどのように順番付けしますか？
   □ 基本建築モデル：スタイルやパターンのバリエーション
   □ 個人の好みに合わせるディテール：色の選択、細部のディテールの選択
   □ サービス：専門家の助言
   □ 価格：予算の算出
   □ 信頼性：ウェブサイトの評判、会社の有名度、資格証明書
   □ プロモーション：広告
   □ その他＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

ご協力ありがとうございました。

何かお気づきの点がございましたらご記入ください。

日付　　　　　　　　　　場所

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