# **Briefing Architectural Design Studio Processes: Linear Stages**

## versus Cumulative Layers

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#### ABSTRACT

This empirical study compares architecture students' design processes as observed throughout an architectural design studio with the target design process initially prescribed in the studio brief. The main question guiding this study is how students' design processes as observed during design tutorials differed from the prescribed linear, stage-based framework of the design studio. Based on the analysis, coding and visualizations of observational data, this paper describes and discusses the design processes of ten undergraduate students of architecture over the course of 17 weeks. Visualizations of tutorial observations indicate that students tended not to follow prescribed design stages sequentially but persistently engaged in continuous and parallel reconsideration of almost all aspects of their work. From the data visualizations, these cumulative and layered processes become visible as 'fan'-shaped diagrams. Results of the study indicate that the role of design stages in design studio briefing may be reconsidered: Rather than enforcing a clear sequence of design steps, their role seems to be to gradually introduce students to increasingly advanced and challenging project scopes. Based on this understanding, this paper provides some suggestions on alternative approaches to design studio briefing.

KEYWORDS: Design Studio Briefing, Design Stages, Design Process, Data Visualization

#### 1 Introduction: Design Process Models

In architectural education as well as architectural practice, design processes are routinely briefed and managed according to linear, stage-based models of the design process. Due to their visualization as linear and sequential downward flows of events toward final goal states, such models are often described as "waterfall models". Waterfall models typically depict a transition from analysis to synthesis based on stages such as data gathering, data analysis, proposal development and proposal implementation (see Fig. 1). Although waterfall models are well-accepted for purposes of coordination and management in a wide variety of processes of production, their suitability in the context of briefing design processes has come under debate in recent research work. Design education thus finds itself in a dilemma: While experienced architectural practitioners tend to be skeptical of stage-based models of the design process, those involved in structuring, coordinating and monitoring design processes – be it in design education or in design management – tend to appreciate such frameworks. Stage-based, linear waterfall models of design processes enable teachers to prescribe, direct and control the flow of design processes and to provide guidance to inexperienced learners, and for these reasons often find their way into the design curriculum. Furthermore, increasing pressure on universities to adopt explicit and outcome-based accounts of teaching are likely to encourage prescriptive tendencies in brief writing as well as studio scheduling.

In observations of applied design processes, designers tend to follow predefined linear stage-based processes only to a limited extent. Based on a detailed empirical study of applied design processes, Guindon (1990) suggests that prestructured top-down decomposition of design tasks is a problematic approach, and that experienced designers will typically embrace individual and opportunistic choice-making. Conklin and Weil (1990) illustrate this difference in line diagrams (Fig. 1) where lines plotted to illustrate the design progress of two different designers indicate sudden and unpredictable jumps between predefined design stages rather than an orderly and linear progression of steps as found in the waterfall model. In design processes as observed in practice designers frequently transition between reflecting on the design task and developing or implementing design proposals, at almost any stage of the design processes addressing the same design task. By expressing their argument visually in diagrams (Fig. 1), Conklin and Weil (1990) draw attention to the contrast between *descriptions* of design processes as observed in practice and *processes* as they are conventionally accepted in the management and engineering domains.

In a comprehensive review of previously proposed design process models, Gedenryd (1998) rejects the separation of design processes into stages entirely and argues that design processes may best be described as processes of interactive inquiry. Gedenryd (1998) argues that the conventional separation of design processes into sequential stages results in distorted views of the design process. By assuming that analysis always precedes synthesis, for example, analysis is given disproportionate importance. During design processes, development of understanding of design challenges typically proceeds in parallel to, and in relation to, the development of design proposals. Maher *et al.* (1996) have described this pattern as co-evolution of problem and solution. This requires designers to maintain awareness of the possibility of reconsideration of many aspects of an ongoing project even when focusing on one particular aspect. Analysis of the design task and its context may thus involve synthesis, and vice versa. Guindon (1990), Conklin and Weil (1990) and Maher *et al.* (1996) all employ diagrammatic visualisations to illustrate and discuss the characteristics of design processes, and to contrast them with linear stage-based models. But does this discrepancy between prescribed design stages and applied design processes suggest inadequacy as Conklin and Will suggest?



time since beginning of design process

Figure 1 Individual design processes (dashed lines) in relation to stage-based sequential design process model (after Conklin and Weil 1990)

Alternatives to stage-based models such as inquiry (Gedenryd, 1998) or evolution (Maher *et al.*, 1996) do not seem to offer educators similarly practical frameworks in writing studio briefs. In this context, this paper examines how prescribed design stages and applied design processes are related within the educational setting of an architectural design studio. Can the discrepancy between the need to prescribe on the part of the teachers and the need to divert from prescribed schedules on the part of the students even be understood as a productive context for design processes? To this end, this paper reflects on design studio experiences primarily based on digital data visualisations of field observations. This study describes and analyzes the authors' observations and makes them accessible in a visual format to inform future design teaching and to explore alternatives in organising design studios. This paper further

develops a previous paper (Herr, 2010) which emphasizes the process of data visualization employed. The primary concern of this paper is how design studio education may be understood and further developed based on the results of the study.

#### 2 Managing Divergent Processes in an Architectural Design Studio

The architectural design studio discussed in this paper was a particularly well-planned second-year studio at a Chinese university in 2009. It was taught by 8 tutors, each supervising a group of 8-12 students, who worked individually. As is often the case for architectural design studios, the schedule and brief of this studio set out a linear sequence of several design stages which students are required to follow. The assumption behind this briefing is that students ought to proceed through several steps in their learning so as to achieve design outcomes of a high quality. In this view, the nature of students' design processes is thus linked to the quality of their work. Teachers, acting as managers of their students' design processes, accordingly aim to guide students to good results through adhering to a clear predefined process. This view was affirmed by the coordinator of the design studio for several years. Expressing his empathy with students' difficulties in learning architectural designing, he noted that this studio structure, while seemingly establishing a tight framework for students' learning, had been more successful than other, less structured studio briefs. In the case of this studio, he surmised the need for a highly structured design process resulted from the learning needs and preferences of Chinese students.

The design studio was initiated by teachers handing out a detailed schedule to students at the beginning of the semester. The schedule prescribed students' design activities for each of the twice-weekly tutorial meetings and lectures in the following stages: 1. site analysis, 2. concept development, 3. spatial design, 4. structural design, 5. elevation and façade design, 6. staircase design, 7. finalizing and drafting. This overall plan was consistently enforced through the requirements that students had to comply with in seven interim presentations and submissions. During studio tutorials (Fig.2), however, students' design processes and progress seemed to differ not only from the initially given plan, but individual students also differed from each other.



Figure 2 Tracking students' design processes during design studio tutorials

Based on the understanding of designing as a circular, conversational process, where new ideas arise from differences in understandings or viewpoints between those engaged in the conversation (Glanville, 1995), tutorials and the opportunities for exchange they provide can be seen as central to design development. While students can emulate such conversations by and with themselves (ibid.), tutorial conversations with tutors are essential sources of ideas as they are usually not entirely controlled by either student or tutor, and support both variety generation as well as variety reduction. In tutorial conversations, new ideas may thus hatch between the perceptions and intentions of tutors and students (Herr and Karakiewicz, 2008). In this primarily qualitative case study, tutorials are seen as pivot points of the design process, where students' thoughts and decisions are developed and made explicit. For this reason, observational data collected during these occasions is taken to be representative of students' current design stage. Tutorials during which students were absent as well as meetings consisting of lectures without tutorials are not considered in the data coding and subsequent visualisations and left blank. The following sections examine these field observations of the design processes of 10 individual students, how these can be expressed visually and how they relate to the initially given schedule.

#### **3** Observations, Coding and Visualisation

During tutorials and intermittent design reviews, I collected an extensive amount of field observation data as a studio tutor and participant observer. Data collection continued throughout the design studio, consisting of both written notes and photographs that mainly served as memory aids to allow comprehensive subsequent write-ups of observations. This paper presents an analysis and discussion of the design studio progress of students based on this data. To analyze the large amount of field notes, observations were reviewed and coded based on the initially determined 'stages' of the design studio as defined in the studio brief. These seven categories, as outlined in Section 2, represent a stage-based model of the design processes that proceeds from research and analysis to partial solutions to overall design proposals. While this choice of only a few simple coding categories ignores many of the qualitative and individual aspects of designing, it also provides a basis for clearly illustrating the differences between prescribed design processes as laid out in the brief and students' experiences in tutorials with the author. Defined a priori, the stage-based systematic and linear model of design processes adheres to a goal-oriented and problem-solving based view of designing. Coding design processes as experienced by tutors and students within design tutorials according to these categories offers an opportunity to illustrate differences and similarities between the expected and the observed design processes. Figure 3 shows coded notes derived from roughly 14,000 words of field notes in an Excel spreadsheet and the analysis and visualizations derived from these notes in the three-dimensional modeling software Rhinoceros 3D in conjunction with VBA scripting in Excel (Fig. 3)



Figure 3 Coded field notes and expression as data visualisation

Visualizations of the coded field observation data stored in the Excel spreadsheet were produced with a combination of VBA scripting in Excel and three-dimensional modeling in Rhinoceros 3D. In this study, relatively simple and straightforward data visualization afforded insights that may be difficult to gain, illustrate and show otherwise. Data visualization offers analysis and insights through visual understanding of patterns within data which are often difficult to present and describe in other ways. Figure 3 shows how numerical and textual coded data (Fig. 3, left) may be rendered more understandable in visualizations (Fig. 3, right). The following questions underlie the data visualizations presented in the following sections: How can individual students' design processes be described in relation to the predefined framework of design stages? How do individual students differ from each other? Furthermore, how could these answers inform the prestructuring of future design studios?

#### 4 Design process visualization and analysis

The diagram format developed to express the field observation data in terms of the seven design stages prescribed in the studio schedule consists of circles which are divided into seven segments corresponding to the seven prescribed design stages. Segments are delineated through axes radiating outward, indicating progression of time in successive tutorials. When mapping design stages onto this diagram format, concentric circle segments indicate the progression in time from the centre of the diagram outwards, describing the contents discussed in each of overall 30 tutorial meetings. Within each concentric circle (indicating one tutorial meeting), any combination of seven stage segments is possible to indicate the design concerns observed during tutorials and coded to conform to the seven design stages outlined in Section 3. In the following, this diagram format provides the basis for illustrating tutorial observations by the author. In Figure 6, the basic diagram format is changed slightly to allow for more emphasis and clarity or to facilitate quantitative comparison.



Figure 4 Design stages as prescribed in the studio brief (left) and as observed in the design process of an average students during design tutorials (right).

Figure 4 illustrates the predetermined sequence of design stages as found in the studio brief

(left-hand side) and the design processes of an average student (right-hand side) as observed during studio tutorials. When comparing visualizations of students' design processes to the prescribed sequence, students' design processes differ in two main aspects: the sequence of progressing through the predetermined design stages, and the amount of attention and overall time dedicated to each of these stages. Where the prescribed design stages are aligned neatly along a spiral, students' design processes are much more spread out, in particularly in the earlier stages of students' design processes. One striking observation is that all of the observed students diverted from the prescribed sequence of stages as set out in the studio brief. The analysis and comparison of field observation data shows that students tended to distribute their energy unevenly and not necessarily according to the prescribed design schedule. Students instead seemed to emphasize individually chosen aspects of their design processes while trying to simultaneously comply with the prescribed design stages in order to comply with basic requirements. These individually determined foci can further be described as clusters along the timeline (Fig. 4). The student design process visualized in Figure 4 (right), for example, indicates the students' proccupation with plan development and refinement (Stage3) in two distinct bouts early and late in the design process.



Figure 5 Design tutor's covering of design 'stages' in discussions with students throughout the design studio (left) and individual design processes of all observed students (right)..

With students' design processes diverging not just from each other, but often also from the prescribed studio schedule, studio tutors experience discussions across a broad range of topics during each tutorial. Figure 5 illustrates how each tutorial meeting (consisting of individual discussions with all ten students) covered a much broader range of design stages than the prescribed stages for that meeting (as suggested by the spiral-shaped visualization in Fig. 3, left).

As illustrated in Figure 5, students' design processes seem to negotiate and compromise between adhering to prescribed design stages roughly while still maintaining individual ways of working and thinking. To emphasize individual ways of addressing the initially prescribed design stages, the previously introduced diagrams are rendered three-dimensionally, with the circular segments indicating tutorial meetings placed with increasing distance along the z axis according to the studio timeline. Figure 6 compares three-dimensional visualizations of three students' design processes. While the performance of these students in the observed design studio varied (left-hand side: good performance, middle: average performance, right-hand side: below average performance), all diverge from the initially prescribed 'spiral' of progressing through design stages in the same way (Fig. 3, left): In the diagrammatic visualizations presented in this paper, all students' design processes present as cumulative, fan-like shapes. In many instances, new design stages introduced or suggested by the studio schedule do not only incite students to consider new aspects of their developing design proposals, but also seem to trigger the re-thinking of previously addressed aspects, adding new layers to a cumulative process of thinking, which produces the 'fans'. The role of prescribed design stages in the observed design processes seems to be to unfold these fans.



Figure 6 Three-dimensional visualization further emphasizes the cumulative nature of students' progression through the prescribed design stages.

#### 5 Relating process visualizations to students' studio performance

Students' final grades were determined at the end of the studio based on a weighted calculation of previous submissions and reviews of drawings and models handed in at the end of each design stage. When comparing visualizations of students' design processes to their grades, it seems that those students

who engaged more actively in rethinking and refining their projects beyond the currently prescribed design stage received good grades (average and above). None of the ten observed students followed the schedule literally in terms of exclusive sequential design stages. Figure 6 shows the design processes of 3 students: a student performing very well in terms of final grades (left-hand side), an average student (middle) and a student performing not very well in terms of final grades (right-hand side). When comparing the process visualizations, it may be concluded that willingness to reconsider and revise previous decisions is a designer's strength rather than a weakness. Based on my observations during tutorial meetings, the best-performing students characteristically developed very intense engagements with their design projects, often reconsidering many previous thoughts in the light of new ideas to 'get it right'.

Students were assessed independently of whether they followed the prescribed design stages during each meeting, which suggests that adherence to the linear stage model was not necessarily expected by studio tutors. There seems to be an implicit understanding that the prescribed design stages coordinate the design process and assure completeness of student work but that they are not meant to be understood literally nor actually followed. Rather than prescribing sequential steps in the design process, design stages seem to introduce new layers to a cumulative and holistic thinking process. To experienced architects, this may be a self-evident statement – to others, including students learning to master architectural design processes, this understanding may not be as obvious. As design expertise, including design teaching expertise, is rich in tacit knowledge that remains implicit in the actions of the experienced practitioner, design teachers may even believe their design processes are best organized by following preconceived linear steps. It is the aim of this paper to challenge this belief through comparing widely accepted but idealized expectations of the design process with empirical data derived from observing design studio processes.

#### 6 The challenge of prescribing designerly inquiry

This study is limited to the detailed examination of one particular design studio, and the design processes of ten students as I observed them as their tutor throughout the design tutorials of one semester. While the scope of this empirical study is limited, it has provided a basis for developing an understanding of the design studio process and its underlying expectations as well as visual material to share this understanding. The process of coding and visualizing field observations implies choosing a particular viewpoint. This is expressed in the formats of the diagrams presented in the previous sections, where emphasis is placed on the description of students' design processes in terms of design stages, their expression as visual patterns, their quantification and their unfolding in time.

If design processes are experienced as holistic and cyclical by designers, how can they be reconciled with prescribed linear design processes? How can descriptions of conversational novelty generation (Glanville, 1995) or opportunistic inquiry (Gedenryd, 1998) be thought of or planned as linear sequences? The 'fan' shapes expressed in particular in Figures 5 and 6 may provide one possible answer. Design processes are described as cyclical as they are experienced as generating new ideas in a process of recurring playing with, re-considering and modifying of previous ideas. The fan-shapes in the visualizations suggest recurrent and parallel consideration of individually chosen foci, where new ideas trigger the rethinking of previously made decisions. The fan shapes can thus be read as design cycles that increasingly widen their scope with the introduction of every new design stage, which leads to interconnections, increasing coherence and stability amongst all elements of the projects. This also allows teachers to gradually introduce students to complex architectural design tasks in a layered process of considering an increasing number of challenges simultaneously. If the prescribed design stages were to be followed exactly and exclusively, students would have to set all other considerations aside to focus on only one aspect of their projects at a time. Most students observed in this study instead seemed to maintain a holistic view of their design projects by remaining open to review and rebuild previous and partial solutions in favor of more fitting or more consistent ideas. While working on particular tasks, students seemed to keep previous decisions in mind for possible changes, thus consistently keeping options for improvement open.

Based on the outcomes of this study, I understand the relationship of prescribed design stages and applied design processes in the architectural design studio both in a dynamic and interdependent relationship. This may be described in analogy to the relationship between design tutors and students: Studio tutors usually have empathy with their students and will attempt to steer them into a direction deemed desirable, but will also take into account their individual or collective tendencies in design processes, possibly even over-compensating for such tendencies. Students' design processes will neither follow teachers' advice nor prescribed design stages literally nor may this be intended by the tutors. Tutor advice can inspire and initiate new aspects and layers of thought, which lead students to develop their own responses (that may be quite different from the ideas of the tutors). While students' design processes may be unpredictable and highly individual - the opportunistic inquiry described by Gedenryd (1998) and Conklin and Weil (1990), design studios need to be planned and structured to fit into allocated times and budgets similar to design processes in practice.



C) Design stages with averaged lengths and recurring design stages

Figure 7 Prescribed design process in the observed studio (A) and alternative stage-based design process sequences (B, C)

The traditional studio structure which emphasizes intense individual tutorial conversations between tutors and students once or twice per week already provides a middle ground between rigid overall frameworks and the opportunistic and unpredictable design processes experienced by individual students. Based on the outcomes of this study, it seems that the studio structure provided support to unfolding accumulative processes rather than determining a linear roadmap. In future design studio instances, I am thus interested in exploring this understanding further, such as by suggesting a layered structure that acknowledges explicitly the need to simultaneously (re-)consider any aspect of the design project that may be necessary. Another possibility may be to avoid a literal prescription of design stages and taking into greater account the dynamic navigation process characteristic of designing which Gedenryd (1998) has characterized as "interactive inquiry". Based on the analysis of observations in this study, alternative frameworks for organizing design studio progress may be suggested. Figure 7 compares the stage-based design studio framework underlying the studio observed in this study (Fig. 7, A) with two alternative, but still stage-based options for prescribing and organizing design processes (Fig. 7, B and C). The observed studio framework was based on stages of roughly average length (Fig. 7, A), which in effect emphasized students' early design stages, which they could re-consider most thoroughly. Small changes in this framework may result in different, possibly more balanced design processes: By increasingly extending the duration of design stages towards the end of the studio (Fig. 7, B), for example, issues introduced in later design stages may be given more time to be considered thoroughly in relation to earlier design decisions. A second option (Fig. 7, C) may be to keep design stages short but to re-introduce them repeatedly throughout the design studio, which may benefit those design tasks that tend to be neglected after being 'ticked off' students' list of requirements. One particular case in point for this challenge is the task of site context consideration, which is often neglected at later points in students' design processes simply because 'site analysis' was prescribed only as the first and introductory design stage. Overall, linear design stages may best be understood as initiators of layered inquiry rather than as discrete steps, and thus make possible alternative design studio processes and briefs.

#### 7 Limitations and future work

The aim of this paper is to make explicit a gap observed between design brief and actual design processes of students in an educational design studio setting. The purpose of making explicit this gap is not to judge but to be able to examine and discuss how it may relate to teachers' guiding of design students within architectural design studios. Many purposes may be underlying the writing of design briefs, depending on even more diverse contexts. This study is limited to the observation of one particular architectural design studio where undergraduate students worked from a carefully outlined design brief which was the outcome of several years' feedback between an evolving studio design brief and teachers' and students' reactions to it. Furthermore, the cultural and educational context likely played a considerable role in the aims of the studio which in turn determined the writing of the design brief. One conclusion this paper draws from the observations made is to call attention to the difference between brief and design process, and to remind teachers, managers or researchers involved in the writing of design briefs to be aware of this gap and consider it in their preparations and expectations. Such a reflection then may provide alternative stage-based design studio frameworks, akin to those that have been discussed briefly in Section 6 above.

This study lays the groundwork for future research which may compare different kinds of design briefs and their respective outcomes in similar design studio settings. Recent work by Collins (2009) and Sipilä and Perttula (2006) in the fields of Product Design and Engineering Design suggests that the writing of design briefs influences design idea generation, and may provide points of departure for similar studies in the context of architectural design. Comparative studies on designing, however, are at risk of oversimplifying the nature of design processes when applying the scientific research paradigm. According to Rittel and Webber's (1973) seminal paper on the nature of design problems, one hallmark of design problems - and processes - is that they are unique, and not repeatable. This nature of design processes essentially calls into serious question any empirical study on design studios with a comparative objective, especially between different cultures. In this study, the approach taken thus focused primarily on careful and detailed observation with the aim of providing others involved in similar tasks of providing stage-based briefs to manage or teach design processes some food for thought.

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# 建築設計工作室過程概要:線形階段與漸增階層

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### 摘要

此乃以經驗為主的研究,比較如觀察建築設計工作室一樣觀察建築系學生的設計 過程,和依照工作室概要的初步規定的目標設計過程。此份研究最主要的問題是: 學生在個別的設計指導的設計過程中,和設計工作室概要內規定的線形、階段基 礎的架構有何不同。基於觀察資料的辨識和形象化的分析,這份報告描述並討論 十名建築系大學生在為期17週的課程中的設計過程,個別指導的觀察力形象化顯 示,學生傾向不跟隨規定的連續設計階段,而是堅持對他們作品的全方位的連續 和平行思考。從資料的形象化來看,這些漸增的階層過程變得如扇形圖般的清晰 可見。研究結果顯示,設計階段在設計工作室概要的角色可被考慮為:他們的角 色似乎是逐步地介紹學生漸增的方案階段和具挑戰性的方案領域,而不是實踐一 個清楚連續的設計步驟。基於此種理念,此份報告提供設計工作室概要的數種替 代方法。

**關鍵字**:設計工作室概要,設計階段,設計過程,資料形象化