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# ARE ARCHITECTS ABLE TO ADDRESS THE ISSUES IN THE DESIGN OF SUSTAINABLE BUILDINGS?

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## ABSTRACT

Many architects' solutions to design problems are developed through an intuitive approach to the design process. Although schools of architecture generally teach methods of determining the thermal performance of buildings and increasingly cover issues related to the energy embodied in the building fabric, it appears that this type of performance modelling and analysis is undertaken by only a few architects in practice.

The adequate modelling of overall building performance, particularly related to areas of environmental concern, will become increasingly important as sustainable building practice becomes more of a critical issue in building design.

It is contended that, before architects can adequately address sustainable issues related to their designs, they must develop a culture in which a full understanding of the environmental performance of the proposed building is evaluated. There is little evidence that such a culture is developing although the tools for evaluating building performance are available in many practices. The reasons for this are many including the cost structure of architectural fees, the difficulty in using the currently available analytical tools and the expectations of regulators and clients.

Unless architects are pro-active in implementing a policy that leads toward a broad acceptance and implementation of a more analytical approach to building design, there is a danger of two things occurring. Firstly, the architecture profession will not be in a position to constructively contribute to the debate on sustainable issues and secondly, they will be designing buildings that do not perform in such a manner as to be considered to conform to sustainable principles. If these occur, architects will lose the opportunity to contribute constructively and significantly to the future development of the built environment.

## INTRODUCTION

The contributors to the built environment are coming under increasing pressure from issues arising out of environmental concerns expressed by various sectors of the local, national and international community. The architecture profession is endeavouring to respond through position statements and policy development which are may be seen as establishing their response to the environmental agenda.

A key element in this discussion is the concept of sustainability. Its meaning in an architectural context is informed by the following:

***sus.tain.able*** *adj (ca. 1727) 1: capable of being sustained 2 a: of, relating to, or being a method of harvesting or using a resource so that the* *resource is not depleted or permanently damaged <~ techniques> <~ agriculture> b: of or relating to a lifestyle involving the use of sustainable methods <~ society> -- sus.tain.abil.i.ty n* (Britannica 1999)

While statements of intent may be used in identifying how the architecture profession intends to deal with environmental issues, the impact that architects currently have in making a contribution to sustainable buildings is questionable. For the purposes of this discussion, it is assumed that the current sustainability debate and resultant actions are an approriate response to perceived environmental changes. Whether it is even possible, given the current world population, to have sustainable architecture without depletion or permanent damage to resources will be the subject of ongoing debate.

In this context it is fruitful to revisit the definition of architecture:

***ar.chi.tec.ture** n (1555) **1**: the art or science of building; specif: the art or practice of designing and building structures and esp. habitable ones **2 a**: formation or construction as or as if as the result of conscious act <the ~ of the garden> **b**: a unifying or coherent form or structure <the novel lacks ~> **3**: architectural product or work **4**: a method or style of building **5**: the manner in which the components of a computer or computer system are organized and integrated* (Britannica 1999)

The key phrase in this definition being *...the art or science of building….* A disaggregation of this leads to the definitions of art, science and building.

***²art** n [ME, fr. OF, fr. L art-, ars--more at arm] (13c) **1**: skill acquired by experience, study, or observation <the ~ of making friends> **2 a**: a branch of learning: **(1)**: one of the humanities **(2)** pl: liberal arts **b** archaic: learning, scholarship **3**: an occupation requiring knowledge or skill <the ~ of organ building> **4 a**: the conscious use of skill and creative imagination esp. in the production of aesthetic objects; also: works so produced **b (1)**: fine arts **(2)**: one of the fine arts **(3)**: a graphic art 5 a archaic: a skillful plan b: the quality or state of being artful 6: decorative or illustrative elements in printed matter*
***syn** art, skill, cunning, artifice, craft mean the faculty of executing well what one has devised. art implies a personal, unanalyzable creative power <the art of choosing the right word>. skill stresses technical knowledge and proficiency <the skill of a glassblower>. cunning suggests ingenuity and subtlety in devising, inventing, or executing <a mystery plotted with great cunning>. artifice suggests technical skill esp. in imitating things in nature <believed realism in film could be achieved only by artifice>. craft may imply expertness in workmanship <the craft of a master goldsmith>* (Britannica 1999)

***sci.ence** n [ME, fr. MF, fr. L scientia, fr. scient-, sciens having knowledge, fr. prp. of scire to know; prob. akin to Skt chyati he cuts off, L scindere to split—more at shed] (14c) **1**: the state of knowing: knowledge as distinguished from ignorance or misunderstanding **2 a**: a department of systematized knowledge as an object of study <the ~ of theology> **b**: something (as a sport or technique) that may be studied or learned like systematized knowledge <have it down to a ~> **3 a**: knowledge or a system of knowledge covering general truths or t he operation of general laws esp. as obtained and tested through scientific method b: such knowledge or such a system of knowledge concerned with the physical world and its phenomena: natural science **4**: a system or method reconciling practical ends with scientific laws <culinary ~> **5** cap: christian science* (Britannica 1999)

***build.ing** n (14c) **1**: a usu. roofed and walled structure built for permanent use (as for a dwelling) **2**: the art or business of assembling materials into a structure* (Britannica 1999)

It is apparent that the art of architecture is inherent in the individual. It is *...skill acquired by experience, study, or observation…*and *...art implies a personal, unanalyzable creative power….* Few would dispute that architecture has these characteristics.

The relationship between science and architecture is also apparent with architecture as a profession supporting *...the state of knowing: knowledge as distinguished from ignorance or misunderstanding…, knowledge or a system of knowledge covering general truths or the operation of general laws esp. as obtained and tested through scientific method…* and *...a system or method reconciling practical ends with scientific laws….*

Architecture may therefore be redefined as *skill acquired by experience, study, or observation implying a personal, unanalyzable creative power OR the state of knowing a system, knowledge or system of knowledge or method reconciling practical ends with scientific laws for the art or business of assembling materials into a structure.*

Clearly, a combination of definitions may be developed from this discussion however the key element with in this debate is the the notion of a dicotemy between art and science in the context of sustainable architecture. Can this be maintained with architects still being relevant to a society in which environmental issues become increasingly important?

## ART, SCIENCE, ARCHITECTURE AND SUSTAINABILITY

Several issues in the design of sustainable buildings may be identified. Among these are:

Building process efficiency
Building waste minimisation
Embodied energy
Operational energy
Occupier behaviour
Maintenance process
Waste recycling/disposal
Adaptive reuse
Demolition process
Recycling of building materials

These encompass the concept of the cradle to grave dealing with, construction, usage, maintenance, recycling and disposal during design. This therefore implies a thorough understanding of the totality of the life of the building and all materials and processes which go into it. There is little evidence that the architecture profession deals with buildings in such a comprehensive way.

What evidence there is indicates that architects utilise little formal means, other than precedent or form vocabulary, to support their design decisions. This may be appropriate during an era when significant gains may be made in energy performance and reduced $CO_2$ emissions by strategies such as thicker insulation, sun shading on windows and greater thermal mass (eg. Roaf 2000) When a finer balance needs to be achieved between such variables as thermal mass and insulation vs embodied energy, the methods currently used will no longer be appropriate.

The issue of developing tools which give more detailed information for the evaluation of design and construction decisions is one which the building industry as a whole and architects in particular need to address. This then refocuses the discussion on the relationship between art and science in architecture.

**Architectural practices as predictors of performance**

The design process is one in which predictions are made. It is expected that something which designed now and built in the future will perform as predicted. Engineering as a diverse profession has established itself as a predictor of future performance based on mathematical modeling. Although subject to refinement, development and revolutionary change, the relationship between theoretical (predicted) and actual performance is fundamental to the engineering disciplines. Strong elements of that which is fundamental to the definition of science are evident in engineering.

The role of the architectural design process as a predictor of the future is less clear. The experience of the designer when establishing the spacial relationships between functional requirements demanded by a client should ensure that the building works in the manner predicted. This may also be evident with respect to the spacial and visual quality of the building and its relationbship to its surroundings.

Although the spacial, visual, and functional relationships are viewed as critical to architecture, buildings operate on other levels. The performance of buildings against sustainability criteria are now being seen by architects as an increasingly important requirement.

The assumption which is fundamental to this requirement is that architects are in a position to predict and evaluate the performance of their designs based on sustainability criteria. It is apparent in the architectual literature that there is concern for environmental performance of buildings. Buildings which are warm in winter and cool in summer and others with external shading which protects windows in summer but which can be raised in winter may address these issues. However, it is apparent that very little architectural discourse addresses the sustainability issues described above in any but the most cursary manner. The concept that a building in a cool temperate environment can have floor to ceiling glazing while maintaining a comfortable living environment with out significant energy input is at least questionable even if it can be supported. What is of concern is the lack of evidence to indicate that such claims can be validated.

This raises the issue of one of the functions of the design process being as a predictor of building performance. The vocabulary of sustainability such as north facing windows shaded in summer along with high levels of insulation, few if any windows facing west and the use of recycled materials does not necessarily make a sustainable building. Of real concern should be the maintenance of an internal environment acceptable to the client with minimal energy input (both direct and embodied).

The prediction of whether this can be achieved is fundamental to any process claiming to result in a sustainable design.

**Architecture and design tools**

The increasing availability and reduced cost of computer based simulation tools for the design and construction industry should result in increased levels of use and hence more reliable predictions of outcomes for the design and construction process. There is little evidence that this is the case.

Architectural practices have tended to apply computing to previous methods of operation without significantly changing the manner in which they are carried out (Dawson 1996). This has resulted in computers being used for the production of drawings similar to those which were originally producted by hand. Where three dimensional modeling has been developed, it is primarily used for visualisation in a similar manner to that of hand drawn architectural rendering.

The impact of the development of computers as building design and performance simulation tools similar that used in the automotive and aircraft industries has been minimal. The use of computers for drafting can be seen to be the result of the requirement of the construction industry to have documentation in paper form which then becomes part of the legal relationship between parties to the design and contruction process.

Simulation of building performance during design requires three dimensional models as the basis for thermal and acoustic modeling and which may then form the foundation for constuction process analysis. However, each performance analysis tool requires a separate computer model to be prepared for each type of analysis. While it is also possible to extract orthographic projections for working drawings from three dimensional computer models this requires yet another model to be prepared. Anecdotal evidence suggests that architectural practices are reluctant to develop three dimensional models appropriate for performance simulation due to the additional time required in their preparation. This not allowed for in the current fee structure where competition is fierce.

Irrespective of the multiplicity or complexity of three dimensional models required, the legal environment in which practices operate inhibits thorough performance analysis using available simulation tools. Unless a client requires such analysis on a modest building, in which case an enviromental or acoustic engineer may be engaged, the architect is unlikely to offer this as part of the core service. On larger buildings appropriate consultants will be engaged as a matter of course.

If performance modeling software is to be used as part of the design process it tends to be easy to use and only indicative of the predicted performance or difficult to use and comprehensive in its results (Maver 2000). The comprehensive yet user friendly performance modeling software is yet to be seen.

**Architectural practice as a learning organisation**

It is axiomatic that when an architectural practice is commissioned for a design the resultant building will be unique in many respects. The building is therefore a prototype for a production run of one. This places onerous responsibilities on the designers and builders of that building. In particular, previous experience in designing and constructing similar buildings is highly desirable. Hence, specific architectural practices tend to specialise in particular building types such as hospitals or other buildings with similar high levels of complexity.

The assumption is that prior experience results in knowledge of the particular issues associated with a specific building type and this is then able to be recoverd and applied to a new situation. There is little evidence that this type of learning takes place in any other than an ad hoc manner. Many times knowledge resides in individuals and is wholly dependent on their experience and skills for its discemination to others in the practice.

In reality much of architectural education is founded on this method of learning from the design studio to through to graduate architect (Cuff 1991). This can result in students who have limited experience in the formal acquisition of knowledge which may be identified as a characteristic of scientific research with this limitation carried through to practice. Although architectural science is part of the current architectural educational curriculum, the primary focus of most students in academic programs is the design studio. This leads to the neglect of skills which would prepare them for objective investigations into the result of their design decisions.

Thus very little attention is paid to formal mechanisms for either validating design decisions or for the comprehensive storage or retrieval of the body of practice experience. (Figure 1)

establishing the relationship between the parties to the design and construction process.

The outcome of this is that any interaction between the participants in building procurement tends to be in the context of their legal relationship between one another rather than in providing a quality outcome for the client. Under conditions in which maximum efficiency and minimal waste is desired (sustainable construction) this lack of cooperation is counter productive to the optimal utilisation of resources and skills of those involved.

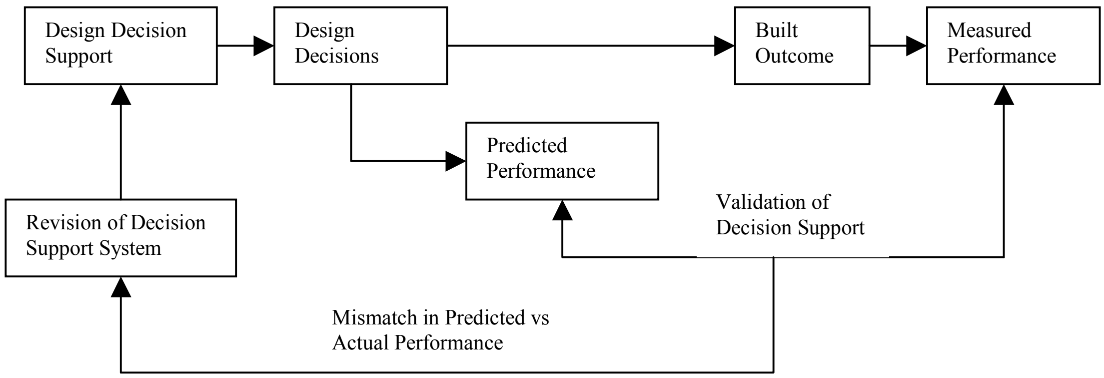


**Figure 1** Validation of Decision Support System

The outcome of this process is that architectural practices which are unable to put into place formal and sound procedures for identifying and evaluating predicted building performance against actual performance may be ill equiped to learn from design decisions. This will place them at a serious disadvantage in an environment of change.

**Architectural practices and the construction industry**

The separation of the design from the construction process has been fundamental to the constuction industry for a considerable period of time. The outcome of the design process is an incomplete two dimensional description of a three dimensional object prepared with little consideration of the construction process. While this does support specialisation in the industry, it precludes the development of a cooperative approach to building procurement. This inhibits collaboration between designers and builders which then prevents experience in construction informing the design and the design intent being withheld from those undertaking construction.

As a result an adversarial environment is created which makes cooperation difficult and encourages a strong legal framework for

# DISCUSSION

The issue of defining and implementing a sustainable built environment is unlikely to reduce in significance in the future. Recent lack of will by national governments in being unable to reach agreement as to ways of reducing greenhouse gasses has increased the responsibility put on those influencing the environment in which we live.

Within the current practice climate, architects are facing the prospect of contributing little to the development of sustainable buildings in any comprehensive or meaningful way. With only a small proportion of buildings involving architects as part of the design process the profession needs to be strongly proactive in defining and addressing the sustainable agenda.

It is possible to find more information about the speed, fuel consumption and maintenance requirements of a $15,000 car than it is to establish the predicted energy consumption and thermal performance of a $500,000 dwelling.

While the architecture profession is preocupied with the art of architecture it will be difficult for it to contribute in any meaningful way to discussion as to how sustainability can be achieved. The current relatively simplistic approach to what is assumed to be sustainable without proper analysis of either predicted or actual performance does little to further understanding as to what constitutes sustainable design.

## CONCLUSIONS

The definition of architecture as the art OR science of building requires review. If architects are to be taken seriously as contributors to a sustainable future, architecture needs to be redefined and practiced as the art AND science of building.

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