

CHAPTER TWO

DESIGN METHODS AND PROCESS

This chapter reviews the basic concepts of design problems, methods, and processes. It presents the pertinent research studies on site analysis and discusses its position in the design process. The chapter also shows the relevance of these studies in implications for this research.

2.1 Design Problems

Since the Greeks, the western philosophical tradition has focused on propositional knowledge, which asks the classical epistemological questions about truth or falsity, and the evidence for asserted claims, and their relations to other problems. Design problems are related to these various epistemological questions. According to Lawson's research (1980), design problems are hard to define. He argues that designers make contributions to the interpretation of a problem, while searching for solutions in the design process, both of which require skilled and subjective judgment. Therefore, designers sometimes modify the rules and their infrastructures in the process of design.

Meanwhile, others differentiate design problems based on different types of knowledge. For instance, Rittel (1972) argues that information, which can be viewed as "a process," leads to knowledge, and that time can also be an element of knowledge. The process can be the "paradigmatic revolution," meaning an entire system is broken into pieces, or a new entity arises. Rittel categorizes complex design and planning knowledge into five types: *factual knowledge* reflects the recognition among participants; *deontic knowledge* describes the ideal situation; *explanatory knowledge* provides reasons for the deontic knowledge and is used to find the solution to the problem; *instrumental knowledge* reflects

the consequences of design and planning tasks under certain conditions; and *conceptual knowledge* aids in communication.

Similarly, many attempts have been made to define architectural design. Some define it in terms of certain well-established fields. For example, Rowe (1987) points out that design is often located in an ambivalent position between the forms of fine art and technical science (Figure 2-1a). Vitruvius asserts that the basic factors of architecture are providing firmness, commodity, and delight (Figure 2-1b). Later and still accepted is that the theory of evaluating successful designs is more or less based on Vitruvius' three factors of architecture and emphasizes one of these factors. One example is that contemporary linguistic studies use similar terms (syntactic, pragmatic, and semantic) to those used by Vitruvius.

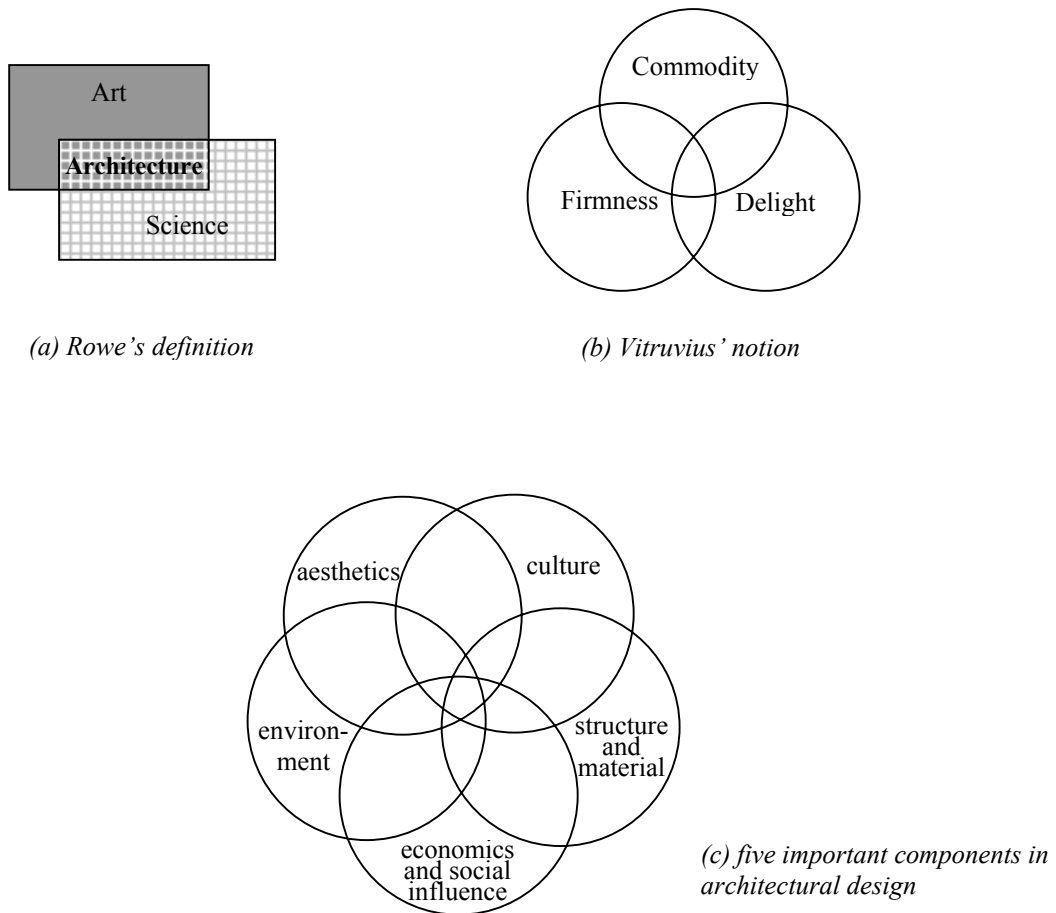


Figure 2-1 Architectural design definitions

Since the early nineteenth century, the environmental influence and cultural context also have become important concerns in architectural design. In the introduction of *Environmental Aesthetics*, Sadler and Carlson (1982) indicate that the aesthetic properties “of the physical world include formal qualities of beauty, such as balance and contrast, which are highly valued in the arts and underlie much empirical research in environmental aesthetics, and a number of different kinds of non-formal ones” (p.4). Various theories of ecological systems in the past forty years have similar interests in culture and society, economy, and environmental science. Sim Van der Ryn and Cowan (1996), realize that ecological design provides the opportunity for a shared understanding of the design problem, suggesting a “participatory” process to exchange technical disciplinary languages and break down barriers between professionals and users. Theories and insights from their studies not only provide designers with an interdisciplinary knowledge and understanding of projects, such as energy resources and regional economy, but also promote collaborative community participation involving users at large.

Therefore, current curricula of architectural schools and principles of design professions suggest that there are at least five important components in design: aesthetics, culture, environment, structure and materials, and economics and social influence (Figure 2-1c). Designers are expected to consider these components throughout every phase of the design process.

2.2 Design Methods and Process

2.2.1 Design Methods Studies

The objective of design methods studies, which began in the late 1950s, is to recapture design decision-making activities so that designers can follow a defined procedure from the formulation of the program to its final solution effectively and efficiently. Thus, design activities would be communicative, comparable, reversible, and repeatable. Jones identifies six approaches to design methods: “black box,” “glass box,” problem structure, control, observation, and evolution, the first three of which were well addressed in various publications in the 1960s (Broadbent, 1969).

The “black box” approach concerns the creativity and mystery of design. It sees design as an abstract process that occurs in the mind of any given designer. As such, design cannot be analyzed, but techniques such as brainstorming and the application of synetics are helpful in visualizing the design process.

The “glass box” approach analyzes design based on its logical process and decision sequence. The design process is a sequence of events, which includes identification, analysis, synthesis, and evaluation. Useful methods in this approach include systems analysis, operational research, critical path, set theory, logical model, “feed-forward,” and design territory map (Broadbent, 1969). Archer (1969) proposes a logical model that assembles sets of skills, sensibilities, and disciplines. The overall conceptual framework also links different techniques and emphases in various stages. The three major components are the project processing timeline, a number of analogues in one or more systematic models, and a reiterative problem-solving routine (Figure 2-2).

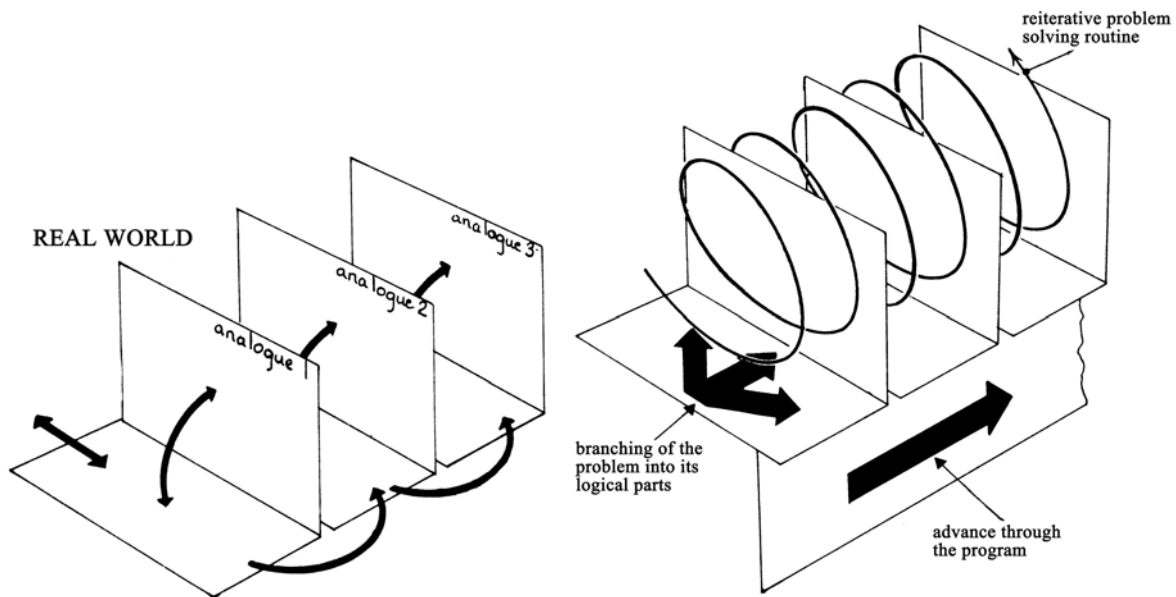


Figure 2-2 Design process (Archer, 1969, p.94 and p.100)

Markus (1969) also observes that there are two distinct design structures: a sequential process and an iterative process. On one hand, the sequential process transforms an activity to a later one. Each step inherits the output from the previous one and also becomes an input for the next step. A design failure occurs when retracting steps to an earlier one. The handbook from the Royal Institute of British Architects (RIBA), for example, includes a

sequential structure of the design process. The handbook lists twelve major chronological phases in the design process, starting with identification of a program to post-construction feedback (Table 2-1). On the other hand, the iterative and cyclic process of the design is

Table 2-1 Twelve chronological phases in the processes (Markus, 1969)

1. Inception	7. Bills of quantities
2. Feasibility	8. Tender action
3. Outline proposals	9. Project planning
4. Scheme design	10. Operation on site
5. Detail design	11. Completion
6. Production information	12. Feedback

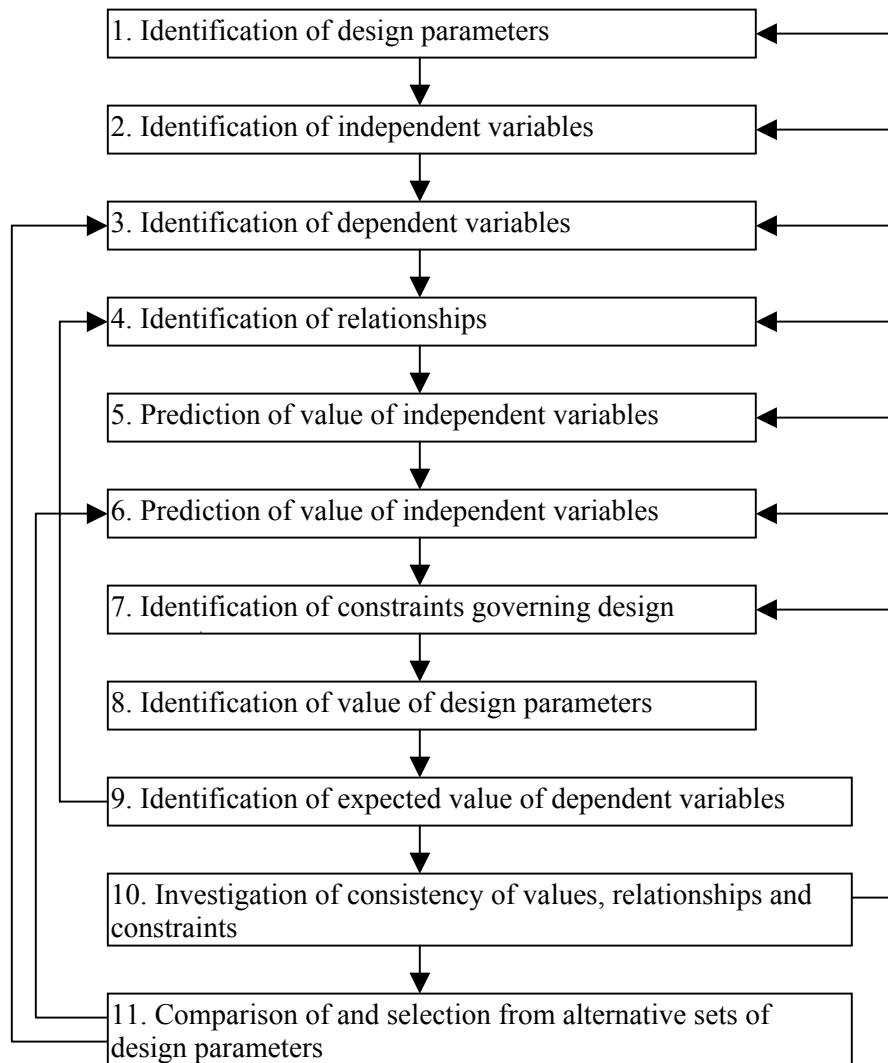


Figure 2-3 Eleven stages in the decision sequence (Markus, 1969)

referred to as a decision-making process such as Levin’s eleven stages. The vital differences between the sequential and the iterative processes are the feedback loops. In the RIBA handbook, step twelve, “feedback,” can only contribute to solving the “next problem” because it is too late to change the design at the completion of the project. However, if a feedback analysis provides an unsatisfactory solution in a decision sequence, the sequence can start again from a certain intermediate stage. For example, in Levin’s eleven-stage decision sequence (Figure 2-3), designers can compare and select alternatives (stage eleven) by referring back to identify variables and their relationships (stages three and six).

The approach of the third method, “problem structure,” consists of many variations, including morphological analysis, analysis of inter-connected decision areas, decomposition analysis, and relational theory. Asimow (1962) divides the overall design process into seven phases, beginning with a feasibility study. For each of its phases (feasibility, preliminary, and detailed design; and planning for production, distribution, consumption, and retirement), he also develops a morphological analysis. Figure 2-4 shows Asimow’s diagram for a preliminary design. The objective in this phase is to identify the best design from a number of alternatives.

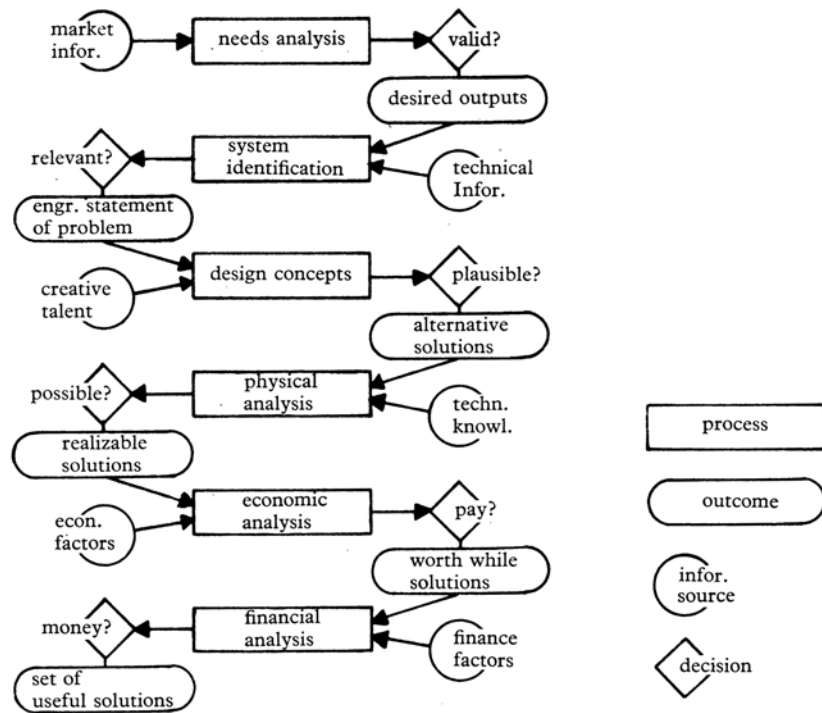


Figure 2-4 Diagram for a preliminary design (Asimow, 1962).

Alexander (1964) also offers a “decomposition” method to divide the problems into “fit” and “misfit” variables. This method evaluates variables based on their ability to connect with others. Then, diagrams that geometrically show the characteristics of each group of “misfit” variables are combined and modified to solve the problem. In practice, Guerra (1969) uses this method starting with collecting data sets, investigating available sites and the physical site, and checking generalized human needs.

2.2.2 *Popper’s Influence*

However, Sullivan and Hillier (1972) observe that problems appear when the investment in design methods does not match the “deterioration” of building quality. The major criticism of the “glass box” approach is its focus on the development of art rather than its concern for the practical aspects of actual buildings. Guerra’s results also show that Alexander’s theoretical method does not always work out because of difficulties in defining diagrams, or because diagrams are misleading. Laudau (1965) further points out the need to reconsider the impact of scientific analysis on design approaches.

As a result, the evolution of design methods comes from Popper’s philosophy of science and from the systems approach to problem solving. Popper offers a revolutionary solution to the “problem of induction” in science by using the “deductive method of testing,” which is based on an asymmetry between verification and falsification (Popper, 1988). He argues that science proceeds by a process of conjecture and refutation. The process starts with a conjecture and try to falsify it; it then succeeds, move on to the next conjecture until a conjecture is found that is not falsified. Popper also bridges the gap between science and art. Magee summarizes Popper’s explanation with the following:

[Scientific] theories are not bodies of impersonal facts about the world but are products of the human mind makes them personal achievement of an astonishing order. Scientific creation is not free in the same sense as artistic creation for it has to survive a detailed confrontation with experience: nevertheless the attempt to understand the world is an open task, and as creative geniuses Galileo, Newton and Einstein are on a par with Michelangelo, Shakespeare and Beethoven (Magee, 1973, p.23).

Therefore, design can be considered to be an iterative, “trial-and-error” process that relies on knowledge, experience, and intuition. Rzevski (1980) further suggests four features of the design process – design is (1) an investigative process, (2) a creative process, (3) a rational process, and (4) a decision-making process. The problem-solving framework involves four steps: understanding a design problem, generating a tentative solution, iteratively testing and refining details, and finally, outputting a design solution, which suggests a new design problem in the future. According to Wang, Popper’s philosophy has “fundamentally reshaped the design process” (2002). He compares the traditional and Popperian’s design process in the following diagram:

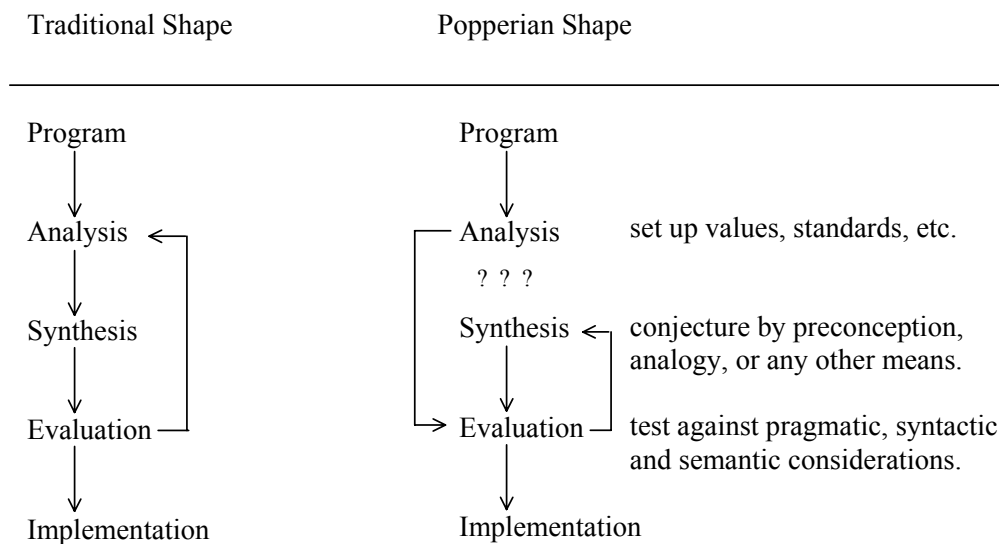


Figure 2-5 Diagram adapted from Broadbent (Wang, 2002)

2.2.3 Computerized Information Systems

In the past twenty years, researchers have studied new design methods including computerized information systems. Based on the theory of intelligent design choice, Simon (1981) contends that there are three functional elements of design: conception, development and implementation. The identification of these functional elements of design is subject to the dynamic nature of the design process and does not imply only a simple sequential relationship (Figure 2-6). Jacques and Powell (1980) expand the range of design methods

into computerized information systems by exploring concerns about data analysis techniques, structured methods, and user participation alternatives. The structured system indicates a hierarchical structure with black-box abstractions, a top-down refinement process, functional modules, and decomposition halts at appropriate levels.

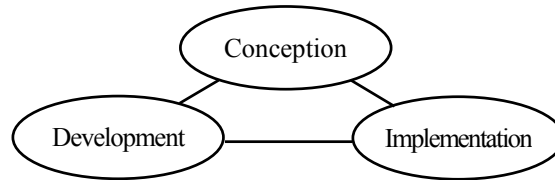


Figure 2-6 Three functional elements of the design process

2.3 Site Analysis

According to LaGro, building sites are the smallest units in a broad range of spatial scales when performing site analyses. In regional planning or at a large-scale project development level, the objective is to choose an ideal location for development. Land evaluation involves semi-detailed surveys and site analyses of selected area. The objective of site planning is to conform with the site master plan. Major tasks of site planning are detailed surveys and site analyses of confirmed development area. The objective of site design is to technically design site programs, using very detailed site analysis (Kim, 1994). Both landscape architects and architects are involved in site analysis. Architects focus on building designs and their relationship to their site conditions and other surrounding structures. Literature review shows that site analysis is a systematic diagnostic process. It is also an important beginning for the design process.

Lynch (1971) defines site planning as a practical art. He notices that in practice, Chinese garden designers carefully looked at the site itself, visited it under different circumstances, and mediated on its character. Murcutt also mentions “the central design issues are humans – their history and culture; space; light ... and responsibility to the land” (Murcutt, Beck, and Cooper, 2002, p.17). In his lecture at the National Building Museum in Washington, DC., Murcutt notes that he normally visits the site for a housing project several times, in different seasons, at different times of the day, and under different weather conditions, in order to fully understand the site’s characteristics.

Lynch also points out that organizing the external environment can be addressed using a systematic approach. His site planning process includes eight stages: defining the problem, programming and the analysis of site and user, schematic design and preliminary cost estimate, developing design and detailed costing, contract document, bidding and contracting, construction, and occupation and management (Lynch, 1971, p.11). The systematic surveys start with understanding the site's history and ecology. He further suggests analysis of detailed physical and biological aspects of a site, including topographic, climatic, and circulation information. For example, designers should give special attention to various subsurface conditions, including the water table, organic soils, toxic material, and evidence of slides and flood. Careful examinations of landforms should consider slope, visual form, plant coverage, and site character. In addition, climatic analysis should cover the prevailing local climatic data, as well as the reflection and conductivity of the site surface. Topography could also influence solar radiation and air movement.

For Todd, the objective of site analysis is “to separate a whole into simpler components” and “understand them in relationship to one another and to the whole” (Todd, 1985, p.11). Designers should avoid getting too much information to begin with, or performing an oversimplified analysis, which is virtually worthless. They also need to identify irrelevant factors and potentially important ones. Todd divides site analysis information into four categories, and suggests that designers use his list as a checklist (Figure 2-7). Under each factor, he provides detailed fields for consideration. For example, there are six areas to consider with regard to the wind factor: (1) microclimatic effects; (2) seasonal changes; (3) odors, trash, and debris carried by wind; (4) blockage and direction changes by adjacent vegetation and structures; (5) signs of wind erosion; and (6) possible structural and functional problems for the building (Todd, 1985, p.17). He further points out that each piece of information gathered in the list should relate to the project and influence design decisions.

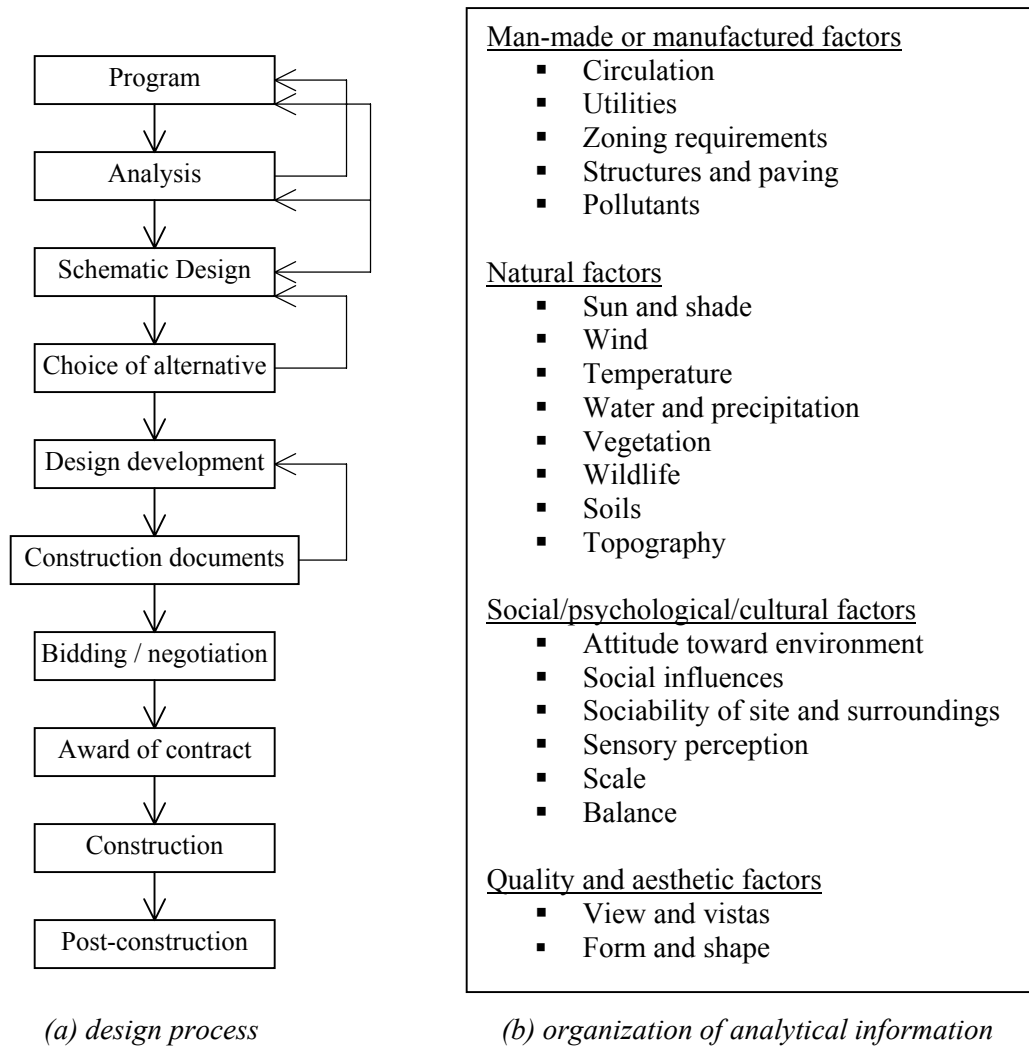


Figure 2-7 Site analysis

LaGro (2001) considers site analysis a “systematic, and often iterative, sequence of steps.” The steps he suggests include site selection, inventory, analysis, concept development, and design implementation (Figure 2-8). Site and contextual data sets fall into three categories: physical, biological, and cultural attributes. He further provides detailed items in each category. Physical attributes include topography, geology, hydrology, soils, and climate. Biology attributes include vegetation and wildlife. Cultural attributes include land use and tenure, land use regulation, public infrastructure, nearby buildings, historic

resources, and perceptual quality (LaGro, 2001, p.v). Factors within these attributes are important characteristics of a certain site.

After the information is collected, a diagnostic process begins. Traditional site analysis is a synthetic process requiring knowledgeable, skilled, and experienced designers to consider all important site factors. Modern variations consider the site inventory maps mentioned above and suitability maps – the results of site development analyses, suitability studies, and, finally, integration and synthesis. Site development should consider how to protect and maintain ecological integrity, critical natural resources, and cultural heritage, with minimum impact and damage to the environment and society. Suitability analysis is “the process of determining the fitness, or the appropriateness, of a given tract of land for a specified use” (Steiner, 1991, p.132). Suitability studies identify areas in a site with different levels of development suitability by applying criteria to selected data sets.

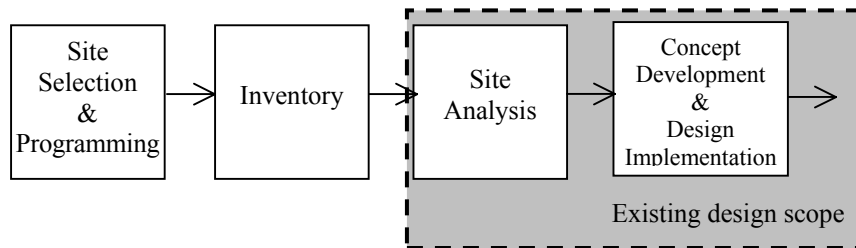


Figure 2-8 Extended design process

Research and practice aside, regulations and professional examinations also recognize the importance of site analysis. The Architect Registration Examination (ARE), administered by the National Council of Architectural Registration Boards, tests candidates on their knowledge, skills, and ability in site analysis and planning as required in the practice of architecture. The “site analysis” part of the ARE is designed to test the ability of designers to consider “topography, vegetation, climate, geographic aspects, and legal aspects of site development”¹. It also includes six sub-tasks: design, zoning, parking, analysis, section, and grading. The analysis sub-task requires that the candidate understands the site-related criteria and constraints that influence the subdivision of land, and identify “areas suitable for the construction of buildings or of other surface improvements.”

¹ Quotation is from ARE website <http://www.ncarb.org/ARE/index.html>.

To sum up, environmental influences and cultural context have become important concerns in architectural design, in addition to Vitruvius' notion of three architectural parameters (firmness, commodity, and delight) since the early nineteenth century. Therefore, design consists of five important components: aesthetics, culture, environment, structure and materials, and economics and social influence. This study considers these components in site analysis because they are important concerns for designers throughout every phase of the design process. Additionally, design theories suggest that design is also a "participatory" process, encouraging interdisciplinary knowledge and collaborative community participation.

Moreover, this research considers the design process as a sequence of events, including identification, analysis, synthesis, evaluation, and implementation. Design can also be considered to be an iterative, "trial-and-error" decision process that relies on knowledge, experience, and intuition. Each piece of information gathered in the program should relate to the analysis and influence design decisions. Feedback loops also provide opportunities to revise solutions and start the decision sequence again. The analysis process in the computer program of this study is implemented to be iterative. It also allows the user to revise settings and restart the analysis (Chapter 4).

Finally, a review of literature suggests an extended design process that begins with site analysis. Most definitions divide the site analysis process into various steps within a structured and integrated system. Traditional steps include selecting a site, locating buildings, and placing utilities. However, in an extended design process, the analysis and selection of a site includes site selection, inventory, analysis, concept development, and design implementation. This research views site analysis as a sub-system within the design process, and the major factors in the design process also form the essence of site analysis and selection. Detailed descriptions in the fourth chapter show how these major factors form different groups of concerns in the proposed framework.