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The relationship between research and design in landscape architecture

Lee-Anne S. Milburn [a,*], Robert D. Brown [b,1]

[a] *Department of Landscape Architecture, Mississippi State University, Box 9725, Mississippi State, MS 39762-9725, USA*
[b] *School of Environmental Design and Rural Development, University of Guelph, Guelph, Ont., Canada N1G 2W1*

Abstract

A study was undertaken to explore the incorporation of research into the landscape architectural design process. A review of the literature revealed five discrete models by which research is integrated into design: concept–test; analysis–synthesis; experiencial; complex intellectual activity; and associationist. In-depth interviews with eight landscape architecture educators and a mail-in survey of all landscape architecture educators in North America failed to confirm the utility of these five models. Instead, a different kind of model emerged from the results. In this model, research is incorporated at three stages of the design process: before design; during design; and after design. Before design, there appear to be two categories of research: indirect (which includes intrinsic research, library research, and review of precedents and case studies); and direct (which includes site inventory and analysis). During design, research seems to have two key roles: influencing the concept generation process and the application of the concept on the site. Five models emerged for using research during design: artistic, intuitive, adaptive, analytical, and systematic. Finally, after design research has two roles: evaluation of design, and justification of design. This categorization, as elucidated by educators, provides insight into the landscape architecture design process and its communication and teaching.

Keywords: Questionnaire; Interviews; Landscape architecture; Design process; Research

1. Introduction

The movement from modernism to post-modernism has slowly been reflected in a changing approach to design. The modernist movement has encouraged the perception of the designer as omnipotent *artist* and *creator*, making decisions based primarily on aesthetic, financial, theoretical, and political concerns. The move to post-modernism has placed a greater emphasis on issues, such as social responsibility, sustainability, environmental responsiveness, environmental integrity and human health. The complexity of these issues is encouraging urban and regional planners, architects, interior designers, and landscape architects to identify research as an essential component of responsible planning and design processes (Gunn, 1978; Lawson, 1980; Nassauer, 1985; Schön, 1988; Riley, 1990; Tufte, 1990; Harris, 1995; Innes, 1996). The relationship between research and design has been discussed extensively in the literature (e.g. Zube, 1980; Nassauer, 1985; Lawson, 1992; Selman, 1995; Brink, 1997; Benson, 1998; Selman, 1998; Thwaites, 1998; Zube, 1998; Armstrong, 1999; Bowring, 1999; LaGro, 1999) in an attempt to reconcile traditional

* Corresponding author. Tel.: +1-662-325-7897; fax: +1-662-325-7893.
E-mail addresses: lmilburn@lalc.msstate.edu (L.S. Milburn), rbrown@oac.uoguelph.ca (R.D. Brown).
[1] Tel.: +1-519-824-4120; fax: +1-519-767-1686.

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forms of design understanding and the requirements of rigorous scholarly research. In order to resolve this issue, it is important to understand how professionals view and use research in their work. This paper examines how landscape architecture educators integrate research into the process of landscape architectural design.

2. Methods

This study used a three-stage approach to investigate the various methods of integrating research and design. A critical review of the literature provided a framework for examining the issue under study, pilot study interviews with faculty of the School of Landscape Architecture at the University of Guelph explored the range of perspectives on the relationship between design and research, and a survey of all landscape architecture educators in North America asked detailed questions informed by the interviews.

2.1. Literature review

A critical review, integration, and synthesis of the literature yielded five models. These models provided the basis for the development of a questionnaire that evaluated which of these models were used by educators, and whether they were seen (as suggested by the literature) to be mutually exclusive.

2.2. Interviews

Nine educators in landscape architecture at the University of Guelph were approached during May 1998 to participate in a pilot study interview to investigate the views of educators in landscape architecture relative to the incorporation of research in the design process. Eight individuals agreed to participate in an individual interview and complete a questionnaire on the topic, which was provided 1 week prior to the interview. The questionnaire included both open- and closed-ended questions. Participants were informed that the open-ended questions were to be the basis of the individual interviews, and were requested to complete the closed-ended section of the questionnaire within 2 weeks of the interview. The interviews were taped, and responses were transcribed and analyzed using content analysis techniques to group comments reflecting similar attitudes. The pilot study questionnaire and interviews were followed by a pre-test of the survey instrument with a group of eight planning educators at the University of Guelph.

2.3. Questionnaire

The self-administered questionnaire was mailed to all assistant professors, associate professors, and professors listed as landscape architecture faculty in the 1998 Council for Educators in Landscape Architecture (CELA) directory. In order to maximize response rates, Dillman's Total Design Method (1978) was adopted, which recommends sending a cover letter, keeping the questionnaire short, providing an incentive such as a copy of the results, including a stamped self-addressed envelope, and sending two follow-up mailings which include a reminder letter and an additional copy of the questionnaire. The design of the questionnaire and survey implementation was consistent with Dillman's revised Tailored Design Method (2000), which attempts to "... create respondent trust and perceptions of increased rewards and reduced costs for being a respondent, ... take into account features of the survey situation, and ... overall reduction of survey error" (Dillman, 2000, p. 4), though the traditional method of a single-mode instrument and standard mail delivery were chosen as a result of sample size, potential sensitivity of the survey topic, and limitations of electronic media at the time of administration. The survey was sent to a total of 490 individuals on 30 March 1999. Follow-up mailings of a reminder letter and an additional copy of the questionnaire were sent on both 27 April 1999, and on 19 May 1999. Two percent ($n = 9$) of recipients contacted us to say that they felt they should not be included in the study. Another 10 individuals either returned the survey incomplete because they had no time to fill it in ($n = 4$) or because they had moved or were on leave ($n = 6$). Considering the nineteen unanswered questionnaires our adjusted return rate was 63% ($n = 297$). Dillman's Total Design Method commonly receives response rates ranging from 58 to 92%, with an average of 74%. As such, this return rate is within the range reported by Dillman (1978, 2000) and comparable with other surveys of this population (Chenoweth and Chidister, 1983). Babbie (1990) considers return

rates over 50% as acceptable for analysis, though there is some concern that respondents may not be entirely representative of the entire population.[2]

The questionnaire was designed to identify how educators perceived research as being incorporated into the design process. Questions on demographic characteristics, exposure to research, research productivity, world view, and attitudes toward research were included to provide insight into responses to the research—design questions and identify potential correlations between attitude to the research—design relationship and background and experience. Questions were based on three sources: Chenoweth and Chidister's (1983) survey of the same population on the topic of research in landscape architecture; literature in the areas of design, psychology, research, and survey methods, and responses to the pilot study interviews and pre-test survey. The questionnaire included only closed-ended questions with a comment area at the end, and involved nominal, ordinal, and ratio level data. Attitude questions were primarily ordinal level scales, chosen to minimize completion time and maximize response rate, as well as to facilitate analysis.

3. Results

3.1. Literature categories

The literature provides models to represent the relationship of research which informs the content of design, and the design process itself. It also identifies the variations of design approach as dependent on the individual and the project structure. While there is some overlap between the models, for the purposes of analysis they were treated as discrete approaches. The analysis of the literature suggests that research is collected and analyzed then incorporated into the design process as:

- Criteria against which design concepts are tested and modified (the concept–test and analysis–synthesis models) (Zube, 1980; Akin, 1981; Ledewitz, 1985; Oxman, 1986; Dutton, 1987; Gelernter, 1988; Schön, 1988; Lyle, 1999); or
- Experiences and information which aid in the creation of general principles which are then used to assess specific design situations and evaluate alternatives (the experiential model) (Akin, 1981); or
- An intellectual framework for design which is assessed according to criteria established by rigorous research and behavioral studies (the complex intellectual activity model) (Lawson, 1980; Ledewitz, 1985); or
- Subconscious understanding of issues and problems (the associationist model) (Schön, 1963; Lawson, 1980; Ledewitz, 1985).

The variation in approaches described by the literature could be a reflection of changing paradigms in the design professions. Ian McHarg (1997) discusses a dissension in the profession of landscape architecture after World War I that resulted in two dominant paradigms: conservation/planning and aesthetics. By his definition, planning is the "process whereby a region is understood as a biophysical and social process" and design "follows planning and introduces the subject of form" (McHarg, 1997, p. 321).[3] Thus, the analysis–synthesis and complex intellectual activity models are planning-oriented, as they are dominated by the analysis of physical and social factors, and the concept–test, experiential, and associationist models are design-oriented, as they are dominated by the provision of form. Regardless, as presented by the literature, each model is inclusive of both planning and design as defined by McHarg (1997), though with greater or lesser focus on aesthetic factors.

3.1.1. The concept–test model

The design process is described and defined in many ways, perhaps reflecting the approaches taken by individuals with varying backgrounds, levels of experience, and personalities. Donald Schön has done extensive research in the area of design concept

[2] In the 1970s, return rates above 70% were reported as a result of using the Dillman method (Dillman, 1978). There is evidence, however, that subject cooperation with questionnaires may be declining, as evidenced by dropping response rates to government surveys and censuses, which traditionally have higher response rates than other types of surveys (Heberlein and Baumgartner, 1978, Dillman et al., 1993, Willits and Luloff, 1995). Based on Chenoweth and Chidister's research (1983), it is anticipated that if a bias exists as a result of response/non-response, it will be in the direction of positive attitudes to research and research behaviours, which will result in favourable estimates of most characteristics.

[3] Or, as noted by one participant: "... planning is the basis for design—design is the fruition of planning".

formulation and function. He theorizes that the creation of new design concepts involves the projection of old ideas to new problems, followed by the assessment and alteration of the ideas to allow for situational differences (Schön, 1963). He defines a design paradigm whereby the individual looks for patterns in phenomena, makes use of past experiences in evaluating design options, and tests concepts according to predetermined criteria (Schön, 1988). Lynch and Hack (1984) describe a similar process which involves "incremental adaptation" (p. 130): experiences are collected to enable a cycle of reframing, testing, and invention.

A mental repertoire of situations, schema, exemplars, images, precedents, themes, and typologies may also be used to define a concept, evaluate its appropriateness, test its functionality, and redefine the concept (Lawson, 1980; Lynch and Hack, 1984; Schön, 1984; Ledewitz, 1985). Ledewitz (1985) proposes that design is a dialogue between preconception and reality: the personal repertoire of typologies and images inspires design, and research tests the appropriateness or potential success of the design. This repertoire seems to be the product of lectures, library research, site visits, precedent analysis, behavioral studies, and personal experience and preference. Lyle describes the cyclical process of generating a concept and testing and revision as "proposing and disposing" (Lyle, 1999, p. 128), and asserts that it is a dualistic sequence of analytic activity and intuitive leap.

As illustrated by Fig. 1, the concept–test model can be theorized as involving the generation of ideas from the individual's repertoire of images and design solutions. One or more concepts are defined through an intuitive design process, the concept is evaluated based on predetermined criteria which assesses its appropriateness and functionality, and the concept is refined. The relative merits of each potential solution are considered, and a preferred solution is identified and proposed. Shown graphically, the process is one of overlaying a series of concepts on the design problem, modifying one or more of them for "best fit" and identifying a preference (Fig. 2). As such, the designer develops a personal repertoire through exposure to other designs, experiences and ideas. Once that repertoire is accessed and used to develop a concept, the individual assesses it based on criteria developed from that same repertoire. The design is both based on, and a reflection of, the cognitive and emotive schema of the individual. Those schema provide the understanding which supports the design, and the design solution contributes a new variation to the schema.

3.1.2. The analysis–synthesis model

It could be argued that the analysis–synthesis model has been one of the two traditional paradigms in

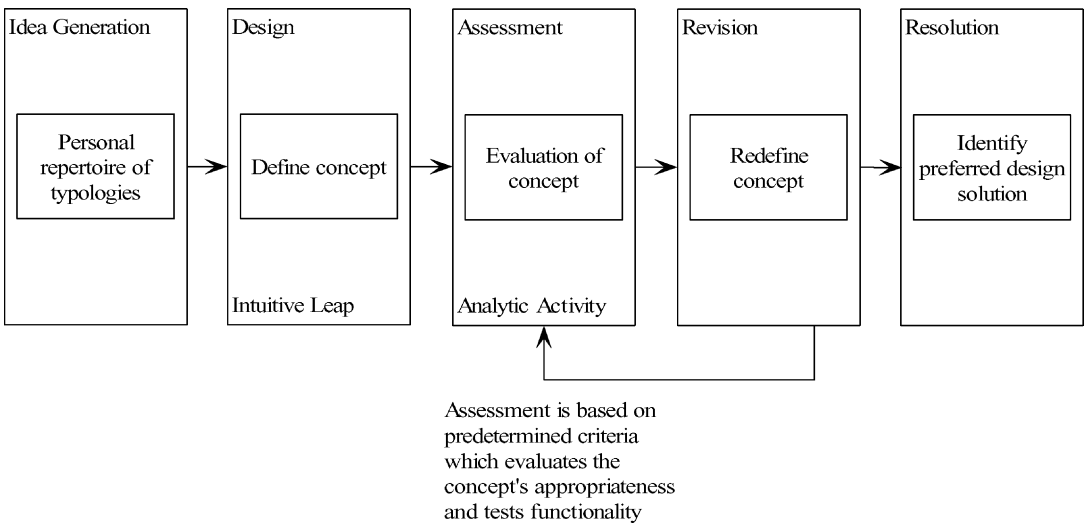

Fig. 1. Relationship between research and design as identified by the concept–test model.

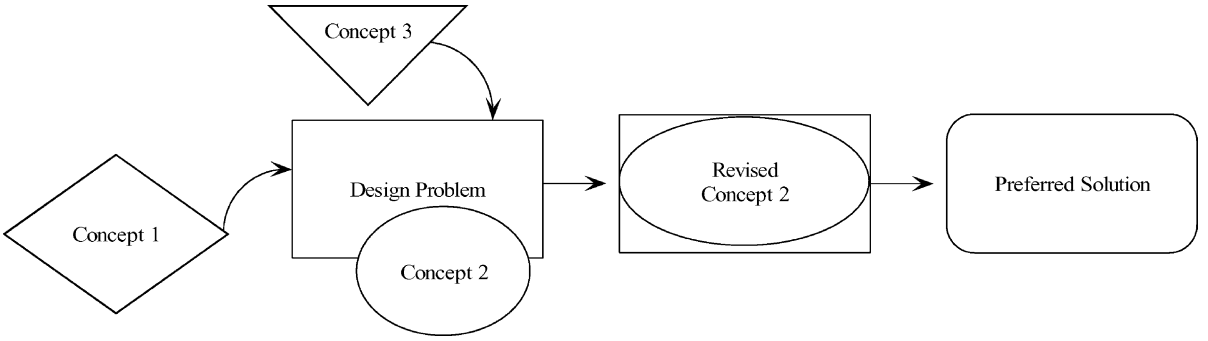

Fig. 2. Schematic diagram of the concept–test model.

landscape architecture, resulting from the influence of key figures, such as McHarg (1969), Marsh (1997), Lyle (1999), Steiner (2000), and LaGro (2001). This model defines the project as a vehicle for incorporating information collected in various ways while expressing design proficiency (Oxman, 1986). It is a didactic approach that defines design as a process in which standard rules are applied, general and more specific data are analyzed, and new ideas are developed and tested (Schön, 1988). Akin (1981) describes this process as the acquisition of knowledge, the application of knowledge, and the assimilation or understanding of knowledge. Applying common landscape architectural terminology to the sequence, it becomes the analysis–synthesis–evaluation model described by Zube (1980), Ledewitz (1985), and Dutton (1987), or the assimilation, general study, development, communication work plan described by the Royal Institute of British Architects (RIBA) (Lawson, 1980). This model involves several important assumptions: research information is provided before the onset of the project; the mind collects this information and stores it until a situation arises where it can be applied (Gelernter, 1988); the problem is broken down into elements; the information is accessed, analyzed, and applied to the appropriate elements of the design; the elements are synthesized to create a coherent design or plan; and results are evaluated and stored for future use (Lawson, 1980; Ledewitz, 1985).

As illustrated by Fig. 3, research involves the acquisition and assessment of knowledge to produce general rules. Design is a process involving the division of the design problem into discrete elements for the purpose of analysis and evaluation through the use of research information. After analysis, the discrete elements are synthesized into a coherent whole. The final stage

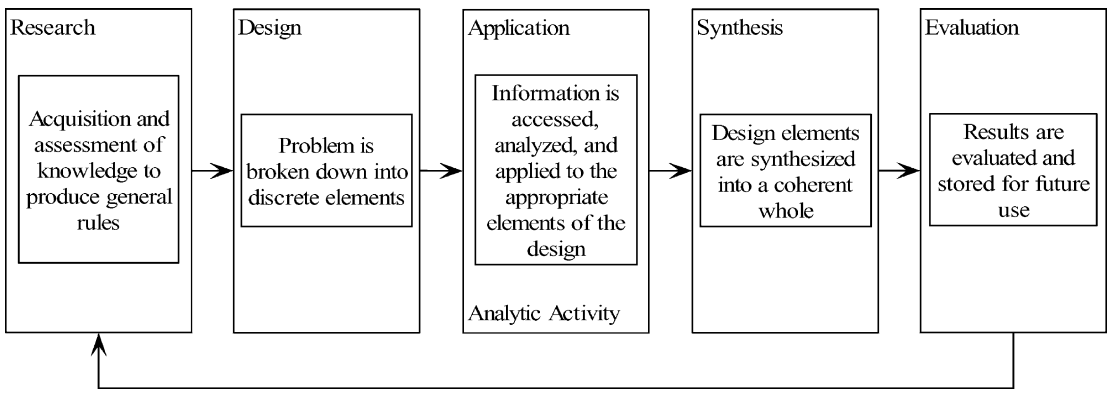

Fig. 3. Relationship between research and design as identified by the analysis–synthesis model.

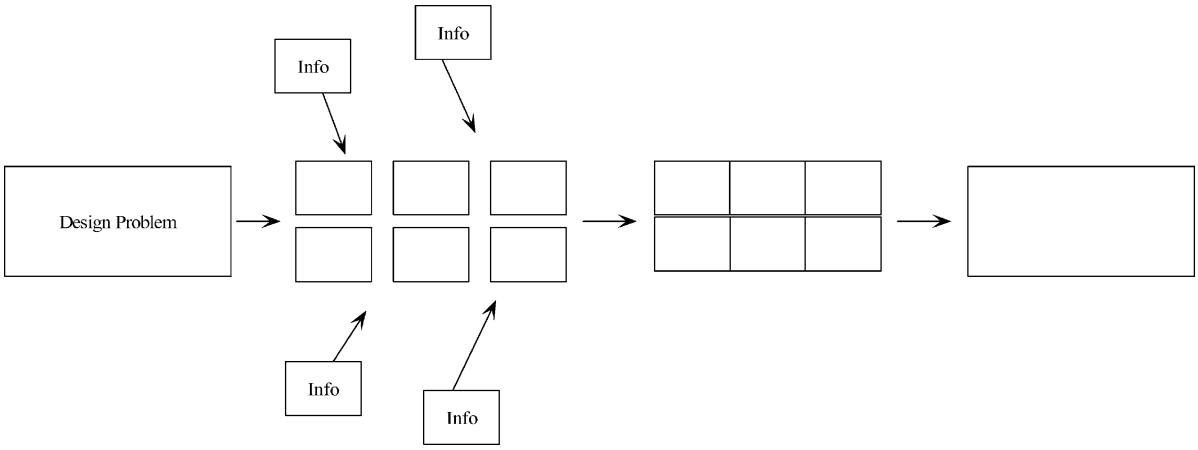

Fig. 4. Schematic diagram of the analysis–synthesis model.

involves evaluation of the results after implementation for the purposes of improving future projects. Shown graphically, the process is one of applying information to distinct sections or layers of the problem or site, and then recombining the sections or layers into a contiguous whole (Fig. 4). Thus, once the information is applied to the problem, the designer synthesizes the analyzed components, producing a design which is a weighted (hierarchical) amalgamation of site features, characteristics and program, as determined by performance criteria. The research provides knowledge to make the design functional and appropriate, and the design is a vehicle for the performance criteria.

3.1.3. The experiential model

An alternative experiential model, which concurrently incorporates the collection and application of information to design, is presented by Akin (1981). This process involves experiencing the consequences of specific design decisions, abstracting general principles applicable to design situations, applying general principles to specific situations, and assimilating the knowledge acquired through evaluation of the design. In this approach, knowledge is acquired through trial and error and information is accessed and applied at all points in the process. The process is cyclical as well as logical, and theoretically incorporates a broad range of research techniques, from ‘implicit’ or designer generated understanding, to ‘explicit’ or precedent, behavioral, applied, and experimental research.

As illustrated by Figs. 5 and 6, the experiential model incorporates the evaluation of design precedents at both ends of the design process. Prior to design, experience determines principles which are the basis of idea generation. After design, construction provides information for the revision of those design principles. For example, once the general principles have been developed and applied to the problem, the individual creates a design solution which is inspired by past design and construction experiences. Their experience provides knowledge to make the design functional and appealing, and the evaluation of the built design facilitates the modification of old principles or the development of new ones.

3.1.4. The complex intellectual activity model

Ledewitz (1985) presents a fourth model, design as a complex intellectual activity. This model describes the design process as the examination of the design problem through the assessment of a series of complex and inter-related components. The problem is solved as a result of the analysis of information provided through research and scientific activity, thereby producing a design. This model is consistent with Gestalt theories of thinking which, applied to the design process, would suggest that the individual would deconstruct the problem into a series of structural relationships which are then reorganized through reframing of the problem, use of similar situations, and trial and error until an appropriate solution is attained

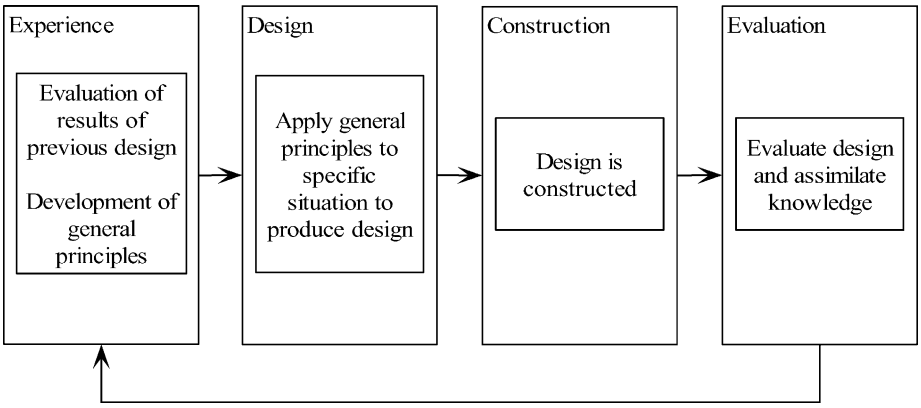

Fig. 5. Relationship between research and design as identified by the experiential model.

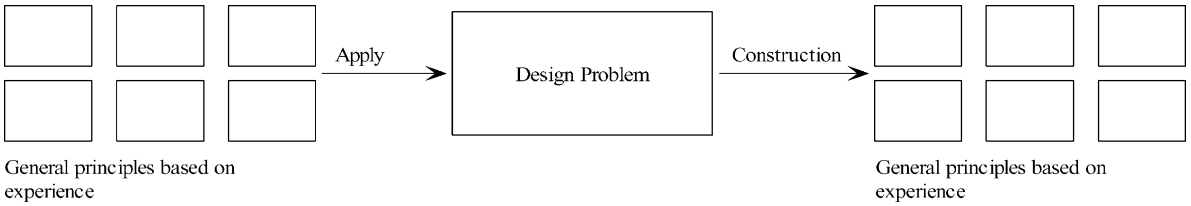

Fig. 6. Schematic diagram of the experiential model.

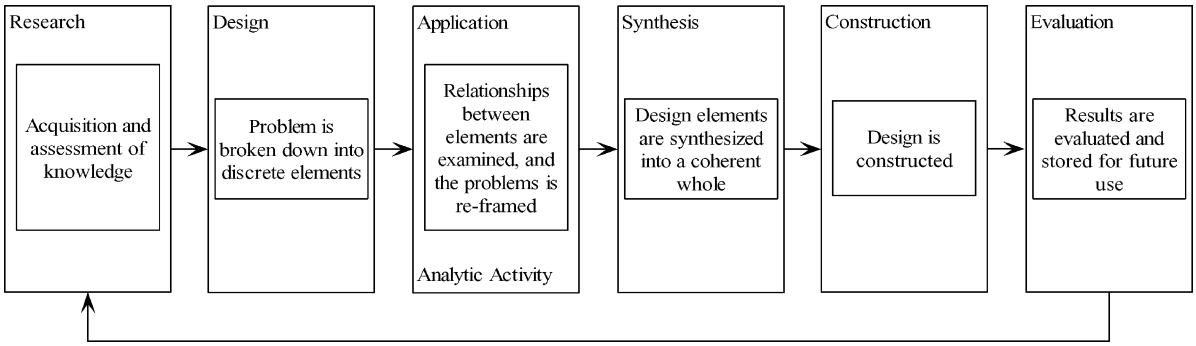

Fig. 7. Relationship between research and design as identified by the complex intellectual activity model.

(Wertheimer, 1959; Lawson, 1980; Motloch, 1991). The thought process involved in the analysis–synthesis approach is highly influenced by the context in which the problem is perceived.

As illustrated by Figs. 7 and 8,[4] this model is defined by its focus on interaction: both in terms of the components of the design problem, and in terms of the relationship between research and design. Research is applied to the design problem, which determines the approach and analytical components. The elements are analyzed not only as discrete components, but the complex relationships between components are also assessed. This process ideally leads to a more complete understanding of the issues inherent in the design problem, and an integrated solution which

[4] One reviewer noted a similarity between part of this schematic and Steiner's Ecological Planning Model (1991, p. 10).

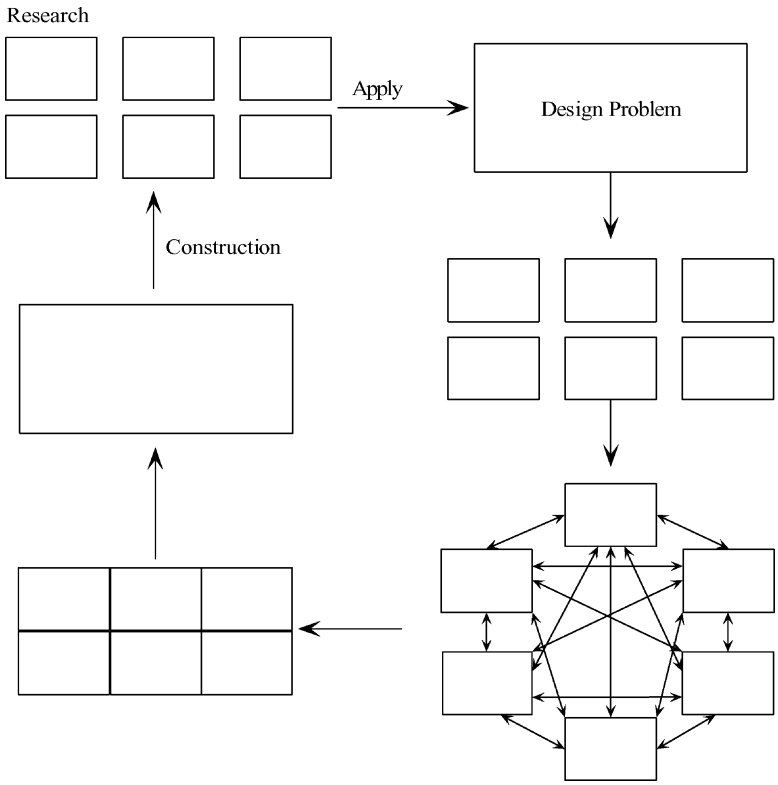

Fig. 8. Schematic diagram of the complex intellectual activity model.

synthesizes the designer's understanding and available research data. Construction provides the opportunity to assess the impacts and relative success of the design, this process informs future design endeavors. Research provides the tools for examining the problem components and their relationships, and the individual synthesizes the component solutions into a functional resolution. The research provides knowledge to make the design appropriate and functional, and the design provides insights for solving future problems.

3.1.5. The associationist model

Ledewitz (1985) identifies design as mysterious artistic inspiration, whereby the design process is personal and unrelated to cognitive analysis. Research information is internalized and informs the content of design without conscious consideration. Unlike the structured heuristic or trial and error approach described by Akin (1981), the artistic inspiration or associationist model approaches design problem-solving as free form exploration or mental association. A form of day dreaming, the associationist approach encourages the individual to relinquish control of their thought process or direction, and allow thoughts to wander (Lawson, 1980). Gestalt theorists contend that new concepts are not simply recombined old ideas, but rather have a separate value greater than the additive value of the parts (Wertheimer, 1959).

As illustrated by Figs. 9 and 10, this model is distinguished by its basis in the unconscious: free form exploration and processes of mental association provide insights which form the basis of the design. The design is revised based on an instinctive understanding of human or natural characteristics or preferences, and it is a synthesis of instinct and expression. Once the unconscious is accessed, the individual creates and articulates a connection between the problem and the idea. The unconscious generates the idea for the design, and the design broadens the unconscious mind's repertoire of approaches/solutions/ideas.

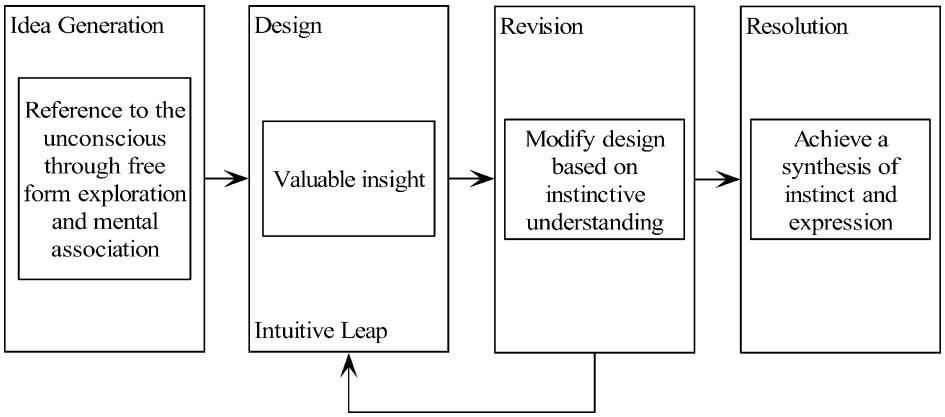

Fig. 9. Relationship between research and design as identified by the associationist model.

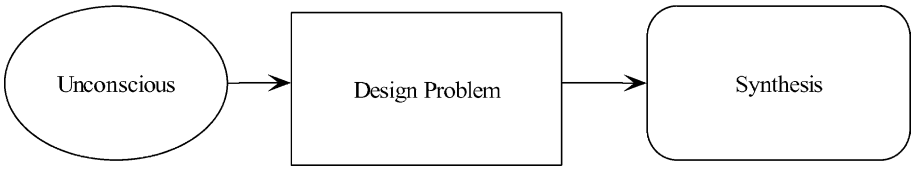

Fig. 10. Schematic diagram of the associationist model.

3.1.6. Comparison of the five models

Table 1 highlights the similarities and differences between the models. The analysis–synthesis and complex intellectual activity models are distinct from the other models because of their focus on the site for ideas and design concepts, and for their tendency to break down the problem into components, rather than taking a holistic approach. The concept–test and associationist models are similar in that they draw upon the cognitive and emotive resources of the designer for idea and concept generation, and take a holistic approach to design. The experiential model is unique in its conscious use of experience for idea generation. In summary, the models are differentiated by several characteristics:

- Source of ideas or concepts
- Inclusion of a pre-design research phase
- Inclusion of a post-construction evaluation phase; and
- A holistic, discrete, or interactive approach to problem solving

Table 1
Comparison of literature models

Model	Source of ideas or concepts	Pre-design research phase	Post-construction evaluation phase	Approach to problem solving
Concept/test model	Personal repertoire	No	No	Holistic
Analysis/synthesis model	Site	Yes	Yes	Discrete
Experiential model	Experience	Yes	Yes	Holistic
Complex intellectual activity model	Site	Yes	Yes	Interactive
Associationist model	Unconscious	No	No	Holistic

It could be argued that each model provides a partial understanding of the relationship between research and design and that the complexity of today's design problems require an amalgamation of these approaches. The variation in approaches identified by the literature is likely a reflection of societal changes in attitudes towards the role of the designer and perspectives on cognitive processing.

The literature presents the models as mutually exclusive, and the individual is described as choosing one over the others as their primary framework for addressing the relationship between research and design. The five models identified above were used to develop the questions for the in-depth interviews and the surveys.

3.2. Interviews

The content analysis of the interviews supported the literature categories, though the results suggested that:

- the concept–test model and the analysis–synthesis model were used more frequently than the other three;
- the associationist model was used least often; and
- the models were not necessarily distinct, but an interaction might occur which was previously unidentified.

Further analysis using inductive analysis techniques[5] was undertaken after the analysis of the questionnaire results. This analysis clarified and suggested explanations for some seeming anomalies in the survey data.

3.3. Questionnaire

The results of the questionnaire supported the literature categories as an aggregate, but contradicted the literature's assumption of distinction. The respondents claimed to embrace to some extent four of the five models: their design process was inclusive of concept–test processes, analysis–synthesis, complex intellectual activities, and associationist processes (Table 2). Responses to the experiential questions were mixed. No one model was embraced by any one respondent over the others, and the five models were considered complementary and congruous. Correlations between the individual questions for each model were weak to moderate, ranging from −0.015 for the experience questions (34 and 37) to 0.551 for two of the complex intellectual activity questions (29 and 32). The lack of consistency in the correlations between the individual questions addressing the models suggested that factors other than the techniques used to incorporate research into the design process were influencing question responses.

These factors were explored by subjecting the eleven questions to a factor analysis using SPSS principle components analysis with a varimax rotation (Tables 3 and 4). Factors resulted which suggest that attitudes toward the integration of research in the design process can be defined by five indicators:

- Factor 1: When information is collected and used
- Factor 2: How information is understood
- Factor 3: How research is used
- Factor 4: Quality of research
- Factor 5: Types of useful research

The factor loadings indicate that each factor is representative of a proportion of the variance found in the attitudes, and each factor is highly independent of the others (Babbie, 1995), as well as being substantively equally significant.

3.4. Consolidated results

The lack of consistency of the results with the distinct models presented in the literature encouraged the researchers to undertake an extensive consolidated analysis of the surveys and interviews, using inductive analysis techniques to identify new categories and inter-relationships.

Further analysis of the interview data suggests that the relationship between research and design is defined by timing of research, type of research, function of research, and approach to integration. In light of the factor analysis, these influences have been categorized as:

- Research stages (Factor 1)
- Research classes (Factor 5)

[5] Patton defines inductive analysis as "... immersion in the details and specifics of the data to discover important categories, dimensions, and interrelationships; begin[ning] by exploring genuinely open questions rather than testing theoretically derived hypotheses" (Patton, 1990, p. 40).

Table 2
Distribution of indicator question responses

		Strongly agree/agree (valid %)	Neutral/no opinion (valid %)	Strongly disagree/disagree (valid %)
Concept/test	33. Research information should be used to assess and prioritize design alternatives	86	11.3	2.7
Concept/test	35. Research information should be used to determine the potential success of a design	63.4	27.2	9.4
Analysis/synthesis	30. Research information should only be collected in the preliminary stages of the design process	7.1	10.2	82.7
Analysis/synthesis	25. Combining information gathered from written sources, experts, and on-site investigation to guide design is research	69.1	11.3	19.6
Experience	34. Research information is best understood when it is applied on a site	30.3	47	22.6
Experience	37. Only applied research is of use to landscape architects during the design process	8.8	6.1	85
Complex intellectual activity	29. Research information should be collected throughout the design process	79.6	11.6	8.8
Complex intellectual activity	32. Research information should be used throughout the design process	91.2	6.5	2.4
Complex intellectual activity	41. Research must be verified by experts in order to be acceptable for use in the design process	29.9	24.7	45.4
Associationist	31. Research information should subconsciously inform the design process	41.7	29.3	29
Associationist	26. Application of the design process and utilization of research methods are mutually exclusive approaches to solving problems	6.1	7.8	86.1

Table 3
Factor analysis eigenvalues and percentage variance explained

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	Percentage of variance	Cumulative %	Total	Percentage of variance	Cumulative %	Total	Percentage of variance	Cumulative %
1	2.661	24.187	24.187	2.661	24.187	24.187	2.087	18.977	18.977
2	1.423	12.936	37.124	1.423	12.936	37.124	1.512	13.742	32.719
3	1.265	11.503	48.627	1.265	11.503	48.627	1.463	13.302	46.021
4	1.043	9.485	58.112	1.043	9.485	58.112	1.269	11.538	57.559
5	1.010	9.180	67.292	1.010	9.180	67.292	1.071	9.732	67.292
6	0.812	7.381	74.672						
7	0.671	6.100	80.772						
8	0.646	5.877	86.649						
9	0.526	4.781	91.430						
10	0.513	4.666	96.096						
11	0.429	3.904	100.000						

- Research quality (Factor 4)
- Research comprehension (Factor 2)
- Research roles (Factor 3)[6]

[6] The interview data suggest that Research Quality and Research Comprehension are less crucial in the design process than the other three factors, though they are a concern.

The final factor is the Design Model, which is a product of the integration of the previous factors and the individual's preferred design approach.

3.4.1. Research stages

According to interview participants and survey respondents, research is incorporated into the design

Table 4
Factor loadings for attitude question responses[a]

	1	2	3	4	5
30. Research information should only be collected in the preliminary stages of the design process	**−0.712**	0.146	0.035	−0.07	0.287
29. Research information should be collected throughout the design process	**0.794**	0.104	0.106	0.069	−0.04
32. Research information should be used throughout the design process	**0.625**	0.04	0.454	−0.04	−0.01
31. Research information should subconsciously inform the design process	0.052	**0.719**	−0.326	−0.04	0.192
34. Research information is best understood when it is applied on a site	−0.09	**0.76**	0.132	−0.124	−0.200
26. Application of the design process and utilization of research methods are mutually exclusive approaches to solving problems	−0.04	0.145	**−0.809**	0.142	0.048
35. Research information should be used to determine the potential success of a design	0.319	0.427	**0.438**	0.367	−0.0995
33. Research information should be used to assess and prioritize design alternatives	0.363	0.405	**0.516**	0.311	0.144
25. Combining information gathered from written sources, experts, and on-site investigation to guide design is research	0.508	0.072	−0.02	**−0.595**	0.342
41. Research must be verified by experts in order to be acceptable for use in the design process	0.138	−0.09	−0.08	**0.795**	0.125
37. Only applied research is of use to landscape architects during the design process	−0.192	−0.05	−0.03	0.043	**0.863**

Extraction method: principal component analysis. Rotation method: varimax with kaiser normalization.
[a] Rotation converged in 22 iterations.

process at three stages: before design, during design, and after design. In the words of study participants, designers need to build "... up [their] information base to respond to design" since they must "... understand the human and the natural condition *before* they can design in it" (emphasis added). As such, research occurs prior to design in order to identify the extent of the issues and options for their resolution. During design, research takes the form of "... integrative threads—an idea at the beginning is merged and integrated with others as they go along so that the thread of knowledge goes right through the design—everything from program and site analysis to perspectives proving your case" (study participant). Research "influences the organization of the design" through "exploration through design application" which provides "... options or opportunities which the research then helps ... choose the appropriate route" (study participants). Finally, research is used after design to justify "... the kind of work that they are doing. To respond to challenges it has to be substantiated—you have to persuade people of ideas. In order to effect change you have to use information as part of the defence of the idea" (study participant). Of key importance is the recognition that "designs should have a basis that can be tied back to an understanding of processes which are often based on research findings. To have credibility the designer should be able to give sound rationale for his/her design" (study participant).

The presence of a "during design" research stage is an important distinction between the study results and the literature. As identified in Table 1, the analysis–synthesis, experiential and complex intellectual activity literature models incorporate both a pre-design research phase and a post-construction evaluation phase. Neither the concept–test nor the associationist model incorporate either. Notably, however, none of the models recognize a "during design" research phase: a phase that is arguably central to three of the five models identified as a result of this study (see Table 5).

3.4.2. Research classes

Before design, there are two classes of research which are commonly undertaken: indirect research or preparatory/orientational research; and direct research. The former includes four types of research:

- Intrinsic research
- Library research

Table 5
Integrative design/research framework

	Research is ... prior to concept generation	The research ... the concept	The concept ... the research	The concept is ... on the site	Alternative concepts are ... according to research	Design approach	The site is ...	Focus
Artistic	Set aside	Is separate from	Transcends	Applied/linked to/connected with	Assessed, prioritized, judged and modified	Creative	Extraneous	Product
Intuitive	Absorbed	Inspires	Transforms	Overlayed	Assessed, prioritized, judged and modified	Emotive	Incidental	Product
Adaptive	Absorbed	Inspires	Translates	Adapted	Assessed, prioritized, judged and modified	Responsive	Contingent/conditional	Product
Analytical	Carried along	Informs	Transposes	Interpreted	Assessed, prioritized, judged and modified	Pragmatic	Important/significant/ prominent/emphasized	Process
Systematic	Carried along	Motivates	Transmits	Integrated	Assessed, prioritized, judged and modified	Formulaic	Critical/paramount	Process

- Precedent review
- Case studies[7]

Intrinsic research, also described as personal experience or experience-to-date, is a design-specific "profound understanding of human values, namely spiritual, physiological, psychological, social" (Broadbent, 1995, p. 22). One participant identifies this type of research as a "major area of contribution [which involves] ... their basic understanding or street smarts—what are people like". This form of research is based on an intrinsic understanding of human nature, movement, and preferences based in the designer's personal experience.[8]

Library research involves conducting a review of relevant literature related to "current ideas, trends, names, practitioners, precedents, projects" for the purposes of "building up [an] information base to respond to design" (study participants). It should be noted that the use of the term research as applied to a literature review is controversial. As stated by study participants, "Library research—this is normally part of scholarship generally, not a research method," and "info gathering is not research, determining the validity and reliability of info is [sic]".

Precedent review involves "... evaluating built designs aesthetically or socially, which have a satisfactory resolution" or "... looking back at other cases that are similar—taking inspiration from other works that were done before" (study participants). It is intended to develop confidence through the study of other examples of design which address similar issues.

According to Mark Francis, a case study is "... a well documented and systematic examination of the process, decision-making and outcomes of a project, which is undertaken for the purpose of informing future practice, policy, theory, and/or education" (Francis, 2001, p. 16). Study participants value the technique because it enables the designer to "... see how other people have responded to research, imperatives of their site, or other research, be it climate, soils, vegetation, psychological, etc." (study participant). Interview participants and survey respondents frequently grouped precedent review and case studies together, applying an apparently temporal distinction: if the project was modern, an examination of it was a case study, if it pre-dated 1950, the research involved a precedent review.

The second class of research is identified as direct research. This process does not necessarily involve research conceptualization, data collection, or analysis and synthesis, but rather focuses on "documentation and site inspection including plant identification" and is often "... unsystematic and [of] haphazard, inconsistent quality" (survey participants). Study participants identified their primary form of direct research as the process of site inventory and analysis, defined as site specific information collection, evaluation, and editing.[9]

3.4.3. *Research quality*

As identified above, participants largely recognize the inconsistent quality and lack of rigor of landscape architectural research. As noted by one participant, "most site related "research" is little more than data gathering from sources that have done the research already, e.g. soils maps and data about them". In general, "we are a profession based upon anecdotes and not on incremental knowledge" (study participant), which results in less rigorous research. The quality of research in landscape architecture is a controversial issue evidenced by comments from both interview and survey participants. While scholars, such as Zube (1980, 1998), Riley (1990) and LaGro (1999) call

[7] According to one participant, the survey should have distinguished between research and scholarship. "Finding what is already known is scholarship; inventing new valid and dependable knowledge is research. Your survey seems to confuse these issues. Generally site analysis is not research for the simple reason that the intent is not to generate new knowledge that can be applied to other situations. If a doctor treats your illness, it's practice; if he experiments with your treatments in order to learn how to better treat others, it's research. Also, refereed journals are not the only measure for determining whether content is likely to be valid and reusable. ... I don't do "research" on most of my projects. I collect and analyse data relating to the specific problem, and I apply knowledge derived from research to help me make decisions. I also consider experience to be a special type of informal research—the knowledge may lack rigour in its testing for validity and reliability, but that doesn't mean it is wrong. Thus, the act of doing a project (and at least informally assessing its success) helps build a knowledge base that make future decisions on similar projects have greater validity and reliability ...".

[8] Some designers value intrinsic research more highly than rigorous scholarly work. As stated by one participant, "Common sense is often worth more than an expert's opinion".

[9] Some study participants also identified surveys and interviews as central to their design process.

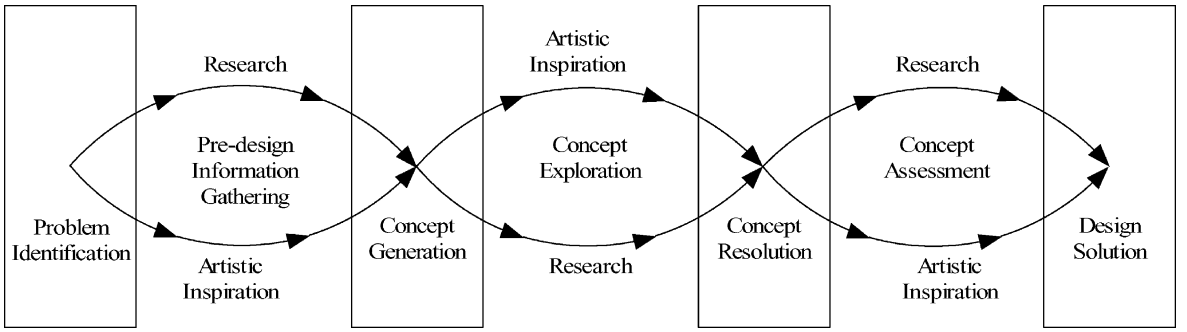

Fig. 11. Stages of the interactive research/design process.

for more rigorous research in landscape architecture, many educators and practitioners feel that design is the profession's key contribution: "with all the emphasis on research and other 'trendy' methodologies, please don't forget that Landscape Architecture is still a fine art in an era of computers and virtual 'un-reality' and we are compelled to solve problems for human needs in a world of 'standards' not originality and creativity or respect for history or nature" (study participant).

3.4.4. Research comprehension

While the literature categories suggest several perspectives on how people understand information (e.g. Ledewitz, 1985; Gelernter, 1988), study participants displayed a surprising consistency in their opinions. A relationship between acquiring and applying information is required to create a dynamic interaction between theory and practice. This interaction is central to the understanding of research information and its appropriate application. According to one educator, "I have students who will happily write a thesis on the "theory" of housing design, but haven't a clue as to how to approach siting a building cluster and grading it so you can (legally even) walk (roll a chair) from a parking area to a unit . . . "In theory, there is no difference between 'theory' and 'practice,' however, in practice there often is".

3.4.5. Research roles

The literature models identify research as having two key roles: development of criteria for concept evaluation; and development of general rules for application during design. A post-construction evaluation phase can also involve research. In contrast, the proposed models (see Table 5), illustrate an interactive relationship between research and design. The process involves four stages: problem identification; concept generation; concept resolution; and design solution (Fig. 11). Research dominates the initial and final phases, while the middle phase is dominated by artistic inspiration. Notably, both research and artistic inspiration have roles at every stage in the process. The results indicate that research is central to concept generation and the application of the concept on the site. The design models are largely differentiated by their approach to these two issues.

3.4.6. Design models

The study results (Table 5) suggest five models to explain the distinct approaches to the incorporation of research into design:

- Artistic
- Intuitive
- Adaptive
- Analytical
- Systematic

The artistic model is similar to the associationist model described by the literature. Fig. 12 schematically represents this model's relationship between

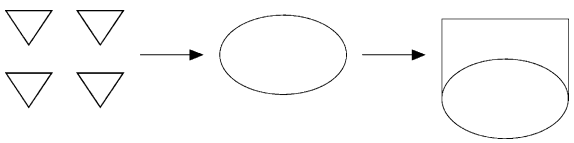

Fig. 12. Schematic diagram of the artistic model.

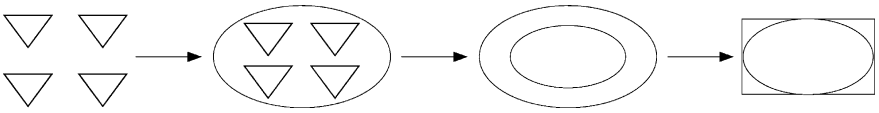

Fig. 13. Schematic diagram of the intuitive model.

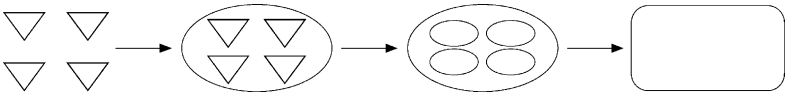

Fig. 14. Schematic diagram of the adaptive model.

research (triangular forms), design idea and concepts (oval), and the site (rectangle). Research is set aside prior to concept generation, and is separate from the concept. The concept is then applied on the site. Proponents of the artistic model see research as potentially limiting design: "too much research leads to a loss of creativity—you can not move on. At some point you have to go from all the stuff you know and move on to the way you feel about it" (study participant). Research is something which must be *transcended* to be truly creative. Nevertheless, research has its role in this model: the designer is educated and informed by available information which is used to assess, prioritize, judge and modify the concept. The design approach is creative, and the focus of the design process is the product.

The intuitive model (Fig. 13) is dominated by emotion and instinctive response. Research information (triangular forms) is absorbed and inspires the concept (oval). The concept is not a reflection of the research, but rather a transformation which involves a dialogue of idea and site (rectangle). The proponents of this model "... trust something intuitive in themselves to integrate information in when it is appropriate" (study participant). Research informs design, but must be significantly modified for use in the creative design process. The site is incidental to the design process, which focuses on the product. As stated by one study participant, you "prepare information, take it, and find a site on which to apply it ... whittle it down through subjective and graphic vision making".

The adaptive model (Fig. 14) is responsive to the site, though the process is still dominated by a focus on the design product. Like the intuitive model, research (triangular forms) is absorbed prior to concept generation (oval) and inspires the design concept. Significantly, however, the concept translates the research, it retains the form and content of the information on which it is based. The concept is adapted to the site (rectangle) as responsiveness to site and program is a concern.

The analytical model (Fig. 15) reflects a more pragmatic approach to design. Research (triangular forms) is central to the design approach: it consciously informs concept generation, and the concept (oval) transposes the research. This approach adopts both basic and applied research and recognizes that research may not be applicable to the site (rectangle) in its traditional form. Research is interpreted in light of site issues and program concerns, and interacts with the design problem. This cognitive process involves an analysis which identifies site opportunities and constraints, which in turn determine the physical and ideological framework of the design solution. The

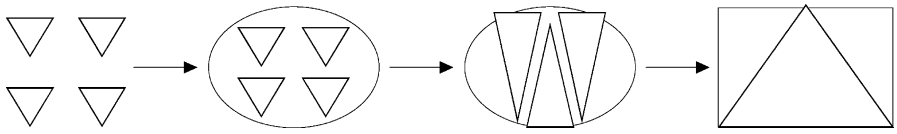

Fig. 15. Schematic diagram of the analytical model.

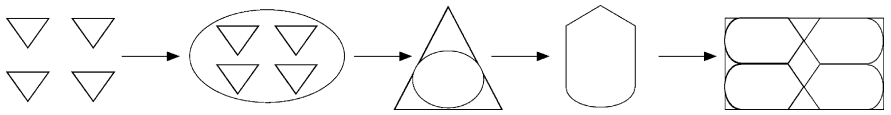

Fig. 16. Schematic diagram of the systematic model.

Table 6
Comparison of integrative design/research models

Model	Source of ideas or concepts	Pre-design research phase	During design research phase	After design research phase	Approach to problem solving
Artistic model	Subconscious	Yes	No	Yes	Interactive
Intuitive model	Research	Yes	No	Yes	Interactive
Adaptive model	Research	Yes	Yes	Yes	Interactive
Analytical model	Research	Yes	Yes	Yes	Interactive
Systematic model	Research	Yes	Yes	Yes	Interactive

analytical model emphasizes site conditions, context, and program requirements, and focuses on process rather than product.

The systematic model (Fig. 16) is similar to the analytical model in terms of the central role of research in design. In this model, however, the research (triangular forms) determines the concept (oval), and the concept is a tool for transmitting the integrated complexities of the site (rectangle). The design approach tends to be formulaic: problems are identified, standard solutions are applied, and the problem is resolved. According to one study participant, designers must "start with a good systematic template" that will help them "... define what is possible, define what is feasible and desirable and make various choices". This approach tends to see design primarily as a problem solving exercise, which is driven by established rules and procedures.

The integrative design/research framework (Table 5) differentiates between the five models based on

- what the designer does with the research before concept generation (*research is ... prior to concept generation*);
- the relationship between the research and the concept *(the research ... the concept*);
- what the designer does when they create a concept (*the concept ... the research*);
- the relationship between the concept and the site (*the concept is ... on the site*);
- the assessment of the concept (*alternative concepts are ... according to research*);
- *the design approach*;
- the role of the site in the design process (*the site is ...*); and
- the focus of the design process (*focus*).

The models are different from those in the literature in several important ways:

- all models have a pre-design research phase that educates the designer about similar sites or potential solutions;
- the adaptive, analytical, and systematic approaches consciously use research during design—as distinguished from the literature models, which do not draw research into the design process;
- all the models use research to assess, prioritize, judge and modify their design solutions, whereas the literature models lack this function;
- Similar to the complex intellectual activity model from the literature, all the models use an interactive approach to problem solving—though the design approach differs from one to the other (Table 6).[10]

These results, viewed in concert with the factor analysis, clarify the factors as follows:

- Factor 1: Research stages—when information is collected and used: before, during, and after design.

[10] Terminology in the text and Table 4 is that of the interview participants and survey respondents, or is directly based on their comments.

- Factor 2: Research comprehension—how information is understood: subconsciously, consciously, and when applied.
- Factor 3: Research roles—how research is used: to generate concepts, assess, rank, judge and modify alternatives, and to determine the potential success of a design.
- Factor 4: Research quality—available research is often too specific or of inconsistent quality for use in the design process.
- Factor 5: Research classes—types of useful research: intrinsic research, library research, precedent reviews, case studies, and site inventory and analysis are useful during design.

4. Discussion and conclusions

As shown by the results of this study, the key issue in understanding the relationship between research and design is not an adequate understanding of the design process, but rather the definition and application of research. Definitions of research are highly individual and linked to field of expertise. Zube (1980) argued that research spans a range of activities, from casual observation to scientific inquiry. He recognized that the inclusion of library research or on-site inventories as contributions to a larger body of knowledge is contested, though rarely by landscape architects. The value of research, on the other hand, is accepted as evidenced by the positive attitudes displayed by the respondents to the survey, and the almost seamless incorporation of research results (as variously defined) into the design process. The framework suggests that the introduction of research into design can lead to a more rational, objective process without a loss of creativity or synthesis. It also provides flexibility for the individuality and prescription which are inherent parts of design. Finally, the model illustrates that the categories presented by the literature lack an understanding of the complexity of the relationship between research and design, and the many ways the two interact and combine throughout the design process. The model provides the justification and rationale for the integration of research in the design process, and should facilitate the communication of design ideas and products to students, educators, practitioners, and the public.

The complexity of the relationship between research and design evidenced by the models is a reflection of landscape architecture's increasing willingness to struggle with progressively more complex problems requiring ever more sophisticated solutions. Society continues to demand environmental and social appropriateness, unique and creative solutions, rationale and justification for designs, and prescriptive understanding about the implications and functioning of a proposed design. These demands have resulted in a changing approach to design and design education that reflects the movement from modernism to post-modernism.

Educators in design professions such as landscape architecture, architecture, planning, and interior design have the responsibility of teaching students the skills which will not only allow them to convert research data into designs, but also to express those images and design ideas in written and verbal form. In order to do this, educators must understand how they themselves move from numeric and semantic to visual data. Understanding and resolving the dichotomy of words and images is crucial to today's problem-solving processes, whereby design "... is not the aggregation of objectively-derived facts, but a dialectic between pre-conceived solutions and observed facts" (Ledewitz, 1985, p. 4). Unfortunately, this connection and the dominance of information and technology encourages the designer to be increasingly dependent on pre-conceived ideas (Hillier et al., 1976) and easily accessible information, without the rigor of scientific inquiry, immediate experience, or objectivity. Thus, the availability of information in one form discourages the striving for information in another, thereby encouraging a mechanization of individual thinking and dependence on words rather than thinking and design (Hillier et al., 1976; Lawson, 1980; Tufte, 1990, 1997, 2001). Schön's response to this problem is to argue that educators should teach "... what scientists do instead of their results" (1988, p. 4), thereby, providing individuals with the tools and methods for scientific inquiry without restraining creative thought.

The adoption of an integrative approach to problem solving using approaches ranging from the creative to the formulaic is a recognition of the societal demand for environmental and social appropriateness, unique and creative solutions, justification of design decisions, and prescriptive understanding about the

implications and functioning of design solutions. These models recognize that the relationship between acquiring and applying information should be both interactive and recurring. According to one participant, this results in "... a simultaneous awareness of what is and what should be".

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