A multidisciplinary challenge within the procedure of designing in a complex undefined domain

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Abstract:
Modern architectural design may be generally appointed as complex. Hence, designing in an undefined domain within the field of architecture (e.g. From the urban to the building and down into the materialisation) is also a risky task. Hence, in some situation, such a design has to deal with one or more severe constraints, therefore such a design environment represent an extremely busy situation. This design, such as designing for a Sustainable Reconstruction of Houses in a Seismic Desert environment (i.e. SRH-SD), may become too vague to reach any appropriate conclusions.

For which systemisation is a good solution to avoid the possible complications and chaos, which has been provided in a larger frame of study (e.g. See also Shahnoori, 2008; Shahnoori, 2009; Shahnoori et al., 2010a; Shahnoori et al., 2010b, Shahnoori et al., 2011a). In this solution, the design Processes has been modelled as a system in the Glocal (Global and local) Process Model or the GPM. Each phase of the GPM has been assumed as a Subsystem. To formulate complications in critical phase, such as the Exploration Phase, the items and segments of the phases need also organisations and arrangement. Therefore, as the previous research concentrated on the first phase (i.e. the “need”); the current research focuses on the second phase of the GPM, the Exploration phase. Thus, first the importance and crucial role of the exploration phase is discussed. However, to enable the design to benefit from the valuable outcomes of this phase it need to be organised. Therefore, in the first postulation, it is a subsystem, and then it comprises its own internal environment and elements, and structure. Therefore, after discussing this and the argumentations a model of such a subsystem will be presented.

Keywords:
Complex design situation, process modelling, Sub-systemisation, Exploration Phase, Sustainable Reconstruction, Seismic Desert houses.

1. Introduction
Many cases of failure of buildings, although may relate to the design conclusions, do not directly concern the conceptualisation. This category of design failures does not originate from the issues relevant to the conceptual design, but from other issues as design background and the theoretical supports. However, one part of such problems may be rooted to the design information and knowledge (Murthy et al., 1994; Eckert et al., 2000; Murty et al., 2002; Lawson, 2004). This inappropriateness may also be due to the complexity of the design situation. Nevertheless, if this design is going to be applied in a demanding situation its results or the consequences may go far beyond the single failure of a building. A demanding case of such a complex demanding situation is design for
Sustainable Reconstruction of Houses in a Seismic Desert area, or the SRH-SD (Shahnoori et al., 2007b).

The majority of successful architectural designs dovetail well with their context and function perfectly (Lissitzky, 1970; Prophyrios, 1984; Hersi et al., 1988, Lawson, 2006). In most of such designs, the designer is familiar with the design environment and acquires a great deal of information and knowledge before the conceptualisation phase is initiated (Schon, 1983; Mitchell, 2004). However, unlike theories and methodologies, the necessary data, information, relevant analysis (Oxman et al, 1993, Herschel et al., 2001; Mc Donnell et al., 2004), and theoretical outputs are case-related. Thus, they may differ from case to case. According to the Glocal Process Model, GPM (see Shahnoori et al., 2010a) and its supporting theory, these are called upon in the second phase, exploration phase.

Therefore, in a complex design situation such as a Sustainable Reconstruction of Houses in a Seismic Desert area (SRH-SD), it comes after the need (the first phase) has been defined (Shahnoori et al 2010b). Because of contribution of the Global knowledge and the local application (i.e. In the SRH-SD) this model of processes have been previously (see also Shahnoori et al., 2010a) called Global (Global/Local) Process Model or the GPM (figure1.). However, the exploration phase of the GPM includes all items involved from the beginning of a design to the end of prioritisation, selection, and theoretical decision-making. Nevertheless, these are being iteratively worked out; therefore, they will be finalised only when the design is completed.

![Figure 1. Schematic demonstration of the GPM](image)

### 1.1. Overview

In a SRH-SD, the abundance of items, aspects, and domains involved in the exploration phase of the GPM creates a busy environment that may become too vague. However, these all should be incorporated in the design as they play critical roles in the appropriateness of the design conclusion. This is because this phase is the design background in terms of various cases, and here the design theories and knowledge are provided or refined. Therefore, the exploration phase requires particular organisations that support the design and ease the accessibility of the information for the conceptualisation phase of the SRH-SD. Because of this, intuition, as the only support for a complex design, is not reliable, although it is required.

Of course, great designs need great intuition (Alexander, 1971; Lawson, 2006). Data, information, and knowledge are of other requirements in a complex design situation. Heavy (2005) states: ‘The completion of a science requires that all things relevant to our project be reviewed, one by one, in a continuous uninterrupted well-ordered enumeration.’
Adequate enumeration or induction is essential when the knowledge of something cannot be reduced to simple intuition, because if we do not infer something immediately from something else, but rather from other disparate propositions, our intellect does not have the capacity to include them in a single intuition, nor can we distinguish all the links in a single chain. This is even more important for a design, as it needs greater elucidation of some issues in the later stages (Holzer, 2009).

The exploration phase of the SRH-SD contains the rational/factual parts of the design. Although these outcomes are iteratively completed at the end of the design process, the majority of them are achieved at the end of the exploration, and prior to the conceptual design phase. Therefore, the exploration phase of a complex design process is also an important part of setting the design theory. Based on these theoretical outcomes, the conceptual design starts as the practical solution.

2. Exploration phase in an architectural design

Normally at the beginning of an architectural design task, the general function and location are stated first, and the client gives a list of wishes or objectives (Schon, 1985; Ferguson, 1993). This first principle data may also include some extra information. In the statement of Leupen et al. (1997), the principle data include a given programme and a site. The investigations follow this recipe, thus this is the starting point of the investigation. In the study of Moughtin et al. (2003), the ideal situation for the development is where there is already design and planning guidance available for the given site. Apart from the division of the investigation methods (Simon, 1977), a general approach is to seek out which items or groups of items require further investigations. For a complex design, these items can be placed in different categories. For example, they may be divided into the following:

Technical investigations
Economy and finance
Social aspects
Local aspects
Global aspects
Environmental aspects …

Depending on the particular design task, a designer may study the local climate and environment, infrastructure, landscape and the surrounding buildings at the site with regard to their orientation, architecture, and spatial configurations. Some of the criteria have already been set (e.g. Pre-defined objectives), and these are refined in terms of the size, form, and orientation of the building, soil conditions (and stabilisation characteristics if required), the layout, and the function. External and internal relationships, which influence the form and functional figure of a building, should be also considered at this stage. Managing the structure, the contents, the skin, and generally the construction system is another essential item in the whole project. Finally, based on the criteria, the designer will decide on the materialisation of the building, the internal elements, and the building system. The interactions and interferences of the different levels and different domains sometimes require redesign and rethinking. For example, the materialisation has a close relationship with the building system, recycling, reusing, and sustainability of the whole project. Thus, the elementary design and the materialisation are intensely interrelated.

In a comprehensive procedure, the aim of the analysis prior to the conceptual design is to determine which characteristics need to be created and which criteria need to be met. The above-mentioned groups of items involved in a design are variously classified by different people or in terms of various methods. However, after listing all the requirements and
issues relevant to a particular design situation, the second task is to look for interaction between these requirements (Alexander, 1964). The limitations involved in the design are examples such problems. For example, the financial scope of the client often forms a design limit. Such limitations may play a crucial role in influencing the design elements and even the entire design, and may consequently cause a considerable increase in the complexity of the design. At this level of influence, these are major problems and called 'design constraints' in this study. Each design constraint may cause complexity for a design, and a combination of two or more of these may source extreme complexity.

2.1 Complexity and the role of the “exploration” in a design

Because of involvement of so many variables in a complex situation as a SRH-SD, the designer or the design team needs to compare values in order to prioritise and select items based on the available criteria. However, the criteria may not always be exact with regard to some particular items. This is also due to the nature of architectural design, which deals with art, technology, and sciences (Achten et al., 2001; Sarıyıldız et al., 2003; Lawson 2006). In this type of multidisciplinary environment, a combination of aesthetic and technical aspects creates potential for complexity. Interaction between these multiple disciplines further increases the complexity (Alexander, 1964). The growth of this complexity may cause conflict with respect to the end requirements and consequently the relevant solutions; thus, it may result in greater complications. The sensitivity and importance of the exploration phase is due to such factors. The entire area of the exploration phase can be called ‘collaborative knowledge’ (Hubers, 2008). According to Hubers (2008), there are five reasons for the application of this collaboration:

- Decisions at the beginning of the design process have a major influence on the cost-quality ratio
- At the beginning, there is potential contribution through knowledge and experience of all stakeholders
- The growing complexity of building projects
- The client’s demand for guarantees and the claims that different parties may receive because of building failures lead to these parties wishing to have influences on the design
- Because the advice of experts often comes too late, when other developments have already altered the design; there is a waste of time and money in the design process

Hence, because of broadness of the area of architectural design, a large body of knowledge is required to come to a scientifically based design (Carrara et al., 1994; De Jong et al., 2002) and a systematic approach to the design (Goldschmidt, 1991). This knowledge may contribute in several stages (Holzer, 2009), even in the decision-making (Chen et al., 2006), or to the different disciplines (De Jong et al., 2002). For example, De Jong et al. (2002) refer to the variety of the required collaborative knowledge for design. This is required from different aspects, based on particular goals, with various directions in architecture (De Jong et al., 2002). From Zeisel’s (1984) point of view, designers need knowledge that helps them decide how things might be. They also use knowledge that informs them of how well things might work (Lawson, 2004). According to Lawson (2004),
the application of such knowledge is a highly selective process, which inevitably results in designers making their own unique interpretation of design problems. He emphasises the requirement for knowledge, which generally forms a theoretical background and a tacit structural organisation.

Similar to the current research Pugh (1991) also mentions the exploration phase as being essential for the success of the design conclusion, and refers to this stage as ‘front-end’. In Pugh’s study (1991), a genuine understanding of the ‘Need’ of the user depends on this stage. He states ‘The more thoroughly you deal with this area, the more professional you will become.’ In current standard designs, architects mostly focus on setting the requirements before undertaking the conceptualisation. For example, from a detailed view, O’Reilly (2000) states: ‘Defining requirements, and their communication to others is the root of good briefing. Deciding on a final design or other solution before making a full assessment of the client and user’s needs and problems may prove very costly.’ Of course, setting the requirements is very important for a design, but it covers only a part of the exploration phase defined in this study. Communication and sharing the knowledge is the other important issue that needs to be taken into account (van loon, 1998; Lloyd, 2000; Lawson, 2005).

In the exploration phase, the relevant data, information, and knowledge of all the pertinent factors form the basis for decision-making and design conclusions. Therefore, the role of this phase for the rest of the complex design processes is similar to the role of foundation for the structure of a building (e.g. Scheme in fig.2.). Although a bad superstructure may always collapse, an important condition for the survival of a good superstructure is a strong foundation. The stronger and safer this theoretical information is, the better the practical design will become. However, properly accessing to these information and the theoretical outcomes, entails an appropriate systematisation and arrangement of them.

![Figure 2. Schematic illustration of the role of exploration (e.g. of the GPM) in a complex design](image)

3. Solution finding with a brief theoretical overview

Organisation and application of a system make a complex subject understandable and discussable between several people, rather than haphazard and chaotic. Similarly, organisation is useful in a complex design. Besides, a particular organisation is required for the exploration phase of a design in which an abundance of items creates a busy environment that may become too vague. Thus, in order to implement the achievements of the exploration phase the appropriate arrangement is crucial.

3.1. Organising the design foundation, introducing a subsystem/ Discussion

According to Cross (2008), modern design is generally complex. Nevertheless, Hubers (2008) states this complexity in architectural design is due to the involvement of new materials and methods. He indicates that the organisation and classification of subsystems or sub-processes help to organise such complexity and the potential complications. It needs to be mentioned that these administrations do not necessarily guarantee an appropriate solution. However, these are supports to avoid obvious failure in complex
situations. It should be reminded that there is no fixed limited detailed plan or classification (e.g., model) for sorting out an architectural design. This is analogous to the statement of Jones (2002) as 'It's only the existence of existence that is fixed.' Leupen et al. (1997) also state that the involved aspects do not arise in a fixed, logical order: 'Designing is not a linear process, with a specific task leading to one and only one possible solution.' With these, a sub-arrangement and sub-processes in a large frame (i.e., the flexible structure of the entire design process/the GPM) form an effective way of making the method applicable to various cases. Therefore, the design information and the principle knowledge can be better arranged within the sub-system of the 'exploration' phase. This method is similar to the parallel languages of scientific programmers (Pancake et al., 1990).

Similar to the organisation of a system and subsystems in this study, Poynter (1969) divides a design into two main scales. In the first view, he shows that there is an underlying physical structure in any part of the built environment. In the second, he mentions the atoms of the structure and their relationship as the basics of the structure of this environment. In another impression (i.e., in parallel languages), Pancake et al. (1970) point to the way researchers in the field of computer science work on parallel programs, suggesting that existing single languages may not support scientific works.

Finally, another similar approach was found in the study of Williams (1973). He states 'when a theory deals with entities that are physically part of another entity, one of those entities is the fundamental entity of the theory, and all results of the theory can, and should, be expressed in terms of that fundamental entity'. Based on these discussions, the current study proposes the Exploration Phase as a Subsystem (i.e. May be abbreviated as SEP) inside the GPM system. However, due to the mentioned involvements, interactions, and possible conflicts, and regarding the significant role of the SEP in the design conclusion for a SRH-SD, relying on a simple (sub) systemisation is still risky. Therefore, internal organisation is also very useful. The proposed solution for this, relates to the methodical preparation of SEP, especially for the critical final stages, as well as for the entire design (see Shahnoori et al 2011e) This internal arrangement also provides fluent communications between various experts that involve in the design in a SRH-SD.

### 3.2. A general classification of actions inside the SEP

The process of problem statement, analysis and synthesis in science (Bunge, 1967), albeit with slight changes, is adjustable in the second stage of a design process for the SRH-SD (the exploration) as well. However, to designers, it seems that the analysis or understanding of the problem is largely bound up with the synthesis or the generation of a solution (DAYTU, 2004). From Ritchey’s (1996) point of view, this is the case for scientific method too. He states that analysis and synthesis, as scientific methods, go hand in hand: they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results. The terms analysis’ and ‘synthesis’ come from Greek, meaning ‘to loosen up’ and ‘to put together’ respectively (Webster, 2005). According to Ritchey (1996), analysis is the procedure by means of which we break down an intellectual or substantial whole into parts or components. Synthesis means combining separate elements or components in order to form a coherent whole. These definitions are also very well applicable for the SEP of the SRH-SD, which as small system is a coherent whole and on the other hand encompasses separate items that should be combined and applied in a design.

As was also argued earlier, in order to provide an internal arrangement for the SEP several approaches were studied. For example, a similar approach to the current research has been found in the study of Markus and Maver (1967). In a general classification for
elaborating the architectural design, they also use the scientific process as the main basis. Their proposed scheme is shown in Fig. 3. In this map, the searching for relationships, looking for patterns in the information available and the classification of objectives are the analytic components. They order and structure the problem (Lawson, 2006). The synthesis is characterised by an attempt to move forward and create a response to the problem. Lawson (2006) calls it the ‘generation of solutions’. According to Lawson (2006), ‘appraisal involves the critical evaluation of suggested solutions against the objectives identified in the analysis phase’.

![Figure 3. The map of the design process according to Markus and Maver](image)

However, the other similar approach was found in the study of Alexander’s (1964). He breaks a problem down into smaller problems to make it soluble. This is also similar to Krauss’s study (1996) stating ‘One must break down the problem into smaller pieces and build it back up into a final solution.’ However, the current research tends to use this approach for the problem as well as solutions, in which the sub-solutions may also contain smaller-scale solutions. Aiming at these, and applying a scientific approach to the design discipline, based on the philosophy of Bunge (1967) and analogous to the approach of DAYTU (2004) and Ritchey (1996), a general classification of the exploration phase containing three main parts can be arranged. These are (i) investigation and exploration, (ii) analysis, and (iii) theoretical prioritisation, synthesis and decision-making. These form the basis for the conceptual design. The scheme in fig. 4. shows these general typology and categorisation for the main activities and sequences within the SEP. However, in view of the above-mentioned arguments, a further division on a detailed scale is also helpful for designing within a complex and demanding situation as a SRH-SD.

![Figure 4. General classification of actions inside the exploration phase](image)

4. Summary and Conclusions

- Classification and organising the exploration phase of a design is an appropriate approach for further systemisation in order to achieve a successful conclusion in a complex situation as a SRH-SD. However, the whole data, information, prioritisation, selection, and decision making for an architectural design complete/progress not only
sequential but also parallel. It means that some parts related to the “exploration” will be achieved and corrected in conceptualisation phase or even in the later stages.

- Exploration phase is a vital phase of a complex design, and is sensitive for a successful design in a SRH-SD. This importance is not only due to its role as a foundation for the design but also because it includes critical steps such as prioritisation, selection, and decision making. The results of this phase are the theoretical outcomes of the design, which are the bases to go in action in the conceptual design.

- To organise the exploration phase, the information can be categorised in three main groups of (i) investigation, (ii) analysis, (iii) theoretical hypothesis and synthesis. However, according to the major role of the exploration phase in the conclusion of a complex design, extra emphasises and connections to other phases of the design are required. These relationships and connections, similar to the GPM, are shown by iterative feedback loops in the scheme in fig 5.

![Diagram showing the basic model for modelling the architectural design processes in a complex Design situation](image)

**Figure 5.** the basic model for modelling the architectural design processes in a complex Design situation

### 5. References

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