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Integrating New and Innovative Design Methodologies at the Design Stage of Housing: 'How to go' from Conventional to Green

I. Spanos, K. Holmes

Kenneth Holmes Associates - Chartered Architects,
Coventry, UK
e-mail: i.spanos@coventry.ac.uk, kenneth_holmes@tiscali.co.uk

M. Simons

School of Science and the Environment,
Coventry University, Coventry, UK

R. Hall, K. Chapman

Hall Bros - Construction - Development – Property,
Coventry, UK

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Abstract
Housing design, both architectural and engineering, is a complex and interrelated set of activities. Much has been written about how the design process works both in theory and in practice. Conventionally, there is a well-developed concept, which conceives the process as a basically linear series of steps contained within a total context or framework. The central design core consists of the key stages of investigation, generating ideas, synthesis, construction, and then evaluation. The synthesis stage is important; this is where all the technical facets of the design are brought together and formed into a 'final product design specification'. The design core is enclosed within a boundary, containing all the other factors and constraints that need to be considered. This is a disciplined and structured approach to the design process. It sees everything as a series of logical steps situated between a beginning and an end. The proposed design model sees the design process as being also circular, or cyclic, rather than strictly sequential. The process goes round and round, continually refining existing ideas and generating new ones. This activity is innovation based. However, every new construction project is unique. The main elements of the ''creativity-evaluation'' process, is the judgment of the lateral thinking, and the choice of channels for transferring knowledge to team individuals. This paper describes, and evaluates, the approaches taken to achieve the change. It provides information in 'how to go' approach a design procedure in order to most efficiently transfer most sufficiently new knowledge to the team. The model has been tested for an environmental friendly housing project, but it could be easily adopted for other new types of construction processes.

1 Introduction

Even if sustainability has always been integrated in architectural design, latest European Union regulations (2003) [1], and client needs, require a move from the strictly conventional buildings to buildings with innovative designs, which shall be designed within an environmental consciousness procedure. For the UK housing and building industry that is a radical change. Egan (1998) [2] recognized the need of the UK construction industry to be informed by experiences of radical change and improvement in other industries, and by experience of delivering improvements in quality and efficiency within programs. In contrast to construction industry, manufacturing, information technology, and genetics industries have been continually regenerated through innovation.

According to Rothwell & Wissemann (1986) [3] an innovative product is one that is distinguished from previous ones by its uniqueness in form, function, or behavior. Innovations generally fall into two categories: fundamental and adaptive. A fundamental innovation results in a new product or process, and is one that is not thought to be required prior to its introduction. An adaptive innovation is one that is need generated. For housing design process, innovation will fall between the above categories. Von Oech (1998) [4] clarifies how innovation has always been a major ingredient to developing technology or advancing technology, or both. The aim of this case study is to examine if a conventional housing project can be developed, and then advanced to be "sustainable", through innovation in the design stage.

This paper describes, and evaluates, approaches taken to achieve innovation and change in the design stage of housing. This study forms part of the Department of Trade and Industry (DTI) of United Kingdom sponsored Knowledge Transfer Partnership between Coventry University and Kenneth Holmes Associates Chartered Architects of Coventry.

2 Existing Design Procedure and Its Limitations

Housing design, both architectural and engineering, is a complex and interrelated set of activities. Much has been written about how the design process works both in theory and in practice. The construction of every new building is a technical complex system, equivalent to the production of a car prototype from the automotive industry.

Conventionally, there is a well-developed concept, which conceives the process as a basically linear series of steps contained within a total context or framework. The central design core consists of the key stages of investigation (i.e. development of the brief, research), generating ideas, synthesis, construction, and then evaluation. The synthesis stage is important; this is where all the technical facets of the design are brought together and formed into a 'final product design specification'. The design core is enclosed within a boundary, containing all the other factors and constraints that need to be considered. This is a disciplined and structured approach to the design process. It sees everything as a series of logical steps situated between a beginning and an end. A schematic representation is shown in figure 1 on the next page.

The conventional design procedure has limited innovation dynamics due to the rigidity of its boundaries between its subgroups. To further support the need for creativity in the design of complex technical system we could learn from other innovating industries such as the "information technology" and "manufacturing" industries.

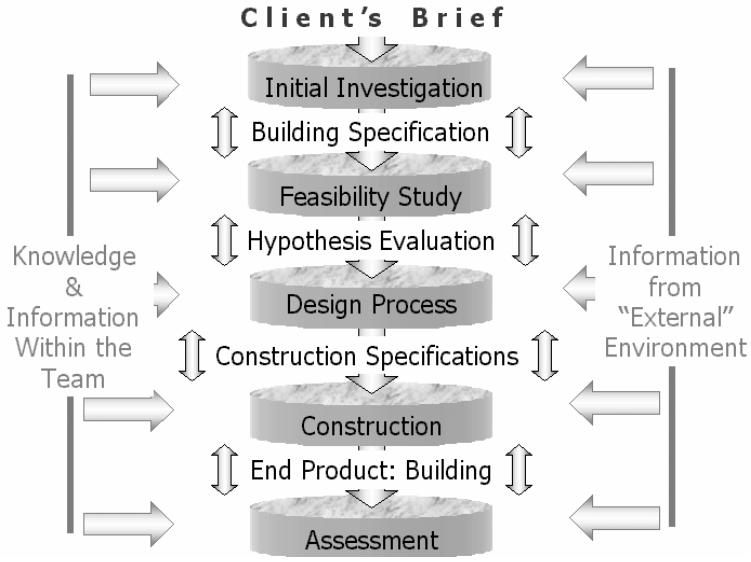

Figure 1- Conventional Design Procedure of a Housing Project

3 Proposed Design Procedure

Although companies and organizations recognize the fundamental importance of innovation to their continued survival, it is often treated as secondary subject about which little concrete can be said. We will quote Lobert's & Dologite's [5](1994) three reasons that justify the use of innovations by designers. 1) Technology is evolving, thus we should continually look for new ways to utilize resources; 2) Simple systems have already been developed and implemented when the challenging ones are still ahead; and 3) Some systems are old, not meeting existing demand, and will soon become outdated. One proposal to increase the innovativeness of complex technical systems, equivalent to the complexity of the design process of a building, is to integrate more creativity into the system design process as it was discussed by Couger [6] (1990). Without creativity involved in the system design process, designers are likely to converge and sub-optimize solutions to the design problem.

In Golberg's (2000) [7] analysis some of the technical lessons of genetic algorithm processing are reviewed and their implications are briefly explored in the context of organizational change. Golberg's explains that if we were to only choose better solutions repeatedly from the original database of initial solutions, we would expect to do little more than fill the "population examined" with the best of the "first generation". Thus, simply selecting the best is not enough, and some means of creating new, possibly better designs must be found; this is where the genetic mechanisms come into play. Recombination is a genetic operator that *combines bits and pieces of "parental solutions" to form new, possibly "better offspring"*. For a housing development design process, this can be accomplished by a procedure, which will examine and reevaluate existing construction systems that are already used in housing projects. At the same time continuous feasibility study process should be in place that will examine and evaluate all the new construction, structural and services systems that may be integrated and adopted in the design stage. It is accepted thought that if such a procedure will be successful, it should be *S.M.A.R.T.*, i.e. *S*pecific, *M*easurable, *A*chievable, *R*ealistic, and *T*ime-specific.

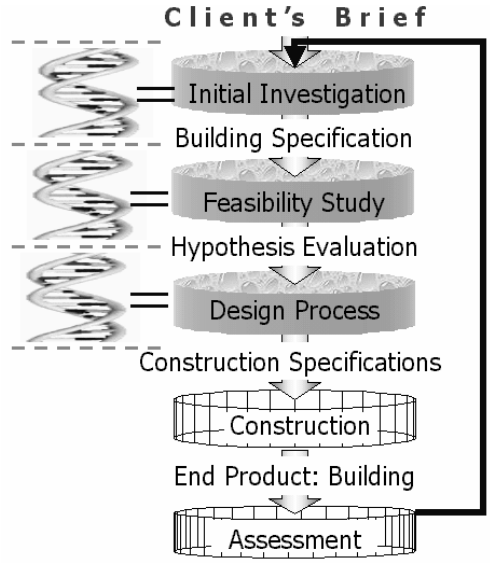

Figure 2 - The Proposed Design Procedure for Innovation

Therefore, it is important to challenge the limited understanding of the 'design process'. It is possible to promote a different image of design as a knowledge process capable of adapting to appropriate factors. The proposed design procedure examined is shown in figure 2. Through this perspective the main challenge for designers is to be able to apply design strategically to access the knowledge embedded in networks of the professionals involved in an effective process to promote and support innovation in any given context. Renewal of process requires new ways of search and design of investigation processes. This implies a strategic approach to innovation and breakthroughs in which trans-disciplinarily is a key factor to obtain viable results [8]. Face-to-face communication among designers from different professions is necessary when there is a high level of uncertainty in the engineering design process [9]. The "*D*esigning a *N*ew *A*pproach" proposition includes 5 key steps which are repeating in the order listed: Evaluation of the Limitations, Ideas Generation, Analysis with Regard to Other Systems, Simulation of all the Parameters Involved, and finally, Assessment through a Sensitivity Analysis. For more information refer to figure 3.

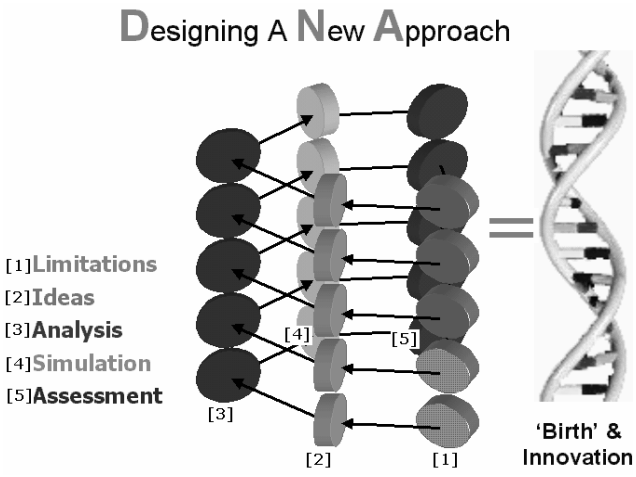

Figure 3- Structure of "Designing a New Approach"

Designers involved in complex, non-routine design processes, similar to one-off housing development, rely heavily on face-to-face conversations with other designers and professionals for solving problems and developing new innovative ideas. The information exchange has first to be digested, then analyzed, and finally evaluated. An artistic representation of this concept is presented in figure 4. This procedure though might not be beneficial if it is repeating without any useful outcomes.

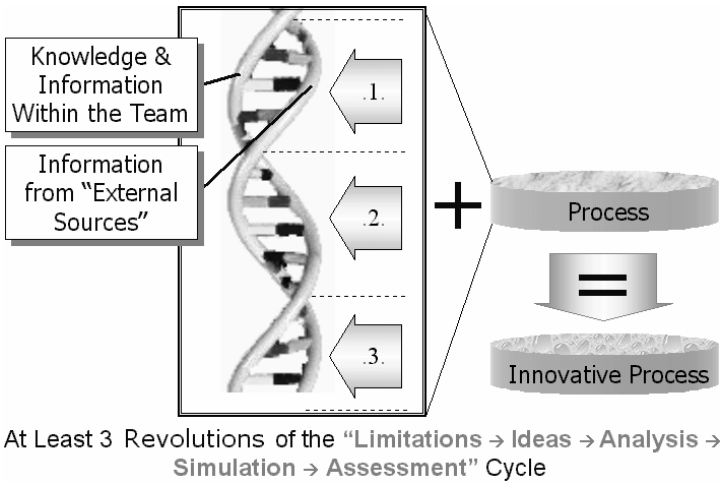

Figure 4 – "*D*esigning a *N*ew *A*pproach" Procedure

Salter & Gann [10] (2002) findings suggest that to support innovation in project-based environments, more focus needs to be placed on time management. In their research, designers felt that time pressure was the main factor that limited innovation. Overcoming this cycle of crisis and catch-up is a key challenge for design practices working in project-based environments, i.e. multi-professional building design environments. Greater attention to allowing time for designers to resolve problems at an early stage in design processes could have significant benefits for designers and their clients.

The Knowledge Transfer program, reported to in the introduction, was designed in order for a number of information channels to be assessed. The timetable used in shown in figure 5. More potential possibilities would exist if other members of the innovation team were able to participate in same manner as the individual, who was managing the program.

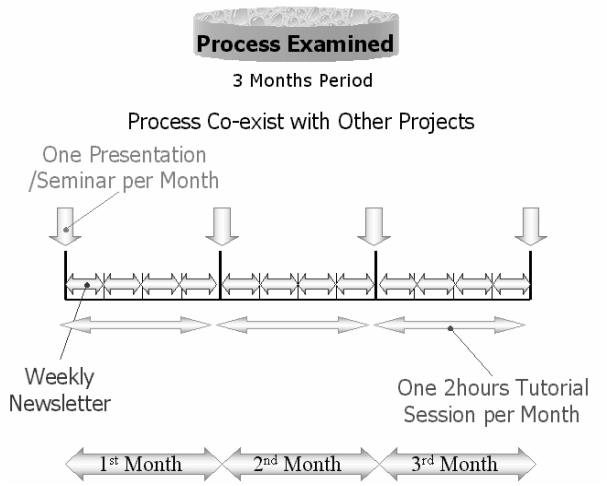

Figure 5 – The 9th Month Period Design Timescale of Innovation

Apart from well-managed timescales creativity is also required. Coates (1992) [11] insists that invention involves a high dose of creativity. People who are early adopters also often bring a substantial degree of creativity to their decision. Coates add that there is a large body of well-established knowledge about individual creativity. For the work presented in this paper, this knowledge has been identified, evaluated, and people trained to use their creative capabilities more effectively by utilizing tools that have been presented during well-organized seminars and one-to-one tutorials.

Although in the procedure proposed standards can restrain innovation by codifying ineffective or outdated technologies, and thus increase the resistance to change, standards generally stimulate innovation directly by codifying and gathering technological experience and forming a baseline from which new technologies emerge. As an example, refer to EU Directive on the Energy Performance of Buildings (2003) [1], Findings presented by Allen & Sriram (2000) [12] identify *that "standards also spur innovation indirectly because they increase competitiveness, which in turn spurs innovation"*.

4 Conclusions

According to Coates (2000) [13] there is a large anecdotal literature about creative organizations, coming out of highly productive organizations, but the development of adequate theory and empirical evidence of the general rules for a creative environment still lie ahead. Even on the physical side of the creative environment Coates concluded that we know relatively little. The study, presented in this paper, reveals the need and the requirements of creativity for designing a "green" housing development by integrating "*D*esigning a *N*ew *A*pproach" methodology in the initial investigation, feasibility study, and design process. A comparison between *conventional* and *innovative* design process for the design of buildings is shown in figure 6. The schematics presented should be examined in conjunction with figures 3 to 5. The innovative model is the one that will give birth to sustainable, i.e. green, developments in contrast with the conventional non-sustainable to future environmental and social changes buildings.

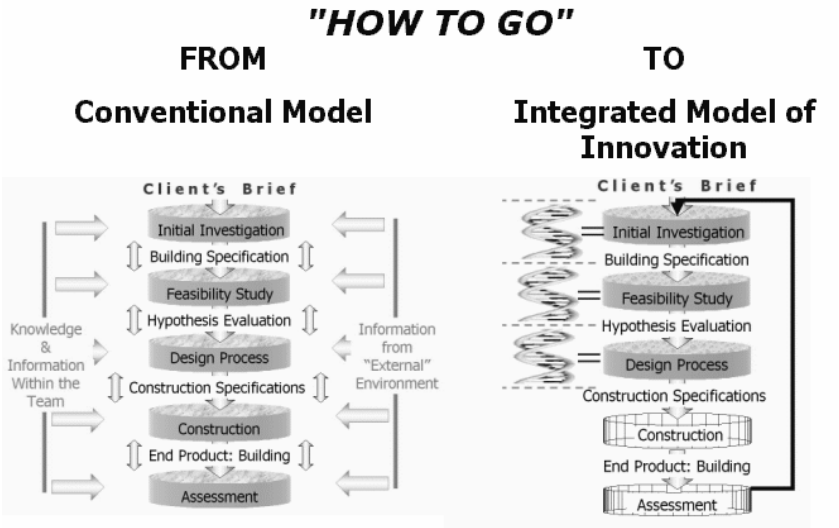

Figure 6 – Comparison Between Conventional and Innovative Design Process for Buildings

The paper describes, and evaluates, the approaches taken to achieve the change. In order to most efficiently transfer most sufficiently new knowledge to the team continues structured communications channels are required between the professionals involved. The model has been tested for an environmental friendly housing project, but it could so easily be adopted for other new types of construction processes. The response of the personnel involved is show in figure 7.

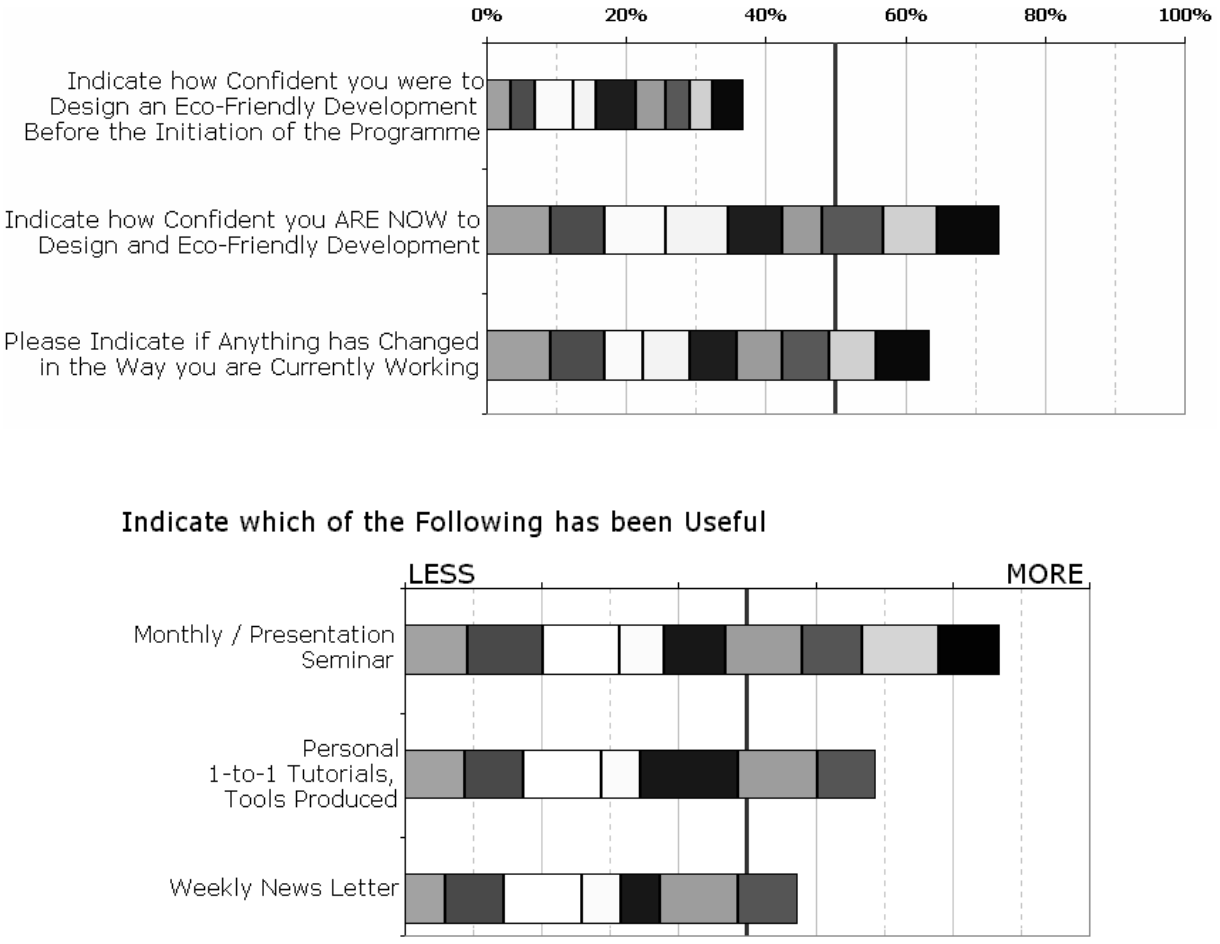

Figure 7. Summary of questionnaire answers from Kenneth Holmes Associates personnel in respect of the program and the "Integrated Model of Innovation"

Part of the success of such an approach requires enlightened clients willing to invest and stimulate innovation. The success is proportionate to the involvement and commitment of all members of the client and design team and the integrated model of innovation.

Finally, it has to be mentioned that customer needs and expectations often provide direction for design innovation in the field of sustainability. However, to be competitive, house and building companies must strive to produce "green" products with broader features that exceed the customer expectations, but at the same time to be accepted from a broad customer base. The role of the institutions is crucial for raising awareness of the final product, i.e. sustainable development with regards climate and environmental changes, to potentials and end users.

Acknowledgements

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