CAPTURING AND MAINTAINING THE CLIENTS REQUIREMENTS

Full Paper

FRONT-LOADING THE BUILDING DESIGN PROCESS FOR ENVIRONMENTAL BENEFIT

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ABSTRACT

Front-loading is the notion of placing increased emphasis on making decisions at the earliest possible stages of the design process. In this case the emphasis is on those decisions regarding the building's relationship to the environment (Watson 2004).

Investigations into the nature of the design process reveal that design moves forward through a process of problem solving. Popper's model of conjecture and refutation as the means by which scientific knowledge advances, has been applied to the process of design (Hillier et al, 1972). Hillier et al found that the role of problem *setting*, is as important as that of problem *solving*, when it comes to achieving environmentally responsible outcomes. If an environmental issue is not contained within a design problem, then it is unlikely that it will form part of the solution. A key task then, in the designers problem solving process, is that of *pre-structuring* of the design problem. It is at this stage of pre-structuring that environmental issues must enter the problem solving process to influence the design outcomes.

One explicit influence on pre-structuring is the brief for a building design. It is the brief that lays out the specific requirements of the client, and it is in this document that environmental issues may be explicitly stated. Research in practice has involved a series of case studies that were conducted to examine the process of front-loading the design process. The front-loaded process was based around the development of an 'Environmental Brief' (Watson et al, 2000). The conclusions are that a key path of events lead, not directly to improved implementation of environmental strategies in the final designs, but to improved achievement of goals set at the beginning of the design process, no matter what the level of sustainability of those goals. Hence, the key process becomes that of attempting to set environmental goals as high as possible.

Keywords: Front-loading, Briefing; Pre-structuring; Environmental Brief, Design Process.

1. INTRODUCTION

When a client approaches a designer with environmental responsibility as part of their agenda for the design of a building, it becomes the responsibility of the designer to try to achieve this goal, just as it is their duty to try to achieve the other design goals set by the client. How does a designer take on issues such as environmental responsibility, and incorporate them into a design? To understand this it is important to understand how design actually occurs, that is how the design process proceeds forward from a set of requirements to a solution that fulfils those requirements.

The first part of this paper will examine the theoretical mechanisms by which designers can take on environmental goals. It looks at how the influence of those goals is enforced as the design progresses, so that the final design reflects the goals set, and then how the designer can assesses design decisions as they are being made as a means of ensuring goals are met. Popper's model of *conjecture and refutation* (Popper, 1999a)*,* which was developed as means of describing how scientific knowledge advances, is used in this context as the basis upon which to investigate the process of design. Design is shown to proceed through the solving of design *problems*. The role of the designer in *setting* design problems is shown to be as important in achieving environmental outcomes, as the process of *solving* the problems.

The second part of the paper moves to the practice of architecture, and in particular the role of briefing in design. The argument is made that the briefing process, and the design brief as a document, must play a critical role if environmental goals are to be translated into strategies for design and then design outcomes. The brief can play a key role in informing the setting of design problems throughout the design process. A series of case study projects have been undertaken to test the notion of *front-loading* of the design process with environmental considerations. The medium through which this front-loading occurred was defined as an *Environmental Briefing* process, and the development of an *Environmental Brief* as a document. Some of the more interesting and informative outcomes from these case studies are presented here as a means of illustrating the key roles of the design briefing process, and the brief as a document, in terms of facilitating the implementation of environmentally responsible design.

2. THE NATURE OF DESIGN

There have been numerous attempts to define the process by which design moves forward from a need to a solution that satisfies the need. A review of these is contained elsewhere (Watson 2004). The theory presented here is based around the idea that design moves forward by a process of problem solving.

2.1. DESIGN PROBLEMS

In response to short comings of earlier attempts to describe the process of design, Hillier Musgrove and O'Sullivan in their seminal paper on design methods 'Knowledge and Design' (Hillier et al, 1972) proposed the model of *conjecture/analysis*. The conjecture/analysis (C/A) model is based on Karl Popper's work investigating the development of knowledge in science. Popper proposed the model of *conjecture and refutation*, as the means by which scientific investigation moves forward (Popper, 1999a) (the distinction between refutation and analysis will be made below). Simply put, the conjecture/refutation (C/R) model proposes that it is problems and not observations that are the starting point for scientific investigation (Bamford, 2002). Once a problem is identified a solution for that problem is conjectured and then begins the process of refutation or *error elimination*, in which the conjectured solution is subjected to tests in an attempt to prove it false. If the conjecture is refuted then the process begins again. If the conjecture is not refuted then scientific investigation may move on to other problems and the piece of theory stands as accepted until such time as it is refuted (Popper 1999a). The model can be represented by the following equation, which is useful shorthand with which to discuss the model (Brawne, 1995).

P_1™ TS ™ EE ™ P_2

Here P_1 is an existing problem, TS is a tentative solution proposed for that problem (a conjecture), EE is the process of error elimination (attempted refutation) and P_2 is the new problem or set of problems that arise from the error elimination process.

Popper's model is centred on the process of error elimination. That is, refuting erroneous theories and discarding them. The process of error elimination is one that can be seen to be the way in which nature advances – Darwin's theory of evolution by natural selection – hence it makes sense that it would explain the way knowledge would progress (Popper, 1999b). Popper makes this point by the title of one of his presentations 'All Life is Problem Solving', inferring that essentially life moves forward through error elimination and that all problem solving can be seen to be conducted in the same manner (Popper, 1999b).

The distinction between refutation and analysis, that is between C/R as a model for science and C/A as a model for Design is made because of the nature of design conjectures. Design conjectures are predominantly of a nature that they are not refutable or falsifiable (Brawne, 1995). Design moves forward by analysis of a conjecture and then discarding of it as unacceptable rather than by refuting it as in proving it to be false (Bamford, 1990). However, some design problems could be seen to be false, for example a design for a building that included ceiling heights of 1.5m. Such obviously problematic conjectures, though, are rarely put forward in the first place, at least by experienced designers.

The C/A process, P_1 ™ P_2, can be applied as a description of problem solving in design, in three ways. Firstly the whole building may be conceptualised as a problem to be solved where P_1 = the design problem and P_2 = the final design. It must be remembered however that this is not a description of the design process, as in a period of putting forward tentative solutions followed by a period of error elimination and then a solution P_2 is reached. C/A describes a cognitive process that may be occurring over a very short or very long period of time either during or outside the actual time being spent designing a building. For example, a designer may have designed a number of libraries over her career. The design of libraries as a type of building becomes a design problem in itself. Even though the designer is not currently engaged in the design of a library, the problem still exists and she may spend time analysing conjectures regarding the problem.

The second way the P_1 ™ P_2 process may be applied is in the progression of design throughout the design process of one particular project. For example, in relation to the problem of obtaining natural daylight in a building there will be a series of problems to be resolved starting at the very broad level and moving to more detailed ones, such as from building orientation, to window size and position and on to shading elements.

The third application is in the development of ideas or techniques across a series of design projects. Brawne provides an example of this in the work of engineer Peter Rice and his development of structural detailing for the Centre Pompidou. The solutions were arrived at through the development of ideas that had been observed in previous projects by Rice and others in the design team (Brawne, 1995).

The conjecture/analysis model defines design essentially as an act of problem solving. It delivers the notion that design moves forward within a single design and across subsequent designs, by a process of error elimination. In delivering this understanding the C/A model forms a solid framework for more detailed investigation of the design problem-solving process. In particular the following section will look into what occurs pre-P_1, or in other words pre-design problem.

2.2. PRE-STRUCTURING AND SETTING OF DESIGN PROBLEMS

In the conjecture/analysis model conjectures are presented by the designer as tentative solutions to problems, but the question remains 'how does the designer arrive at a conjecture?' Except for complete novices, designers tend to conjecture with a reasonable expectation that what they are proposing will satisfactorily solve the problem, or at least give an approximation that can be used for further refinement (Bamford, 2002). But what do they base their expectations on? Hillier et al argue that the designer *pre-structures* the design problem, P_1, and that they do this by applying constraints (Hillier et al, 1972). Constraints are either externally produced, such as by clients, site or regulation, or they are internally produced cognitive constraints, such as aesthetic sensibilities, social or environmental ethics, or any combination of these. Further, Hillier et al suggest that design solutions are only understandable in relation to the design problem as set by the pre-structuring (PS) process. Hence, they suggest that the critical point at which to influence the design outcome is at the stage of the pre-structuring of the design problem. In other words, if a consideration is not part of the definition of P_1 then there is no way that it will be part of the solution P_2 (Hillier et al 1972). Adding PS to the simplified representation of the C/A process gives the following:

PS™ P_1™ TS ™ EE ™ P_2

The concept of PS added to the conjecture/analysis model gives a description of the realistic notion that the designer in addressing P_1, brings all of the conceptual baggage of previous experience both, in design and from their life in general. Further the concept of PS means that this experience, along with the characteristics of the project at hand informs the definition of P_1, that is, the design problem itself (Hillier et al, 1972). Hence a critical part of the designer's role is the *setting* of the design problem, not just the *solving* of it. This becomes a critical concept when introducing new parameters into the design process, such as environmental considerations.

At the beginning of the process of solving a design problem, whether it be the design of a whole building or a detail within it, there are theoretically an infinite number of potential solutions that could be reached in solving the problem. In design there is no single 'correct' answer as there apparently is in science, but numerous designs that could solve a problem satisfactorily.

Building on Hillier et al's, work, Darke introduces the concept of the *primary generator* (PG) as the means by which architects quickly reduce the number of potential solutions to a design problem (Darke, 1984). A PG is in essence a constraint to the possible set of solutions (Darke, 1984). PGs are a part of the act of the setting of the design problem, that is, the pre-structuring process, as defined by Hillier et al. This is the case whether or not the PGs are made explicit and form part of the design brief or remain implicit to the architect's cognition.

An example revealing the effect of primary generators comes from Darke. She interviews Kate Macintosh (KM), designer of a housing project by the name of 'Dawson's Heights'. When asked to discuss how the concept for the project was arrived at Macintosh replied:

> *KM: 'Well, obviously the site is a very unusual one, in London, and I always have been one of the romantic school that think you should try to express the unique quality of the site… …so that was the main starting off point. And of course the other peculiar fact… …was the fact that the hill is unstable, and only the top third… …was buildable economically…(Darke, 1984)*

This shows two constraints being applied to the setting of the problem for the design of the housing estate. The first, expressing the nature of the site, is an internally applied constraint imposed by the designer. It is something that she brings to the design problem. This inclination to express the quality of the site is something she would have brought to any project. It just happens that this project came to be under her control. As a primary generator this notion of expressing the qualities of the site has the effect of immediately reducing the number of potential solutions. The design is now predestined to move in a certain direction, different from what it would have had other primary generators been put in place, such as, for example, the notion that all of the houses on the estate should face the equator for the best passive design. The second primary generator, the condition of the soil, is an externally applied constraint. This also immediately reduces the potential field of solutions, but this is not something that the architect brought to the project, it is specific to this project. Taking these two primary generators into consideration the architect now has a more refined design problem, upon which to conjecture. The representation of the design problem solving process may now be refined with the following, where IF = the infinite field of potential solutions and PG = the primary generators:

IF™ PS ™ P1™ TS ™ EE ™ P2
(PG)

From this discussion then it can be seen that, the notion of the PG is very useful in terms of the pre-structuring of the design problem. It does provide the designer a more refined design problem upon which to conjecture. This returns to the point of the designer as problem setter and it can easily be seen how environmental issues could become primary generators if designers are aware, or have the inclination and or the requisite knowledge upon which to conduct such a problem setting exercise.

In essence then, there must be a broadening of the scope of issues dealt with when defining the design problem, such that it includes environmental considerations. The point to be made is that it is not enough to take a standard design problem as the starting point for the design process and then to attempt to adopt environmental strategies at a later point. If environmental considerations are not part of P_1, then there will be no reason to eliminate non-environmental conjectures through the error elimination process and hence P_2 will not reflect environmental considerations. Inherently therefore, the first point at which environmental considerations must be dealt with in the problem solving process is at the stage of formulating P_1, the design problem, both for the building as a whole and for individual design problems throughout the design process.

2.3. CRITERIA FOR ASSESSING DESIGN SOLUTIONS

Another useful aspect of the concept of pre-structuring is the way in which it establishes criteria for the designer against which the success of TS (conjectures), proposed in response to P_1, may be assessed. Using Darke's example of Kate Mackintosh given above, there would be explicit requirements placed on that design due to the conditions of the soil. These requirements become design constraints, such as a two-storey height limit or conglomeration of buildings in that area of the site that is most suitable. They then form criteria, albeit very basic in this example, against which conceptual design conjectures could be assessed. Criteria based on the romantic notions that Mackintosh speaks of would be more subjective, but would none-the-less be critical in guiding the assessment of conjectures by the designer. These criteria produced as part of pre-structuring the design problem may also be shown on the P_1 ™ P_2 representation:

IF™ PS ™ P_1™ TS ™ EE ™ P_2

Criteria

To explain, the criteria produced through the pre-structuring process are used in the process of error elimination to assess tentative solutions. This assessment process leads to the TS being either supported or discarded and hence the P_1 ™ P_2 model may be refined again as shown below:

D

IF™ PS ™ P_1™ TS ™ A™ S™ P_2

Criteria

Here A = the assessment based on criteria from the pre-structuring, D = discarded conjecture and S = supported conjecture. In the case of S, P_2 is achieved and the process moves on to the next problem to be solved. In the case of D the process may return either to the original problem and the proposal of an alternative, but better informed, tentative solution based on the original problem, or the process may return to the pre-structuring of P_1. The latter would occur when the process of design problem solving has revealed more about the nature of the problem and hence a re-framing of it is warranted. This is very often the case and a quote from another of Darke's respondents, Richard MacCormac illustrates this point.

> *A brief comes about through essentially, an ongoing relationship between what is possible in architecture and what you want to do. And everything you do modifies your idea of what is possible… you can't start with a brief and (then) design, you have to start designing and briefing simultaneously…(Darke, 1984)*

The essence of this comment is that the process of design always has the potential to inform the setting of the design problem itself.

As the building design process progresses, the problem solving process and in particular the process of EE, reduces the number of potential solutions from an infinite field at the outset to the final, single design that is constructed. Though logically this statement is incorrect, as there will always be an infinite number of potential solutions at any point during the design process, the notion of a gradually reducing set of possible solutions is a good representation of the reality of the design process and therefore is a good model to work with (Bamford, 2002). Once design decisions are made they place constraints on future decisions. A good analogy for this situation is that of the sculptor with a block of stone. Initially it could be sculpted in to anything. However, there is a certain point at which enough maneuvers have been made such that it can no longer be, for example, a horse and it is obviously going to become a person, though it may still yet be a man or a woman. Further along the process it is obvious that it is not to be a man, and that it is to be a woman, but it could still be any number of individual women, and so it goes on.

Where a definite goal is put in place at the outset of a design process, for example to design a building that requires an absolute minimum of artificial lighting, it can be seen how it is critical that decisions relating to the achieving of that goal are made in a certain sequence. For example, there are decisions about siting and orientation, openings, shading, internal layouts and zoning and the internal surfaces, that will all have an effect on achieving the lighting goal stated above. Though there may not be quite so fine levels of tolerance as the sculptor works with, these individual design problems must be addressed in roughly the order given here, in order that major design revisions, such as a re-siting of the building late in the design, may be avoided. Design goals set at the outset of the design process are essential to informing design problem setting and solving all the way through the design process

The important point to note is that, just as pre-structuring is critical in all design problems throughout the design process, not just during the early stages, so too, error elimination is critical from the very first decisions to the last. It is worth repeating that there is no pre-structuring phase, or tentative solutions phase or error elimination phase in the design process. They each occur in relation to every design problem encountered.

In relation to environmental information then, it seems that it would be beneficial to have information about certain problems available at certain times throughout the design process to facilitate both the PS and EE processes, or in fact the PS ™ Criteria ™ EE process. In addition, in relation to EE there is the opportunity to provide help to create criteria, or even to provide assessment criteria in themselves, with the aim of guiding the assessment of conjectures. Finally there is also scope for providing assistance in actually conducting assessment of criteria, in other words the process of design decision-making.

For building design then, the critical activity in the design process is the briefing process. By the process of developing the brief clients can have input into the design process by defining requirements, and in particular defining environmental issues to be considered and levels of performance that are desired. It is through the brief as a document that the design problems for the building are made explicit. However, the brief is not something that is formed at the beginning of the design process and then remains unchanged. Framing MacCormac's quote from above, in terms of the conjecture/analysis model, it is through proposing tentative solutions, and error elimination that the designer is able to redefine and refine the design problem. This again, is the notion of the designer as problem setter, not just problem solver.

3. A FOCUS ON THE DESIGN BRIEF

Having gained an understanding of the internal mechanisms of the designer's processes we can move on to the interaction between the client and the designer through the practice of design. It is through the briefing process that the client is able to have formal input into the design process.

The process of briefing, as stated by the Royal Australian Institute of Architects (RAIA), involves the coming to an agreement by the client and the designer as to among other things, the design objectives, spatial requirements, functional requirements and budgetary requirements (RAIA, 1993). In reality, negotiation on these aspects continues throughout the design process, as was suggested by the quote from MacCormac presented above. To this end the RAIA also state 'The Brief is a dynamic document which is refined throughout the design process. (RAIA, 2003). However, for the purposes of getting under way with designing of the building, a point must be reached at which the brief is agreed to by the client and designer. The RAIA state 'It is important, however, that before extensive design work commences, the design brief is compiled and signed off by the client.'(RAIA, 2003). At this point the brief as a document comes into existence and it becomes a key reference for the remainder of the design process.

3.1. FRONT-LOADING THE DESIGN BRIEF

Research into environmentally responsible design process has been undertaken through a series of six case studies (Watson, 2004). These included five single, domestic residences and one commercial office fitout. The clients for all of the projects expressed a desire, to a varying degree, to be environmentally responsible through their buildings. One of the primary aims of the research was to investigate whether or not placing increased emphasis on environmental issues at the earliest stages of the design process improved the implementation of environmental strategies in the design outcomes. The term used to describe this increased emphasis is *front-loading.*

From the theoretical investigation of the design process it was noted that, for environmental issues to be part of design solutions they have to be part of the design problem and hence they need to be in the designers pre-structuring. Therefore front-loading the design process with environmental issues was seen as being the way to make these issues explicit, such that they would be able to inform problem setting throughout the design process.

The case study projects occurred in series over a span of three years. The research took a reflective practice approach. The front-loading approach was initiated out of discoveries from the first of the projects. The approach was then refined through the series of case studies as the results what had been implemented were analysed.

3.2. THE ENVIRONMENTAL BRIEF

For application in practice in the case study projects, the form taken to create a front-loaded design process was termed an *Environmental Briefing Process*. Discussion between the designers and clients were based around the development of a document which came to be termed the *Environmental Brief*. One of the key research findings was that it is important to distinguish between the document produced and the process undertaken, because of the different roles they played in producing benefits for the design outcome.

As might be expected, the environmental brief contains more than a typical design brief. By bringing environmental design decisions to the start of the design process the information contained within the brief is broader in scope and typically more detailed than a standard brief. This was so much so that late in the series of case studies it was determined that the term ‘Brief’ was misleading and undervaluing the amount of information contained within the document and the term Environmental Strategies Report was used.

The case studies revealed some critical roles of the briefing process and the brief as a document. The following is a brief summary of these leading to a critical path of events that were seen to ensure that environmental goals were met, whether they be strenuous or weak. The results also points towards the way to achieving improved implementation of environmental issues.

4. KEY ROLES OF AN ENVIRONMENTAL BRIEF

4.1. THE BRIEFING PROCESS AS EDUCATIONAL TOOL

Clients enter the design process as the party with control over the resources that are going into the project. They also enter with a level of environmental knowledge that varies between clients. There is a role therefore, in the process of environmental design to attempt to educate the client with the goal of raising their level of understanding and therefore their desire to allocate resources to the environmental aspects of the project.

The clients of the five residential case studies were characterised by being well educated, at least one member of each household held a university degree, and by all having the desire to be environmentally responsible. These factors may be seen to have made them a more receptive audience than would be typical. However, the clients differed in four key ways crucial to the eventual level of implementation of environmental strategies. Firstly, they all came with a different perception of what was environmentally sustainable. Secondly, they had unique set of desires and priorities for the project. Thirdly, they were open to being educated in the environmental issues to a different degree, and fourthly they all had different budgets and hence access to resources to work with. Of these factors, education cannot change the budgetary constraints, though it could change priorities within those constraints. The other three factors however, may be influenced by the education of clients, hence the aim of education was to raise the understanding of the concept of sustainability and to change desires and priorities to be more in favour of environmental considerations.

Evidence from the case studies did not suggest that education of the client directly informed the pre-structuring for the designer, but certainly it had an effect on problem setting, because the clients must come to agreement with the designer as to what many of the design problems will involve.

The education of clients is critical as an intermediate step towards implementation. The role of education is to alter priorities in order to alter implementation. To this end, clarity of the presented information is of critical importance.

4.2. THE DISCUSSION OF ENVIRONMENTAL ISSUES

Apart from education regarding environmental issues, it is also important that these issues are simply raised at the outset of the design process, even if all parties are fully aware of the issues. If they are not raised then there is not much chance that they will be considered for inclusion in the brief and hence form a part of the design problems. The wider the range of environmental issues raised at this early stage the wider range that may be included in design solutions.

In the case studies it was possible to discern a link between the raising of issues, the setting of goals and then the achieving of goals set, whatever the performance level of those goals in terms of implementation. An aim for the environmental briefing process therefore is to attempt to cover the broadest possible range of environmental issues. Having said this, there is a balance to be struck between being too detailed and hence bogging down the design process, and confusing or scaring the client, and being too simplistic and hence missing opportunities that may have otherwise emerged if issues had been discussed.

4.3. THE BRIEF AS BRIDGE BETWEEN GENERIC AND SPECIFIC

Having said that the broadest possible range of issues should be raised in the briefing process, it is also important to note that not all issues can be considered or taken on board. The brief acts as a bridge between the consideration of generic environmental issues and the specific issues that will be included in the project.

The briefing process must facilitate unique project requirements to be taken into consideration and thereby shape the rest of the design process. Environmental issues range from global in nature such as greenhouse gas emissions to very particular, project specific issues, such as specific health requirements of a client that may have asthma. Figure 1 illustrates the environmental briefing process taken from one of the case study projects. In this particular case a Building Environmental Assessment tool, the GBTool, was used as a comprehensive and widely accepted source of environmental issues and assessment criteria. Through the briefing process these were tailored to the nature of an office fitout, and then tailored to the specific client requirements for the project.

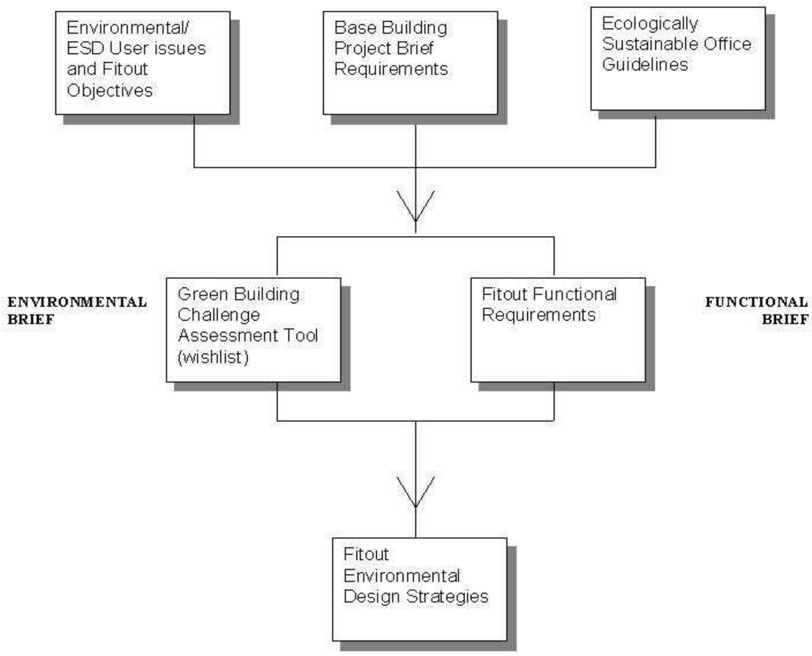

Figure 1: Flow diagram representing the environmental briefing process of the EPA Fitout project (Thomson et al, 2001)

4.4. FACILITATING THE SETTING OF PRIORITIES

The raising of issues, and the education of clients, through the process of creating a specific brief, out of a set of generic issues, is in essence assisting the client to determine priorities for the allocation of their resources. The aim is that environmental issues will be raised in the list of priorities on the assumption that the top priorities will get the greatest attention and have the highest chance of being achieved. As noted above, all of the clients in the case study projects had the intention of being environmentally responsible, though to varying degrees. This was reflected in the priorities that they set.

Through the case studies it was found that the setting of priorities, is the primary means of dealing with value conflict between environmental issues and between environmental and non-environmental issues. The aim of the environmental briefing process is to facilitate the setting of priorities at the earliest possible stage of the design process. Where priorities were not firmly established conflict tended to occur right through the design process, causing delay and angst between client within a project. Once a set of priorities are established then specific environmental goals can be set for the project.

4.5. FACILITATING GOAL SETTING

Typically a client brings a series of functional goals to a project. As part of the environmental briefing process they were asked to include their environmental goals. The designers brought to the process what was termed an ‘environmental wishlist’ as seen for example in figure 1, which included an extensive set of environmental design issues for potential inclusion into the design. The briefing process then involved the 'marrying' of functional and environmental goals to form a set of overall goals.

The setting of goals regarding the environmental performance of the project is a key activity that must take place at this early stage of the design process, even if those goals change throughout that process. The goals, once set are able to inform the pre-structuring of design problems. Goals may be prescriptive, such as the inclusion of specific environmental technologies or strategies, or they may be performance based, setting the desired levels of environmental impact, such as energy, water or material usage over the life of the building. Evidence from the case studies that goals were set, either formally or informally, with regard to environmental performance would indicate that consideration has been given to environmental issue. These goals then become the source of criteria which will facilitate the environmental decision-making throughout the rest of the design process.

An simple example of goal setting informing design decision-making comes from one of the domestic residences, in which there was a goal on behalf of the clients to be self sufficient in terms of electricity usage. Part of the design problem for the roof of the house, therefore, was for it to be north facing at around 30º for the optimal installation of photovoltaic cells and a solar hot water system. In general the results from the case studies showed that there was a reasonable correlation between the level of environmental performance set at the outset of a project and that which was achieved in the final design.

In order to improve implementation however, this will only be achieved through education of the client and discussion of issues. An issue can only be included in a goal and therefore influence problem setting is if it is raised as an issue. Logically the same would apply to the increased environmental performance of goals set. Only through education and discussion regarding more stringent environmental performance may such things possibly be incorporated into goals. It must be noted that education and discussion will not necessarily lead to inclusion of issues into goals, but that without these inclusion will definitely not occur. Figure 2 characterises the critical sequence of events leading to the improved implementation of environmental strategies as derived from the evidence from the case studies regarding the front-loading process.

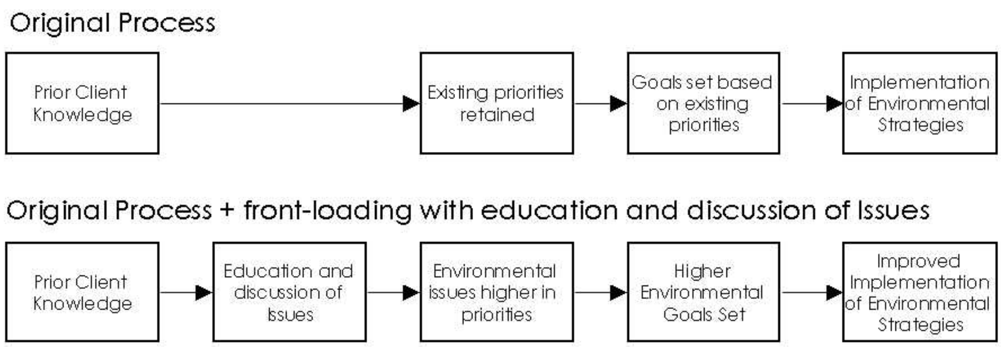

Figure 2: The sequence of events leading to improved implementation of environmental strategies, with and without front-loading of environmental issues (Watson, 2004).

4.6. THE BRIEF AS STARTING POINT FOR DESIGN ASSESSMENT

If implementation of environmental strategies is to be achieved in the final design, then there must be some way of assessing the design as it evolves. As part of the

$P_1 \Leftarrow P_2$ process criteria are developed either implicitly or explicitly from the pre-structuring of the design problem. It is these criteria that are used as a means for making assessments of design conjectures as part of error elimination during the problem solving process. Hence, evidence that environmental criteria were being produced out of the front-loaded design process would indicate that the process at least had the potential to aid in the decision-making process. In some cases, as for example in figure 1, explicit assessment criteria were taken from existing sources, in that case the GBTool.

There was evidence from the case studies that criteria from problem setting were being used as a means of assisting design decision-making and that this in turn lead to implementation of environmental design strategies. The strongest evidence came from those case studies in which the environmental goals were the highest. This makes sense, because if there are more environmental issues locked into goals, then there should be more criteria based on those environmental issues with which to assess design decisions. The best example is perhaps the criteria of roof slope for solar technologies that was suggested in the front-loading process of all of the residential projects, but which was only achieved in the end for the one of the houses. It was those clients that had placed the highest priority on the strategy, hence when the issue of roof slope came up as a criteria against which to measure conjectures, and only those conjectures which satisfied that criteria were accepted.

Figure 3 illustrates the sequence of events connecting goal setting to the design problem solving process and the criteria for assessing conjectures. The importance of goal setting as a task in the front loading process becomes apparent. If there is no environmental goal setting in place, as seen in the top half of figure 3, then this can not form part of the design problem, which in turn will produce no criteria against which to measure conjectures, there would be no influence on the error elimination process and hence no influence on implementation of environmental strategies.

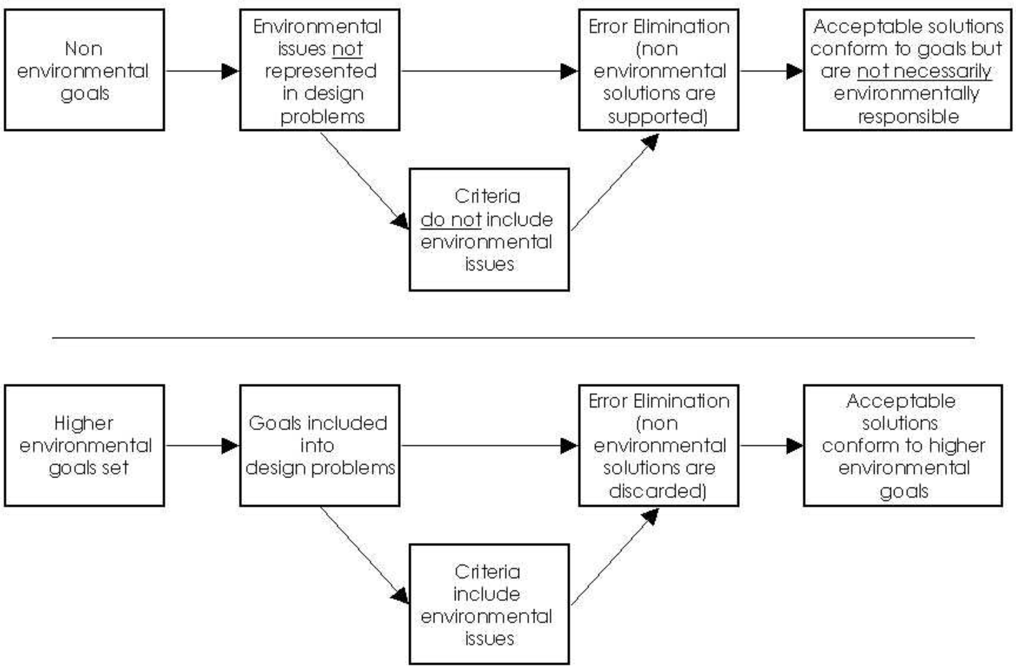

Figure 3: Comparison of design problem solving process leading to potentially non-environmentally responsible solutions (above) and to environmentally responsible solutions (below). (Watson, 2004)

An important task for the environmental brief is to facilitate the linking of environmental assessment criteria to the particular goals set for a project. To this end there needs to be a certain degree of flexibility in the content of environmental assessment criteria in order to cater for unique project goals.

4.7. THE BRIEF AS A RECORD

The final role of the environmental briefing process to be examined, is that of providing a record. Recording the issues considered, goals set and decisions made, benefits not only the project for which the brief is being developed, but future projects. Dealing with the complexity of environmental issues, though these issues vary from project to project, will be assisted by reference to such a record of previous decisions made and the outcomes that resulted from them.

The notion of bringing forward of information, knowledge, experience or solution sets from previous projects for use on the project under consideration is termed *feed forward* (Prieser, 1999). Feed forward is a critical process as part of the iterative improvement of building design in general and, in particular here, in terms of improving environmental performance. It is particularly useful if knowledge gained from past projects can be used to inform the design process from the earliest stages, to prevent progressing in directions that may have already been found not to be useful and to prevent the need for repeating research groundwork. The feeding forward of knowledge and ideas had a large influence on the pre-structuring of design problems for the designer. As the Hillier et al state, a large part of pre-structuring relies on the designers past experience (Hillier et al, 1972).

For the individual project, in order that the front-loaded process, and the products coming out of it, namely the briefing document and the goals contained within it, may have some bearing on the design decision-making process, there must be evidence that this document is being referred to throughout the design process. There was certainly evidence of this in the process of design decision-making in the case studies. However, importance was placed on the environmental briefing process and continued adjustment of the brief as a part of the design process, as opposed to the importance of the brief as a document itself.

The process of recording goals in the brief cements issues in place for the designer and perhaps more importantly for the client. When design decision-making then occurs there can be a greater degree of confidence that the correct decision is being made relative to the project goals. An architectural brief should continue to evolve throughout the design process and recording this evolution will assist in keeping a harmonious relationship with the client as the designer attempts to fulfil the clients wishes. In those case studies where goals were not formally recorded problems were encountered when it came to making design decisions.

5. CONCLUSIONS

For design solutions to achieve the environmental performance level desired by clients, goals must be put in place as early as possible in the design process. These goals, encapsulated in the briefing process, go on to inform the pre-structuring of design problems by the designer, throughout entire design process. Design problems addressed early in the design process have the greatest impact on the design because they limit the potential solutions to later design problems. It is most critical that these early design problems are set with environmental considerations in place.

The indication from the research is that in order to increase the implementation of environmental strategies the key tasks are to educate the clients and raise environmental issues with them as early as possible in the design process with the aim of encouraging the clients to raise environmental issues up their list of priorities. Only then will these issues be more likely to be enshrined in to project goals and then be able to inform design problem setting and hence design solutions.

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