Exploring the Impact of Rule Algorithms on Designers' Cognitive Behaviour in a Parametric Design Environment

By

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(Rongrong Yu)

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Abstract

Parametric design has been increasingly applied in the architectural industry in recent years. Researchers have studied the designers' behaviour in parametric design environments using various methods. However, there is a lack of empirical evidence to support the understanding of how parametric design affects designers' ways of thinking.

This research aims to explore the impact of the rule algorithm feature in parametric design environments on designers' behaviour. To achieve this, a protocol study was conducted comparing designers' cognitive behaviour in a parametric design environment (PDE) with their cognitive behaviour in a traditional geometric modelling environment (GME). Eight professional architects participated in the experiment in which each of them was required to complete two design sessions with design tasks at similar complexity level, one in each environment. A "think aloud" method was used to collect data during the design experiment. By employing protocol analysis, the collected data were coded and analysed using the function-behaviour-structure (FBS) ontology.

From a comparison of the protocol analysis results of designers' behaviour in the PDE and the GME, there are limited differences found between the two. From these results, we can infer that designers' high level thinking does not vary significantly in response to the tools they use. That is, whatever environment they are in, their design thinking shares some commonalities in how they approach design. However, in terms of the impact of rule algorithm use in the PDE three major differences have been revealed by this study as follows.

First, designers express an exchange of cognitive behaviour between the two levels of activities – design knowledge level and rule algorithm level. The results indicate that the design knowledge-related activities dominate the parametric design process for all cognitive issues. Therefore, we can infer that in the parametric design process, designers still expend most effort on design knowledge; parametric scripting is mainly used to support their intention of generating models.

Second, by calculating the transition probabilities between FBS design issues, we found the transition probability from F to S is much higher in the PDE. F to S is a typical design pattern which is derived from designers' existing knowledge/experience. That is, designers tend to use the existing design patterns more frequently in the PDE. Three types of design patterns in the PDE have been identified and discussed.

Third, in parametric design environments, the design problem formulation is more tool-oriented. Based on the division of two levels of design activities, and by calculating the frequency of transitions between the design problem and solution spaces, characteristics of problem-solution co-evolution processes in the PDE have been discussed. For example, the co-evolution process typically occurs at the individual design knowledge level or rule algorithm level, and only relatively infrequently do transitions occur across the two levels. The most representative activities of parametric design (activities on the rule-algorithm level)

seems to play more important roles in design in the later stage of the design session. Based on these findings, a model which illustrates the main co-evolution process in the PDE has been proposed.

Results of this research enhance our understanding of parametric design: although parametric design tools have many advantages related to its rule algorithm feature, such as flexibility, and efficiency, architectural design knowledge is still essential for defining/formulating the design problem. The design patterns identified from this cognitive study could be deliverable to students, which could possibly assist in learning parametric design more efficiently and systematically. Results of this study also imply that the way in which designers use parametric design tools is a critical point determining whether parametric design would benefit their design processes. The proposed research outcome will be beneficial for design educators, designers, design researchers, and also software developers.

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Chapter 1: Introduction

Parametric modelling technology was first used in fields that are not conventionally associated with architecture, such as aerospace and mechanical engineering, ship building and industrial designs, with the aim of catering for curved surface modelling and crafting. Later, from the 1970s onward, parametric concepts and technologies entered the architecture field. Since this new technology has been adopted by the building industry, it's powerful capabilities have led to some new aesthetic styles as well as new working modes: the former because parametric design environments (PDEs) allow architects to create and experiment with dynamic and complex forms; the latter because the efficiency of PDEs make it possible to have numbers of complex variations accessed and generated in parallel. As a result of this, many authors have described it as a revolutionary driver of change in contemporary architecture (Schumacher, 2008). According to Kolarevic (2003), parametric design is characterised by a rejection of the static solutions found in conventional design systems. There is evidence in the literature suggesting that parametric design and traditional design approaches are different both in terms of design outcomes and processes (Gane, 2004; Park et al., 2004). Moreover, it has been argued that in parametric design processes, the designer's thinking differs in a variety of ways from traditional design thinking (Aish, 2005; Woodbury, 2010).

Given this context, this study aims to explore the impact of parametric design on designers' behaviour by comparing it with behaviours found in geometric modelling environments. Firstly, eight architects (with no less than two years' experience of parametric design) were recruited to complete two conceptual architectural design tasks using, respectively, a parametric design tool and a geometric modelling tool. Their design processes were video-recorded as primary data. In the second step, protocol analysis was applied to these recordings to identify the designers' behavioural patterns in both the PDE and the geometric modelling environment (GME). The video-recorded data was transcribed, segmented, and categorised according to a coding scheme which has been adapted for coding parametric design processes. By comparing the identified behavioural patterns in the two design environments, the characteristics of parametric design are explored and discussed.

There are nine chapters in this thesis. After this introductory chapter, background information and current relevant research are reviewed in Chapters 2 and 3. Then the research method and research design is illustrated in Chapter 4. Chapter 5 outlines the general results from the experiments. Data analysis is presented in Chapters 6, 7 and 8. Finally, Chapter 9 concludes the study.

1.1 MOTIVATION

Recent literature suggests that different design media can affect designers' creative processes. For example, Tang et al. (2011) compared designers' behaviour in freehand and digital sketching environments, a study which suggests that the digital environment has an influence on designers' low level design thinking. Bilda et al. (2006) explored the differences between blindfolded and freehand sketching; their study points out that the blindfolded environment has advantages in facilitating design conceptualisation. By comparing designers' cognitive processes in CAD and freehand sketching (Bilda & Demirkan, 2003), researchers found that CAD has some levels of restriction on designers' conceptual development in terms of their perception of visual-spatial features and organisational relations in design. Kim and Maher (2005) have drawn several conclusions about design creativity when they compared Graphical User Interface (GUI) and Tangible User Interface (TUI), the results of their study suggesting that TUI benefits designers' behaviour from various perspectives. These studies suggest that digital design environments potentially have an impact on designers' behaviour: that digital design media may advance designers' thinking with certain restrictions, and the features of digital design environments can play an important role (Tang et al., 2011) in facilitating designers' design process.

Parametric design has been increasingly applied in the building industry in recent years. Evidently, parametric design is different from conventional design methods both in terms of design processes and outcomes. Many thought-provoking questions have been asked recently by stakeholders in the design industry exploring the difference between conventional design and parametric design methods. Apparently, the overarching interest of much of this past research is to determine whether or not parametric design methods benefit designers in their design process. Some studies have attempted to provide answers to this question, potentially supporting this view by showing that parametric tools advance design processes in a variety of ways. For instance, there is evidence that idea generation is positively influenced in PDEs. Particularly, in Iordanova et al.'s (2009) experiment on generative methods, ideas were shown to be generated rapidly while they also emerge simultaneously as variations. Moreover, Schnabel (2007) shows that the PDE is beneficial for generating unpredicted events and can be responsible for accommodating changes. However, researchers have typically studied design behaviour in the PDE mostly by observing students' interactions in PDEs in design studios or workshops. Arguably, this approach cannot provide an in-depth understanding of designers' behaviours. This empirical gap will be addressed in the present study by adopting the method of protocol analysis. Lee et al. (2014) presented a pilot study using protocol analysis to evaluate creativity in PDEs. The results of their study identified some conditions that potentially enhance creativity in PDEs. Using the same method, Chien and Yeh (2012) explored "unexpected outcomes" in PDEs. However, without a basis for comparison, it is difficult to suggest how parametric tools affect designers' behaviour. As a relatively new design technology, the question of whether PDEs can assist the design process is therefore a current and important topic to explore. In particular, there is a lack of empirical evidence supporting an understanding of designers' behaviour in PDEs compared to that in traditional design environment such as GMEs.

1.2 AIM AND OBJECTIVES

1.2.1 Research Aim

The aim of this study is to explore, using empirical evidence, the impact of parametric design on architects' behaviour during their design process.

1.2.2 Research Objectives

To achieve this aim, the following four objectives have been identified, each of which have a series of associated activities to achieve the objective:

Objective 1: To formulate and conduct an experiment to collect empirical data of designers' interaction with a parametric design tool and a geometric modelling tool.

- Establishing an appropriate experiment to compare designers' behaviour in two different design experiments.
- Observing how designers' behaviour is affected by using the parametric design tool by comparing it to behaviour observed when using the geometric modelling tool.
- Collecting the empirical data for protocol analysis.

Objective 2: To develop a suitable coding scheme for protocol analysis in both the PDE and GME.

- Establishing the theoretical foundation of a coding scheme for protocol studies of parametric design, reflecting on the characteristics of parametric design.
- Designing and testing the coding scheme for capturing designer's behaviour in both the PDE and GME.

Objective 3: To apply the protocol analysis technique using the developed coding scheme to identify design behavioural patterns in parametric design and geometric modelling processes.

- Investigating designers' thinking/action activities repeated during both design sessions.
- Generalising designers' typical behavioural patterns in the PDE and GME.

Objective 4: To compare the patterns identified in the two design environments, to explore the impact of parametric design on architects' design processes.

- Analysing the patterns identified in the two design environments to explore the differences/similarities in designers' behaviour between the PDE and GME.
- Investigating the unique patterns in the PDE, exploring the characteristics of parametric design patterns from various perspectives.
- Investigating the implications of the identified behavioural patterns for both design and designers.

The results of this research are expected to enhance our understanding of designers' behaviour in PDEs, from various perspectives of design cognition. The identified patterns or factors which affect designers' behaviour potentially contribute new knowledge of design, new methodologies of design cognition, and parametric design technology development. In both design practice and education, these findings are transferable and deliverable for designers and students alike.

1.3 RESEARCH SCOPE AND LIMITATIONS

The scope of this study is defined by the specific views of various key concepts, and the methodology of the study. The concepts and the methodology as well as their limitations are discussed as follows:

- There are multiple, and sometimes conflicting, definitions of design. In architectural practice, design as a process is mostly seen in an artistic way which tends to be more imaginative, unpredictable and spontaneous (Lawson, 1997). Another way of describing design is from an engineering view. As Gero defines: "Design, in one sense, can be conceived of as a purposeful, constrained, decision making, exploration and learning activity" (Gero, 1996, p 435). The engineering view of design has a more rational foundation and therefore most formal design studies focus on this aspect. In this study, the definition of design adopted is more akin to the latter engineering view, which is based on design cognition studies. To make it more precise, the definition of design in this study is: *Design is a purposeful exploration activity conducted under certain design environments, which is a problem–framing and solving process including sub-processes of formulation, analysis, synthesis, evaluation and reformulation*.

- This study explores designers' behaviour in the parametric design and geometric modelling environments. To align with the engineering way of defining and understanding design, this study refers in the design process to different levels of designers' intentions. That is, to reflect on designers' reasoning, decision-making and logical development during design. The definition of the parametric design process is therefore a process of the logical rule system design which represents designers' intentions in a PDE.

- It is not an easy task to define "parametric design", while it is also very difficult to describe what is "non-parametric" (Burry, 2011). The present study is a comparison between the two design environments and their impact on designers' design process. The critical difference, in the present context, between parametric design and traditional geometric modelling tools is associated with the application of a rule-based algorithmic process. Yet, to a certain extent architectural design has always been a rule-based algorithmic process. But, as Ostwald (2012) notes, such methods were often peripheral to the design process in previous eras, while today they have potentially become central or pivotal to the process. For example, in PDEs designers design not only by applying specialist knowledge, but also by defining and applying rules and their logical relationships using parameters. In contrast, in GMEs, the rules are present, but they are less significant or less central to the overarching process. Thus, in this study, discussion of the rule-based or algorithmic processes is used in a narrow technical sense to only refer to the generative engine in a PDE.

- To investigate the parametric design process, this study adopts protocol analysis (Ericsson & Simon, 1993; Gero & Mc Neill, 1998) – a well-known cognitive method for exploring designers' activities and behaviours. The common limitation of protocol analysis is that only a relatively small sample size can be accommodated in the method. Nonetheless, it can still provide a very detailed data set and enable an in-depth analysis of the collected protocol data. In this study, eight professional architects were recruited to develop a conceptual architectural design task using commercial parametric design tools. Protocol analysis with eight participants is a relatively large-scale cognitive study and is capable of producing comprehensive data analysis suitable for the level of a PhD.

- Another limitation is that the study is based on simulated experiments, which would not be exactly the same as those undertaken in a real design practice. However, to conduct the study and produce reliable and useful data, we have to control the condition of the experiments. By studying designers' behaviour in the artificially simulated design experiment, it is possible to identify and isolate certain detailed design activities and design processes to only focus on the conceptual design stages.

- The design software used in this research is Rhino and Grasshopper, which are typical parametric tools in the field. There are various other parametric design tools applied in the design industry, and they have their own particular features which may differ from those tested. However, most parametric design software shares similarities characteristic of parametric design. That is, they are rule-oriented, parametric variable controlled. Therefore Rhino and Grasshopper are adequate to represent parametric design in general.

- The research proposes a design experiment in which many variables may affect the results including, for instance, the cultural and linguistic backgrounds of the participants. Furthermore, although the two design briefs in the PDE and the GME are set to have a similar level of complexity, they will still have a certain degree of difference which may affect the results. In the experiment design, we tried to minimise all other variables to ensure that the only variable being measured and compared is the difference between the two design environments. However, even with this intent, it is possible that some other variables may contribute to the results.

- Other limitations that should be taken into consideration are that the experiments only use two simplified architectural design tasks (refer to Section 4.2.3) to ensure that the participants can complete the task on time during the experiment, and to limit the quantity of the video recorded data so that the coding and analysis can be completed within the timeframe of the study. The specific types of the design tasks and their simplified nature may also influence the results of the study.

The following two chapters provide a review of the literature on parametric design (Chapter 2) and on protocol studies on designers' cognitive behaviour (Chapter 3). Chapter 2 illustrates both the practical and theoretical background of parametric design and highlights the need for the current research. Chapter 3 establishes the background of the research methodology applied in this study.

Chapter 2: Literature review I – parametric design

This chapter outlines the current literature on parametric design. Firstly, some important concepts are introduced. Secondly, background information about parametric design practices is provided – as are some limitations identified by practicing architects. The third section explores the characteristics of parametric design thinking, which would be a part of the foundation of the coding scheme proposed. Finally, in the last section the rationale for developing a coding scheme is provided.

2.1 DEFINITION OF IMPORTANT CONCEPTS

2.1.1 Parametric design

Parametric design is an approach that focuses on the representation and control of the relationships between objects: it supports the creation, management and organisation of complex design models (Woodbury et al., 2007). Using parametric design tools, designers can make rules according to the performance requirements of a design. A parameter is a value or measurement of a variable that can be altered or changed. The object will have some rules embedded in a parametric system and when one parameter changes, other parameters of the object will adapt automatically (Ostwald, 2012). By changing parameters, particular instances can be created from a potentially infinite range of possibilities (Kolarevic, 2003).

From these definitions above, parametric design has the following features. Firstly, it is parameter-oriented: Eastman argues that in parametric design the variables are defined by parameters including distance, angles, etc. (Eastman, 2008). Most parameters are related to geometric modelling, and some of them are connected to functional requirements. Secondly, there are relationships between variables; the parametric system will update when the variables are changed. As Cárdenas (2007) notes, it establishes the relationships between modelling components defined by constraints. While Abdelsalam (2009) claims that the relationships are maintained by variations, in most cases, both constraints and variations in combination help to build the relationships between the modelling components and rules. However, the system may become "over-constrained" if there is no effective control (Burry, 2003). Thirdly, the characteristics of rule-based algorithms make the design process controllable and flexible (Schnabel, 2007; Abdelsalam, 2009). As Abdelsalam (2009) argues, by making rules, designers can produce variations which result in *"fully organized controllable building forms"*. Fourthly, it is an efficient process from which multiple design solutions can be developed simultaneously. Both Hernandez (2006) and Karle and Kelly (2011) emphasise that to develop parallel ideas is one of the main advantages in parametric design.

In summary, parametric design is a dynamic, rule-based design process controlled by variations and constraints, in which multiple design solutions can be developed in parallel. It is effective in generating complex forms and optimising multi-solutions. Therefore, parametric design is usually utilised in form-generation, structural and energy optimisation problems, as well as construction of complex building forms. As a new digital design method, parametric design is quite different from traditional CAD/CAM because of these rule-based algorithmic characteristics.

2.1.2 Parametric modelling

Parametric modelling is "*a design methodology used to create design spaces and geometric dependencies within a model*" (Gane & Haymaker, 2009, p 81). It provides a description of the design through parameters and relationships that allow for variations, by which designers are able to change the values to generate and optimise with more design solutions. The biggest advantage of parametric modelling is that it allows changes to the parameters of the geometric model at any stage of the design process (Monedero, 2000). Figure 2.1 shows the interface of Grasshopper (a parametric design software plug-in for CAD modelling tool Rhino) in action, which shows that geometric modelling (left) is controlled by a series of designed rules (right).

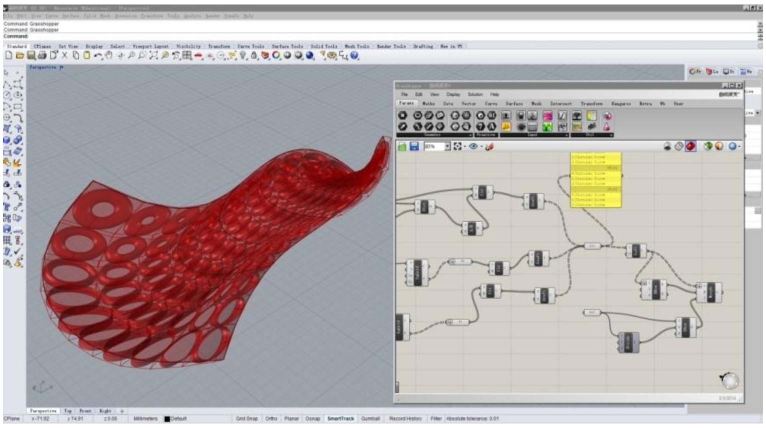


Figure 2.1. Interface of a parametric design software Grasshopper (source from the author).

2.1.3 Parametric variations

In a parametric design, variations are controlled by changing the values of parameters and constraints without destroying the original structure of the modelling. Variations can be single or multiple, independent from or interactive with each other. Karle and Kelly (2011) argue that as a new design method, parametric design does not push designers into generating the right design solution but, rather, into asking the right questions. As a result, the selection of variations is an important step in the parametric design process. By selecting appropriate variations, design problems can be identified, and then a series of rule-sets with associative variables can be established, supporting the emergence of a dynamic and flexible design process.

In the design field constraints control the entire design process, determining the uniqueness of each design project and helping designers describe the range of variations. In the geometric modelling process, the optimisation evaluation is determined by a series of constraints, so constraint satisfaction plays a key role in the decision-making process by connecting individual input factors with design outcomes. In the parametric design process, constraints limit the effects of parameters on the design object, as well as controlling the possibilities for variation. There are two forms of constraints – dimensional and geometric (Monedero, 2000). Geometric constraints are properties that control how geometric entities relate to each other. Dimensional constraints are properties that can be assigned to a singular value, relating the geometry to a numerical value that fixes its behaviour until it is changed or removed. As well, if in a parametric modelling process the model is under-constrained, some additional parameters need to be specified, whilst an over-constrained model indicates a contradiction somewhere (Monedero, 2000).

2.2. PARAMETRIC DESIGN PRACTICE IN ARCHITECTURE

2.2.1 Brief history of parametric design

- ***Origin of Parametric Design***

In 1978, Hillyard and Braid proposed a system that allowed the specification of geometric constraints to be restricted to a certain range (Hillyard & Braid, 1978). It was not developed further until more recently, but it remains one of the first attempts to theorise *constraints* and *variations* in design systems. A few years later, based on Hillyard and Braid's work, Light and Gossard presented what was called *variation geometry* or *variation design* (Light & Gossard, 1982). Their work provided geometrical representations with new mathematical and geometrical tools. These modelling tools were utilised widely in aerospace, ship construction and product design industries. Since the late 1980s, Frank Gehry, a leading architect, used CATIA 5.0 as a platform for the documentation of his designs, and as a component of this tool, a parametric package was used for Nurbs surfacing. Though most of Gehry's designs used parametric techniques only in the documentation stage, around that time his style triggered some new architectonic possibilities through his use of this tool. Without parametric tools, these dynamic, open-ended, and consistent design styles would have been difficult to complete. Later, his company, Gehry Technologies, developed a parametric software called Digital Project (DP) which was capable of handling complex architectural designs based on CATIA5.0.

- ***Development of Parametric Design***

From the mid-1990s, the number of architectural organisations that explored and developed tools for parametric representations in building design increased significantly. During this period, software like *GenerativeComponents™ (GC), Grasshopper* and *Processing* were developed and metamorphosed quickly from generation to generation. By the year 2000, the applications of parametric techniques in building design had matured and a growing number of buildings using parametric design methods were proposed and constructed. The key proponents of parametric design in the design industry at this time included Foster+Partners, Zaha Hadid Architects, UNStudio, KPF, AAEmtech, and SPAN. During that time designers were able to use parametric design tools to produce and control a *free-form skin* for the building. This was a major breakthrough over conventional practice, as the main tasks of some of these leading architects and firms changed into designing through parametric modelling.

In the academic world, the AA in London, LAAC in Spain, Hyperbody in Delft University of Technology, Columbia University and MIT all became cradles for the next generation of parametric designers. Meanwhile, annual computational design conferences including ACADIA, ASCAAD, CAADRIA, eCAADe, SiGraDi, CAAD Futures, DDSS and others have increasing numbers of papers on parametric design, a factor which has played a dominant role in the digital design arena. During the 2011 ACADIA conference, "Parametricism" was listed as the main theme of the conference and since then there have been several annual workshops which have successfully promoted parametric design. These include the *Smart Geometry* and *Modelab* workshops.

- ***Parametricism***

Developed for over 20 years, parametric design is playing more and more important roles in architectural design, especially among leading design practices. Some authors have argued that it has become a design style that is replacing Modernism (Schumacher, 2008). In the 2008 biennial exhibition of digital design which was held in Venice and titled *"Out There：Architecture Beyond Building*", Parametricism was developed and described as a combination of concepts that "*offer a new, complex order via the principles of differentiation and correlation"* (Schumacher, 2008, p 15). The overarching implications of these concepts are still underexplored.

Nonetheless, architects still often maintain modernist aesthetics but use parametric modelling to absorb complexity. For instance, the Soho Shang Du in Beijing is considered a well-designed building with a rather conventional appearance which has been produced using parametric tools (Figure 2.2). Whether parametric design will be the future architectural style is still in doubt.

Figure 2.2. Soho Shang Du, Beijing. (source: http://www.sohochina.com/en/shangdu/photo.asp?iClassID=42&DjjIntPcnt=4)

2.2.2 Parametric design tools

To date, several software applications have been adopted widely to advance parametric concepts. Most of these have script plug-ins which enable designers to make rules more freely. Some of these applications are discussed below.

- ***GenerativeComponents™***

In 2005, GenerativeComponents™ (GC), a new design software from Bentley Systems, was developed by Robert Aish. It deals with generative design concepts targeting design processes from the conceptual phase to final documentation. At the same time, GC is integrated with BIM as well as analysis and simulation platforms for providing feedback on several design aspects. This integration also potentially makes design intention more precise, realistic and efficient from the conceptualisation to detailed production and fabrication.

- ***Rhino and Grasshopper***

Rhinoceros (Rhino) is a stand-alone, NURBS-based 3D modelling tool. It was developed by Robert McNeel. The software is commonly used in industrial design, architecture, marine design, jewellery design, automotive design as well as multimedia and graphic design. As the most widely used parametric software, Grasshopper is a graphical algorithm editor which is integrated into Rhino as a plug-in. It is structured with specific definition files that link to the main model in Rhinoceros. Usually, Grasshopper is used as a generative tool rather than a modifier in design processes. Compared to other parametric design software, Grasshopper is applied more widely throughout the design industry because of its relatively low cost and ease of manipulation.

- ***Digital Project and CATIA***

Computer Aided Three-dimensional Interactive Application (CATIA) was developed in 1977 by French aircraft manufacturer Avions Dassault. Thereafter, it was adopted in the aerospace, automotive, ship-building and other industries for its ability to control complex geometry and manufacturing accuracy. Since 1977, six versions of CATIA have been developed and used commercially and in the last two decades, its popularity in the architectural field has grown significantly. Based on CATIA 5.0, Gehry Technologies developed Digital Project (DP), which was particularly targeted at the architectural design industry. Digital Project is known to be a very powerful parametric CAD package that handles both complex parametric and geometric associations.

- ***Scripting tools***

Scripting uses computer programming languages like Java and Visual Basic (VB) to interpret commands and interchange them each time when scripts are run. It can establish and control the parameters and translate the ideas of a designer into codes that are easily identified by a computer. Consequently, designers can control the logic of designing in a way that allows them more freedom than any other tools, as it is able to make rules according to certain project scenarios or specifications. A major advantage of this approach is that repetitive tasks can be automated, potentially offering endless generative possibilities as contents and behaviours can be automatically modified. Currently, the most-used scripting languages include Pythonja, VB and Ruby, whilst scripting tools include Python script, Rhino-script, Processing and CAD-script.

- ***Plug-in analysis tools***

There are several analysis tools that are capable of importing design data into parametric design software applications. For example, Ecotect is used for analysing energy use; while ETABS is used for analysing structural data. These plug-in tools provide the possibility of generating more precise solutions while they make the optimisation process more traceable than in non-parametric design environments.

All these parametric tools share similar characteristics: being rule-oriented, supporting changeability and free-form generation. Different parametric tools also have their own features: Rhino and Grasshopper are the most commonly used tools in the architectural domain; as visual programming software they are allegedly easier for architects to learn. Scripting tools are also beneficial for their flexibility; allowing designers to do their own programming without many fixed components; while Digital Project and GenerativeComponents™ are better for large project corporations, management, etc.

2.2.3 Limitations of parametric design practice in architecture

Parametric design has been practised all over the world in recent years leading to the suggestion, in the media, that the computer has gradually become the designer rather than providing the initial design assistance that it was meant to. Its characteristics, such as flexibility and controllability, have rapidly escalated its popularity (Barrios, 2005; Fischer et al., 2005; Salim & Burry, 2010). However, a number of problems have been reported regarding its application, some of which are identified below as its limitations and challenges.

1. ***High Acquisition and Implementation Cost:*** Most parametric design software applications are expensive, requiring powerful computer hardware environments to succeed. Some large-scale and complex design organisation tasks will even require additional and specialised computing power. Therefore, it is difficult for small design firms to adopt parametric design, due to the high cost, additional hardware and software training, and other associated changes required for the practices to adopt the approach.

2. ***Variation Selection:*** A typical challenge of using parametric design is how to select appropriate variations. Peña and Parshall (2001) have argued that problem finding is the most important part in design processes, and only by defining problems appropriately would problems be solved. In parametric design, defining variations is critical to representing design concepts. Variation triggers flexibility and the possibility to develop parallel ideas. Designers benefit in having multiple variations, and this only makes sense when the number of alternative variations is controllable. For example, some design factors such as Energy Conservation Index (ECI), budget, architectural building code and structure can be quantified. However, other factors such as aesthetic, historical context and social influence are difficult to measure. As a result, architects still have to take the lead in critical thinking by using their architectural knowledge to solve potential design problems even with the use of parametric design tools.

3. ***Complexity of Architectural Representation*:** Parametric design opens up new opportunities by allowing the production and construction of complex and expressive building forms. However, some designers over-pursue complex and attractive appearances which can make some parametric design practices superficial. After all, for architecture, the complex form should come from the complex behaviour of people rather than bizarre appearances (Leach, 2008).

2.3 LATEST TRENDS IN PARAMETRIC DESIGN RESEARCH

In recent times, academic researchers worldwide have been actively engaged in studies on parametric design. Some of the dominant trends are discussed below.

2.3.1 Parametric design and form-finding

Parametric design tools capture and explore the critical relationships between the design intention and geometry. Designers interact with the tools through dynamic modelling, designing rules and capturing relationships among building elements. In building form-finding, the use of parametric methods can help with the modelling process, and the integration of parametric design can also enhance design flexibility and control (Fischer et al., 2003).

Hnizda (2009) proposed two geometric modelling methods in parametric design – *object extraction* and *transformation*. He tested the two methods by examining the separation of formal aesthetics and functional processes using a single grain silo (cylinder) in a PDE (Grasshopper). To a large extent, the form-finding approach is dependent on variation settings, as in Baerlecken et al.'s (2010) work on the form-finding process in PDEs from aspects of the variation settings. The parametric variation selected in their study is the functional and structural properties and resultant from sun-shading. It can be seen that the selection of parametric variation has a significant impact on the final form. To study form-finding in PDEs, Hnizda's study looks at modelling method, while Baerlecken et al. looks into problem finding from the early design stage. Both studies examine ways of form-finding in PDEs from different perspectives.

Another significant study of form-finding in PDEs is its utilisation in "Sagrada Familia". Gaudi's "Sagrada Familia" cathedral is characterised by curved sculptural surfaces that follow certain rules. These rules in Gaudi's design provide additional possibilities for analysis and modelling using parametric tools (Roberto & Hernandez, 2004), representing simple geometrical rules and basic procedures, which result in a rich formal language. As Mark Burry stated: *"(the) use of ruled surfaces provides an invaluable codex for communication between distanced collaborating parties"* (Burry, 2003). From 2003, Mark Burry and his colleagues worked on the development of a parametric system for modelling complex geometry based on the case study of the "Sagrada Familia". The research later extended to aspects of construction, in which they suggest that parametric tools could have been used effectively in the building's construction (Figures 2.3 and 2.4). The study shows that parametric design tools can both shorten the project period and simplify the process – the "Sagrada Familia" project is ongoing, and the estimation is that there will be thirty years before it is completed. The study of Gaudi's cathedral provides practical evidence of rule-based algorithmic applications using parametric design tools.

Figure 2.3. Columns in Sagrada Familia cathedral (Roberto & Hernandez, 2004).

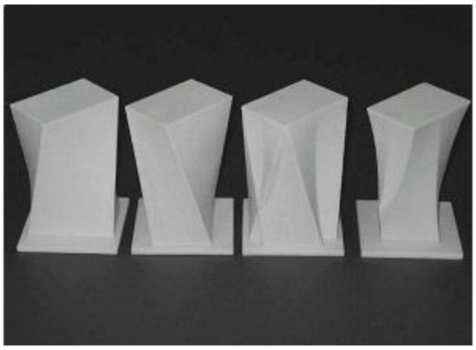


Figure 2.4. Rapid prototypes of the parametric model for the cathedral (Roberto & Hernandez, 2004).

Another theme in the parametric modelling process, is that researchers keep asking if there are certain steps they can follow in order to make the modelling process traceable. "Design patterns in parametric modelling", as proposed by Woodbury et al. (2007), show that parametric modelling can be transformed more easily by using design patterns, so that a general method can be adopted to solve particular design problems. Woodbury et al. observe that:

"Patterns are a way to identify successful general strategies that exemplify a key concept in a memorable fashion that can easily be taught." (Woodbury et al., 2007, p 229)

In 2007, the first three design patterns in parametric modelling were proposed. Detailed demonstration of design patterns in parametric modelling is provided in Woodbury's book "Elements of Parametric Design". In the book, parametric design patterns are proposed as an abstract and reusable tool in PDEs, which have significant influence on both education and practice (Woodbury, 2010). By learning these patterns, architects and students are able to master the parametric design method more efficiently and skilfully.

2.3.2 Parametric design and building performance

Most applications of parametric design developed for building performance are for structural analysis and sustainability performance.

- ***Structural analysis using parametric design***

In structural design using parametric tools, a predefined set of geometrical constraints could be developed as the driver for optimising shapes (Maher & Burry, 2003). Evidence for this has been provided by Maher and Burry in their study by comparing parametric structural analysis software with traditional software in a cross-disciplinary collaboration between architects and structural engineers. In a similar study linking architectural design to structural optimisation in PDEs, Holzer and Hough (2007) investigated geometric generation, structural analysis and optimisation in design processes. They argue that leaving sufficient space for future change will help generate more creative solutions in the early stages of design. Moreover, defining parameters, rules, goals and constraints will help generate a variety of design solutions. These studies explored structural analysis using PDEs, however, most of their works are limited to analysing the volume of structural materials.

Structural analysis using parametric design is a current area that researchers continue to explore. One of the popular tools is ETABS – a structural analysis software in which data can be imported into parametric design software. There are multiple recent studies on the utilisation of ETABS in combination with parametric design tools. For instance, Almusharaf and Elnimeiri (2010) study structural performance in high-rise building design by utilising ETABS in the environment of Grasshopper. A design scenario is presented in which instant feedback on structural performance can be provided during the parametric design process. The combination of structural analysis and parametric design tools not only makes the design process more efficient and precise, but also provides new ways for collaborating between and across disciplines.

- ***Sustainability performance in parametric design***

One of the advantages of parametric design is that it can support optimisation based on a series of analyses. Besides structural analysis, sustainability performance is another important use of parametric design. Currently, sustainability performance in parametric design is being studied in various different ways. For instance, multi-parametric façade elements in a BIM model have been examined by Schlueter and Thesseling (2008). In their study, the performance analysis tools give instant assessment during the design process so that the designers can better consider energy performance (solar gain in different façade forms) while they are modelling geometries. In another recent study a design model that combines parametric modelling technologies and the performance-based design (PBD) paradigm is proposed by Bernal (2011). With similarities to Schlueter and Thesseling's model, Bernal's also provides real-time feedback on the building performance index.

2.3.3 Collaboration in parametric design

With the popularity of parametric design, researchers have begun to examine collaboration within PDEs, including cross-disciplinary and long-distance team cooperation. Past research suggests that collaboration between disciplines at an early stage in the process will improve design through added flexibility and creative opportunity, and it also assists in dealing with any lack of information (Burry & Holzer, 2009). In 2009, Burry and Holzer explored the potential for sharing parametric models in a version-control software, which could be used by remote design teams. Rajus et al. (2010) used the participant observation method to study collaboration in a PDE. In their study, 18 participants were asked to perform two design tasks using the parametric software GenerativeComponents™ (GC). They designed four types of control modes of collaboration and made participants work with different control modes. The results showed that control modes used in collaboration will enhance the user performance and satisfaction with PDEs.

In the early design stage, collaboration between disciplines plays an important role. One typical study in this area is the requirement model proposed by Gane and Haymaker (2009). The requirement model can be used by a multidisciplinary team to collect, weigh and prioritise multi-stakeholder needs, in such a way that the identified requirements are able to be transformed into parameters in PDEs. The proposed model can also build relationships and address conflicts between requirements and design parameters. Gane's and Haymaker's study shows that the development of collaboration through PDEs in early design stages can help with problem finding, which itself can provide a direction for selection of variations in the parametric design processes.

2.4 PARAMETRIC DESIGN THINKING

"Parametric thinking is a way of relating tangible and intangible systems into a design proposal removed from digital tool specificity and establishes relationships between properties within a system. It asks architects to start with the design parameters and not preconceived or predetermined design solutions." (Karle & Kelly, 2011, p 109)

2.4.1 Changes of designers' activities in a PDE

Parametric design is, in comparison with conventional design quite different – not only because it offers a new design tool but also a new way of thinking. The theorised changes of designers' activities in a PDE compared to those in a traditional modelling design environment can be summarised by the following observations:

- ***Designers design rules and define their logical relationships rather than only modelling geometries.***

One of the biggest differences between parametric and traditional design is that rule-sets become basic design procedures in PDEs (Abdelsalam, 2009). While building models, designers set variations, design data flow routes, adjust the values of parameters and revise rules. They are not only thinking about the particular building design, but also the rule design in order to achieve the building design. Additionally, through the control of logical relationships there are more possibilities for design solutions (Hernandez, 2006; Karle & Kelly, 2011).

- ***Designers are free to make changes in any steps of the design***

In the parametric design process, all the systems are differentiated and correlated and all design activities or events communicate with each other (Schumacher, 2008). Designers are free to go back to any step to change parameters or revise rules. This allows them to keep the design 'open' and flexible. The advantage of this is that parametric design saves time spent on repetitive documentation.

- ***Numbers of design alternatives can be developed in parallel***

Traditionally, designers consider a very small number of alternatives because of time limitations (Woodbury & Burrow, 2006). So, as Akin (2001) argues, design solutions are not optimal, but only satisfactory, according to a pre-set level of aspiration. In the parametric design process, once the rules are made, large numbers of design alternatives may be generated (Figure 2.5). This process provides a variety of possibilities, as well as widening the designers' thinking. The alternatives can be developed in parallel, so designers do not need to predetermine design solutions at an early stage (Hernandez, 2006; Holland, 2011; Karle & Kelly, 2011). Parametric design allows this level of intelligence to be added to initial ideas and maintained through into the later stages. As a result, the final design solution, which is analysed and optimised, will, most likely, be better than the single solution derived from the traditional design method.

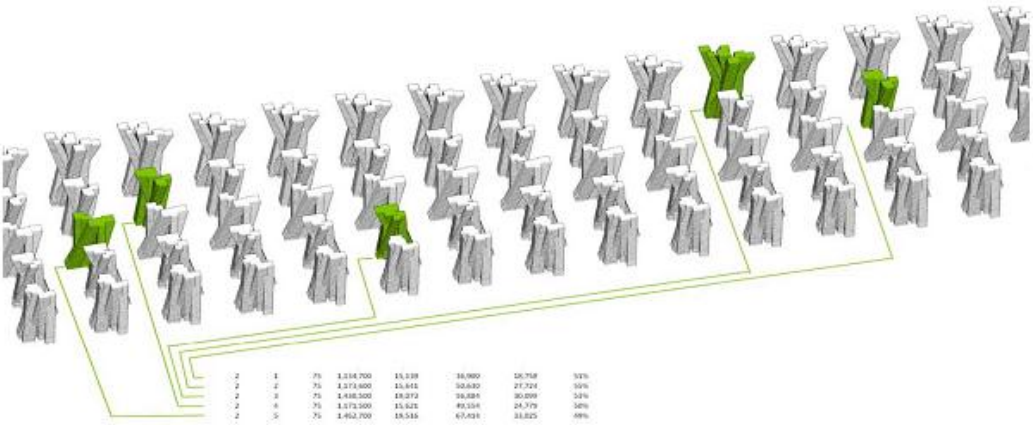


Figure 2.5. Numbers of design alternatives generated in Grasshopper (Holland, 2011).

2.4.2 Characteristics of parametric design thinking

In order to identify the characteristics of parametric design thinking, this section reviews recent studies on parametric design thinking.

Robert Woodbury (2010) defines parametric design thinking using three characteristics – thinking with abstraction, thinking mathematically and thinking algorithmically. *Thinking with abstraction* is a base for generating numbers of alternatives and reusing model parts. *Thinking mathematically* is coding theorems and constructions into propagation graphs and node update methods. *Thinking algorithmically* means that the scripting language provides functions that can add, modify or erase objects in a model. The basic requirement is to establish the data flow route clearly – step by step and precisely.

Woodbury's characteristics of parametric design thinking are focused more on the mathematical aspects of modelling. He claims that in a PDE designers need a different kind of geometric knowledge that can "predict persistent effects to understand the diversity and structure of the mathematical toolbox, and to shuttle between the intended effect and mathematical invention that models it" (Woodbury, 2010, p 84). That means designers need to know more than merely their architectural knowledge – such as the knowledge to ensure that the mathematical tools will work in the design development processes.

However, there should also be a balance between tool manipulation and the utilisation of architectural knowledge in the parametric design process. Thus, with the popularity of parametric design, designers who embrace *Parametricism* may tend to abandon some very significant architectural thinking. Some of these architects have a tendency to avoid subjective judgement and produce novelties through computing power: they are using parametric design tools without addressing basic issues of building design such as peoples' psychological needs, social and historical impact, environmental concerns, as well as functional and programmatic requirements (Castellano, 2011). In such cases, buildings designed from a purely form-based method often fail in a way that loses the essential meaning of architecture.

Aranda and Lasch (2008) suggest that parametric design communicates between two worlds. The first, entirely abstract and coded from which complex spatial worlds could emerge through very simple mathematical expressions governed by parameters. The second, is very real and alive, it is the one we find through our interactions every day with people, communities and cities (Aranda & Lasch, 2008). Therefore, the balance in using algorithmic thinking and architectural thinking is very important in the parametric design process: architects are familiar with architectural design thinking, but how should algorithmic thinking be developed and integrated with architectural thinking in a PDE? This is an open research question.

Aish proposes two levels of algorithmic thinking. In the first level, there is a desire to explore geometric subtleties in which equations are established to describe modelling relationships; while another level is a desire to apply ideas of "consistency" or controlled "unpredictability" over large data sets, wherein associative data will sometimes emerge from previously unexplored conditions (Aish, 2005). Aish's first level of algorithmic thinking can be defined as geometrically based, manually controlled and predicted; while the second level can be defined as data-based, automatically generated and unpredicted.

Generally, researchers have identified two aspects of parametric design thinking: one is abstract and rule-oriented, the other is alive and design-oriented. When using parametric tools, designers should communicate between the two aspects and keep the balance: not "over-algorithm", while at the same time taking full advantage of the power of parametric design.

2.5 PARAMETRIC DESIGN ENVIRONMENTS AS TWO OVERLAPPING CONCEPTUAL DESIGN SPACES

From the review of parametric design above, we can see that parametric design is typically presented as being different from any traditional design method due to its rule algorithm feature. In addition to documentation and modelling, rule algorithm design activities in PDEs assist designers by generating design paradigms and constructing data structures (Iordanova et al., 2009). However, the ways in which parametric design is used by architects are not well understood which is why some argue that parametric design "requires a deeper understanding of how it can support our intentions as architects" (Sanguinetti & Kraus, 2011, p. 47). Compared to traditional design environments, in PDEs architects not only design by applying specialist knowledge, but they also explicitly define rules and their logical relationships using parameters (Abdelsalam, 2009). When an architect models a building form using parameters they must assess variations, design data flow routes and adjust the values of parameters, and revise rules. At this time they are not only thinking about the particular building design, but also the rule design. It is through the control of logical relationships between forms and functions that the possibilities for design solutions are heightened (Hernandez, 2006; Karle & Kelly, 2011).

Therefore, in a typical parametric design process there are design activities on two levels: the design knowledge level and the rule algorithm level (Figure 2.6). At the design knowledge level, architects make use of their design knowledge, including, for example, how to adapt a building to the site, how to shape the way people use the building, and how to satisfy the requirements of their clients. At the rule algorithm level, designers apply design knowledge through the operations of the parametric design tools, including defining the rules and their logical relationships, choosing the parameters suitable for a particular purpose and importing external data into the proposed rules. During the design process, designers progress by applying specialist knowledge; in some parts (namely the rule algorithm level) they apply design knowledge indirectly by defining rules and their logical relationships, and this is known as parameterisation.

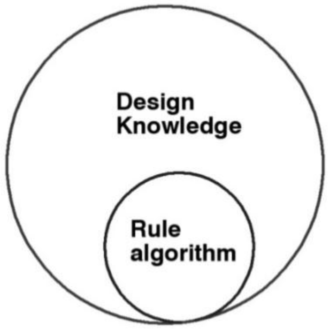


Figure 2.6. Two types of design spaces in the PDE.

In summary, the research into parametric design provides us with a solid foundation to further explore designers' ways of thinking in the PDE. However, these researches are mostly undertaken by observing designers' and students' interactions within PDEs in design studios or workshops, or supported by interviews and questionnaires or are argued on the basis of self-experience. Arguably, these approaches are inadequate to provide an in-depth understanding of designers' behaviours in PDEs. This empirical gap will be addressed in the present study by adopting the method of protocol analysis. Protocol analysis is introduced in the next Chapter.

Chapter 3: Literature review II – protocol studies on designers' cognitive behaviour

This chapter outlines the current literature on protocol studies of designers' cognitive behaviour. Firstly, protocol analysis as a research method in design studies is presented. Thereafter, current design protocol studies are considered, and finally the FBS ontology is introduced as the theoretical model and foundation for the coding scheme used in this study.

3.1 OVERVIEW OF PROTOCOL ANALYSIS

3.1.1 Protocol analysis as a research method for design cognition

Protocol analysis is a method for turning qualitative verbal and gestural utterances into data (Ericsson & Simon, 1993; Gero & Mc Neill, 1998). It has been used extensively in design research to develop an understanding of design cognition (Suwa & Tversky, 1997; Atman et al., 1999; Kan & Gero, 2008). According to Akin (1986), a protocol is the record of the behaviours of designers, made using sketches, notes, videos or audio. After collecting the protocol data, certain coding schemes will be applied to categorise the collected data, enabling detailed study of the design process in the chosen design environments. As Gero and Tang (2001) note, protocol analysis has become the prevailing experimental technique for exploring the understanding of design.

Usually in protocol analysis, concurrent and retrospective protocol collection methods can be applied in design experiments (Ericsson & Simon, 1993; Dorst & Dijkhuis, 1995). A concurrent protocol involves participants in an experiment verbalising their thoughts when working on a specific task – also called the "think aloud" method – whereas a retrospective protocol explores what designers were thinking while designing, a process which is applied as soon as they have finished the design task. Some studies have compared these two protocol collection methods. For instance, Kuusela and Pallab (2000) argue that concurrent protocols are more suitable for examining the design process and can generate larger numbers of segments, while retrospective protocols are more suitable for examining design outcomes. Another example of this comparison is Gero and Tang's (2001) study exploring design processes. Their results show that concurrent and retrospective protocols lead to very similar outcomes in terms of exploring designers' intentions during design processes. But they also conclude that concurrent protocols are an efficient and applicable method by which to understand design processes. Retrospect protocols are commonly believed to be less intrusive to the design processes.

There are two approaches to protocol analysis: process-oriented and content-oriented (Dorst & Dijkhuis, 1995). The process-oriented approach focuses on describing the designers' intentions such as design plans, goals and strategies. The content-oriented approach focuses on the cognition of problem-solving, which means it looks at what designers see, and what knowledge they use to achieve specific design outcomes (Suwa & Tversky, 1997). As this study intends to explore the designers' thinking patterns in PDEs, the process–oriented approach is used.

3.1.2 Procedure of applying protocol analysis

There are several common procedures for applying the protocol analysis method. According to Ericsson and Simon (1993), the general procedures include:

1. Proposing a hypothesis or direction of observation;
2. Experimental design and subject recruitment;
3. Conducting experiments;
4. Transcribing protocols and materials generated in the design process;
5. Devising a coding scheme;
6. Encoding protocols;
7. Quantitative and qualitative comparison of encoded protocols;
8. Proposing results.

To date, protocol analysis has been extensively used to study designers' behaviour**,** providing the theoretical basis and practical guide for the current study. In the present research, the common procedure of protocol analysis is adopted, which follow steps 1-8 in Ericsson and Simon's (1993) approach. There are several alternative methods to segment data, such as dividing by a fixed time duration, on individual sentence or on the meaning of the protocol. In step 6, during the encoding process, the present research segments the transcribed data based on the content meaning of protocols, and then categorises each segment using the developed coding scheme.

3.2 DESIGN PROTOCOL STUDIES

Protocol analysis has been used in the past to compare different design environments (Bilda & Demirkan, 2003; Kim & Maher, 2005; Bilda et al., 2006; Kan & Gero, 2009b; Tang et al., 2009; Kan et al., 2011; Tang et al., 2011). In this section we list studies using protocol analysis undertaken between 1996 and 2014 (Table 3.1).

Table 3.1. List of reviewed journals articles (71) adopting protocol analysis and identified by SCOPUS, from 1996 to 2014, searching using keywords: "protocol analysis" and "design".

Journals	Articles	The number of articles
Design Studies	(Galle & Kovács, 1996; Suwa & Tversky, 1997; Suwa et al., 1998; Valkenburg & Dorst, 1998; Chan, 2001; Gero & Tang, 2001; Ho, 2001; Seitamaa-Hakkarainen & Hakkarainen, 2001; Kavakli & Gero, 2002; Stempfle & Badke-Schaub, 2002; Taura et al., 2002; Bilda & Demirkan, 2003; Chiu, 2003; Meniru et al., 2003; Akin & Moustapha, 2004; Atman et al., 2005; Bilda et al.,	29

	2006; Menezes & Lawson, 2006; Bilda & Gero, 2007; Kim et al., 2007; Kim & Maher, 2008b; Liikkanen & Perttula, 2009; Lemons et al., 2010; Rahimian & Ibrahim, 2011;Tang et al., 2011; Chai & Xiao, 2012; Bertoni, 2013; Chandrasekera et al., 2013; Vallet et al., 2013)	
Research in Engineering Design	(Atman & Bursic, 1996; Frankenberger & Auer, 1997; Mc Neill et al., 1998; Sim & Duffy, 2003; Chakrabarti et al., 2004; Deken et al., 2012; Mohamed Khaidzir & Lawson, 2013)	7
Artificial Intelligence for Engineering Design Analysis and Manufacturing (AIEDAM)	(Wu & Duffy, 2004; Lindekens & Heylighen, 2008; Al-Sayed et al., 2010; Goldschmidt et al., 2010; Jin & Benami, 2010; Strickfaden & Heylighen, 2010)	6
Journal of Engineering Design	(Coley et al., 2007; Houseman et al., 2008; Kim et al., 2011; López-Mesa et al., 2011; Wang et al., 2013)	5
International Journal of Technology and Design Education	(Welch, 1998; Welch et al., 2000; Wang et al., 2010)	3
Automation in Construction	(Kavakli, 2001; Ibrahim & Pour Rahimian, 2010)	2
Journal of Engineering Education	(Atman & Bursic, 1998; Davis et al., 2002)	2
Creativity Research Journal	(Hasirci & Demirkan, 2007)	1
Educational Technology Research and Development	(Azevedo & Jacobson, 2008; Leblebici-Başar & Altarriba, 2013)	2
Environment and Planning A	(Burnett, 2008)	1
Human Computer Interaction	(Kim & Maher, 2008a)	1
International Journal of Human Computer Studies	(Kennedy et al., 1998)	1
Architectural Engineering and Design Management	(Gül, 2009)	1
Artificial Intelligence Review	(Do & Gross, 2001)	1
Computer Aided Design(CAD)	(Jee & Kim, 2010)	1

International Journal of Applied Engineering Research	(Kuate et al., 2012)	1
American Journal of Psychology	(Kuusela & Pallab, 2000)	1
Journal of Creative Behaviour	(Gero, 2011)	1
International Journal of Architectural Computing	(Yu, et al., 2013)	1
Electronic Journal of Information Technology in Construction	(Yu et al., 2012)	1
Co-Design	(Ensici et al., 2013)	1
Design Issues	(Sarkar & Chakrabarti, 2013)	1
Design Journal	(Leblebici-Başar & Altarriba, 2013)	1

From Table 3.1, we can see that most protocol studies are published in *Design Studies* followed by *Research in Engineering Design*, *AIEDAM*, and *Journal of Engineering Design.* The majority of these were focussed in the period between 2001 and 2003, and later, between 2008 and 2010. From 2001–2003, the application of the protocol analysis method started to become popular in design research. During this period most of the protocol research focuses on studying designers' cognitive behaviour in sketching environments, which is a basic and essential skill for designers. During the later 2008–2010 period, emerging digital design tools brought new challenges for designers. Researchers at this time were interested in exploring whether/how the new digital technologies can assist designers' cognitive processes. During this period, the protocol studies focussed more on designers' behaviour in digital environments, such as CAD, digital sketching, Tangible User Interface, haptic interface, etc. The large number of studies shows that protocol analysis is one of the most frequent and reliable techniques applied in design studies.

3.3 OVERVIEW OF CODING SCHEMES APPLIED IN PROTOCOL STUDIES

In a protocol study the coding scheme is very important for the encoding and analysis of the data collected from the design process. The earliest coding scheme in cognitive studies was proposed by Eastman, who use design units, constraints and manipulations to encode protocols and explore the behaviour graph in the design process (Eastman, 1970). Since then researchers continued to develop a variety of coding schemes to address specific research problems.

Some protocol studies which provide two significant coding schemes are as follows. The first is focused on the design action categories proposed by Suwa and Tversky (1997), which is a content-oriented approach. The second was developed based on Gero's (1990) Function-Behaviour-Structure (FBS) model. Kan and Gero started working on a protocol study based on the FBS model as a coding scheme in 2009. They claim that although there have been many protocol studies, it is difficult to compare them because of the use of different coding schemes. Their aim was to develop a coding scheme based on the FBS model to be the basis for a universal coding scheme applicable to the whole design domain (Kan & Gero, 2009a). This FBS coding scheme is a process-oriented approach that focuses on a designer's intentions. These coding schemes are two of the most influential in the advancement of protocol analysis, and they provide a foundation for the coding scheme developed within this study.

3.3.1 Protocol studies using Suwa's coding scheme

First established by Suwa and Tversky (1997) and later developed by Suwa et al. (1998), Suwa's coding scheme is widely applied to cognitive design studies and especially in studies of free-hand sketching processes. Tang and Gero conducted further research based on this scheme (Gero & Tang, 1999; Tang & Gero, 2000; Gero & Tang, 2001; Tang & Gero, 2001). Suwa's coding scheme comprises four categories – physical, perceptual, functional and conceptual (Suwa et al., 1998). By using these classifications researchers are able to describe the inter-relationships and explain the origin of re-interpretive thoughts in a designer's sketching session.

Many cognitive design studies adopt or are based on Suwa et al.'s revised coding scheme. For instance, Gero and Tang use it to explore the interactions between sketching and goal-setting. Their results suggest that visual reasoning is of greater proportion in the design process (Gero & Tang, 2001) than previously thought. Bilda and Gero worked on studies comparing sketching and CAD environments (Bilda & Demirkan, 2003). Another typical study based on the revised Suwa's coding scheme is Kim and Mahers' research comparing GUI (Graphic User Interface) and TUI (Tangible User Interface) environments in terms of the collaboration of designers. Their research shows that the use of TUI changes designers' spatial cognition (Kim & Maher, 2005; Kim, 2006; Kim & Maher, 2008b). Dorst and Cross (2001) use protocol analysis to evaluate nine industrial design processes, proposing a refined model of a co-evolution of both the problem space and solution space of the design. The outcome of their study supports Schön's (1983) argument that insight-driven problem reframing is crucial to the creative design process (Schön, 1983). With the emerging technology in the field, researchers started to conduct protocol studies in parametric design environments. For example, Lee et al. (2014) presented a pilot study using protocol analysis to evaluate creativity in PDEs. The results of their study identify some conditions that can potentially enhance creativity in PDEs.

Suwa's coding scheme has been most widely applied in cognitive studies, and there have been a large number of research projects that verify its reliability and effectiveness. It comprehensively covers the designer's activities in the design process, especially activities in a sketching environment, thereby confirming it has been applied frequently in studies of traditional design tools.

3.3.2 Protocol studies using the FBS coding scheme

The coding scheme based on the FBS model (Gero, 1990) adopts a process-oriented approach that focuses on encoding the intentions of designers. The coding scheme contains five categories: function (F), expected behaviour (Be), behaviour derived from structure (Bs), structure (S) and description (D). It was first established by Kan and Gero (2009a) before being applied in a growing numbers of studies on design collaboration. A typical example is found in Kan and Gero's research. At first, they use the FBS coding scheme to study different forms of collaborative design activities, presenting the results of different expressions in formulation and reformulation processes (Kan & Gero, 2009a). Later they describe a case of exploring and applying quantitative tools to examine design protocols in a collaborative virtual environment. Their results show that compared to face-to-face design collaboration, the 3D virtual environment slows down design activities and has a tendency to favour certain activities (Kan & Gero, 2010). The following year they used the FBS coding scheme to evaluate the learning process of a design team; in their study, linkographs were used to examine interaction and individual design processes (Kan et al., 2011). Jiang (Jiang, 2012; Jiang et al., 2014) studied multi-disciplinary designers using the FBS ontology, in which both commonalities of design and unique characteristics within disciplines were identified.

Most of the past studies have used the FBS coding scheme to compare design processes in two different design environments. There are two reasons for this: firstly, the FBS model is capable of capturing designers' high-level thinking and second, the FBS model does not contain very detailed design actions, and thus it can be easily adapted for different design environments. For instance, Tang et al. (2009) use the FBS coding scheme to compare free-hand sketching with digital sketching and argue that the two environments are similar in terms of design speed, design process and content. Later in another study, they show that the design processes in these two environments are not statistically different in terms of their distributions and transitions (Tang et al., 2011).

3.3.3 Discussion about existing coding schemes

In addition to the two coding schemes mentioned above, there are other coding schemes such as seeing–imaging–drawing (S-I-D) and seeing–seeing as (S-SA) (McKim, 1980), seeing (S) and seeing as (SA) (Goldschmidt, 1989, 1991; Schön & Wiggins, 1992), novel design decision (NDD) (Akin & Lin, 1995), S-I-D, SA-ST and T-D (Won, 2001) and analysis-synthesis-evaluation (Gero & Mc Neill, 1998). Chien and Yeh (2012) explored "unexpected outcomes" in PDEs using a customised coding scheme to accommodate "Problem structure-searching-feeling-ideating". These coding schemes are generally early explorations for cognitive studies, providing a variety of ways of understanding design processes. However, they are not as general and systematic as the two coding schemes introduced above, which can be applied to different research scenarios. Hence, they are not used as frequently as these two coding schemes.

To date, Suwa's and Gero's coding schemes are still the most widely used in cognitive design studies. In comparison with Suwa's coding scheme, Gero's FBS coding scheme is structured at a higher level due to its process-oriented approach, focusing on the intentions of the designer, while Suwa's coding scheme contains specific design actions, particularly suitable in sketching environments. That is why researchers using the scheme rarely need to change its categories for encoding. The FBS coding scheme has been claimed as a universal coding scheme adaptable to different design environments (Kan & Gero, 2009b). For the present study, we are comparing designers' behaviour in both PDEs and GMEs, therefore, the FBS model is the ideal choice to encode designers' behaviour in both environments.

3.4 FUNCTION–BEHAVIOUR–STRUCTURE (FBS) ONTOLOGY

3.4.1 Studies into the design process in design thinking

Braha and Reich (2003) define the design process as iterative, exploratory, and sometimes a chaotic process. Gero (1996) argues that design is a purposeful, constrained, decision making, exploratory and learning activity. Dorst (2011) proposed that design is an abduction process which frames creation as the core of design practice. Although the definitions of design are pluralistic, from the illustration above we can infer that design is generally an exploratory and purposeful process which is traceable and deliverable.

Another important issue in design research is design thinking. "Design thinking", proposed by Rowe (1991) refers to how designers see and how they consequently think (Liu, 1996). As shown in Figure 3.1, Asimow (1962) regards design as a problem-solving process involving synthesis, evaluation, and analysis. Similarly, Lawson and Dorst (2009) divide the design process into formulating, representing, moving, evaluating and managing. Stempfle and Badke-Schaub (2002) describe the design process as generation, exploration, comparison and selection, where generation and exploration are an expansion of the design problem while the last two are for narrowing down the design solution.

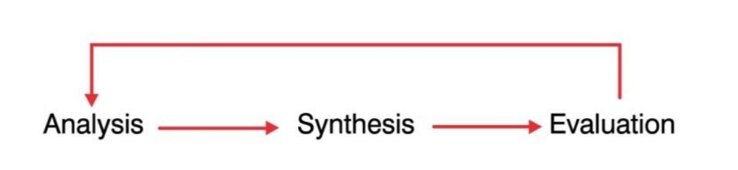


Figure 3.1. Design process model (Asimow, 1962)

Studies into design process and design thinking include the areas of expert vs. novice, design media influence, design team collaboration, etc. To examine designers' cognitive behaviour in a simulated design environment is an effective way of understanding the design processes and it has been adopted in most of the current studies into design process and design thinking.

3.4.2 FBS ontology

Gero's FBS model (1990) has been applied in many cognitive studies (Gero & Tang, 1999; Kan & Gero, 2005; Kan & Gero, 2009b) because it is potentially capable of capturing most of the meaningful design processes (Kan & Gero, 2009b) and the transitions between design issues are clearly classified into eight design processes. The FBS ontology (shown in Figure 3.2) contains three classes of variables: Function (F), Behaviour (B) and Structure (S). Function (F) represents the design intentions or purposes; behaviour (B) represents the object derived (Bs) or expected from the structure (Be); and structure (S) represents the components that make up an artefact and their relationships. The model is strengthened by two external design factors: requirements (R) and descriptions (D). The first of these represents requirements from outside the design and the second, descriptions, meaning the documentation of the design. Figure 3.2 shows the FBS ontology indicating the eight design processes—formulation, analysis, evaluation, synthesis, and reformulation I, II, and III. Formulation defines the process that formulates a function or sets up expected goals from the existing requirement, while synthesis generates a structure as a candidate solution. Analysis produces a behaviour from the existing structure and evaluation compares Bs and Be to determine the success or failure of the candidate solution. Reformulation is the process from the structure back to itself, the function or the behaviour, which is a reconstruction process. Among the eight design processes, the three types of reformulation processes are suggested to be the dominant processes that potentially capture innovative or creative aspects of designing by introducing new variables or new directions (Kan & Gero, 2008; Kan & Gero, 2009b). By calculating the transitions between design issues, various analyses can be conducted. In this study, the FBS ontology will be introduced as the basis model of analysis for developing the coding scheme.

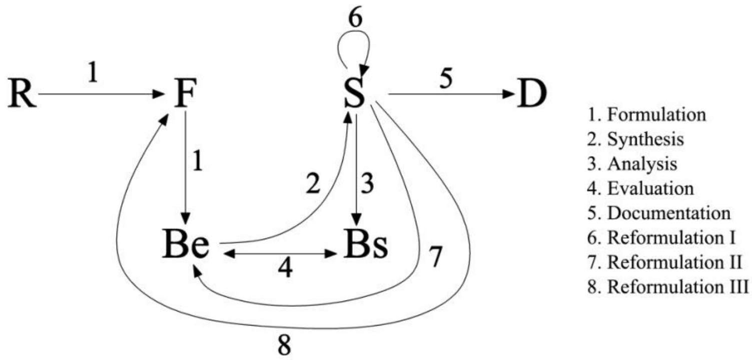


Figure 3.2. The FBS ontology (Gero & Kannengiesser, 2004).

Chapter 4: Research methodology and research design

This chapter introduces the research methodology and the research design of the present study. As illustrated in Chapter 1, this research aims to investigate the impact of parametric design on designers' cognitive behaviour. This outcome is achieved through a comparison of designers' behaviour in a PDE and in a GME. Therefore, the two different design environments are the main variables in the research.

This chapter starts with justifications for using protocol analysis as the research method (Section 4.1). The goal of this chapter corresponds to Objective 1 and Objective 2, listed in the opening section. In the final section, a pilot study is demonstrated to test the experimental setting and the coding scheme, in order to prepare for the main study.

4.1 JUSTIFICATION OF PROTOCOL ANALYSIS

Previous studies on designers' behaviours in PDEs use various research methods. For instance, in Iordanova et al.'s (2009) experiment on generative methods, the observation method is used to examine students' performance in a parametric design workshop. The result of their study shows that ideas were generated rapidly and also emerged simultaneously as variations in parametric design. Schnabel (2007) also uses the observation method to study students during a parametric design course for one semester. His study shows that PDEs are beneficial for generating unpredicted events and can be responsible for accommodating changes. However, such studies, using observation and interview techniques on students in a studio or workshop setting, while valuable, typically lack detailed empirical evidence and can often provide limited understanding of designers' behaviours. This empirical gap is addressed in the present study by adopting protocol analysis, a method used for in-depth analysis of participants' behaviours. Using protocol analysis to study the interaction between parametric modelling and sketching, Sanguinetti and Abdelmohsen (2007) produced and proposed two strategies of design for efficient problem solving. In their study, five students undertook the same task using Digital Project (DP) as the parametric design tool. However, the protocol analysis was not formally conducted with a coding scheme. Lee et al. (2014) have demonstrated the use of protocol analysis to evaluate creativity in PDEs. Using the same method, Chien and Yeh (2012) explore "unexpected outcomes" in PDEs. Results of these two studies both confirm the validity of the method, and suggest that some conditions in PDEs can potentially benefit the designers' process. Using protocol analysis, these studies provide quantitative results to explore designers' behaviour in parametric design environments.

The main research method adopted in this study – protocol analysis – is also regarded as having adequate theoretical evidence of its effectiveness. Cross (1999), lists several legitimate methods for studying design thinking including protocol analysis along with interviews with designers, observations, case studies and simulation trials. Protocol analysis is a common method for cognitive design studies that has been developed and tested over decades and which is thought to be superior to and more reliable than other methods. Its primary limitation is that the due to the large quantity of the protocol data collected and the complexity of the coding and analysis procedure only a relatively small number of subjects is commonly possible. Nevertheless, it can produce rich data for in-depth analysis in order to provide a comprehensive understanding of an issue which interviews or questionnaires cannot achieve.

4.2 EXPERIMENT SETTING

In the experiment devised for this research, eight designers were recruited to complete two different design tasks with similar levels of complexity in a PDE and a GME. Participants were all experienced architects with at least two years of parametric design expertise and more than five years of experience in architectural design. The experimental environment was a computer installed with Rhino and Grasshopper. During the experiment designers' activities and verbalisations (of these activities) were video-recorded by a screen capturing programme; the recorded data forms the basis of the protocol analysis. There were two design sessions, with one session using Rhino (GME) and the other session using Rhino and Grasshopper (PDE). Designers were asked to finish both sessions in 40 minutes for each design session (80 minutes total). Task 1 was a formal massing concept for a community centre and task 2 was a similar concept for a shopping centre. Both buildings contained some specific functional requirements. The design sessions and tasks were randomly matched prior to the experiment. The two design tasks were created to have similar levels of complexity. Through these strategies, the research method has sought to minimise the impact of variables other than the two different design environments.

4.2.1 Selection of subjects

In the proposed experiment, the selection of participants is important as it can influence the objectivity and reliability of the final results. The principle behind the selection is to reduce as much as possible individual differences and other subjective influences. The criteria of selection for the eight architects was that they should have more than five years' architectural design experience and no less than two years' experience using parametric design tools, to ensure that the participants are experienced both in architectural design and in operating parametric design software. The requirements of two years' experience using parametric design tools is due to the fact that Grasshopper, as a parametric design software, was developed in 2007 and gained wider adoption only during the 2010s. By the time this research was conducted, most parametric designers have only gained two to three years' experience with the tool. Previous protocol studies often select subjects with experience levels ranging from five to ten years as expert designers (Gero and Kannengiesser, 2014, Kan and Gero, 2009). However most parametric designers tend to come from a younger generation. Therefore architects with five years' architectural design experience are considered as experienced designers amongst the younger generation and are suitable for the current study. Additionally, participants' abilities regarding creative design and manipulating software should be at a similar level so that individual differences would not greatly affect the final results. In the end, eight designers were found who could satisfy the selection criteria.

Architects were recruited from architectural design companies, tutors of parametric design workshops, and lectures/professors from architectural schools. These include six males, and two females.

Whereas a protocol study of eight designers is sufficient to provide sound results for a PhD, because of the quality and depth of information that is recorded and analysed, we cannot generalise from these results to comment on a larger population of designers. However, based on eight samples, the main design behavioural patterns repeated among designers can be identified, which can provide us with an adequate understanding of parametric design processes, within the given timeframe of a PhD.

4.2.2 Design environments: PDEs VS. GMEs

It has been argued that design media definitely affect designers' design processes (Mitchell, 2003). The most traditional and well-known design medium is sketching. Past research has suggested that sketching can assist design thinking as an effective design medium (Schön, 1983; Black, 1990). As illustrated by Lawson (1997), the design process can be conceptualised as a conversation with drawing. Sketching is an externalisation and holding of representation (Simon, 1973), at the same time it also serves as a primary vehicle for thinking and solving problems (Do & Gross, 2001).

In the late 1990s, with the growth of 3D CAD tools in the design industry, architects began to identify a new ways wherein these tools were superior to previous 2D CAD systems. Typical 3D geometric modelling tools used in architecture today include ArchiCAD from Graphisoft, Revit from Autodesk, Rhino from McNeel, Maya and Sketchup. In the last decade a similar shift has begun to occur, with BIM and parametric design software beginning to challenge the role played by traditional 3D geometric modelling software in the AEC industry.

With the increasing application of digital design tools, scholars have started to study the influence of computational design media on design processes (Gero & Tang, 1999; Bilda & Demirkan, 2003; Fallman, 2003; Kim & Maher, 2008b; Kan & Gero, 2009b). Oxman (2000) argues that design media are knowledge-intensive computational environments. Designers share the design knowledge that can be represented and employed in computational environments. Parametric design, in a computational form, is a new way of thinking about architectural design although its impact on designers' processes hasn't been so well explored.

In the present study, for the purposes of comparison, Rhino was chosen as the traditional geometric modelling environment (GME). Grasshopper, a widely-used parametric plugin to Rhino will be provided to participants as the parametric design environment (PDE) (Figure 4.1). Grasshopper transforms the technical interface into a graphic interface, which makes the rule-setting process more friendly and intuitive. Another benefit is that the educational version of Grasshopper is free – a reason for more designers choosing to use Grasshopper than any other parametric design tool. Therefore, in this study, the selection of Grasshopper made the recruitment of participants relatively easier. Otherwise, most parametric design tools have the same principles of rule-algorithm design, so software selection should not lead to many differences in research results.

The combination of Rhino (GME) and Grasshopper (PDE) as shown in Figure 4.1 is also ideal for the present study as the former offers advanced free-form making tools that will not lead to significant differences from the product produced in the Grasshopper environment. In addition, Grasshopper is an add-on in Rhino, which means that the two design environments are on the same platform. This combination ensures that the comparative goals of the experiment are both more reasonable and achievable.

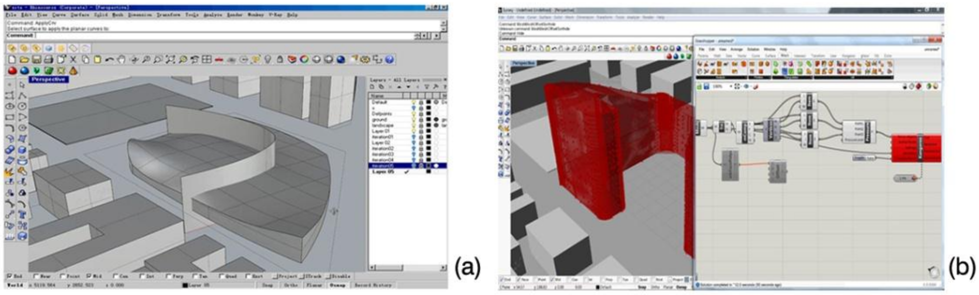


Figure 4.1. (a) Geometric modelling environment (GME) (b) Parametric design environment (PDE).

4.2.3 Design brief

For applications of protocol analysis, it is suggested that the experiment be limited to around one hour in length, meaning that the design task should not be too complex. Most existing studies used simple product design tasks, such as a computer mouse, a mobile phone or even a symbol design. In the architectural field, design tasks are also simplified, such as rearranging furniture or producing a home office layout (Kim, 2006). However, parametric design tools are appropriate for generating complex geometries. If the design task is too simple, the advantages of parametric design tools are difficult to express.

In the present experiment, each designer was required to complete two different design tasks with similar levels of complexity in Rhino (GME) and Grasshopper (PDE). Designers were given 40 minutes for each design session, but were allowed to continue for an extra 20 minutes, if required, in order to complete the task. Considering the time necessary for a conceptual design task, as well as the time involved for later data analysis of the results, 40 minutes is a reasonable time constraint. Task 1 is a conceptual design for a community centre and Task 2 is a similar study of a shopping centre, with both containing some specific functional requirements (see Appendix 1). These functional requirements are the main differences between the two tasks. In all other ways the two design tasks are similar, including the site provided, the required building size, and the extent of the concept development. A pre-modelled site (Figure 4.2) was provided to the designers for each task. Because the present study is focused on exploring designers' behaviour at the conceptual design stage, the designers were required to only consider concept generation, simple site planning and general functional zoning. No detailed plan layout was required. Both tasks focus on conceptual design in general to enable the design process to be completed in a relatively shorter time period, and therefore to be captured and analysed using the adopted method. In order to avoid the bias that can be potentially caused by using the same brief in the two different design environments, the study used two different design briefs that share the same levels of complexity. The tasks were both open and general enough to provide designers with the freedom to enable various possible design strategies to be applied during parametric design. As a result, the designers were allowed to exhibit different ways of approaching parametric design, which are similar to the actual practices of parametric design and therefore useful in order to examine the findings about parametric design. The design sessions and tasks were randomly matched among different designers. During the experiment designers were not allowed to sketch, ensuring that almost all of their actions happened within the computer. This ensured that the design environment was purely within either the PDE or the GME. In this way the research method minimised other variables except for the two design environments, for comparative analysis.

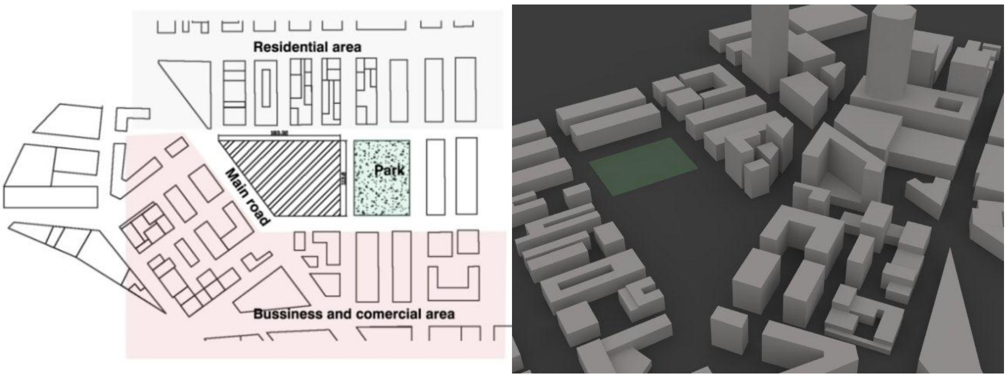


Figure 4.2. Site model provided

4.2.4 Experiment procedures

Before the experiment commences a "warm-up" process was used to familiarise participants with the equipment. According to current studies, the "think aloud" method for protocol data collection may influence participants' perception during design processes (Ericsson & Simon, 1993; Suwa & Tversky, 1997). As a consequence, designers may not be used to talking while they are thinking aloud, which could lead to incomplete data from concurrent experiments. The purpose of the warm-up training is therefore to explain to the participants the significance of the research and to provide training to practise the "think aloud" skills required (Nguyen & Shanks, 2006) so that they can better verbalise their thoughts during the experiment.

The experiment is divided into two parts. In the first part, participants are required to speak aloud what they are thinking while designing. A screen capturing programme records both their words and actions. If there is not sufficient verbal data produced, in the second part the retrospective protocol method is used to produce complementary verbal data. That means that, after finishing the design task, the videos are played back and participants are asked to make additional comments about what they were thinking while designing. The data collected, therefore include verbal information about participants' design intentions as well as visual information about their activities.

4.3 CODING SCHEME DEVELOPMENT BASED ON FBS ONTOLOGY

After collecting the protocol data from each design experiment, a particular coding scheme is applied to categorise the data. This section presents the coding scheme used, which is based on the established FBS ontology (Gero, 1990) and modified specifically for the purpose of encoding both design processes in PDEs and GMEs.

4.3.1 Justification of FBS ontology for coding scheme development

Up to date protocol studies into parametric design include Lee et al.(2014) and Chien and Yeh (2012), both of which adapt Suwa's coding scheme, which focuses on more detailed actions in parametric design processes. In the present study, which compares designers' behaviour in both PDEs and GMEs, a more universal coding scheme is required.

As stated in the previous chapter, Gero's FBS ontology (1990) (Figure 3.2) has been applied in many cognitive studies (Kan & Gero, 2005; Kan & Gero, 2009b) where it has been demonstrated as potentially capturing most of the meaningful design processes (Kan & Gero, 2009b) and recording clear transitions between design instances. The FBS ontology is founded on the requirements of coverage and uniqueness: the categorical concepts that make up the ontology need to cover all the attributes of a design and there can be no overlap of categorical concepts. A major outcome of the FBS ontology is that design processes are a consequence of the transitions between ontological elements and do not require a separately produced ontology of processes. The FBS ontology has been used widely in the domains of mechanical engineering, architecture, software engineering, civil engineering, cognitive psychology, manufacturing, management and creativity research. The behaviour of designers, using the FBS ontology as the basis, can be measured from empirically derived data using protocol analysis. With this ontology it becomes possible to compare designing independent of researcher, independent of domain, independent of education, independent of whether an individual or a team is designing, independent of location or co-location, independent of the use of tools, independent of design experience and independent of design task. Prior to this such empirically derived data from different researchers was generally not comparable and it was difficult to build directly on the research of others. Kan and Gero (2012) apply the FBS ontology to a study of software designers' behaviour, suggesting that the method is effective for encoding programming or rule-based activities across different design disciplines. Given that PDEs enable scripting and programming activities, similarly the FBS scheme will be able to encode both geometric modelling and rule-based algorithmic activities effectively. Therefore in this study it is introduced as a conceptual foundation for developing the coding scheme for protocol analysis.

4.3.2 Development of a coding scheme to study designing in PDEs

The seemingly obvious difference between parametric design and traditional geometric modelling tools is concerned with the application of a rule-based algorithmic process. Taking this into account, a customised coding scheme based on the FBS ontology was developed, where characteristics of parametric design are reflected. Two levels of designers' behaviour were encoded: from the design knowledge level and from the rule algorithm level. In PDEs, both levels of the behaviour occur; while in GMEs, only the design knowledge level of the behaviour occurs because designers consider both the design of the building and the design of the rules in PDEs. In GMEs, only design of the building is considered during design process.

In order to capture designing in PDEs at these two levels, the main class of variables – R, F, Be, Bs, S – are decomposed based on the two types of corresponding design spaces: design knowledge space, denoted by the superscript K, and rule algorithm space, denoted by the superscript R (Figure 4.3). The structure variables in the rule algorithm space (S^R) can have more subclasses of the specific rule algorithm activities in PDEs, allowing for the representation of how parametric tools facilitate design processes. The design knowledge space is similar to traditional design environments which comply with the original FBS ontology; while the rule algorithm space is an adaptation of the FBS ontology for PDEs that uses multiple instances of the FBS variables. In the present study, we adopt the FBS model for our coding scheme development. For this study, one of the original codes in the FBS ontology, description (D), has been excluded because in PDEs this process rarely occurs. For example, in the sketching environment there is a regular need to document or describe design decisions and actions (D), whereas parametric modelling tools automatically document and describe a 3D model directly from the actions of programming and scripting and as part of the consideration of structure (S). Therefore, the present study does not include a consideration of the description (D) code.

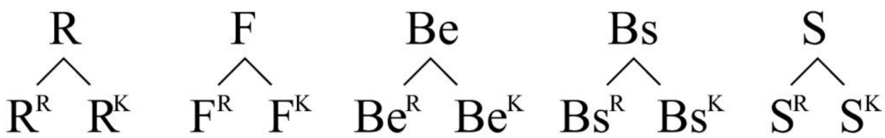


Figure 4.3. Adopting the FBS ontology for PDEs.

4.3.3 Interpretation of FBS coding in the rule algorithm space

- ***Requirement (R^R) in the rule algorithm space***

Requirement (R) variables include "all requirements and constraints that were explicitly provided to the designers at the outset of the design task" (Gero & Kannengiesser, 2014, p. 286). Within the context of the present study, requirement (R) codes refer to the moments when designers consider or review the content of the design brief provided. Since there is only design related information in the brief, all requirement variables will be coded as R^K. Therefore, there will be no instances of requirement variables at the rule algorithm level (R^R).

- ***Function (F^R) in the rule algorithm space***

Function (F) variables describe "the teleology of the object, which means 'what it is for'" (Gero & Kannengiesser, 2004, p 374). Function (F) is the purpose or intention of a design, which shapes the idea in designers' cognitive thinking. The concept of function (F) does not vary between different design environments. The claim is that design tools do not affect the "function" (F) of the design. In PDEs, the architect still needs to consider design intentions, and decide which factors to parameterise or constrain and where to assign the weight for specific factors (Ottchen, 2009). Therefore, in PDEs function (F) variables comply with the original understanding of function in the FBS model. Thus, if designers talk about the design intention or purpose, the segments should be coded as "function" (F^K). When designers' talk about function of the rule, it is about the effect they want the rule to achieve. These segments are coded as expected behaviour of the rule (Be^R). Therefore, there will be no instances of function variables at the rule algorithm level (F^R).

- ***Behaviour (B) in the rule algorithm space***

In the FBS ontology, behaviour (B) variables "describe the attributes that are derived or expected to be derived from the structure variables of the object, which means 'what it does'" (Gero & Kannengiesser, 2004, p 374). There are two types of behaviour (B): expected behaviour (Be) and behaviour derived from structure (Bs). In PDEs, behaviour (B) variables express different meanings at the rule algorithm level.

a) Expected behaviour (Be)

An expected behaviour (Be) is one where "designers use theory or experience to speculate what effect could fulfil a purpose before a specific structure is proposed" (Jiang, 2012, p 36–37). This interpretation has been well understood at the design knowledge level. When it comes to the rule algorithm level, expected behaviour of the rule (Be^R) means that designers set up algorithm goals or think about the way to achieve those goals in the rule algorithm space (Table 4.1).

Table 4.1. Expected behaviour interpretation in the rule algorithm space (Be^R).

Expected behaviour in the rule algorithm space (Be^R)	Description	Typical Activities
	Set up rule algorithm goals.	"The points will be generated randomly".
	Ways to achieve certain rule algorithm goals or related actions.	"The façade is divided up into the panels"; "I will try to get these inter-medium points and create a line."
	Utilising mathematically related commands for parameterisation.	Set Grasshopper components such as "domain", "function", "graft" "flatten", etc.

b) Behaviour derived from structure (Bs)

Behaviours that are derived from structure (Bs) are actual behaviours. At the design knowledge level, Bs represents an evaluation of existing geometry/structure, while at the rule algorithm level, Bs signifies an evaluation of the structure of the rule algorithm. When designers examine the current rule, the segments will be coded as "Bs^R" (Table 4.2).

Table 4.2. Structure behaviour interpretation in the rule algorithm space (Bs^R).

Behaviour derived from structure of the rule algorithm (Bs^R)	Description	Typical Activities
	Checking data flow routes.	Set "panel" or other Grasshopper components for checking.
	Evaluating existing rules.	Make judgement about the rule: i.e. "it has some problem" etc. or check the rule definition from the scripting interface.

- ***Structure (S) in the rule algorithm space***

In the FBS ontology, structure (S) variables describe "the components of the object and their relationships, which mean 'what it is'" (Gero & Kannengiesser, 2004, p 374). In the design knowledge space, structure (S) variables refer to the elements or relationships of the geometries, while in the rule algorithm space, they are defined as the structure of the rule algorithm – the components of rules and their relationships for parameterisation. In PDEs, designers also produce form as geometries; that is, structure in the design knowledge space. This can be modelled by directly applying design knowledge, or through the rule algorithm. In the latter case, a set of parameters and parametric commands will be used. Designers define relationships to connect these elements to form the rule algorithm. When designers organise the structure of rules or make parametric commands, the segments will be coded as "S^R" (Table 4.3).

Table 4.3. Structure interpretation in the rule algorithm space (S^R).

Structure of the rule algorithm (S^R)	Description	Typical Activities
	Talking about or making the structure of rules.	Connect/organise rule components.
	Applying geometry-making commands with features for parameterisation.	Set/change parameters, set/change relationships, etc.

4.4 A PILOT STUDY

This section presents a pilot study conducted prior to the main study. The aim of the pilot study was to test the effectiveness of the experiment setting and the coding scheme as a precursor to undertaking the main study. Therefore, the pilot study was conducted on one designer and focused on testing the setting and the coding scheme. The results of the designer from the pilot study are provided as examples to demonstrate the coding for comparison of behaviour in the two environments.

4.4.1 Summary and result of the pilot study

From the pilot study, the designer showed a clear ability to understand the design brief and operate the software. The time limit meant that all design outcomes were resolved to the same level. In both the PDE and GME, the designer started by reading the brief and inspecting the site model provided. During the design process, the designer also revisited the design brief. The design brief provided details concerning functional constraints and site conditions. It was up to the designer to decide how many of these conditions to consider. As usual in architectural design, different designers can have their own design strategies: some designers may prefer to start from functional analysis, thinking through site conditions and road and traffic information before drawing diagrams of the site to explore these relationships. Other designers may focus on the geometric modelling as the priority. These are all acceptable conditions for the pilot study.

In the pilot study the coding scheme captured most of the cognitive design activities in both the GME and the PDE. For example, in the sample testing, 82.2% of the segments were coded in the PDE, while in the GME, 84.1% were coded. It was also notable that the designer verbalised protocols were accompanied by non-verbalised moves. The two levels (rule algorithm and design knowledge levels) of design activities have therefore been able to be distinguished clearly.

The sample coding of the designer's protocol is presented below.

- ***Design issue analysis.***

In the FBS ontology, the four classes of concept are called design issues. They are function (F), expected behaviour (Be), behaviour derived from structure (Bs), and structure (S). From the analysis, during the parametric design process, the designer considered the brief from both the design knowledge and rule algorithm levels. As shown in Figure 4.4, this designer's activities shifted between these two levels. At the beginning of the design session, the designer considered more design knowledge than rule algorithm. The possible reason is that at the early design stage, the designer analysed the brief and started to form the design concept based on design knowledge.

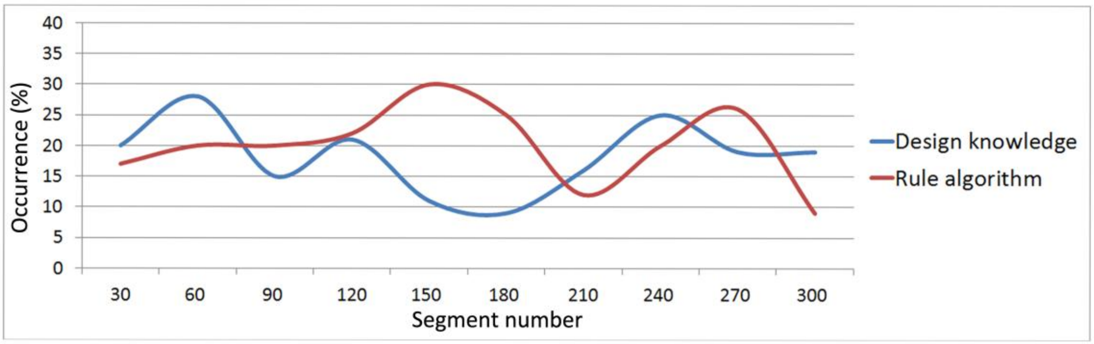


Figure 4.4. Designer's two levels of activities in the PDE.

Figures 4.5 and 4.6 show the distribution of design issues in the PDE and GME. The graph is generated using Linkographer software (Pourmohamadi & Gero, 2011). The horizontal axis represents the segment number that has occurred so far, while the vertical axis represents the segment number of each design issue — R, F, Be, Bs, S that has occurred at this moment. As shown in Figures 4.5 and 4.6, in both the GME and the PDE, the designer had the highest amount of structure-related activities and the least function-related activities. This matches the results of previous cognitive studies using the FBS ontology (Kan & Gero, 2005; Kan & Gero, 2009b). In mid design session, the designer was more active in the PDE than in the GME. In particular, the Be coding is much higher in the PDE than in the GME. This is because the designer set algorithm goals more frequently in the mid design session. Additionally, there are more functions in the GME than in the PDE. That is probably because in the PDE, the designer concentrated on the rule algorithm design; while in the GME, the designer had more time to think about the function or the requirement in the brief.

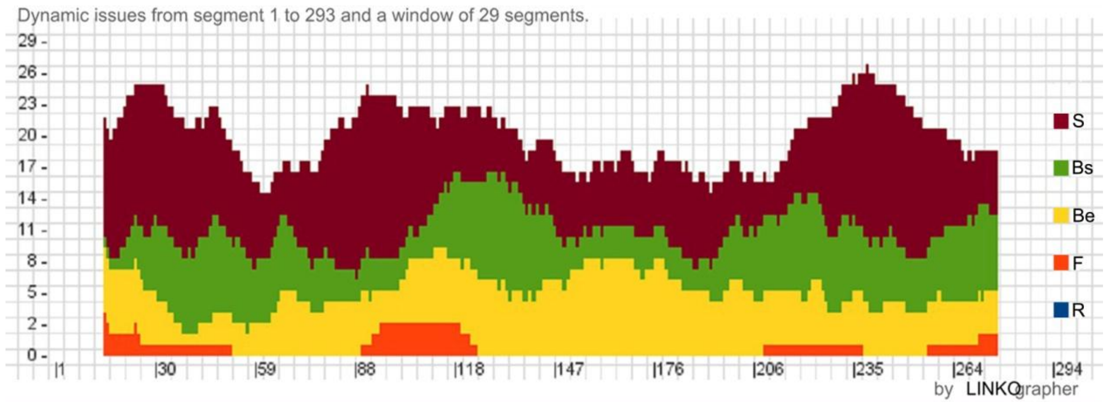


Figure 4.5. The distribution of "design issues" in the PDE.

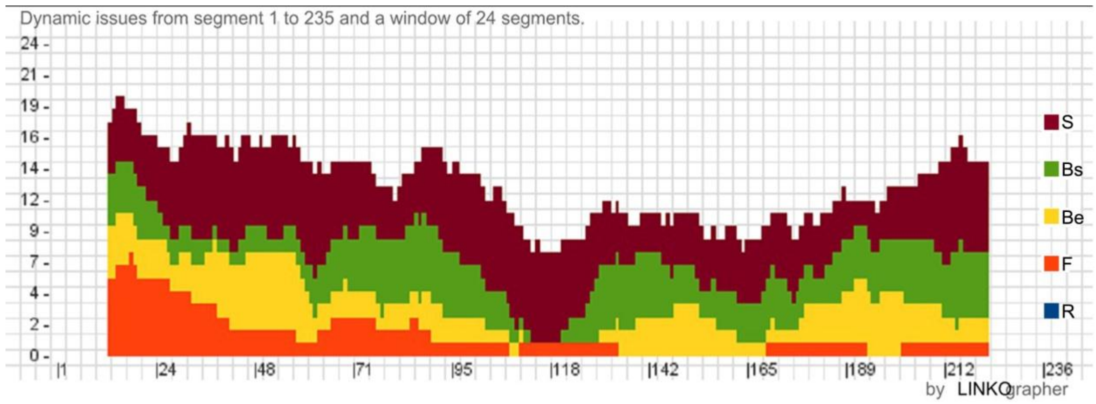


Figure 4.6. The distribution of "design issues" in the GME.

- ***Design process analysis.***

As shown in Figures 4.7 and 4.8, there were more meaningful design processes than design issues. There are eight design processes (see Figure 3.2) presented in the FBS model. In the PDE, they are distributed consistently throughout the whole design session. There are many more reformulation processes in the PDEs, especially reformulation 2, which is the transition from S to Be. This shows that this particular designer, in the PDE, tended to introduce more new variables and directions. More analysis processes occurred in the PDE (from S to Bs), possibly because the designer evaluated the geometric model more frequently during parametric design.

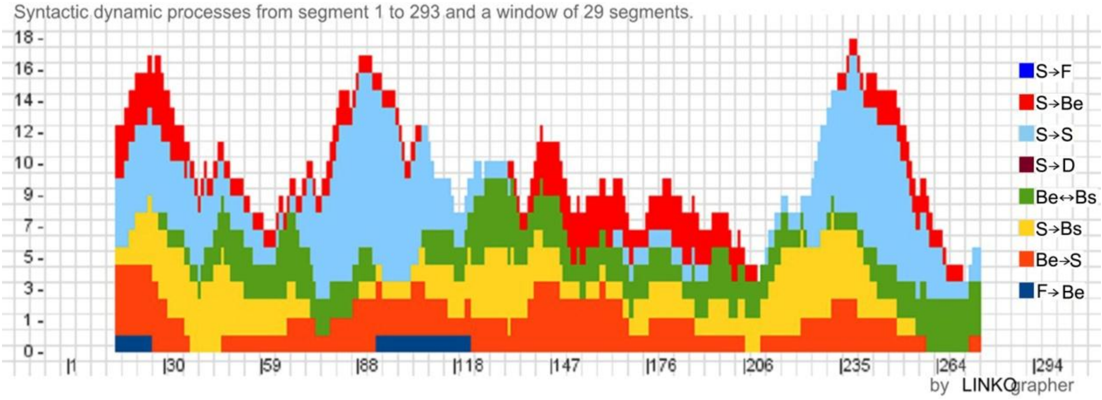


Figure 4.7. The distribution of "design processes" in the PDEs.

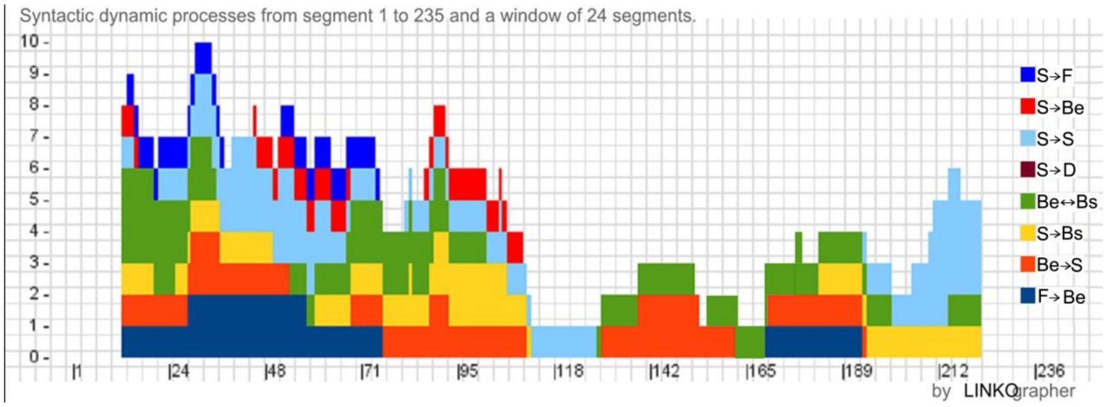


Figure 4.8. The distribution of "design processes" in the GMEs.

4.4.2 Considerations based on the pilot study results

The purpose of the pilot study was not to draw conclusions about PDEs or GMEs, but to test whether the research design and coding was effective for this purpose. Overall the results of the pilot study suggested that the experiment setting is achievable on the practical level and well serves the research aim. It is notable that there were no practical problems identified during the experiment; Meanwhile, the coding scheme can capture most of the designer's cognitive behaviour in the PDE and the GME (>82%); From the sample coding, different distributions of design issues and processes are exhibited between the two design environments. Therefore, the approach well serves the research aim. Based on the pilot study, the following two issues were also identified for better coding the main study:

- In practice, some designers may use pure Rhino modelling for a relatively longer time in the PDE session. Because Grasshopper is an add-on in Rhino, we cannot totally control how designers use the software. Grasshopper and Rhino also share some modelling commands. To address this problem, firstly in the main study, we will remind designers to try to use Grasshopper as much as possible during the PDE session; secondly, in the later coding stage, we will code pure geometric modelling actions as S^k, regardless what design environments they are in.

- In practice during the parametric design process, sometimes designers may trial to test whether the script works or not. In some cases, they may try several times and then give up and make a new script. These testing processes occur more frequently in PDEs than in GMEs, which can cost experiment time and produce meaningless actions. Participants in this study are experienced parametric designers, however the testing processes will still occur in real practice. In this research, the experiment has time constraints. In order to address the problem in the main study, if there are more trials and testing occurring during the experiment, we will allow a slight extension of time (up to 20 minutes) for the session. During the coding, we will exclude the repeated trial processes which may affect the coding results.

From the results of the pilot study, we can see that the distribution of both design issues and design processes can generate meaningful results for comparison. After addressing the problem mentioned above, the experiment setting and the coding scheme are therefore effective for comparing designers' behaviour in the two different design environments – PDE and GME.

Chapter 5: General results

The main study involves eight professional parametric designers each of whom completed two design tasks respectively in the PDE and GME. Therefore protocol data of sixteen design sessions were collected and analysed. This chapter presents the general results from the preliminary data analysis of the main study, including the qualitative observation, basic data description, and statistical analysis of data distribution. The goal of this chapter corresponds to Objective 3, listed in the opening section. Section 5.1 illustrates the observation from the experiments. The basic descriptive coding data are presented in Section 5.2. Sections 5.3 and 5.4 respectively show the statistical analysis of design issues and design processes. Using a paired sample T-test, data distribution of design issues and design processes in the GME and the PDE is compared and discussed. Finally, the structure of the main analysis in the following chapters is outlined.

5.1 GENERAL OBSERVATIONS FROM THE EXPERIMENT

From the observation of the experiment, the eight designers each showed a clear ability to understand the design brief and operate the software. While the time limit was set to ensure that all design problems were resolved to a similar level, some designers stopped at the building mass or façade design. However, they all considered the site planning as well as the building function with some details, providing a considered response to the conceptual design brief. In both the PDE and the GME, designers started by reading the brief and inspecting the site model provided. During the design process, they also revisited the design brief. The design brief provided details concerning functional constraints and site conditions. It was up to the designers to decide how many of these conditions to consider in their design.

Through direct observation we found that in the PDE designers tended to build a “correct” parametric relationship system rather than building a “correct” model. The whole system concept seems to be determined at the beginning of the design stage. Designers in the PDE were not completely sure about what would come out after they made a piece of script, and thus there were multiple “Aha” moments. For example, several times designers stated that “this looks good” or “it starts to look interesting”, which refers to the evaluation of current design situations in the PDE. Designers in the PDE switched between the scripting interface (Grasshopper) and the modelling interface (Rhino) frequently. They tended to go back to examine the model after they changed a parameter or parametric relationship, or went back to check their previous definition using the scripting interface. This inspection of a previous model or script definition can be defined as a kind of perceptual activity, which is connected to the accumulation of generated intentions.

As revealed in this study, designers can exhibit different approaches when applying parametric design. Some of them define and apply rule relationships as the dominant way to explore and progress design concepts, others mainly use rules to generate geometries only. For example, one designer applied the sunlight analysis of the given site model for area planning, which reflects a relatively high-level conceptual parametric thinking. Another designer generated random points to make a variable façade, which mainly aims for an innovative form. As this study focuses on conceptual design in the parametric environment in general, different kinds of approaches to parametric design are seen, which is close to the actual practices of parametric design.

5.2 GENERAL RESULTS OF THE CODING

5.2.1 Reliability of coding

This experiment employs an integrated segmentation and coding method. The segmentation and encoding process are based on the "one segment one code" principle (Pourmohamadi & Gero, 2011). This means that there is no overlapped code or multiple codes for one segment. If there are multiple codes for one segment, the segment will be further divided. Most participants (13 protocols) provided sufficient data during the experiment through the "think aloud" process. For the other three protocols, their "think aloud" protocols did not provide adequate information for the coding. Therefore we conducted post-experiment retrospective interviews with each to clarify and further understand their design thinking and actions during the experiment. Results of the post-experiment interviews have been merged into the concurrent protocols. Table 5.1 provides the general information of the coding coverage. The numbers shown in the table are the average of the eight protocols. The average overall segments are respectively 244 in the PDE and 224 in the GME. Designers also spend more time in the PDE session (48 minutes) than in the GME (44 minutes). On average over 92.2% of segments were coded as FBS codes. Non-codes include communication and software management. The design speed is very similar between the two design environments. The speed of design varies at 3.06–6.86 segments/min, especially in the GME session. That indicates that designers have their own design habits or strategies or that some designers may think and act faster than others.

Table 5.1. General coding information.

	Design Environments	Time (min)	Number of Segments	Coded Percentage (%)	Speed (Segments/min)
Designer 1	GME	67	223	91.93	3.06
	PDE	62	230	97.39	3.61
Designer 2	GME	35	250	96.00	6.86
	PDE	38	190	91.58	4.58
Designer 3	GME	30	145	93.10	4.50
	PDE	43	229	87.77	4.67
Designer 4	GME	39	243	94.65	5.90
	PDE	48	276	88.04	5.06
Designer 5	GME	44	254	92.52	5.34
	PDE	49	243	95.88	4.76

Designer 6	GME	43	230	93.48	5.00
	PDE	50	276	92.39	5.10
Designer 7	GME	43	218	82.11	4.16
	PDE	42	236	94.49	5.31
Designer 8	GME	51	307	94.14	6.02
	PDE	53	271	90.03	5.11
Mean	GME	44	224	92.24	5.11
	PDE	48	244	92.20	4.78
SD	GME	11.22	45.32	4.29	1.20
	PDE	7.43	29.71	3.54	0.53

After transcription, two rounds of segmentation (the division of protocols into individual units based on FBS notions) and coding were conducted. The coding was conducted by one researcher with a time interval of two weeks between the two rounds of coding. Thereafter an arbitration session (to make decisions on any disagreements between codes) was carried out to produce the final protocol. The agreement between the two rounds of coding is 84.77% (GME) and 83.48% (PDE). The final arbitrated results were 92.13% (GME) and 91.53% (PDE). The high level of agreement suggests the reliability of the coding results.

Table 5.2. Agreement percentages between coding phases.

	Design environments	**Coding 1 *vs* Coding 2 (%)**	**Coding 1 *vs* Arbitrated (%)**	**Coding 2 *vs* Arbitrated (%)**	**Final agreement (%)**
Designer 1	GME	88.26	91.30	95.22	93.26
	PDE	80.07	88.04	91.67	89.86
Designer 2	GME	86.80	92.80	93.60	93.20
	PDE	86.32	90.00	96.32	93.16
Designer 3	GME	86.10	91.48	94.62	93.05
	PDE	85.65	88.70	96.96	92.83
Designer 4	GME	74.32	82.57	90.83	86.70
	PDE	74.15	82.63	89.83	86.23
Designer 5	GME	83.53	90.59	92.16	91.34
	PDE	82.79	89.34	93.44	91.36
Designer 6	GME	84.25	94.52	89.73	92.07
	PDE	93.91	96.52	97.39	96.94
Designer 7	GME	90.57	94.67	95.49	95.27
	PDE	84.12	91.70	92.42	92.03
Designer 8	GME	84.36	90.23	94.14	92.18
	PDE	80.81	87.45	92.25	89.85
Mean	GME	84.77	91.02	93.22	92.13

	PDE	83.48	78.16	93.79	91.53
SD	GME	4.82	3.80	2.11	2.49
	PDE	5.71	31.46	2.78	3.11

5.2.2 Descriptive statistics of design issues

Table 5.3 describes the design issue distributions in the GME and the PDE. Since segment number varies for each design session, the frequency distributions of design issues were normalised by converting occurrence frequencies of each design issues into percentage over the total design issues, shown in Table 5.4.

Table 5.3. Design issue distributions in the GME and the PDE.

	R		F		Be		Bs		S	
	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE
Designer 1	5	4	24	9	37	30	55	63	84	118
Designer 2	4	2	18	6	31	36	89	68	98	62
Designer 3	4	4	5	3	18	12	42	75	66	107
Designer 4	5	2	10	8	52	61	73	73	90	99
Designer 5	7	3	23	10	43	58	72	60	90	102
Designer 6	1	1	13	24	27	71	55	57	120	102
Designer 7	16	5	20	20	54	79	41	42	48	77
Designer 8	4	6	25	14	53	68	97	69	110	87
Mean	5.75	3.38	17.25	11.75	39.38	51.88	65.50	63.38	88.25	94.25
SD	4.46	1.69	7.246	7.15	13.41	23.31	20.76	10.62	23.04	17.97

Table 5.4. Normalised design issue distributions in the GME and the PDE.

	R (%)		F (%)		Be (%)		Bs (%)		S (%)	
	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE
Designer 1	2.44	1.79	11.71	4.02	18.05	13.39	26.83	28.13	40.98	52.68
Designer 2	1.67	1.15	7.50	3.45	12.92	20.69	37.08	39.08	40.83	35.63
Designer 3	2.96	1.99	3.70	1.49	13.33	5.97	31.11	37.31	48.89	53.23
Designer 4	2.17	0.82	4.35	3.29	22.61	25.10	31.74	30.04	39.13	40.74
Designer 5	2.98	1.29	9.79	4.29	18.30	24.89	30.64	25.75	38.30	43.78
Designer 6	0.47	0.39	6.05	9.41	12.56	27.84	25.58	22.35	55.81	40.00
Designer 7	8.94	2.25	11.17	9.01	30.17	35.59	22.91	18.92	26.82	34.68
Designer 8	1.38	2.46	8.65	5.74	18.34	27.87	33.56	28.28	38.06	35.66
Mean	2.88	1.52	7.87	5.09	18.29	22.67	29.93	28.73	41.10	42.05
SD	2.59	0.72	3.00	2.81	5.93	9.26	4.59	6.86	8.47	7.40

Table 5.5 presents the articulated design issue distributions in the PDE. As described in the previous section, only protocols of the PDE sessions are coded according to the two levels of activities. The GME sessions only contain design knowledge level. Table 5.6 shows the normalised articulated design issue distributions in the PDE.

Table 5.5. Articulated design issue distributions in the PDE.

	R^K	F^K	Be^K	Be^R	Bs^K	Bs^R	S^K	S^R
Designer 1	4	9	16	14	58	5	32	86
Designer 2	2	6	12	24	54	14	38	24
Designer 3	4	3	9	3	58	17	81	26
Designer 4	2	8	14	47	54	19	33	66
Designer 5	3	10	20	38	47	13	36	66
Designer 6	1	24	30	41	44	13	70	32
Designer 7	5	20	64	15	39	3	57	20
Designer 8	6	14	37	31	62	7	34	53
Mean	3.38	11.75	25.25	26.63	52.00	11.38	47.63	46.63
SD	1.69	7.15	18.29	15.26	7.91	5.76	19.18	24.50

Table 5.6. Normalised articulated design issue distributions in the PDE.

	R^K (%)	F^K(%)	Be^K(%)	Be^R(%)	Bs^K(%)	Bs^R(%)	S^K(%)	S^R(%)
Designer 1	1.79	4.02	7.14	6.25	25.89	2.23	14.29	38.39
Designer 2	1.15	3.45	6.90	13.79	31.03	8.05	21.84	13.79
Designer 3	1.99	1.49	4.48	1.49	28.86	8.46	40.30	12.94
Designer 4	0.82	3.29	5.76	19.34	22.22	7.82	13.58	27.16
Designer 5	1.29	4.29	8.58	16.31	20.17	5.58	15.45	28.33
Designer 6	0.39	9.41	11.76	16.08	17.25	5.10	27.45	12.55
Designer 7	2.25	9.01	28.83	6.76	17.57	1.35	25.68	9.01
Designer 8	2.46	5.74	15.16	12.70	25.41	2.87	13.93	21.72
Mean	1.52	5.09	11.08	11.59	23.55	5.18	21.56	20.49
SD	0.72	2.81	7.96	6.12	5.09	2.80	9.37	10.18

In summary, Tables 5.3–5.6 present the basic design issues distribution coded in this study. Due to the fact that designers complete the design tasks within different timeframes, the segment numbers in different session vary (see Tables 5.3 and 5.5). To make the data analysis comparable, each design session is normalised as percentage of occurrence frequency. In the data analysis process, in order to generalise the results, the mean value of eight designers is used, and SD value is presented to show the data spread among samples. From Table 5.4, we can see that the SD value is relative large (All SD/Mean >50% except for F in the GME is 34%) in F and R in both the GME and PDE, which means the data are widely spread in design issues F and R. This complies with our observation results that different designers have their own design strategy: some considered the function and design brief more, the other were more form-oriented. The relatively large SD value (SD/Mean) in Table 5.6 suggests that all the design issues at two levels of design activities are widely spread except for Bs^K; we can infer that designers have their own unique way of applying parametric tools.

Descriptive statistics of design issue analysis presents the data distribution in terms of the basic FBS variables (R, F, Be, Bs, S). It provides the basis for comparison between the two design environments. Meanwhile, it enables further analysis such as the design processes analysis based on the transition between FBS variables.

5.2.3 Descriptive statistics of syntactic design processes

Applying the FBS model, the syntactic design process is coded. Syntactic design processes are the eight design processes described in the FBS model which are calculated only based on the locations of design issues. The counterpart of the syntactic design process is the semantic design process, which is calculated based on the meaning of coding. Compared to the semantic process which has to be determined by the coder, the syntactic design process which depends on the segment locations calculated by the software is more accurate and objective. Therefore, in this study, we choose the syntactic design process analysis. To analyse the syntactic design process, *Linkographer* software has been applied to calculate the descriptive data. *Linkographer* has been proven to be effective for cognitive design studies using the FBS ontology (Pourmohamadi & Gero, 2011). Table 5.7 presents the syntactic design processes distributions in the GME and PDE. Similar to the design issues analysis, we normalised the data in Table 5.8.

Tables 5.7 and 5.8 present the distribution of syntactic design processes. Similar to the design issue analysis, in order to generalise the results, the mean value of eight designers is used, and SD value is presented to show the data spread across samples. From Table 5.8, we can see that the SD values are relatively larger (calculated by SD/Mean value) in Formulation and Reformulation II in both design environments, which means the data was spread widely across samples in these two design processes.

Table 5.7. Syntactic design processes distributions in the GME and the PDE.

		Formulation	Synthesis	Analysis	Evaluation	Reformulation I	Reformulation II	Reformulation III
Designer 1	GME	8	21	35	22	27	9	10
	PDE	4	18	46	15	60	12	0
Designer 2	GME	2	14	50	21	31	11	6
	PDE	0	15	33	31	10	17	1
Designer 3	GME	2	7	23	10	35	6	1
	PDE	1	4	52	15	46	6	0
Designer 4	GME	4	30	38	30	31	19	2
	PDE	2	26	28	39	50	19	2
Designer 5	GME	5	20	31	29	39	14	3
	PDE	5	31	32	24	41	26	3
Designer 6	GME	2	14	43	14	64	9	4
	PDE	7	34	23	29	38	31	9
Designer 7	GME	9	18	16	24	19	10	3
	PDE	11	33	19	26	30	26	2
Designer 8	GME	5	21	47	35	43	16	3
	PDE	3	22	23	44	37	26	1

Mean	GME	4.63	18.13	35.38	23.13	36.13	11.75	4.00
	PDE	4.13	22.88	32.00	27.88	39.00	20.38	2.25
SD	GME	2.72	6.75	11.72	8.32	13.43	4.27	2.83
	PDE	3.57	10.32	11.61	10.32	14.84	8.43	2.92

Table 5.8. Normalised Syntactic design processes distributions in the GME and the PDE.

		Formulation (%)	**Synthesis (%)**	**Analysis (%)**	**Evaluation (%)**	**Reformulation** I (%)	**Reformulation** II (%)	**Reformulation** III (%)
Designer 1	GME	6.1	15.9	26.5	16.7	20.5	6.8	7.6
	PDE	2.6	11.6	29.7	9.7	38.7	7.7	0
Designer 2	GME	1.5	10.4	37	15.6	23	8.1	4.4
	PDE	0	14	30.8	29	9.3	15.9	0.9
Designer 3	GME	2.4	8.3	27.4	11.9	41.7	7.1	1.2
	PDE	0.8	3.2	41.9	12.1	37.1	4.8	0
Designer 4	GME	2.6	19.5	24.7	19.5	20.1	12.3	1.3
	PDE	1.2	15.7	16.9	23.5	30.1	11.4	1.2
Designer 5	GME	3.5	14.2	22	20.6	27.7	9.9	2.1
	PDE	3.1	19.1	19.8	14.8	25.3	16.1	1.9
Designer 6	GME	1.3	9.3	28.7	9.3	42.7	6	2.7
	PDE	4.1	19.9	13.5	17	22.2	18.1	5.3
Designer 7	GME	9.1	18.2	16.2	24.2	19.2	10.1	3
	PDE	7.5	22.4	12.9	17.7	20.4	17.7	1.4
Designer 8	GME	2.9	12.4	27.6	20.6	25.3	9.4	1.8
	PDE	1.9	14.1	14.7	28.2	23.7	16.7	0.6
Mean	GME	3.68	13.53	26.26	17.30	27.53	8.71	3.01
	PDE	2.65	15.00	22.53	19.00	25.85	13.55	1.41
SD	GME	2.65	4.14	5.93	4.94	9.49	2.093	2.124
	PDE	2.36	5.96	10.49	7.19	9.50	5.00	1.70

The FBS design processes distribution is a further analysis which presents the transition between design issues. It is analysed on the FBS level only without going down to the sub-levels in the PDE (design knowledge and rule algorithm) in order to make the comparison between the GME and the PDE because the sub levels are only relevant to the PDE.

5.2.4 Qualitative description of individual design processes

To obtain a comprehensive overview of designers' performance during the experiment, this section presents the qualitative description of the individual design process of each designer.

- ***Designer 1***

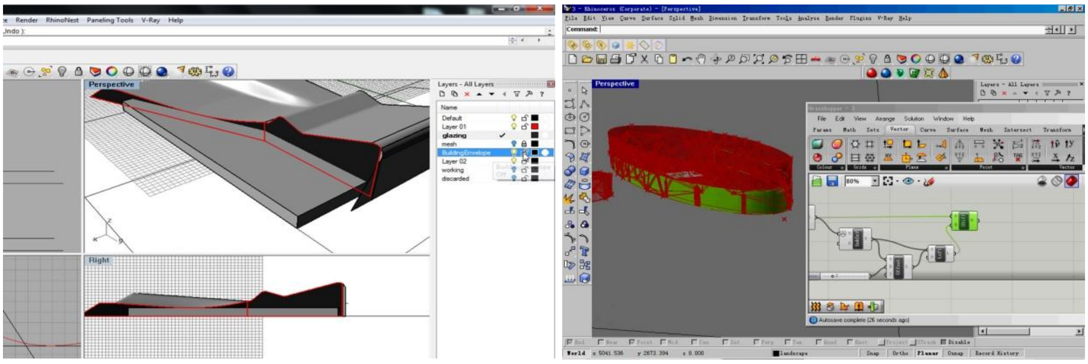


Figure 5.1. Screenshot from Designer 1's design process, Left: in the GME, Right: in the PDE

In the GME session, Designer 1 worked on the task of the shopping centre. The designer started by analysing the site provided. Based on the analysis, there were two main entrances designed, one was from a residential area and the other was from the main road. The designer wanted to make convenient access to the park so that the park could be used in the current shopping centre. Therefore entrances and pathways were made towards the park. At the later design stage, the designer focused on the modelling of the roof and west façade, to make the façade facing the main road look consistent for the city.

In the PDE session, the design task was the community centre. Designer 1 intended to put the outdoor activity area beside the park, and induce people from the park into the building. The main idea was that there was one main building and several small buildings surrounding it. The small buildings were supposed to contain classrooms, meeting rooms, etc. There were also connections between the main building and these small buildings. Later, the designer mainly used Grasshopper to make the façade of the building, which comprised irregular pipes on the façade.

- ***Designer 2***

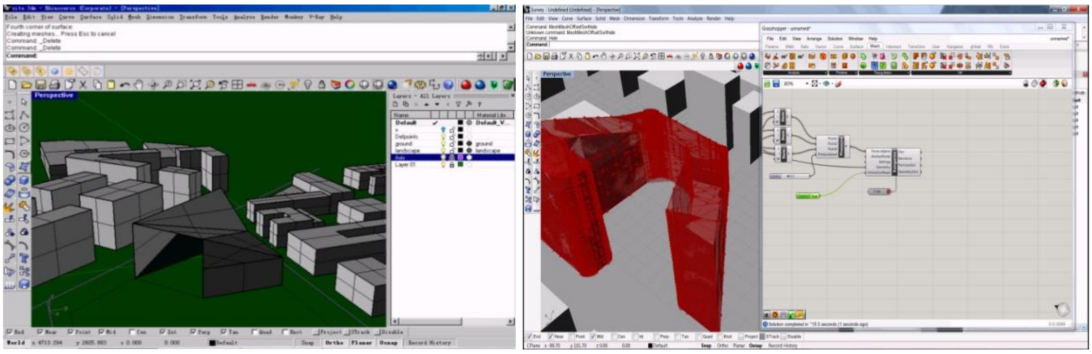


Figure 5.2. Screenshot from Designer 2's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.2, left), Designer 2 selected the shopping centre. During the first couple of minutes, they focused on the site planning, which was about the traffic access around the given area. Based on the analysis, the designer started to build the model. They wanted the form of the building to respond to the surrounding streets, by making the building symmetrical to the main street. The entrance was designed facing the intersection of the two streets – which is supposed to be a meeting point, including coffee area, restaurant, and other leisure places. The designer didn't like the rectangular site; therefore they wanted to introduce some breaks by stretching the building to make some massive levels. The back area was left as the outdoor activity area which could be connected to the park later.

In the PDE session (Figure 5.2, right), Designer 2 worked on the community centre task. At the beginning of the design session, the designer planned to separate the building into two independent parts along the park. After several minutes' trial, they gave up the idea and wanted to make a whole building around a courtyard, and focused on the modelling of the façade. The geometry of the mass was designed responding to the surrounding buildings. Then the designer used an add-on called "Kangaroo" to make a "cage" outside the building mass. At the end of the design session, the designer focused on the modelling of the points and lines on the façade through changing the "pressure" of the mass and also the location/number of points.

- ***Designer 3***

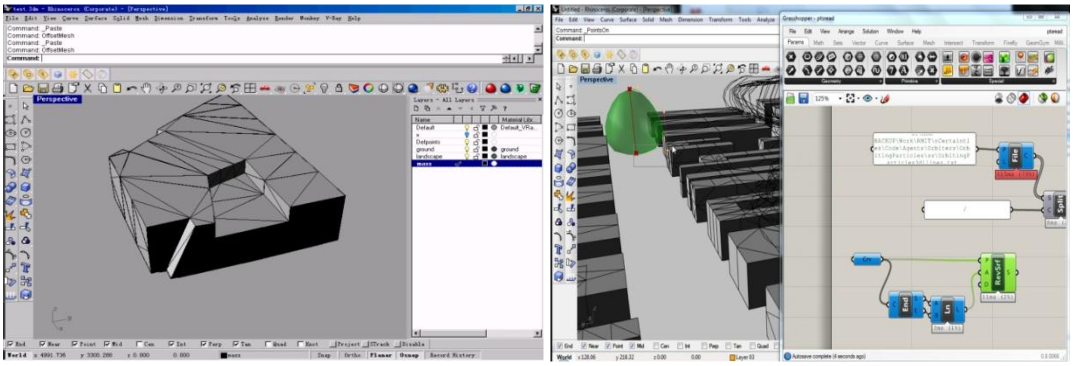


Figure 5.3. Screenshot from Designer 3's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.3, left), Designer 3 worked on the community centre. The designer quickly built a mass to work on, which is responding to the site boundary. When it came to the façade design, they intended to make something different. The idea was to treat the façade as segments and layers of tree. During the modelling, they sliced the façade layer by layer, in order to set the shape, and adjusted the angles. Their intention was to "match the interesting process to creating performance less uniform".

In the PDE session (Figure 5.3, right), the brief was the shopping centre. Designer 3 adopted a concept whereby they put some points into the location where people could potentially be dragged into the building. Then an "egg" was made as the main building mass. The designer made the scripts based on their previous defined scripts. They adjusted the location of the points and the main building during the design process. In this design session, the designer focused mainly on the geometric modelling.

- ***Designer 4***

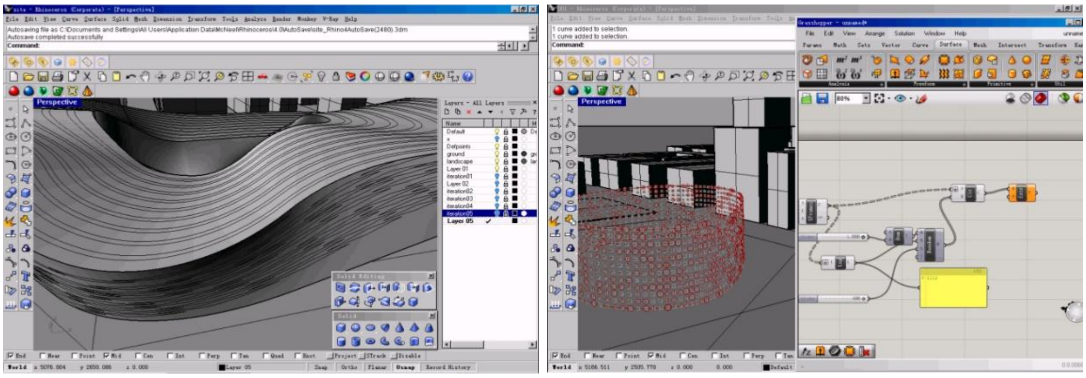


Figure 5.4. Screenshot from Designer 4's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.4, left), Designer 4 worked on the design task of the shopping centre. They started by analysing the design brief and site information, and then planned the traffic route for people and vehicles. A leisure area was put at the southwest corner close to the park. Based on the traffic analysis, the designer made a polyline as the outline, and then covered it as the building mass. The building mass created was a flexible form which considered the information of the entrance, traffic route, cover area, etc. At the end of the design session, some opening patterns were created and flowed onto the façade.

In the PDE session (Figure 5.4, right), the design task was the community centre. Firstly, Designer 4 wanted to make the building mass as a whole ellipse shape on the site. But later, after analysing the site, they changed the building mass into a more free-formed geometry which could respond to the site better. At the later design stage, the designer mainly focused on the façade making. Designer 4 used Grasshopper to divide the building façade equally into some panels, and then randomly picked up some of the panels as windows. Therefore the proportion of windows could be controlled and changed flexibly.

- ***Designer 5***

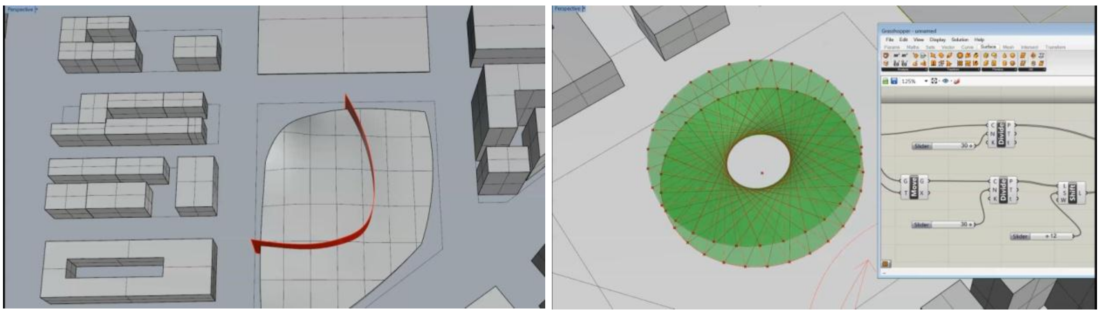


Figure 5.5. Screenshot from Designer 5's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.5, left), Designer 5 selected the task of community centre. The designer started by analysing the site. They considered the park as an important public area that could cooperate with the design. Based on the site and brief analysis, the designer wanted to build a flat surface for the roof that would allow cars to go in. The southeast corner was designed as the centre of the design, and allowed the entrance and traffic for both people and vehicles. A wall was created to separate two parts of the building, and also provide the route for vehicles to enter.

In the PDE session (Figure 5.5, right), Designer 5 worked on the task of the shopping centre. They considered making a two storey "twist" building. At the beginning of the design session, the designer analysed the site and traffic, and made some simple site planning. After that, they started to focus on the building mass modelling using Grasshopper. A "spiral" shaped form was designed for the building mass. The traffic was defined so that cars would go from outside and pedestrians would go from inside of the building.

- ***Designer 6***

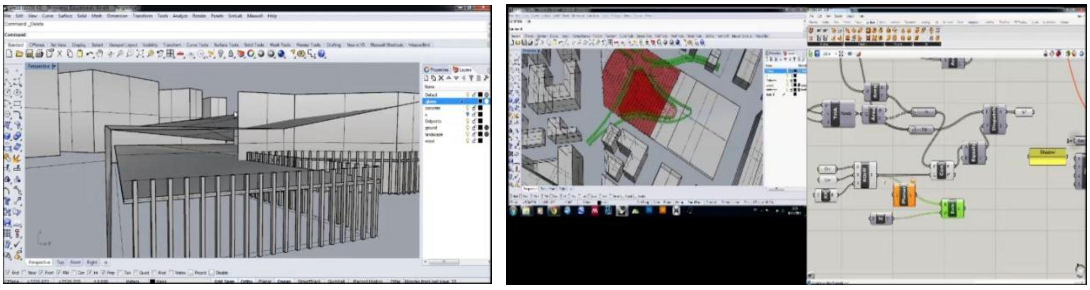


Figure 5.6. Screenshot from Designer 6's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.6, left), the design task was the community centre. The designer intended to create something "classic". At the beginning of the design session, they considered making the central part as a "built point" to get different views from the park. More windows in the north were made in order to let the sunshine in. The classrooms were located on the ground floor and there was a stairway leading to them. The designer intended to create two "languages" on the wall, wood and glass, and some irregular openings were made on the façade.

In the PDE session (Figure 5.6, right), Designer 6 worked on the task of the shopping centre. The main concept was based on the sunlight analysis. That is, locations and shapes of the windows were responding to the local sunlight analysis of the site, which allowed the minimal radiation of the buildings. The designer adopted some existing scripts from his library and made the scripts based on them. Their intention was to make most of the space as an underground level so that the site would become an open area for the city. The open area contained some pedestrian pathways and large areas of lawn on the roof.

- ***Designer 7***

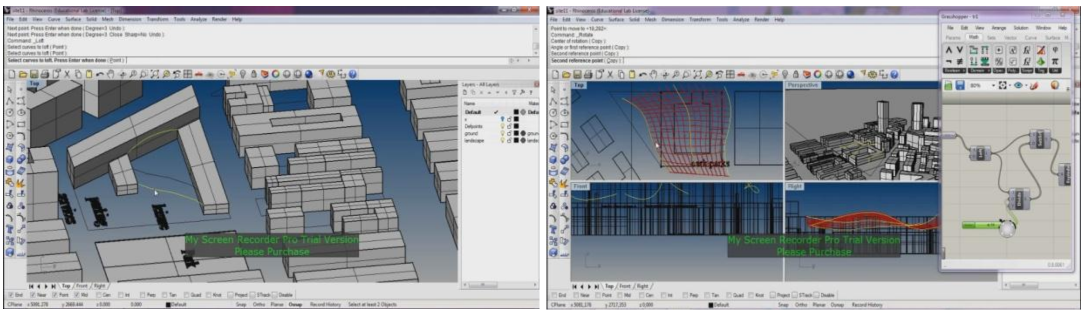


Figure 5.7. Screenshot from Designer 7's design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.7, left), Designer 7 worked on the task of the shopping centre. Their intention was to make the building relate to the urban fibre provided. Therefore they wanted to keep the same shape as the surrounding buildings. The shops were designed facing the main road, and the leisure area was connected to the park, while the service area was located facing the residential area. Therefore, the designer made a “U” shaped building with an open courtyard facing the park. And there was a light cover designed over the open courtyard.

In the PDE session (Figure 5.7, right), the design task was the community centre. Designer 7 started with the site and brief analysis. Based on the analysis, the entrance was made facing the residential area. There were two parts to the activity place – an outdoor activity area and an interior area. Vehicles would enter from the park side, and the parking area was located around the corner. Therefore, the building was a rectangular shape with a “hole” in it; and the “hole” would become the outdoor activity area. The designer built a light roof on the top of the open area to protect against the rain and strong sun. Grasshopper was mainly used to design the roof, where the thickness and shape of the roof could be adjusted as parametric variables.

- ***Designer 8***

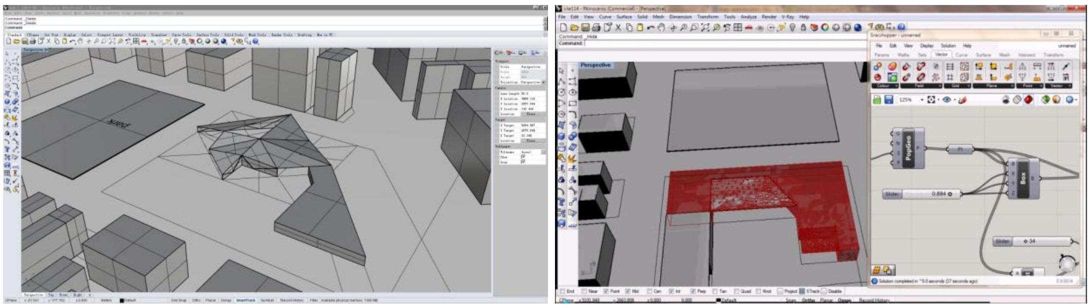


Figure 5.8. Screenshot from Designer 8’s design process, Left: in the GME, Right: in the PDE.

In the GME session (Figure 5.8, left), Designer 8 worked on the task of the community centre. From analysis of the site, they decided to locate the main building beside the park, make the main entrance facing the main road, and the outdoor activity area facing the residential area. The designer intended to make a specific roof which would look nice and at the same time be appropriate for the water flow. The roof was built by adjusting the points and curves. After that the designer focused on the façade design. Some triangular columns were created as exposed structure to support the roof. There was also an internal courtyard beside the outdoor activity area. In the end, the building was designed with a quite irregular form.

In the PDE session (Figure 5.8, right), the design task was the shopping centre. Designer 8 intended to keep the building on the northwest corner, and left the rest of the area as a parking place. They considered the shopping centre should be a long street with more small shops. The main idea was that the shopping centre would open gradually, which means it was not fully covered. Later, the designer made a “core centre” with a semi-opened roof on the top. The “core centre” contained the main leisure area and was supposed to be the communication area where people could meet each other. The designer used Grasshopper mainly to create the irregular openings on the roof, where the opening proportion could be controlled and changed as parametric variables.

5.3 COMPARISON OF DESIGN ISSUES DISTRIBUTION

5.3.1 The overall distribution of design issues

This section presents the comparative analysis of the overall distribution of design issues in the GME and the PDE. Boxplot analysis is applied to report the relative portions each design variable takes in a set of protocols. The boxplot graphically describes the data through five number variables (smallest observation, lower quartile, median, upper quartile, and largest observation). Figure 5.9 is the boxplot analysis of the overall design issues distribution in the GME and the PDE. From the figure, we can see that the two design environments produce similar issue distributions: more cognitive effort is expended on the structure (S) design issues than any others in both environments; this is followed by behaviour from structure (Bs), expected behaviour (Be), function (F), and the least effort is expended on requirements (R).

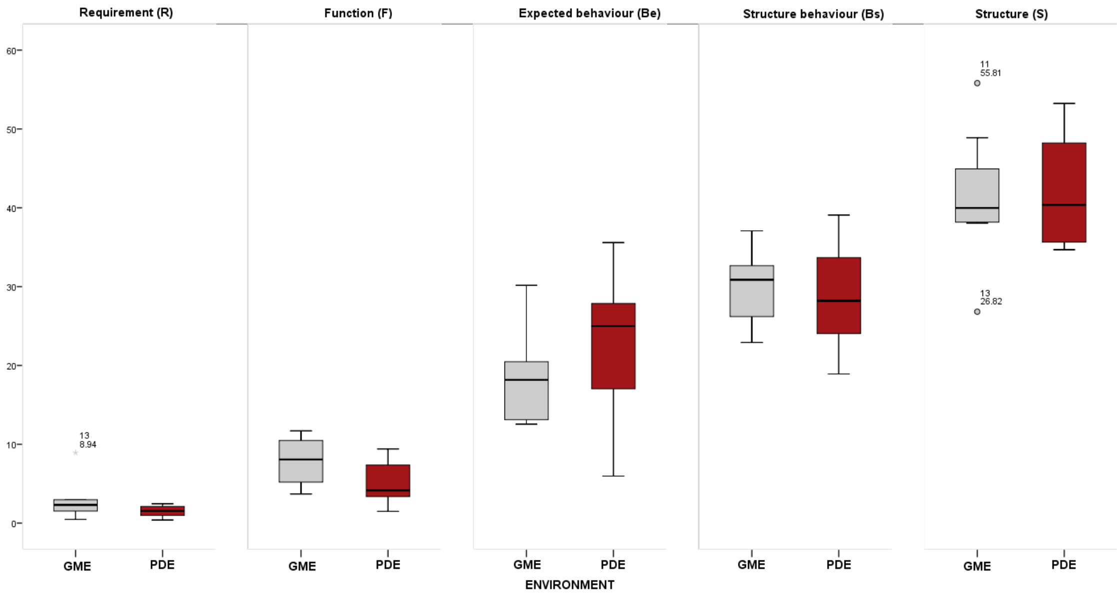


Figure 5.9. Boxplot analysis of overall design issues distribution.

In order to compare the overall design issues distribution between the GME and the PDE, paired sample T-tests were used. Because the experiment used the same group of designers in two different environments, the paired sample T-test should be a suitable data analysis method to make the comparison. Analysis results shown in Table 5.9 suggest that there is no significant difference in terms of overall design issues between the GME and the PDE except Function (F) ($P<0.05$). That is, designers' overall efforts spent on design issues are similar in the two design environments. We can infer from this that whatever design tools they use, designers' cognitive activities at the design thinking level which deals with their design habit, strategy, or preferences would not vary significantly. Higher frequency occurrence of

Function (F) in GME could be due to the fact that designers' cognitive effort is more allocated to the consideration of rule settings in the PDE. That is, when designers think about the goal of the rules they are writing, or the way to achieve this goal, it will be coded as Be^R in the PDE. Therefore, there is less Function (F) in the PDE.

Table 5.9. Paired sample T-test of overall design issues between the GME and the PDE.

GME *vs.* PDE	Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (P)
R	1.35875	2.31368	1.661	.141
F	2.77750	3.26242	2.408	.047*
Be	-4.38250	7.42497	-1.669	.139
Bs	1.19875	4.02967	.841	.428
S	-.94750	8.66604	-.309	.766

*P<0.05

5.3.2 Impact of rule algorithm in the PDE

Figure 5.10 presents the design issues distribution in both the design knowledge and rule algorithm spaces. Figure 5.11 shows the boxplot analysis results. The design issues distribution in the design knowledge space for both the GME and the PDE is shown in blue, the rule algorithm space is shown in red in Figure 5.10. Qualitatively, large differences between the two design environments can be observed including that there is more cognitive effort expended on design knowledge issues in the GME than in the PDE. A comparison of the results shows that although the total distribution of design issues in both environments is similar, the make-up of the design issues is different. In particular, some of the knowledge-related design issues are substituted by rule algorithm design issues in the PDE. This also applies for the design issues of expected behaviour (Be) and structure (S). The high contribution of the rule algorithm to the expected behaviour (Be^R) may be because designers often consider ways to achieve rule algorithm related goals in the PDE; while the significant impact of rule algorithm on Structure (S^R) may be because when designers consider the structure of the design in the PDE, they also put effort into the consideration of the structure of rule algorithm.

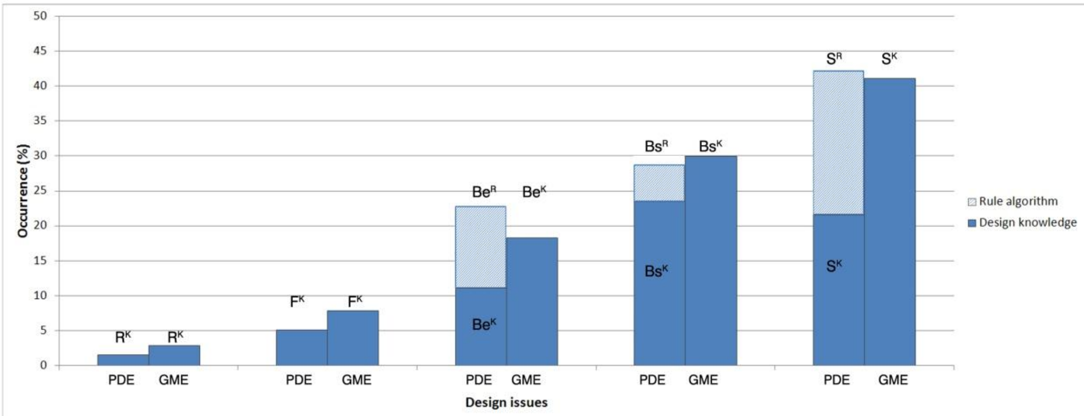


Figure 5.10. Design issues distribution in both the design knowledge and rule algorithm spaces in the GME and the PDE.

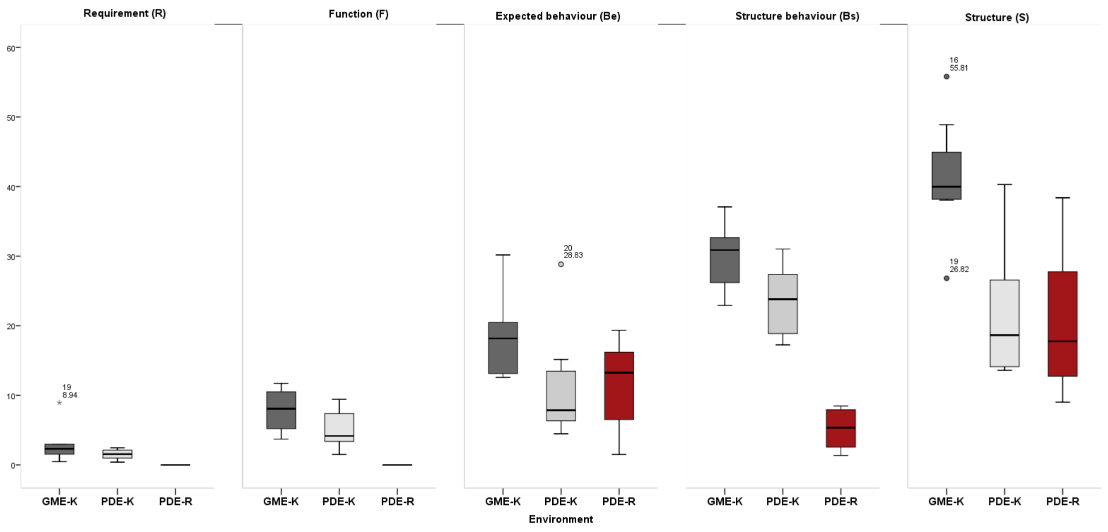


Figure 5.11. Boxplot analysis of design issues distribution in both the design knowledge and the rule algorithm spaces in the GME and the PDE.

Table 5.10 shows the paired sample T-Test of the overall design issues at the two levels of design activities – design knowledge and rule algorithm levels. Because we do not have FR and RR codes, only Be, Bs, and S are compared. At the design knowledge level there are significant differences, exhibited between the PDE and the GME, between Be (T=3.733, N=8, P=.007), Bs (T=5.294, N=8, P=.001), and S (T=5.709, N=87, P=.001). One possible reason is that designers' cognitive effort may have been allocated to rule algorithm settings. In comparing the design knowledge and rule algorithm levels in the PDE, only Bs has significant differences (T=11.450, N=8, P=.000): there is more cognitive effort spent on the design knowledge level in terms of Bs (Bs^k), which suggests that the examination of the model from the design knowledge level occurs more frequently than the examination of the script.

Table 5.10. Paired samples T-test of overall design issues.

		Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (p)
Be	GME-K *vs.* PDE-K	7.20875	5.46170	3.733	.007*
	PDE-K *vs.* PDE-R	-.51375	10.76410	-.135	.896
Bs	GME-K *vs.* PDE-K	6.38125	3.40932	5.294	.001*
	PDE-K *vs.* PDE-R	18.36750	4.53725	11.450	.000*
S	GME-K *vs.* PDE-K	19.53750	9.67932	5.709	.001*
	PDE-K *vs.* PDE-R	1.07875	18.10985	.168	.871

P<0.005

5.3.3 Design issues distribution across different design stages

In order to further explore designers' cognitive behaviour across a design session, each session is divided into three equal parts based on the coded segments: labelled early design stage, mid design stage and end design stage. The design issue distributions divided in this way are presented in Figure 5.12. In terms of the representation in the bar chart, the design knowledge is indicated in blue and the rule algorithm in red. In terms of the overall distribution, the design issues of requirements, function and expected behaviour decrease towards the end of the design session in both the GME and the PDE. For Be, the rule algorithm occupies a larger percentage towards the end of the design session. While for Bs, the algorithm decreases. For S the rule algorithm decreases at the middle of the design session and then rises significantly at the end. From these results some preliminary inferences can be made: that rule algorithm plays an important role in the design issues of expected behaviour (Be) and structure (S) in the PDE, and its impact increases towards the end of the design session. The reason for this is possibly that designers focus more frequently on the structure of rule algorithm at the end of the PDE session.

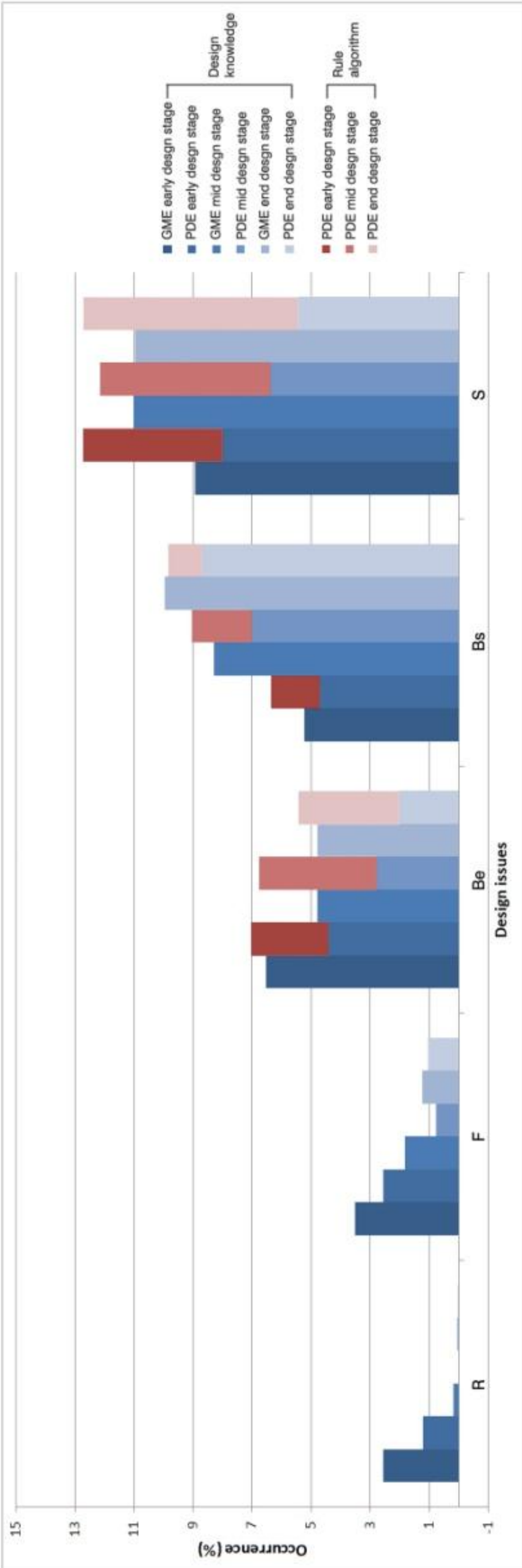


Figure 5.12. Design issues distribution in the GME vs. the PDE.

In order to further compare the design issues distribution in the GME and the PDE, in the rest of this section the design issues distribution at the early, mid and end of the design stage in the two design environments will be statistically analysed and discussed.

1. Design issues distribution at the early design stage in the GME and the PDE

Figure 5.13 shows the boxplot analysis of design issues at the early design stage in both the GME and the PDE. Table 5.11 presents the paired sample T-test of design issues at the early design stages. The results of the test infer that there is no significant differences at the early design stages in terms of design issues distribution (P>0.05).

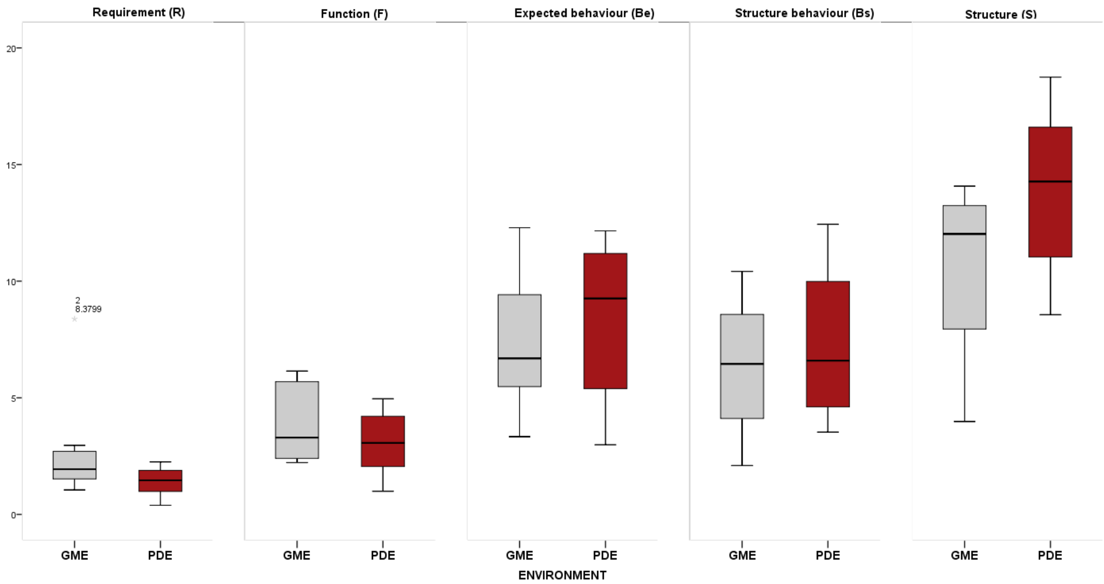


Figure 5.13. Boxplot analysis of design issues at the early design stage in the GME *vs.* the PDE

Table 5.11. Paired sample T-test of design issues at early design stage.

GME *VS*. PDE	**Mean**	**Std. Deviation (SD)**	**t**	**Sig. (2-tailed) (P)**
R	1.30399	2.00284	1.842	.108
F	.81810	1.75634	1.317	.229
Be	-1.00287	3.97716	-.713	.499
Bs	-.94434	1.98416	-1.346	.220
S	-3.33152	4.59509	-2.051	.079

Figure 5.14 shows the boxplot analysis of articulated design issues at the early design stage. Table 5.12 presents the paired sample T-test of the comparison of the PDE and the GME at design knowledge level, as well as the two levels of activities in the PDE. From the statistical analysis, we can infer that the rule algorithm plays an important role in Be and S at the early design stage. From the paired sample T-test analysis, only Bs at the design knowledge level occurs significantly more frequently than at the rule algorithm level (T=2.896, N=8, P=0.023<0.05). That indicates that designers examine or analyse design structure more than analysing the structure of the rule algorithm at the early design stage. There are no significant differences found at the design knowledge level between the PDE and the GME thereby

suggesting that the cognitive behaviours at the design knowledge level are similar regardless of the design environments. This is likely because at the beginning of a process designers have to consider the brief and build the early concept from their architectural design knowledge.

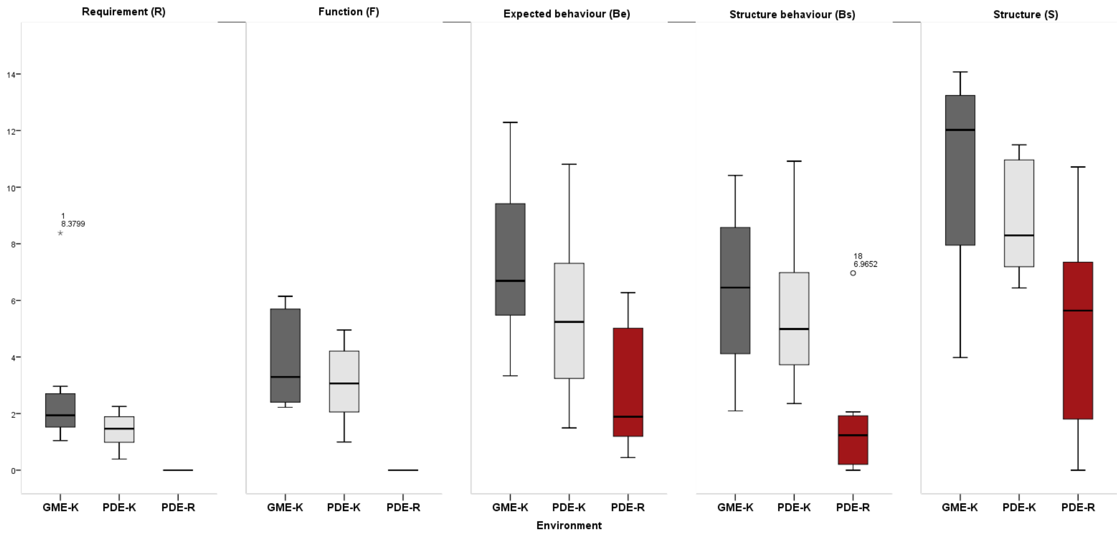


Figure 5.14. Boxplot analysis of articulated design issues at the early design stage in the GME *vs*. the PDE.

Table 5.12. Paired samples T-test of design issues at early design stage.

		Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (p)
Be	GME-K *vs.* PDE-K	1.86264	3.36240	1.567	.161
	PDE-K *vs.* PDE-R	2.62062	4.23906	1.749	.124
Bs	GME-K *vs.* PDE-K	.76598	1.59900	1.355	.218
	PDE-K *vs.* PDE-R	3.87304	3.78234	2.896	.023*
S	GME-K *vs.* PDE-K	1.70675	4.62647	1.043	.331
	PDE-K *vs.* PDE-R	3.81540	4.66512	2.313	.054

$P<0.05$

2. Design issues distribution at the mid design stage in the GME and the PDE

Figure 5.15 shows the boxplot analysis of design issues at the mid design stage in both the GME and the PDE. Table 5.13 presents the paired sample T-test of design issues at the mid design stages. From the analysis (Table 5.11), there is no significant differences of design issues found at the mid design stage *(P>0.05)*. Qualitatively, the occurrence of the design issue Be is higher in the PDE than in the GME, and the data range is wider in the PDE than in the GME. The data spread in Bs is much wider in the GME than in the PDE, which indicates that designers have different distribution of effort on the analysis derived from the structure in the GME.

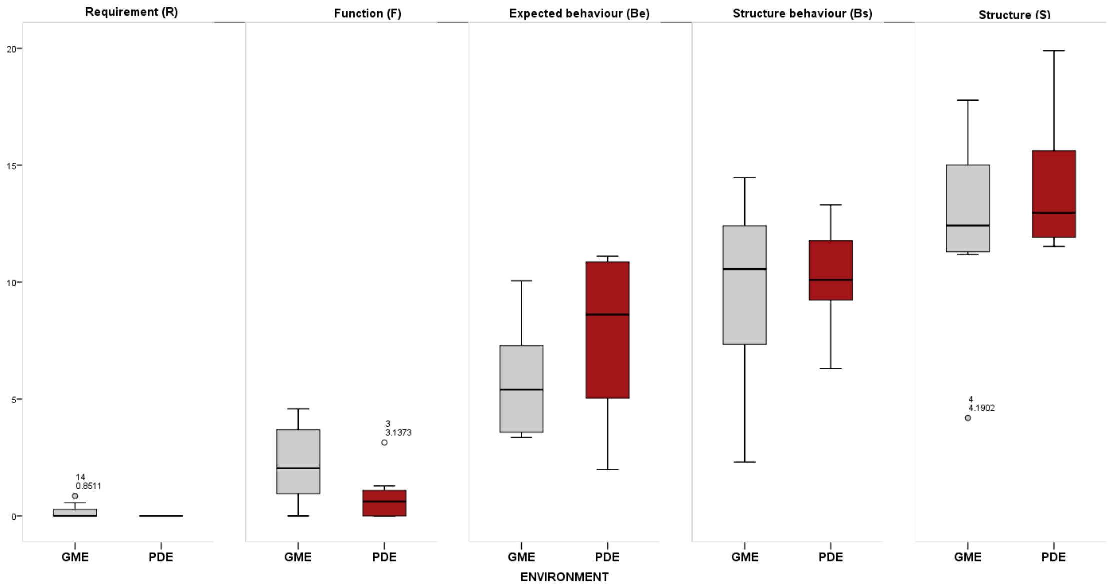


Figure 5.15. Boxplot analysis of design issues at the mid-design stage in the GME *vs*. the PDE.

Table 5.13. Paired sample T-test of design issues at mid design stage.

GME *VS*. PDE	**Mean**	**Std. Deviation (SD)**	**t**	**Sig. (2-tailed) (P)**
R	.17622	.33552	1.486	.181
F	1.42480	2.48929	1.619	.149
Be	-2.02241	3.53594	-1.618	.150
Bs	-.55405	3.56842	-.439	.674
S	-1.62417	3.01579	-1.523	.172

Figure 5.16 shows the boxplot analysis of articulated design issues at the mid design stage. Table 5.14 presents the paired sample T-test of the comparison of the PDE and the GME at the design knowledge level, as well as the two levels of activities in the PDE. From the statistical analysis, we can infer that the rule algorithm plays an important role in Be and S, especially for Be at the mid design stage. Be (T=3.088, N=8, P=.018) and S (T=2.375, N=8, P=.049) at the design knowledge level has significant differences in two design environments. One of the possible reasons is that designers frequently set rule algorithmic goals and consider how to achieve them at this stage. And the consideration of structure is allocated to the structure of the rule algorithm frequently. In the PDE, there are significantly more Bs design issues at the design knowledge level than in the rule algorithm level (T=3.161, N=8, P=.016). That is, designers examine the geometric model much more than checking the rule algorithm.

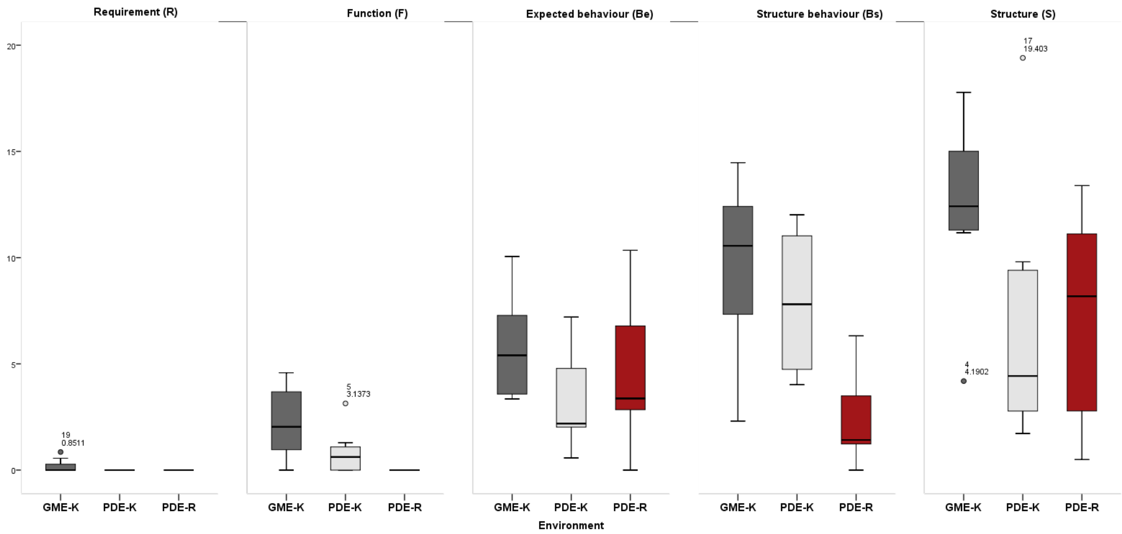


Figure 5.16. Boxplot analysis of articulated design issues at the mid-design stage in the GME *vs*. the PDE.

Table 5.14. Paired samples T-test of design issues at mid design stage.

		Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (P)
Be	GME-K *vs.* PDE-K	2.51910	2.30754	3.088	.018*
	PDE-K *vs.* PDE-R	-1.31901	4.72939	-.789	.456
Bs	GME-K *vs.* PDE-K	1.77301	5.08388	.986	.357
	PDE-K *vs.* PDE-R	5.57194	4.98538	3.161	.016*
S	GME-K *vs.* PDE-K	5.63169	6.70803	2.375	.049*
	PDE-K *vs.* PDE-R	-.46227	10.33360	-.127	.903

*$p<0.05$

3. Design issues distribution at the end design stage in the GME and the PDE

Figure 5.17 shows the boxplot analysis of design issues at the end design stage in both the GME and the PDE. Table 5.15 presents the paired sample T-test of design issues at the end design stage. From the analysis (Table 5.11), there are no significant differences of design issues found at the end design stage *(P>0.05)*. The distribution of Be is spread more widely in the PDE, which means that at the end of the design session, designers in the PDE are considering different ways of achieving their goals.

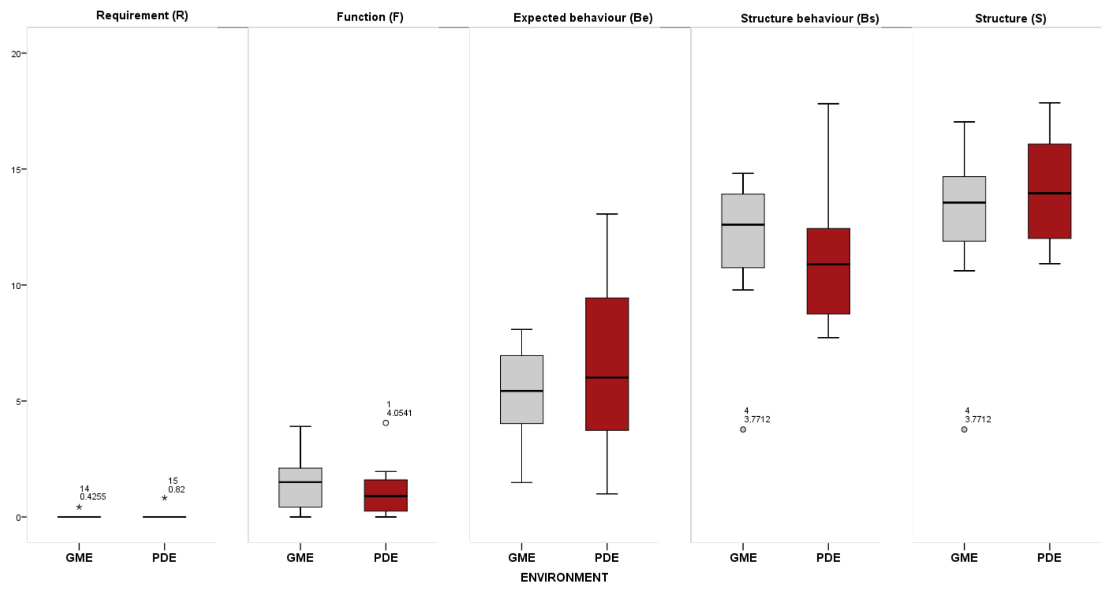


Figure 5.17. Boxplot analysis of design issues at the end-design stage in the GME *vs*. the PDE.

Table 5.15. Paired samples T-test of design issues at end design stage.

GME *VS*. PDE	**Mean**	**Std. Deviation (SD)**	**t**	**Sig. (2-tailed) (P)**
R	-.04931	.34518	-.404	.698
F	.30161	2.04566	.417	.689
Be	-1.25539	2.69768	-1.316	.230
Bs	.42919	3.63484	.334	.748
S	-1.47717	4.34010	-.963	.368

Figure 5.18 shows the boxplot analysis of articulated design issues at the end design stage. Table 5.16 presents the paired sample T-test of the comparison of the PDE and the GME at the design knowledge level, as well as the two levels of activities in the PDE. From the statistical analysis, we can infer that the rule algorithm plays an important role in Be and S, especially for Be at the end design stage. Be *(T=2.522, N=8, P=.040)* and S *(T=3.984, N=8, P=.005)* at the design knowledge level have significant differences between the two design environments. In the PDE, there are significantly more Bs design issues at the design knowledge level than at the rule algorithm level *(T=5.879, N=8, P=.001)*. That is, designers examine the geometric model much more than checking the script in the end.

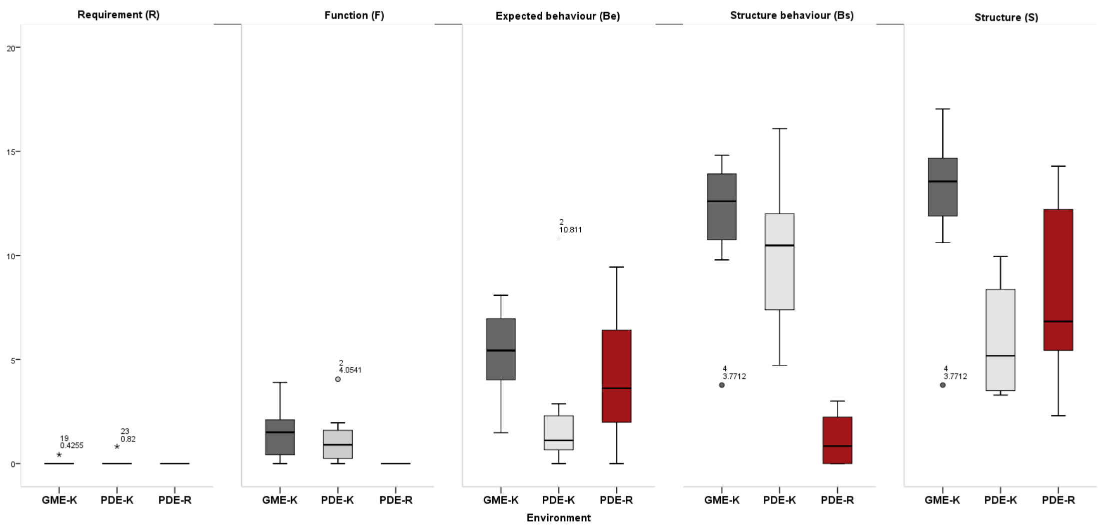


Figure 5.18. Boxplot analysis of articulated design issues at the end-design stage in the GME *vs*. the PDE.

Table 5.16. Paired samples T-test of design issues at end design stage.

		Mean	**Std. Deviation (SD)**	**t**	**Sig. (2-tailed) (P)**
Be	GME-K *vs.* PDE-K	2.92903	3.28556	2.522	.040*
	PDE-K *vs.* PDE-R	-1.81485	5.31313	-.966	.366
Bs	GME-K *vs.* PDE-K	1.57063	3.08592	1.440	.193
	PDE-K *vs.* PDE-R	8.92575	4.29391	5.879	.001*
S	GME-K *vs.* PDE-K	6.71444	4.76644	3.984	.005*
	PDE-K *vs.* PDE-R	-2.27502	6.68748	-.962	.368

*P<0.05

5.4 COMPARISON OF THE DISTRIBUTION OF SYNTACTIC DESIGN PROCESSES

5.4.1 The overall distribution of syntactic design processes

This section presents the comparative analysis of overall distribution of design processes in the GME and the PDE. Figure 5.19 is the boxplot analysis of the overall design processes distribution in the GME and the PDE. From the figure, we can see that more cognitive effort is expended on the analysis and reformulation I processes. This is followed by evaluation, synthesis, reformulation II, with the least effort expended on formulation and reformulation III.

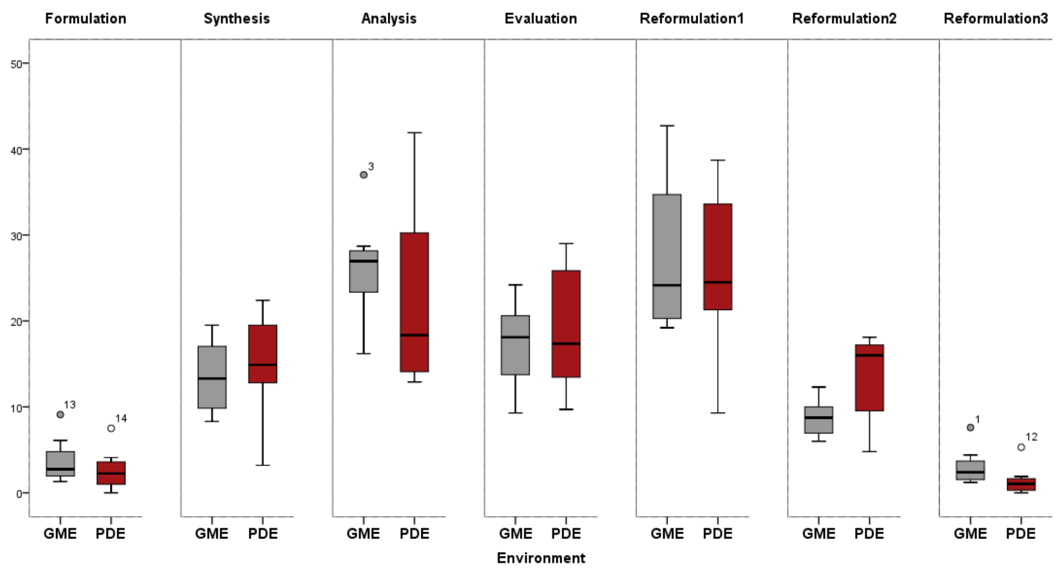


Figure 5.19. Boxplot analysis of overall distribution of syntactic design processes.

Analysis results shown in Table 5.17 suggest that there is no significant difference in terms of overall design processes between the GME and the PDE except the reformulation II process (T=-2.725, N=8, P=0.030). The occurrence of reformulation II is much higher in the PDE than in the GME which means designers reformulate behaviour (Be) more frequently in the PDE. Reasoning from the existing geometric model or rule design, they reset the algorithm goals or the way to achieve them in the PDE.

Table 5.17. Paired sample T-test of syntactic design processes.

GME VS. PDE	Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (P)
Formulation	1.02500	1.77985	1.629	.147
Synthesis	-1.47500	5.49539	-.759	.473
Analysis	3.73750	9.42033	1.122	.299
Evaluation	-1.70000	7.69434	-.625	.552
Reformulation I	1.67500	12.23376	.387	.710
Reformulation II	-4.83750	5.02051	-2.725	.030*
Reformulation III	1.60000	2.97081	1.523	.171

*P<0.05

5.4.2 Syntactic design processes across different design stages

The syntactic design process distributions at the three different design stages in the GME and the PDE are presented in Figure 5.20. From Figure 5.20, some preliminary inferences are revealed: in both the PDE and the GME, analysis occurs more frequently towards the end of the design session, while the occurrence of formulation and reformulation III decreases toward the end of the design session; evaluation processes are active in both the GME and the PDE at the mid design session.

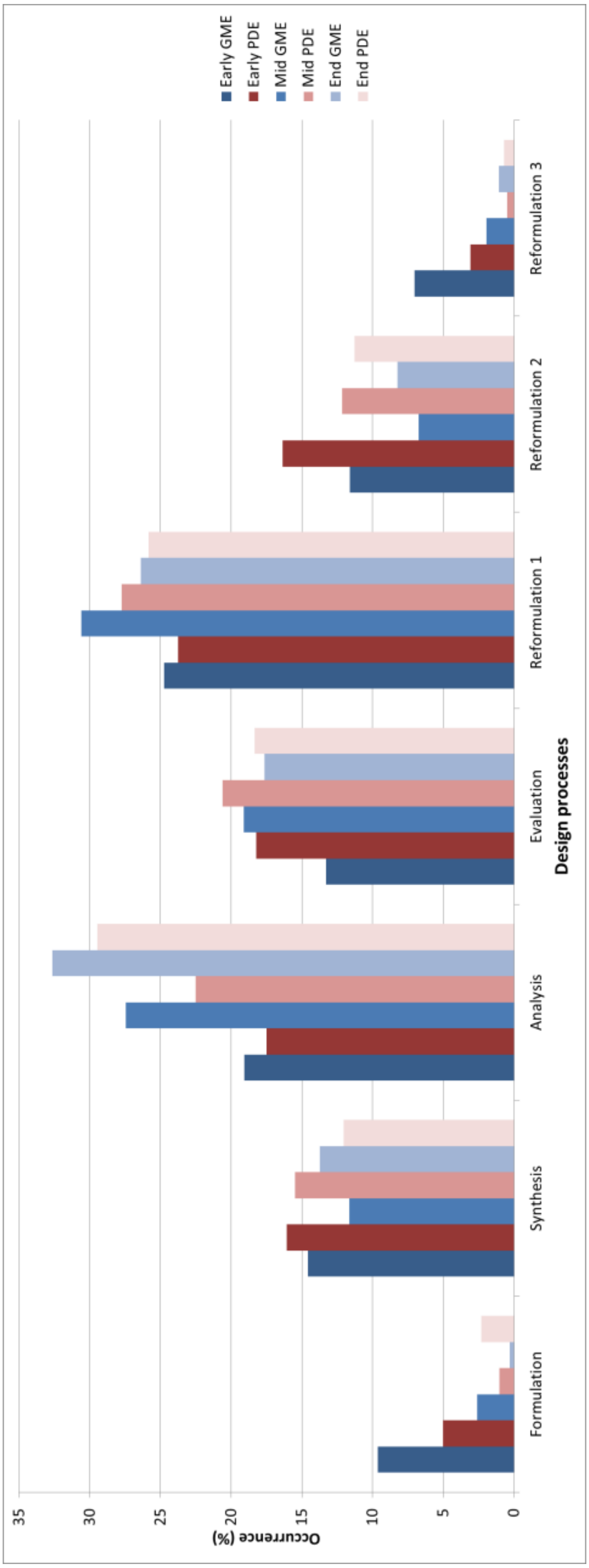


Figure 5.20. Design processes distribution in the GME *vs.* the PDE across the three stages of the design session

1. Design process distribution at the early design stage in the GME and the PDE

Figure 5.21 shows the boxplot analysis of design processes at the early design stage in both the GME and the PDE. Table 5.18 presents the paired sample T-test of design process at the early design stages. From the paired sample T-test there are no significant differences in design issues found at the early design stage *(P>0.05)*. Qualitatively, the occurrence of synthesis and evaluation is higher in the PDE than in the GME. This means designers start to shape the concept towards design structure early in the PDE session. Cross (2011) states that expert designers tend to rapidly go into design solution/structure soon; we can infer that PDEs are beneficial for designers for synthesising design structure early.

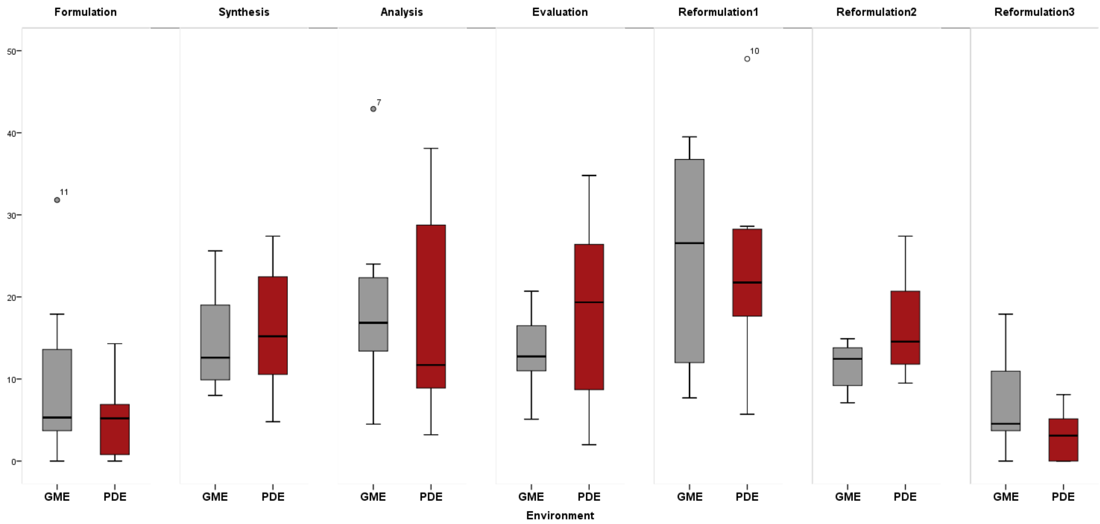


Figure 5.21. Boxplot analysis of syntactic design processes distribution at the early design stage in the GME *vs.* the PDE.

Table 5.18. Paired sample T-test of syntactic design processes at early design stages.

GME *VS.* PDE	Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (P)
Formulation	4.61250	6.80786	1.916	.097
Synthesis	-1.50000	9.06154	-.468	.654
Analysis	1.57500	9.86230	.452	.665
Evaluation	-4.92500	8.34484	-1.669	.139
Reformulation I	.97500	20.42336	.135	.896
Reformulation II	-4.76250	5.93102	-2.271	.057
Reformulation III	3.96250	6.91477	1.621	.149

2. Design process distribution at the mid design stage in the GME and the PDE

Figure 5.22 shows the boxplot analysis of design processes at the mid design stage in both the GME and the PDE. Table 5.19 presents the paired sample T-test of design process at the mid design stages. From analysis (Table 5.19), there are no significant differences of design processes found at the mid design stage *(P>0.05)*. Qualitatively, there are more analysis processes in the GME and slightly more synthesis and evaluation in the PDE at the mid design stage. In the PDE, designers tend to more frequently invest their cognitive effort into rule algorithm at the mid design stage, therefore, more synthesis to structure (Both S^K and S^R) is exhibited.

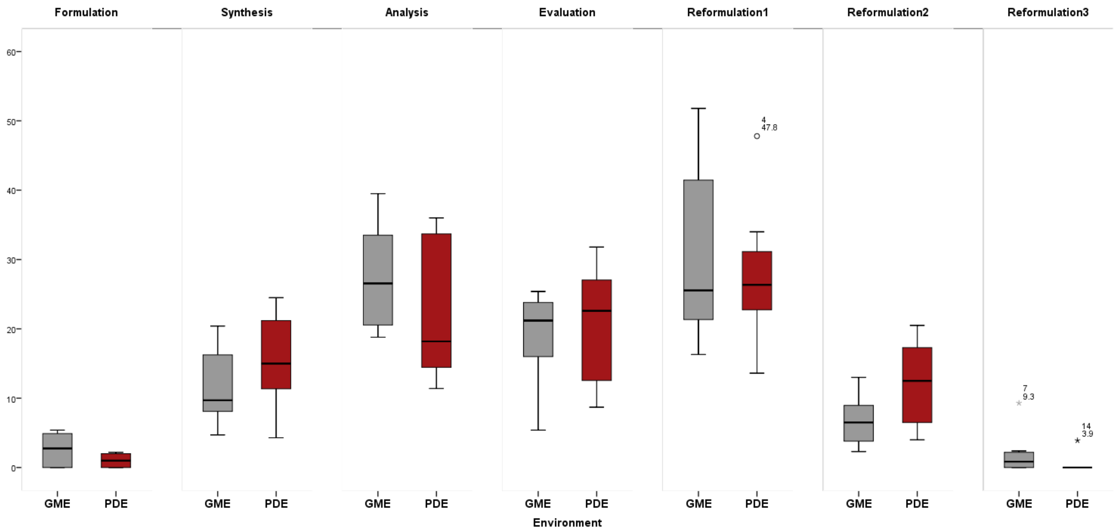


Figure 5.22. Boxplot analysis of syntactic design processes distribution at the mid design stage in the GME *vs.* the PDE.

Table 5.19. Paired sample T-test of syntactic design processes at mid design stages.

GME *VS.* PDE	Mean	Std. Deviation (SD)	t	Sig. (2-tailed) (P)
Formulation	1.56250	3.36747	1.312	.231
Synthesis	-3.83750	7.57985	-1.432	.195
Analysis	4.92500	13.69773	1.017	.343
Evaluation	-1.51250	10.72013	-.399	.702
Reformulation1	2.86250	11.62828	.696	.509
Reformulation2	-5.41250	7.99919	-1.914	.097
Reformulation3	1.43750	3.73820	1.088	.313

3. Design process distribution at the end design stage in the GME and the PDE

Figure 5.23 shows the boxplot analysis of design processes at the end design stage in both the GME and the PDE. Table 5.20 presents the paired sample T-test of design processes at the end design stages. From analysis (Table 5.20), there are no significant differences of design processes found at the end design stage *($P>0.05$)*. Qualitatively, in both the design environments, formulation and reformulation III rarely happen at the end of design stage; there is more analysis at the end of the design session in the GME than the PDE.

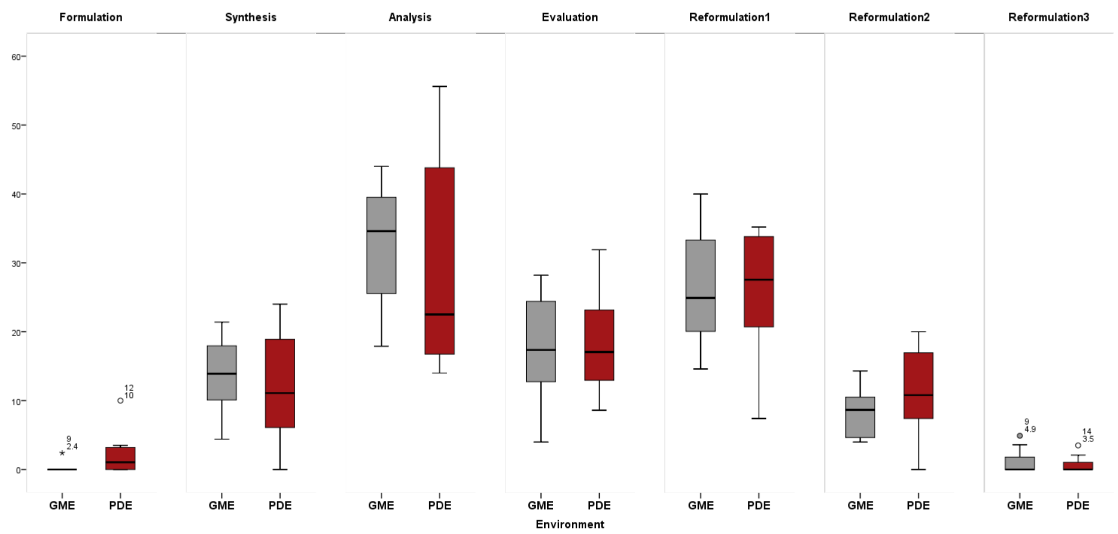


Figure 5.23. Boxplot analysis of syntactic design processes distribution at the end design stage in the GME *vs*. the PDE.

Table 5.20. Paired sample T-test of syntactic design processes at end design stages.

GME *VS.* PDE	**Mean**	**Std. Deviation (SD)**	**t**	**Sig. (2-tailed) (P)**
Formulation	-2.01250	3.74983	-1.518	.173
Synthesis	1.68750	6.97801	.684	.516
Analysis	3.18750	15.10766	.597	.569
Evaluation	-.70000	11.80617	-.168	.872
Reformulation1	.55000	13.90611	.112	.914
Reformulation2	-3.05000	5.59515	-1.542	.167
Reformulation3	.36250	2.74067	.374	.719

The descriptive data distribution from this chapter implies that there are few significant differences between the PDE and the GME except for the consideration of function (F) and reformulation II design process. Other design issues (R, Be, Bs and S) and design processes (Formulation, Synthesis, Evaluation, Analysis, Reformulation I and III) exhibit very similar distribution in the GME and the PDE. We can infer that designers' thinking at FBS level does not significantly change with the method used. This is because designers' high-level thinking at FBS level is related to individual approaches to designing, which does not necessarily change in the different design environments. Analysis of design issues distribution at the two levels of design activities shows that there is more cognitive effort expended on design knowledge issues in the GME than in the PDE. A comparison of the results suggests that although the total distribution of design issues in both environments is similar, the make-up of the design issues is different. Some of the knowledge-related design issues are substituted by rule algorithm design issue in the PDE. Therefore we can infer that the use of the rule algorithm feature in the PDE has an impact on designers' cognitive behaviour.

5.5 STRUCTURE OF DATA ANALYSIS

Based on the descriptive data presented in this chapter, the following three chapters will further analyse the data as outlined in Figure 5.24. These three chapters aim to address Objective 4, listed in the opening section. The three parts of the analysis respectively illustrate the aggregation process of design issues (cumulative analysis), the trend of the design moves (Markov model), and designers' cognitive activities between design problem and solution spaces (co-evolution).

- *Cumulative analysis*. In Chapter 6, we use cumulative analysis to calculate the aggregation process of individual codes. Cumulative analysis is a method which measures the accumulative cognitive effort spent on each of the design issues (Gero & Kannengiesser, 2014). The cumulative occurrence of a design issue is the number of design issues of one category occur up to present occupied in the total number of this design issue. This is a precise analytical model to present the cognitive effort allocation across a design session. From the cumulative analysis, we aim to compare the cumulative models identified in the GME and the PDE and further explore the relative cognitive effort spent on the two levels of activities in the PDE.

- *Markov model analysis*. In Chapter 7, Markov model analysis is applied to analyse the transition probabilities of individual FBS codes from the current state to the future state. Markov model analysis is an analysis method which can identify the transition probability from one state to another (Kan & Gero, 2009b; Kan & Gero, 2010). In this study, it is used in the context of the FBS ontology to describe the cognitive tendency of design moves. From the Markov model analysis, we aim to compare the Markov model in the PDE and the GME to generate the characteristics and the trends of the design moves. The analysis also explores the unique transitions in the PDE compared to the ones in the GME to identify the specific characteristics of the Markov model in the PDE.

- *Design problem-solution co-evolution*. In Chapter 8, we combine the individual codes and categorise them into two design spaces – the design problem space and solution space. By calculating the transitions between the problem space and the solution space, the characteristics of design problem-solution co-evolution are explored. Co-evolution refers to the situation in which designers formulate design problems and explore ideas for design solutions together (Dorst & Cross, 2001). We aim to compare the transition between the problem space and the solution space in the GME and the PDE, in order to identify the unique patterns of the co-evolution model in the PDE.

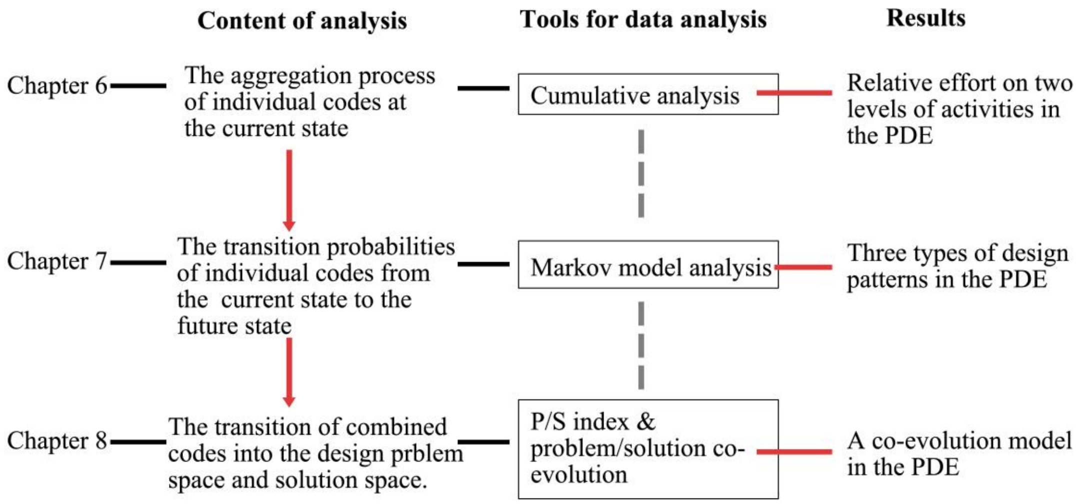


Figure 5.24. Structure of the data analysis.

Chapter 6: Analysis I – Cumulative analysis during parametric design

In order to further understand designers' behaviour during the design session, this chapter presents a cumulative analysis of the design issues. Section 6.1 introduces the cumulative analysis method, which is a formal approach for measuring the cognitive effort spent on each design issues across the design session. Then Section 6.2 compares the cumulative analysis results in the GME and the PDE, and some commonalities in design are drawn from the comparison. Finally, Section 6.3 analyses the cumulative occurrence of the two levels of design activities in the PDE and characteristics of the relative cognitive effort spent on each level in the PDE are presented.

6.1 ANALYSIS METHOD: CUMULATIVE OCCURRENCE OF DESIGN ISSUES

In order to describe the effort that designers expended on each design variable across the design session, cumulative analysis is introduced to exhibit the aggregation process of the design issues. The cumulative occurrence of a design issue is shown by the number of design issues of one category that have occurred so far in a session, divided by the total number of design issues of this type (Gero & Kannengiesser, 2014), as shown in equation (1). From the cumulative analysis, the accumulative cognitive effort spent on each of the design variables during the design process can be identified.

$$Cumulative\ issue = \frac{the\ number\ of\ issues\ that\ have\ coded\ so\ far}{the\ total\ number\ of\ design\ issues\ of\ this\ category} \qquad (1)$$

We will use some measurements based on the cumulative occurrence of the design issues; these measurement methods are adopted from Gero and Kannengiesser's study on the cumulative analysis of multi-disciplinary designers' behaviour (Gero & Kannengiesser, 2014):

- First occurrence at start: if the design issue occurred at the start of the design session or later. This measures when the design issue of a certain category starts.
- Continuity: if the design issue occurs throughout the design session or stops at a certain point.
- Shape of the graph: if the graph is linear or non-linear. Being linear means that the graph is close to a perfect diagonal line (measured by the value of R^2).
- R^2: we set the standard that if R^2 is larger than 0.95, then the graph is linear.
- Slope: a measure of the speed of the design issue generated. The larger the value of the slope, the faster the design issue is generated, measured by how close the graph is to the vertical axis.

These measurements reveal the details of designers' activities across the whole design session. Using cumulative curves, we can develop an understanding of the range and scale of the data. The curves are of different lengths, since the segment number of each protocol varies.

6.2 CUMULATIVE ANALYSIS COMPARING THE GME AND THE PDE

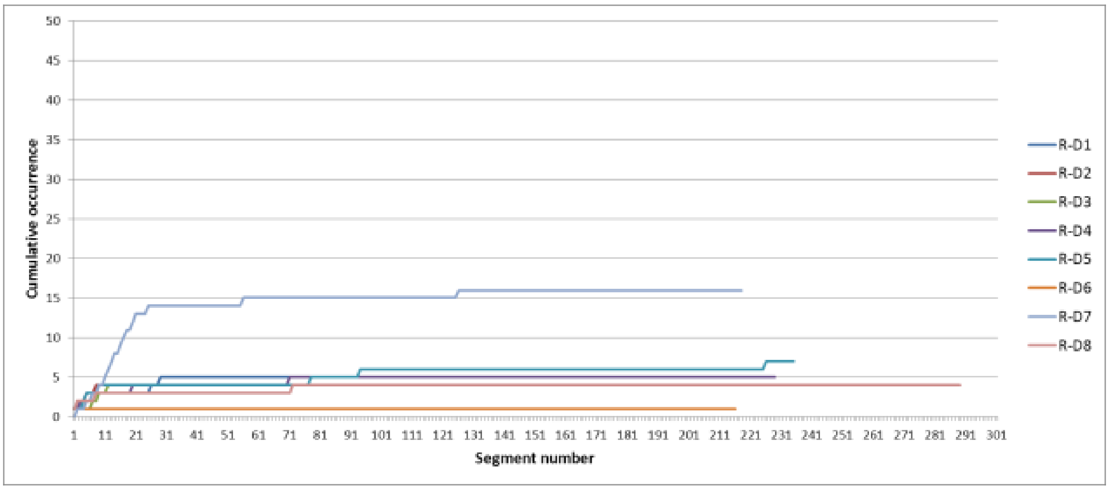
6.2.1 Cumulative analysis of design issues in the GME and the PDE

1. ***Requirement (R)***

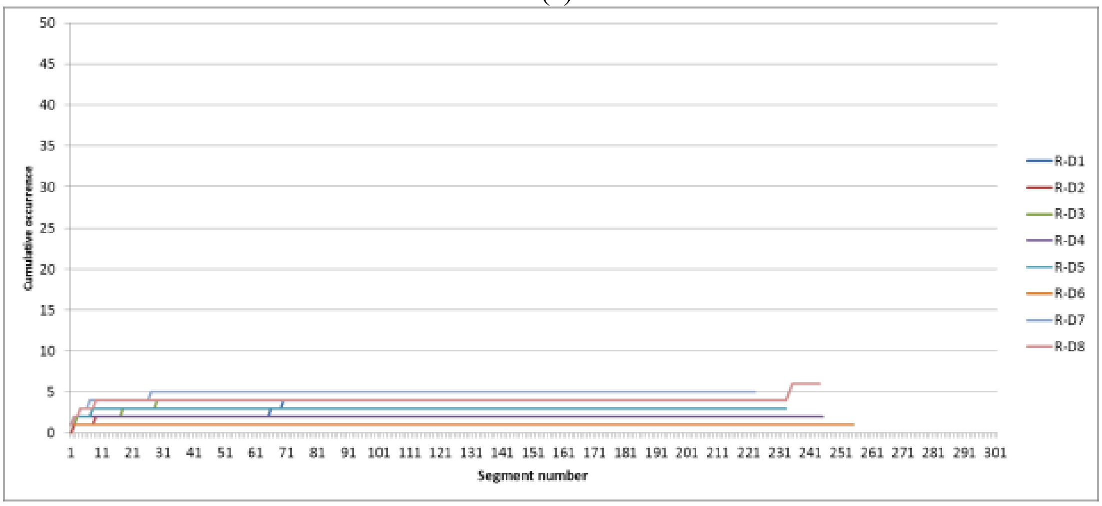
Figure 6.1 illustrates the cumulative occurrence of requirement (R) in the GME (a) and the PDE (b). Table 6.1 shows the measurements and observations of cumulative occurrence of requirement (R) in the two design environments.

The eight lines in Figure 6.1 represent the aggregation processes of the design issue R of the eight designers respectively in the GME and the PDE. In the figure, we analyse from three characteristics of the graph – first occurrence at start, continuity, and shape of the graph. If the cumulative curve starts arising from the beginning of design session (within the first 10 segments), we put "Yes" in the category of "first occurrence at start" in Table 6.1. If it starts after the design session starts (after the first 10 segments), we put "No". In terms of the continuity, if the curve is flat towards the end, it is discontinuous. We set the rule that if the curve keeps flat for a long period of time and only arises in the last 10 segments, it is still discontinuous. Otherwise it is continuous and we put "Yes" in the category of "continuity" in Table 6.1. The shape of the graph is decided by the value of R^2: if R^2 is larger than 0.95, it is linear, otherwise it is non-linear. There are eight designers in the experiment, we hypothesise that if more than six designers exhibit the same patterns, the common model of this design variable is formed based on the six designers' patterns. If less than six follow the same patterns, there is no common model of the aggregation process of this design variable.

As presented in Table 6.1, the occurrence numbers of design issue R of Designer 6 is too low to allow meaningful statistical analysis, so it is shown as "*". As shown in Figure 6.1, compared to the PDE, requirement (R) occurs more frequently in the GME, especially at the mid design stage. Table 6.1 suggests that in both the GME and the PDE, all R issues start from the beginning of the design session. All R issues occur discontinuously, as the curve flattens towards the end of the design session. The curves of the cumulative analysis of all protocols are nonlinear; therefore suggesting a common discontinuous model of aggregation for design issue R in both the GME and the PDE.



(a)



(b)

Figure 6.1. Cumulative occurrence of R, (a): in the GME, (b): in the PDE.

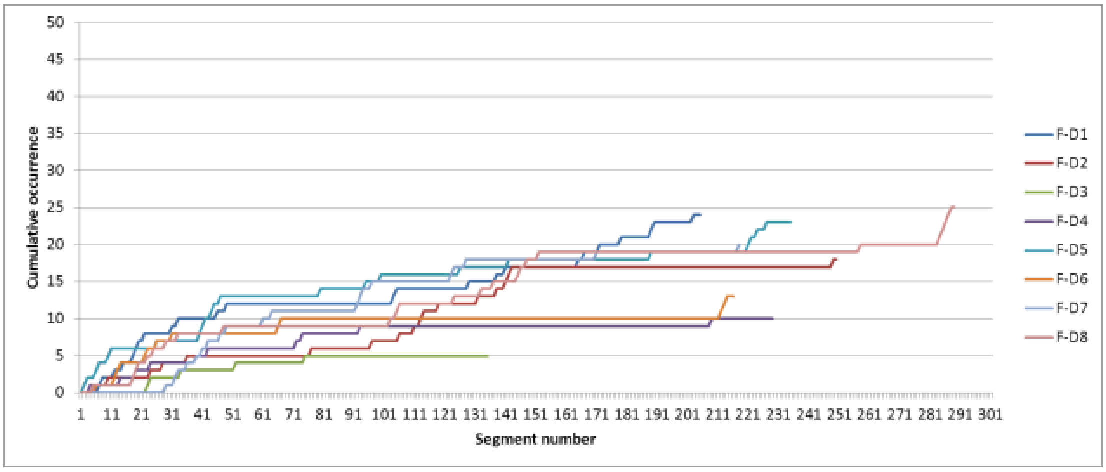
Table 6.1. Measurements and observations of the cumulative occurrence of the R issues.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME
Designer 1	0.011	0.007	0.643	0.330	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 2	0.001	0.001	0.122	0.071	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 3	0.006	0.008	0.332	0.201	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 4	1E04	0.008	0.012	0.558	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 5	0.001	0.014	0.080	0.747	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 6	*	*	*	*	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 7	0.004	0.325	0.240	0.420	Yes	Yes	No	No	Non-Linear	Non-Linear

Designer 8	0.003	0.004	0.198	0.519	Yes	Yes	No	No	Non-Linear	Non-Linear
Common model	NA	NA	NA	NA	Yes	Yes	No	No	Non-Linear	Non-Linear

2. *Function (F)*

Figure 6.2 illustrates the cumulative occurrence of function (F) in the GME and the PDE Table 6.2 shows the measurements and observation of the cumulative occurrence of function (F) design issues in the two design environments. Figure 6.2 and Table 6.2 show that most of the F issues start from the beginning in the PDE, while in the GME, some of them start later. In both design environments, F issues of most protocols occur discontinuously and the shape of the cumulative curves is non-linear, and it suggests a common discontinuous nonlinear model for both the GME and the PDE.



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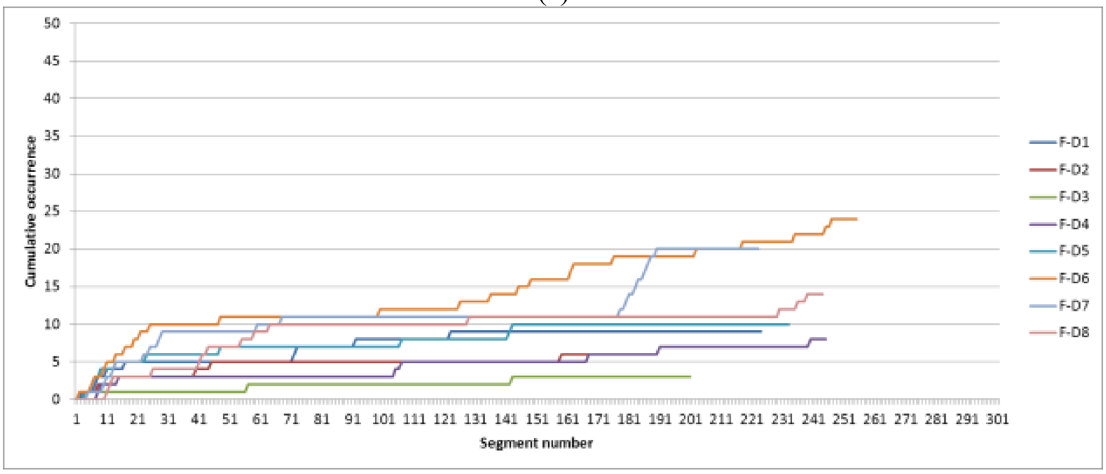


(b)

Figure 6.2. Cumulative occurrence of F, (a): in the GME, (b): in the PDE.

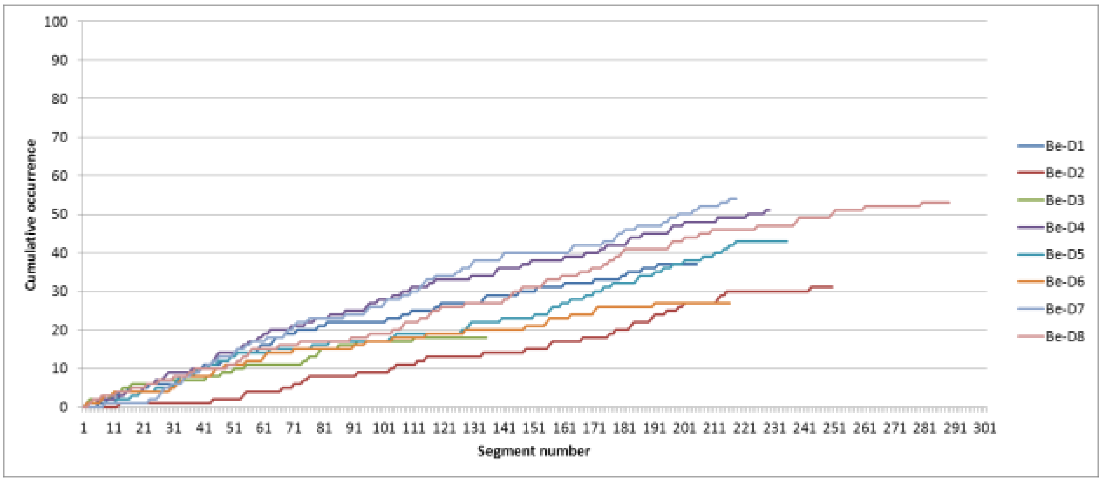
Table 6.2. Measurements and observations of the cumulative occurrence of the F issues.

	Slope	R^2	First occurrence at start	Continuity	Shape

	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME
Designer 1	0.029	0.088	0.796	0.907	Yes	Yes	No	Yes	Non-Linear	Non-Linear
Designer 2	0.020	0.079	0.625	0.899	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 3	0.013	0.042	0.870	0.812	Yes	No	No	No	Non-Linear	Non-Linear
Designer 4	0.025	0.033	0.908	0.734	Yes	Yes	No	No	Non-Linear	Non-Linear
Designer 5	0.029	0.068	0.825	0.867	Yes	Yes	Yes	No	Non-Linear	Non-Linear
Designer 6	0.070	0.029	0.933	0.530	Yes	Yes	Yes	No	Non-Linear	Non-Linear
Designer 7	0.063	0.098	0.752	0.876	Yes	No	No	No	Non-Linear	Non-Linear
Designer 8	0.038	0.068	0.69	0.882	Yes	Yes	No	No	Non-Linear	Non-Linear
Common model	NA	NA	NA	NA	Yes	Yes	No	No	Non-Linear	Non-Linear

3. *Expected behaviour (Be)*

Figure 6.3 illustrates the cumulative occurrence of expected behaviour (Be) in the GME and the PDE. Table 6.3 shows the measurements and observations of the cumulative occurrence of expected behaviour (Be) in the two design environments. From Figure 6.3 and Table 6.3, we can infer that all of the Be issues occur from the beginning of the design session in both the PDE and the GME except for Designer 2. In the GME, the cumulative occurrence curves of all the protocols are continuous, while in the PDE, two of them are discontinuous. The shape of the cumulative curves of the Be issues is linear for all the protocols except for Designer 1 in the PDE, and it suggests a common continuous linear model for both the GME and the PDE.



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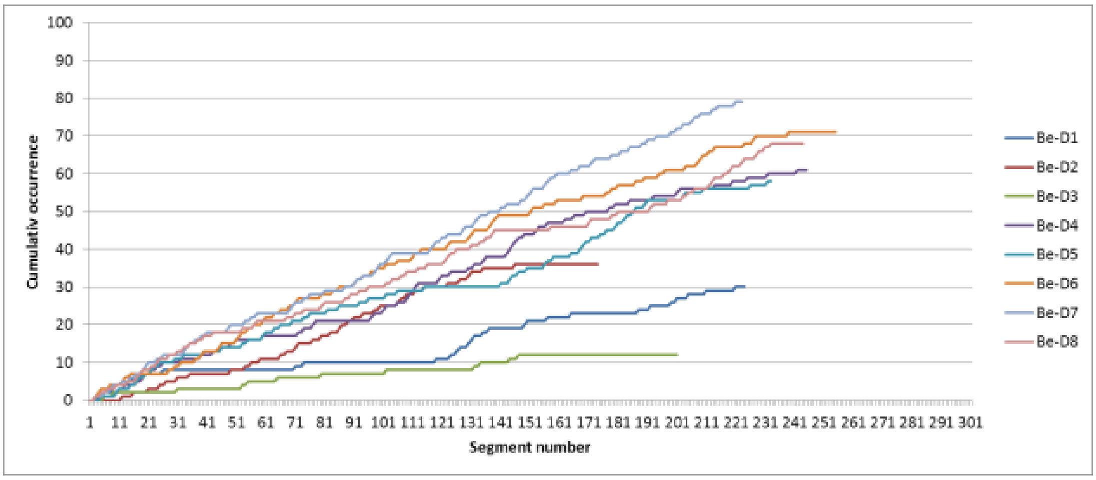


(b)

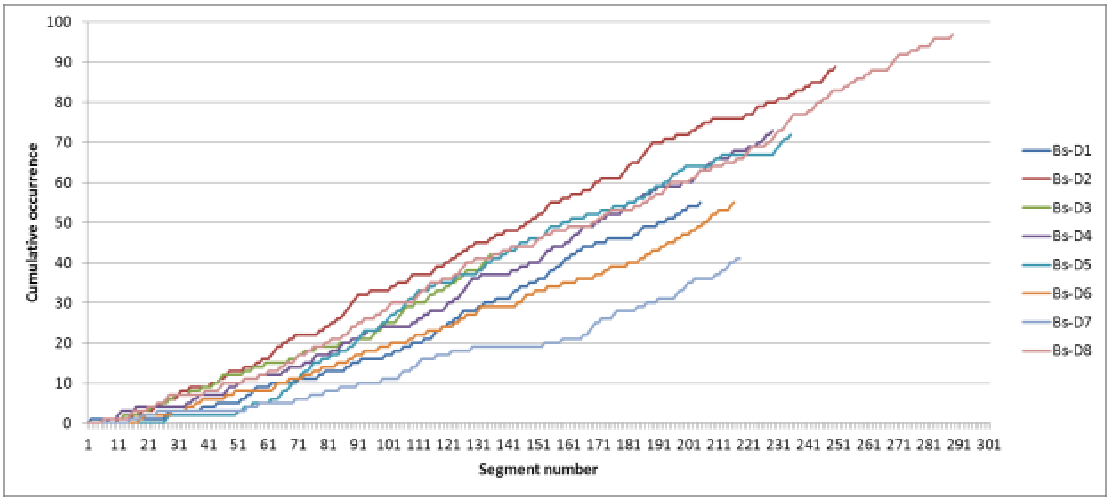
Figure 6.3. Cumulative occurrence of Be, (a): in the GME, (b): in the PDE.

Table 6.3. Measurements and observations of cumulative occurrence of the Be issues.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME
Designer 1	0.121	0.179	0.928	0.968	Yes	Yes	Yes	Yes	Nonlin ear	Linear
Designer 2	0.253	0.140	0.976	0.975	Yes	No	No	Yes	Linear	Linear
Designer 3	0.064	0.133	0.963	0.959	Yes	Yes	No	Yes	Linear	Linear
Designer 4	0.266	0.222	0.985	0.983	Yes	Yes	Yes	Yes	Linear	Linear
Designer 5	0.245	0.176	0.980	0.971	Yes	Yes	Yes	Yes	Linear	Linear
Designer 6	0.292	0.122	0.989	0.964	Yes	Yes	Yes	Yes	Linear	Linear
Designer 7	0.355	0.256	0.997	0.983	Yes	Yes	Yes	Yes	Linear	Linear
Designer 8	0.261	0.194	0.988	0.989	Yes	Yes	Yes	Yes	Linear	Linear
Common model	NA	NA	NA	NA	Yes	Yes	Yes	Yes	Linear	Linear

4. Structure behaviour (Bs)

Figure 6.4 illustrates the cumulative occurrence of structure behaviour (Bs) in the GME and the PDE. Table 6.4 shows the measurements and observations of cumulative occurrence of actual behaviour (Bs) in the two design environments. Figure 6.4 and Table 6.4 suggest that the Bs issues occur from the later design stage of all protocols except for Designer 1 in the GME. The Bs issues occur continuously for all protocols in both environments. All the cumulative curves of the Bs issues are linear, a common continuous linear model for both the GME and PDE is identified.



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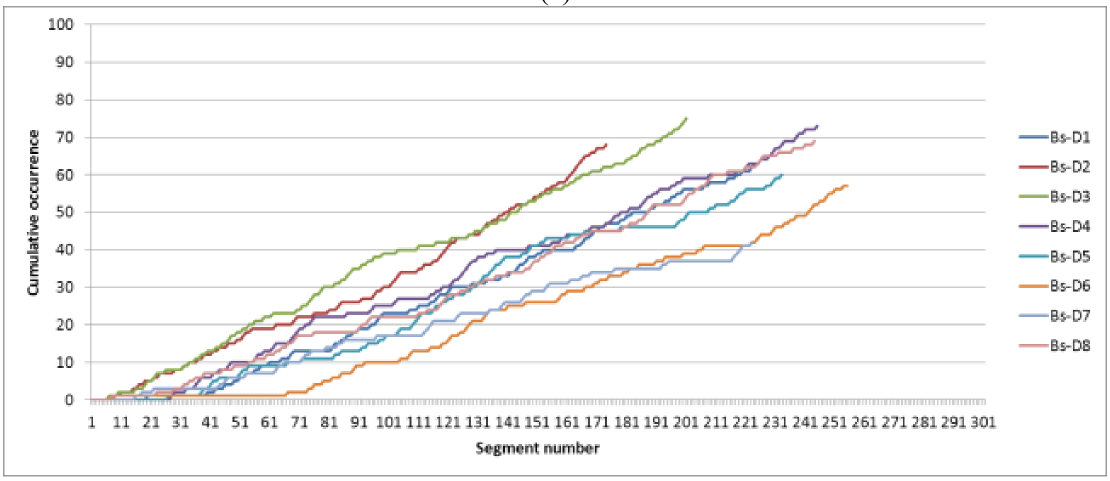


(b)

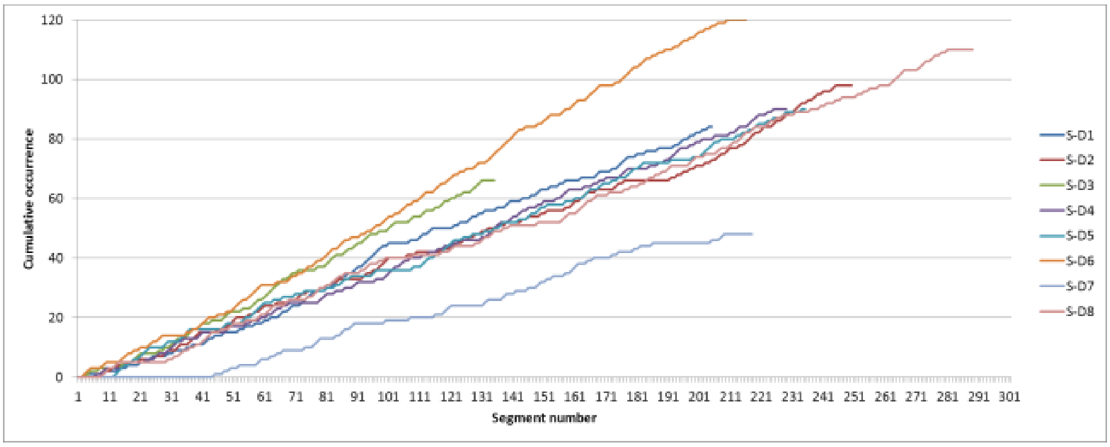
Figure 6.4. Cumulative occurrence of Bs, (a): in the GME, (b): in the PDE.

Table 6.4. Measurements and observations of the cumulative occurrence of the Bs issues.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME
Designer 1	0.306	0.287	0.989	0.970	No	Yes	Yes	Yes	Linear	Linear
Designer 2	0.381	0.375	0.984	0.998	No	No	Yes	Yes	Linear	Linear
Designer 3	0.367	0.293	0.995	0.978	No	No	Yes	Yes	Linear	Linear
Designer 4	0.310	0.323	0.994	0.986	No	No	Yes	Yes	Linear	Linear
Designer 5	0.286	0.355	0.974	0.982	No	No	Yes	Yes	Linear	Linear
Designer 6	0.235	0.253	0.961	0.989	No	No	Yes	Yes	Linear	Linear
Designer 7	0.201	0.179	0.988	0.957	No	No	Yes	Yes	Linear	Linear
Designer 8	0.297	0.346	0.989	0.994	No	No	Yes	Yes	Linear	Linear
Common model	NA	NA	NA	NA	No	No	Yes	Yes	Linear	Linear

5. Structure (S)

Figure 6.5 illustrates the cumulative occurrence of structure (S) in the GME and the PDE. Table 6.5 shows the measurements and observations of the cumulative occurrence of structure (S) in the two design environments. From Figure 6.5 and Table 6.5, we can infer that the S issues of most protocols occur from the beginning of design session in both the PDE and the GME. The S issues of all protocols occur continuously in both environments. All the cumulative curves of S issues have a linear shape, and it suggests a common continuous linear model for both the PDE and the GME.



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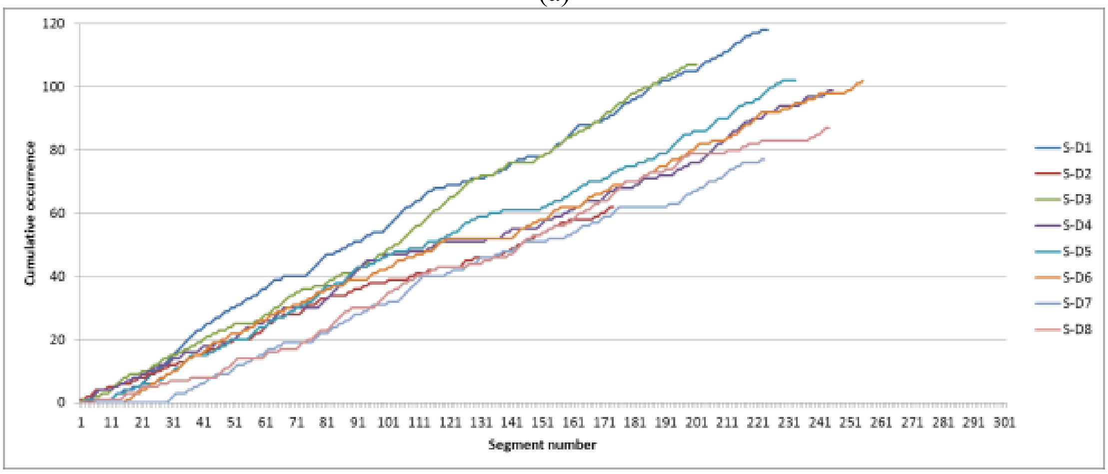

(b)

Figure 6.5. Cumulative occurrence of S, (a): in the GME, (b): in the PDE.

Table 6.5. Measurements and observations of the cumulative occurrence of the S issues.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME
Designer 1	0.532	0.438	0.994	0.993	Yes	Yes	Yes	Yes	Linear	Linear
Designer 2	0.345	0.382	0.992	0.994	Yes	Yes	Yes	Yes	Linear	Linear
Designer 3	0.550	0.524	0.996	0.997	Yes	Yes	Yes	Yes	Linear	Linear
Designer 4	0.387	0.407	0.991	0.997	Yes	Yes	Yes	Yes	Linear	Linear
Designer 5	0.440	0.386	0.995	0.997	No	No	Yes	Yes	Linear	Linear

Designer 6	0.403	0.596	0.994	0.998	Yes	Yes	Yes	Yes	Linear	Linear
Designer 7	0.377	0.264	0.993	0.979	No	No	Yes	Yes	Linear	Linear
Designer 8	0.401	0.389	0.991	0.996	No	No	Yes	Yes	Linear	Linear
Common model	NA	NA	NA	NA	No	No	Yes	Yes	Linear	Linear

6.2.2 Commonalities of the cumulative analysis

From the cumulative analysis of the designers' protocols in the GME and the PDE, no significant differences are found. However, some characteristics of the PDE are revealed as follows.

In the PDE, most of the requirement (R), function (F) and expected behaviour (Be) issues occur from the beginning of the design session, while actual behaviour (Bs) issues occur later. For structure (S), more than half of them occur at the beginning. Most R and F issues have a discontinuous and nonlinear cumulative curve, while the cumulative curve of Be, Bs and S issues are continuous and linear. The occurrence of Be, Bs, and S issues last to the end of the design session. These results mirror those of Gero's and Kannengiesser's (2014) research on the cumulative occurrence analysis of thirteen multidisciplinary designers. Results of their study suggest some significant commonalties of design models: requirement issues (R), function issues (F) and expected behaviour (Be) issues occur from the start. Requirement issues (R) and function issues (F) occur discontinuously, and structure issues (S), structure behaviour issues (Bs) and description issues (D) occur continuously. Function (F) issue suggests a non-linear model, and structure (S) appears as a linear model. Therefore, we can infer that whatever design environment designers are in, these are the common models shared in designing.

6.3 IMPACT OF RULE ALGORITHMS IN THE PDE THROUGH CUMULATIVE ANALYSIS

Since there are no significance differences found by comparing the cumulative analysis in the GME and the PDE, this section explores the characteristics of cumulative occurrence in the PDE. By calculating the cumulative occurrence at the two levels of design activities – design knowledge and rule algorithm – designers' typical activities in the PDE are revealed and discussed.

6.3.1 Cumulative analysis of design issues at two levels of design activities in the PDE

1. ***Cumulative occurrence of overall design issues***

Figure 6.6 illustrates the cumulative occurrence of the two levels of activities in terms of overall design issues in the PDE, while Table 6.6 is the measurements and observations of Figure 6.6. The cumulative analysis suggests obvious differences between the design knowledge (K) and rule algorithm (R) levels: firstly, issues at the design knowledge level of all protocols start from the beginning of design session, while those at the rule algorithm level start later; secondly, the graph shapes of all protocols at the design knowledge level are linear, while half of the graphs exhibit a nonlinear shape at the rule algorithm level. In both environments, the design issues occur continuously for all protocols except for Designer 2 at the rule algorithm level.

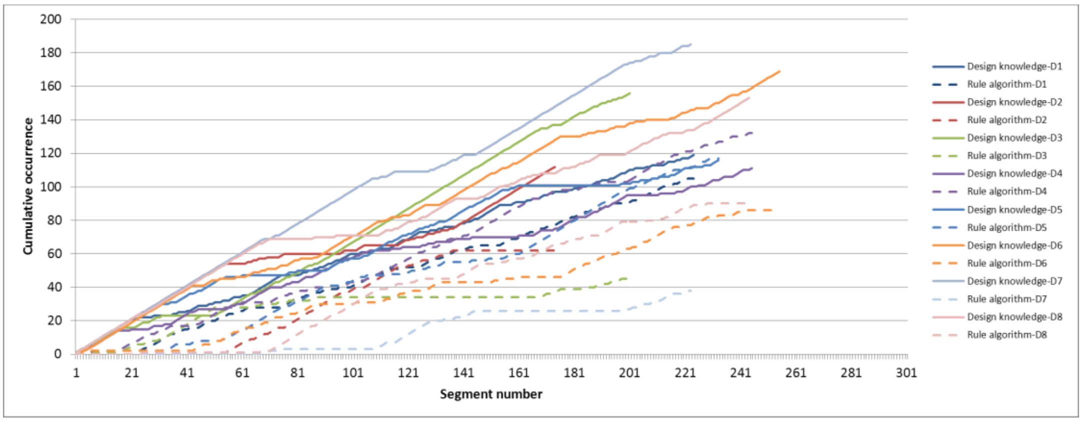

Figure 6.6. Articulated cumulative occurrence of overall design issues in the PDE.

Table 6.6. Measurements and observations of cumulative occurrence of overall design issues at the two levels in the PDE.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	K	R	K	R	K	R	K	R	K	R
Designer 1	0.515	0.485	0.997	0.886	Yes	No	Yes	Yes	Linear	Nonlinear
Designer 2	0.506	0.494	0.934	0.932	Yes	No	Yes	No	Nonlinear	Nonlinear
Designer 3	0.816	0.184	0.984	0.757	Yes	No	Yes	Yes	Linear	Nonlinear
Designer 4	0.421	0.567	0.984	0.993	Yes	No	Yes	Yes	Linear	Linear
Designer 5	0.470	0.530	0.968	0.975	Yes	No	Yes	Yes	Linear	Linear
Designer 6	0.640	0.360	0.992	0.976	Yes	No	Yes	Yes	Linear	Linear
Designer 7	0.814	0.186	0.993	0.886	Yes	No	Yes	Yes	Linear	Nonlinear
Designer 8	0.542	0.454	0.977	0.968	Yes	No	Yes	Yes	Linear	Linear
Common model	NA	NA	NA	NA	Yes	No	Yes	Yes	Linear	Linear/Non-linear

The cumulative analysis can be used to explore the patterns of designers' cognitive activities at the two levels. Differences of slopes at the two levels of design activities indicate the overall occurrence frequency of each design issues. We set the threshold condition as being, that if the ratio of the slopes at the two levels (slope R/slope K) is smaller than 50%, design knowledge dominates the process and rule algorithm is used to support the design process, which is classified as Type 2. Otherwise the two levels of design activities occur at a similar frequency which is classified as Type 1. Figure 6.7 shows the graph of individual cumulative analysis of the overall design issues at the two levels for each of the eight designers.

Type 1

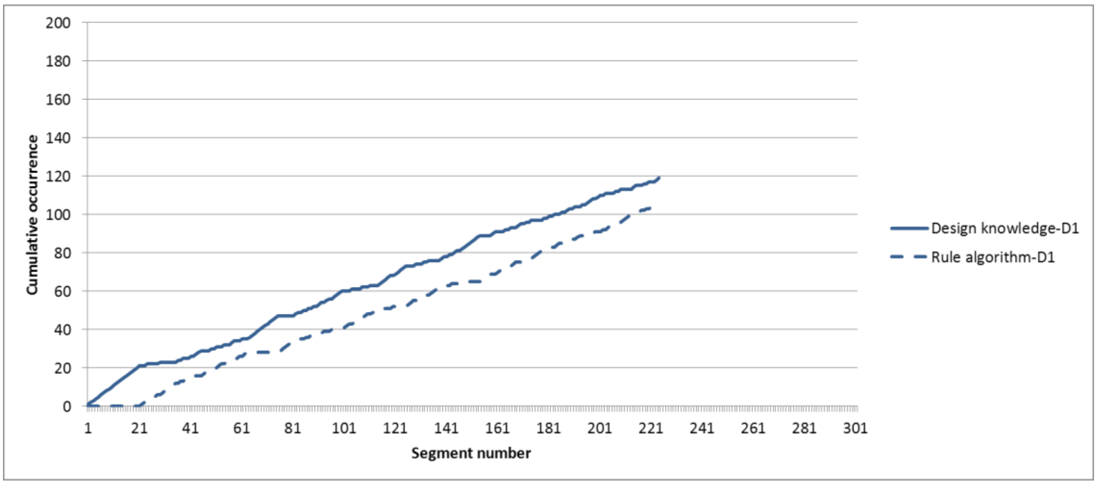

Figure 6.7. (a) Designer 1

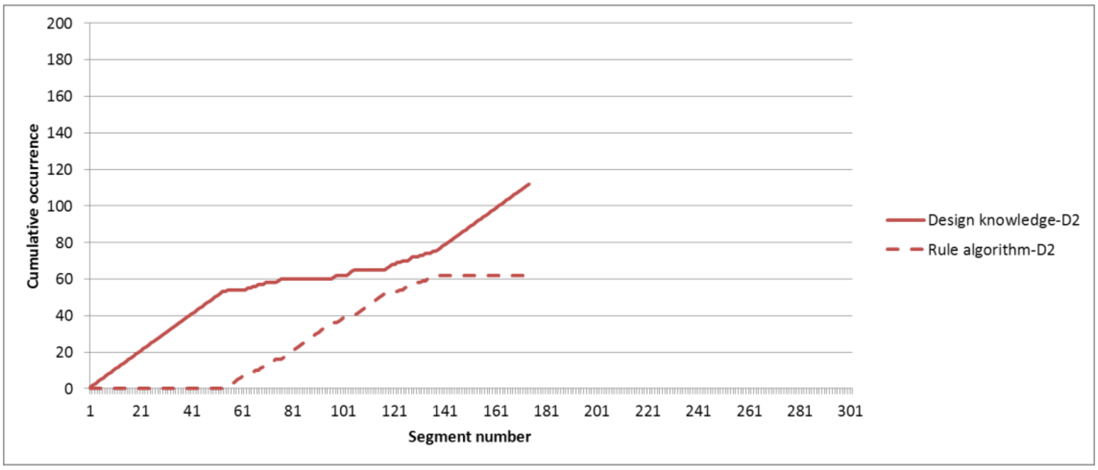

Figure 6.7. (b) Designer 2

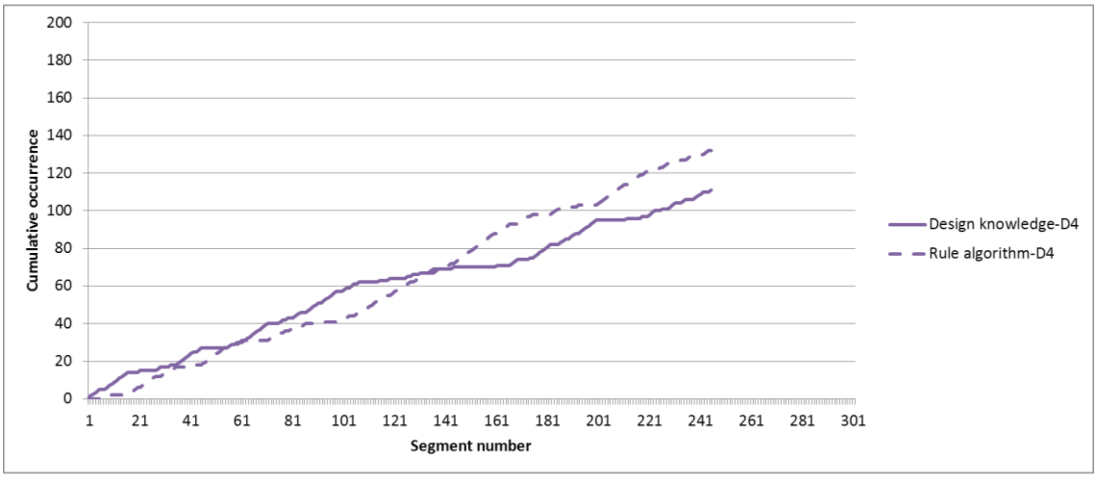

Figure 6.7. (c) Designer 4

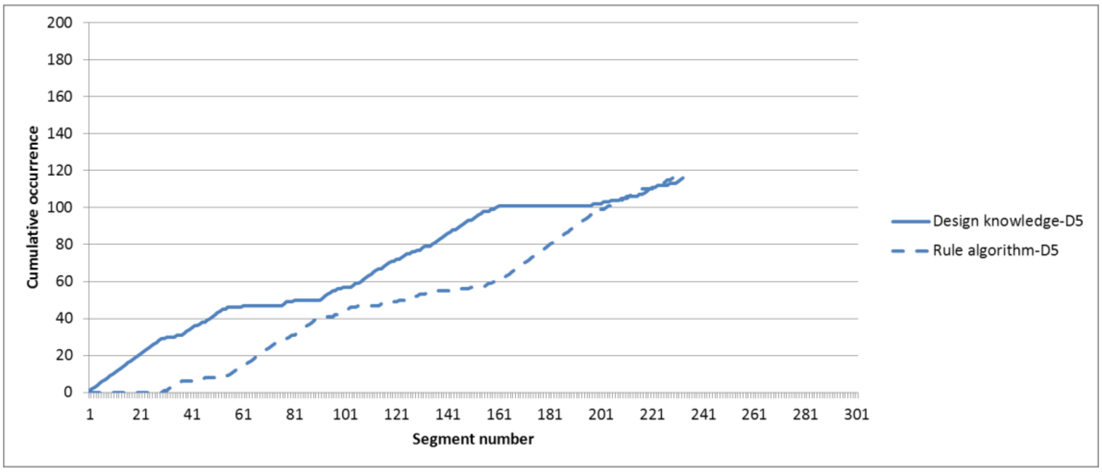

Figure 6.7. (d) Designer 5

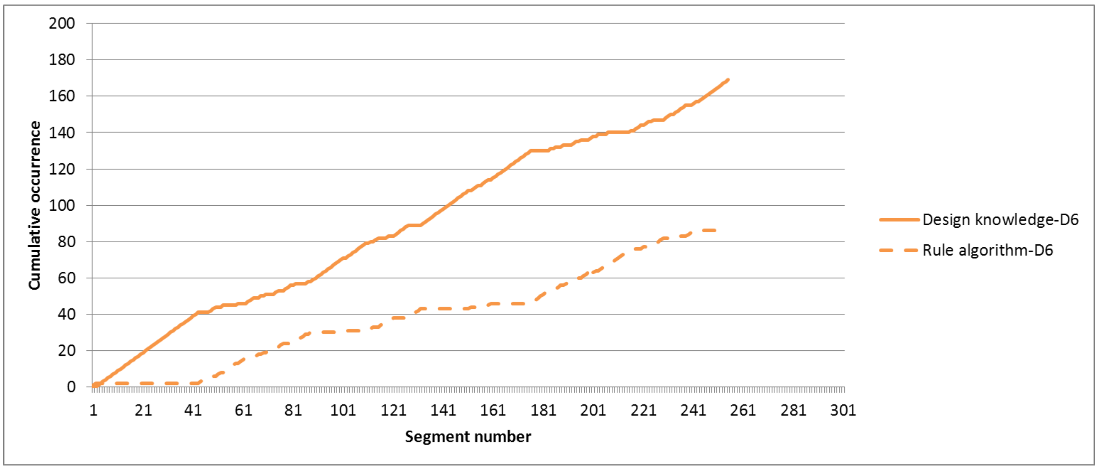

Figure 6.7. (e) Designer 6

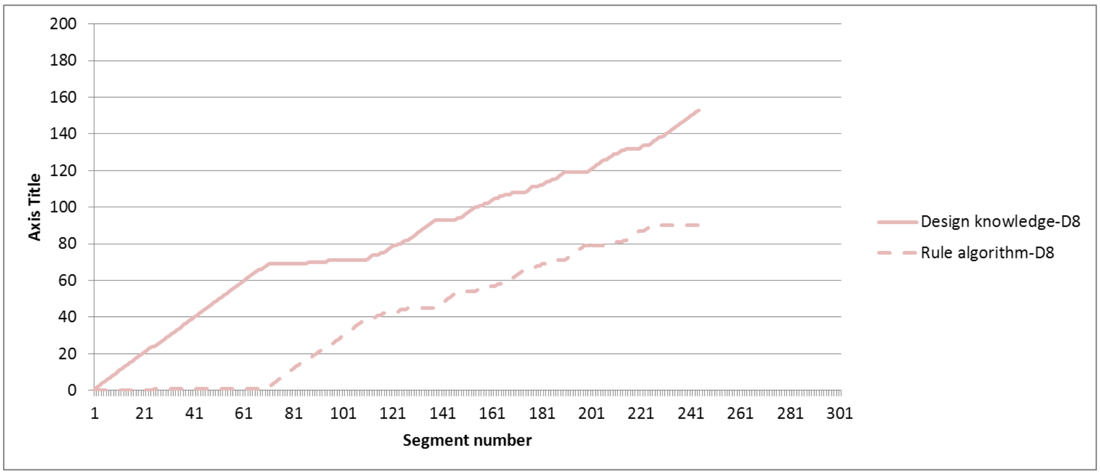

Figure 6.7. (f) Designer 8

Type 2

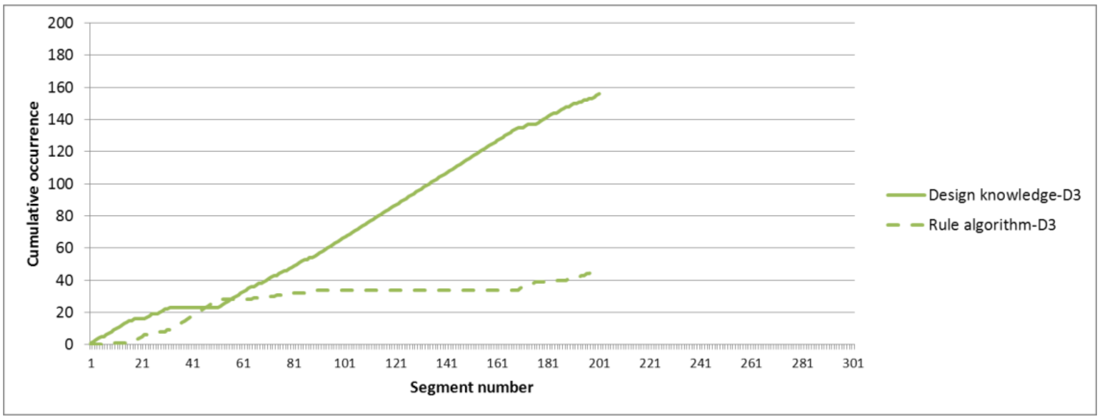

Figure 6.7. (g) Designer 3

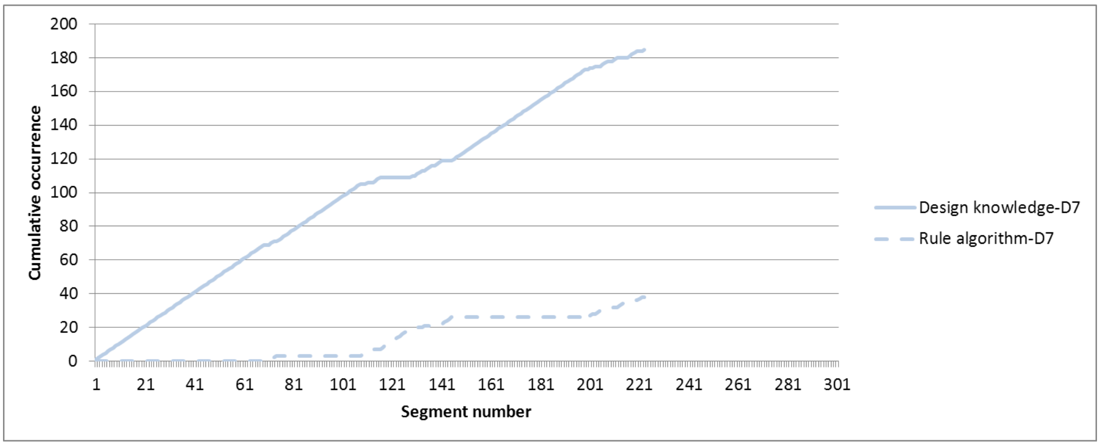

Figure 6.7. (a) Designer 7

Figure 6.7. Articulated cumulative occurrence of overall design issues at the two levels in the PDE for each of the eight designers.

From the analysis above, we can identify two typical patterns of designers' behaviour in terms of the overall design issues in the PDE. As shown in Figure 6.8, Type 1 (Designers 1, 2, 4, 5, 6 and 8) is a pattern where designers interact between two levels of activities frequently. In this type, designers' activities shift between the design knowledge level and the rule algorithm level, and the two levels of activities proceed together. In this type, all of the rule algorithm related activities occur later after the design session starts. Type 2 (Designers 3 and 7) is a pattern in which the design knowledge level is dominant and the rule algorithm level is only for support purposes. Under this type, designers mainly design with their design knowledge, sometimes they use rule algorithm to serve the design purposes.

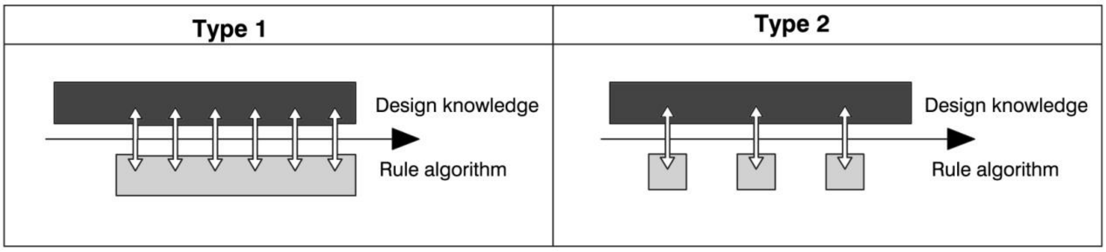

Figure 6.8. Two different patterns of the designers' behaviour in the PDE.

In the rest of this section, we further look into the cumulative occurrence of design issues Be, Bs and S at the two levels of design activities. The reason we exclude F and R here is that they only occur at the design knowledge level.

2. *Cumulative occurrence of design issue Be*

Figure 6.9 illustrates the cumulative occurrence of the two levels of activities in terms of the design issues Be in the PDE, and Table 6.7 shows the measurements and observations from Figure 6.9. The cumulative analysis in Figure 6.9 and Table 6.7 suggests that designers exhibit similar behaviour at the two levels in terms of Be issues: at the rule algorithm level, Be starts at the beginning of the design session for all protocols except Designer 1 and Designer 8 (started at around segment 40). While at the design knowledge level, Be starts at the beginning of the design session for all protocols. The Be issues of most protocols occur continuously at the design knowledge level, with a nonlinear shape for the cumulative curve, as R2>0.95. For the rule algorithm level, there is no clear common model generated in terms of “continuity” and “shape”.

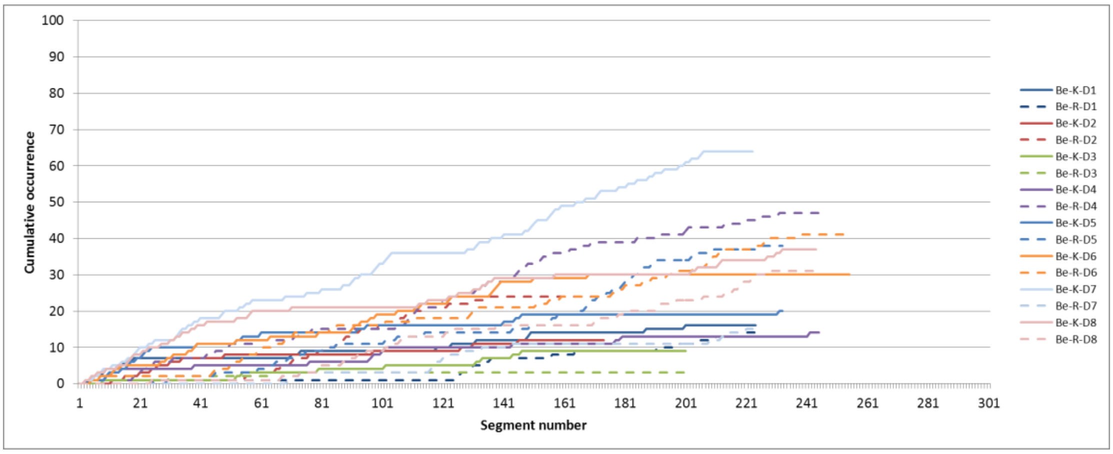

Figure 6.9. Articulated cumulative occurrence of design issues Be in the PDE.

Table 6.7. Measurement and observations of cumulative occurrence of Be issues at the two levels in the PDE.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	K	R	K	R	K	R	K	R	K	R
Designer 1	0.058	0.063	0.937	0.844	Yes	No	No	Yes	Nonlinear	Nonlinear
Designer 2	0.061	0.193	0.841	0.928	Yes	Yes	No	No	Nonlinear	Nonlinear
Designer 3	0.053	0.011	0.952	0.628	Yes	Yes	No	No	Linear	Nonlinear
Designer 4	0.051	0.215	0.932	0.981	Yes	Yes	No	Yes	Nonlinear	Linear
Designer 5	0.064	0.180	0.791	0.940	Yes	Yes	No	Yes	Nonlinear	Nonlinear
Designer 6	0.124	0.168	0.903	0.977	Yes	Yes	No	Yes	Nonlin	Linear

									ear	
Designer 7	0.280	0.075	0.991	0.906	Yes	Yes	Yes	No	Linear	Nonlinear
Designer 8	0.122	0.139	0.914	0.961	Yes	No	Yes	Yes	Nonlinear	Linear
Common model	-	-	-	-	Yes	Yes	No	Yes/No	Nonlinear	Linear/ Non-linear

From the analysis above, we can identify three typical patterns of designers' behaviour in terms of Be in the PDE. As shown in Figure 6.10, in both Types 1 and 2, designers set up goals related to their design knowledge from the beginning to the end of the design session. Type 1 (Designers 1, 6 and 8) is a pattern in which designers mainly set up design knowledge related goals at the beginning, and during the second half of the design session they frequently interact between the design knowledge and rule algorithm levels. Type 2 (Designers 3, and 7, slope R/K<50%) is a pattern in which the design knowledge level is dominant and the rule algorithm level is for support purposes. In this type of pattern, designers mainly set up goals using their design knowledge; they sometimes set up rule algorithm goals to serve the design purposes. Type 3 (Designers 2, 4, and 5 slope K/R<50%) is a pattern in which the rule algorithm level is dominant and the design knowledge level is for support purposes. In this type of pattern, designers mainly worked on the set up of rule algorithm goals or the ways to achieve them.

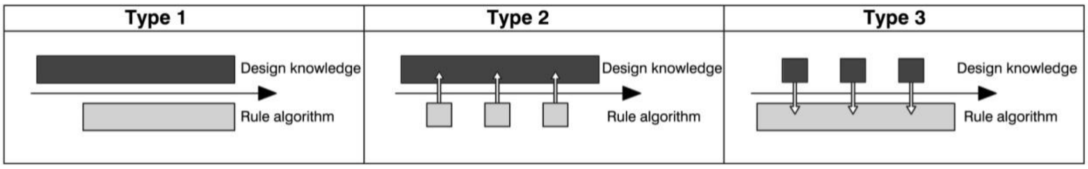

Figure 6.10. Three patterns of the designers' behaviour in terms of Be in the PDE.

3. *Cumulative occurrence of design issue Bs*

Figure 6.11 illustrates the cumulative occurrence of the two levels of activities in terms of design issues Bs in the PDE, and Table 6.8 shows the measurements and observations from Figure 6.11. Figure 6.11 and Table 6.8 suggest some similar characteristics of the cumulative analysis of Bs: firstly, the design issues Bs of all protocols start from the later design stage for both levels; secondly, the Bs issues of most protocols occur discontinuously. The main differences between the two levels of activities are that the shapes of the cumulative curves of all protocols at the design knowledge level are linear, while at the rule algorithm level most of them are nonlinear.

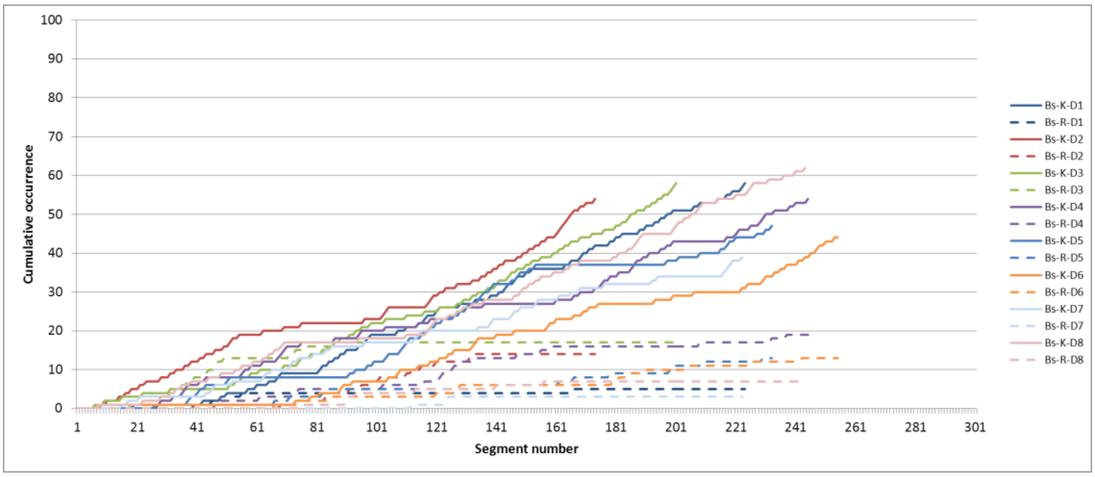

Figure 6.11. Articulated cumulative occurrence of design issues Bs in PDE.

Table 6.8. Measurement and observations of cumulative occurrence of Bs issues at the two levels in the PDE.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	K	R	K	R	K	R	K	R	K	R
Designer 1	0.283	0.023	0.979	0.722	No	No	Yes	No	Linear	Nonlinear
Designer 2	0.269	0.112	0.961	0.886	Yes	No	Yes	No	Linear	Nonlinear
Designer 3	0.284	0.083	0.973	0.680	Yes	No	Yes	No	Linear	Nonlinear
Designer 4	0.216	0.093	0.983	0.947	No	No	Yes	Yes	Linear	Nonlinear
Designer 5	0.228	0.058	0.951	0.957	No	No	Yes	No	Linear	Linear
Designer 6	0.177	0.059	0.954	0.952	No	No	Yes	Yes	Linear	Linear
Designer 7	0.181	0.020	0.988	0.780	No	No	Yes	No	Linear	Nonlinear
Designer 8	0.257	0.040	0.978	0.886	Yes	No	Yes	No	Linear	Nonlinear
Common model	-	-	-	-	Yes/ No	No	Yes	No	Linear	Nonlinear

The cumulative analysis suggests that Bs design issues of all protocols exhibit some similar characteristics, therefore only one pattern is identified (Slope R/K <50%). As shown in Figure 6.12, in this type of pattern, designers mainly focus on analysing the geometric model, occasionally, they inspect and analyse the script.

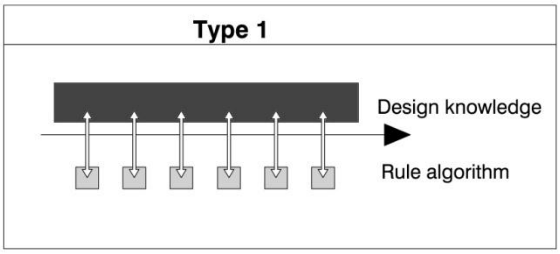

Figure 6.12. The main pattern of designers' behaviour in terms of Bs in the PDE.

4. *Cumulative occurrence of design issue S*

Figure 6.13 illustrates the cumulative occurrence of the two levels of activities in terms of design issues S in the PDE, while Table 6.9 shows the measurements and observations from Figure 13. Figure 6.13 and Table 6.9 show there are some differences between the design knowledge and rule algorithm levels in terms of S based on the cumulative analysis: firstly, the S issues at the design knowledge level of all protocols start at the beginning of the design session, while most of the protocols at the rule algorithm level start later; secondly, for most of the protocols, design issues S occur continuously at rule algorithm level, while it is discontinuous at the design knowledge level. At both levels, for most of the protocols, the shapes of the cumulative curves for S do not suggest a common design model.

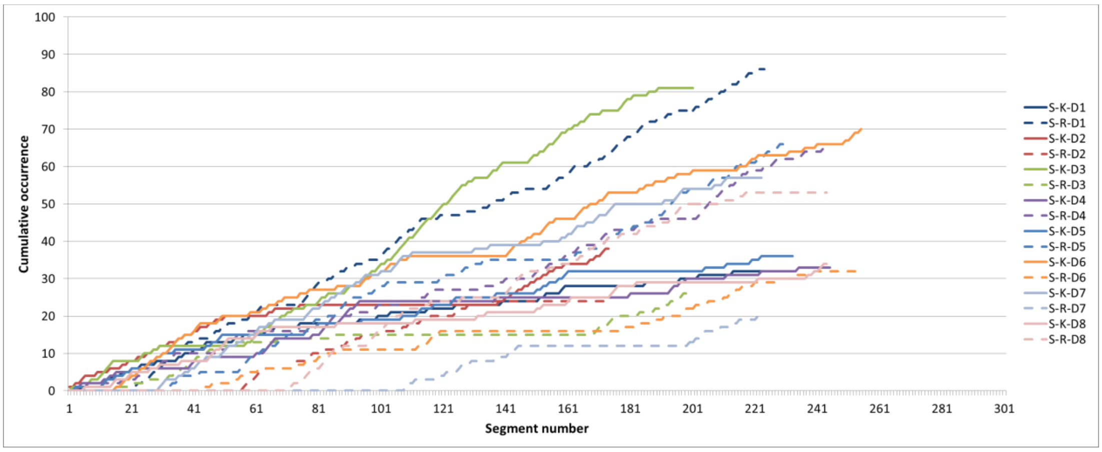

Figure 6.13. Articulated cumulative occurrence of design issues S in the PDE.

Table 6.9. Measurements and observations of cumulative occurrence of S issues at two levels in the PDE.

	Slope		**R^2**		**First occurrence at start**		**Continuity**		**Shape**	
	K	R	K	R	K	R	K	R	K	R
Designer 1	0.133	0.399	0.951	0.996	Yes	Yes	Yes	Yes	Linear	Linear
Designer 2	0.155	0.190	0.862	0.939	Yes	No	Yes	Yes	Nonlin ear	Nonline ar
Designer 3	0.454	0.097	0.973	0.792	Yes	No	Yes	Yes	Linear	Nonline ar
Designer 4	0.129	0.259	0.907	0.978	Yes	No	Yes	Yes	Nonlin ear	Linear

Designer 5	0.149	0.292	0.966	0.978	Yes	No	Yes	Yes	Linear	Linear
Designer 6	0.270	0.133	0.984	0.961	No	No	Yes	No	Linear	Linear
Designer 7	0.286	0.092	0.973	0.849	Yes	No	Yes	Yes	Linear	Nonlinear
Designer 8	0.122	0.279	0.939	0.962	Yes	No	Yes	Yes	Nonlinear	Linear
Common model	-	-	-	-	Yes	No	Yes	Yes	Linear/ Non-linear	Linear/ Non-linear

From the analysis above, we can identify three typical patterns of designers' behaviour in terms of S in the PDE. As shown in Figure 6.14, type 1 (Designers 5 and 2) is a pattern in which designers have frequent interactions between the two levels. In this type of pattern, designers shift between the two levels; the activities of the modelling structure and the scripting structure proceed together. Type 2 (Designers 3, 6, and 7, Slope R/K<50%) is the pattern in which the design knowledge level is dominant and the rule algorithm level is for support purposes. In this type of pattern, designers mainly design the geometric model; sometimes they use scripts to support what they are doing. Type 3 (Designers 1, 4 and 8, Slope K/R<50%) is the pattern in which the rule algorithm level is dominant and the design knowledge level is occasionally considered. In this type of pattern, designers focus on the structure of the rule algorithm rather than the building elements.

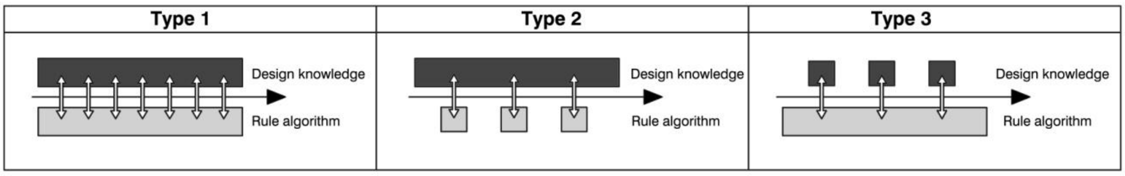

Figure 6.14. Three patterns of designers' behaviour in terms of S in the PDE.

From the cumulative analysis of the designers' behaviour in the PDE, we have identified the characteristics of the aggregation processes of FBS design variables at the two levels of the PDE. To further explore the characteristics of the designers' behaviour at the two levels, in the next section the relative cognitive effort spent on the two levels in the PDE will be discussed to reveal the interactions and switches between the two levels.

6.3.2 Relative effort on the two levels of design activities in the PDE

Our coding scheme coded six ontological design issues from the research, where each design issue maps onto a cognitive activation. Since the length of each design session varies, the number of segments in each session is first normalised to be 100. This then makes each design session the same length of 100 normalised segments. In order to be able to compare the relative cognitive efforts, the cognitive activations associated with design knowledge and those associated with rule algorithm are separated and aggregated across all eight designers.

Function (F) and requirement (R) at the rule algorithm level were coded as zero in this study, because there were no rule requirements in the design brief. Three ontological design issues of expected behaviour (Be), structure (S) and behaviour from structure (Bs) were the most frequently occurring issues and the measurements are made using these issues. For each normalised segment the relative percentages of cognitive effort on the two levels of design activities – design knowledge and rule algorithm – are calculated and plotted. The resulting graphs provide a qualitative overview of the locus of cognitive effort distribution between design knowledge and rule algorithm, in addition to the quantitative values used to produce the graphs.

1. *Overall relative effort of the two levels*

The overall relative effort on two levels of design activities is illustrated in Figure 6.15. The vertical axis represents the average values of the relative effort of the eight protocols. The horizontal axis is the normalised segment numbers.

From the overall distribution of cognitive effort shown in Figure 6.15, we can see that initially the cognitive effort on design knowledge dominates that of rule algorithm. However, as the design session proceeds, the cognitive effort on design knowledge drops from 100% to approximately 60% of the total in a shape that looks like a decay curve. In parallel, as the design session proceeds, the cognitive effort on rule algorithm increases from 0% to approximately 40% of the total in a shape that looks like an excitation curve. Therefore, we can infer that in parametric design, designers still expend most effort on design knowledge; parametric scripting is mainly used to support their intention of generating the design model. The designers often started their sessions by considering design knowledge-related issues, such as building functions; as the design proceeded, they gradually spent more of their cognitive effort on parametric scripting. In the following sections, we articulate these results with further details about the cognitive behaviour related to Bs, S and Be, and draw implications from the findings.

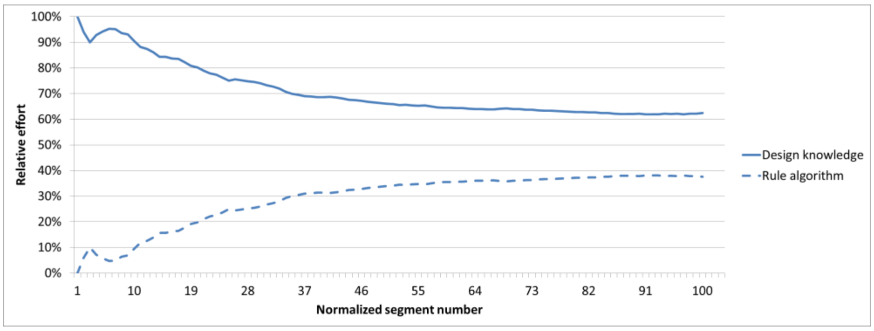

Figure 6.15. Overall relative cognitive effort.

2. *Relative effort on Be of the two levels*

Expected behaviour (Be) means that "designers use theories or experiences to speculate what effect could fulfil a purpose before a specific structure is proposed" (Jiang, 2012, p 36-37). Applying this understanding to rule algorithm related activities (Be^R) means that designers set up rule algorithm goals or think about the way to achieve those goals.

The relative cognitive effort expended on expected behaviour (Be) of the two levels during the parametric design process is presented in Figure 6.16. In terms of expected behaviour (Be), the relative effort expended on the design knowledge level (Be^K) is higher at the beginning and then decreases across the design session; while that on the rule algorithm level (Be^R) rises toward the end of design session. At the end of the design session, designers' cognitive effort expended on the rule algorithm exceeds that of design knowledge. From this we can infer that later in the design session designers tend to focus more on setting up rule algorithm goals and exploring ways to achieve those goals.

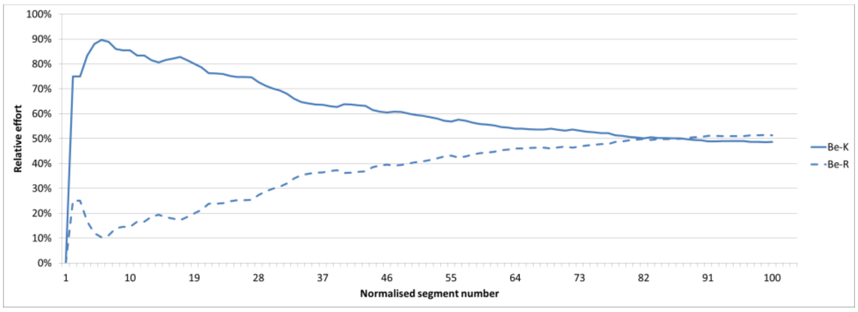

Figure 6.16. Relative cognitive effort expended on Be.

3. Relative effort on Bs of the two levels

Structure behaviour (Bs) refers to the behaviour derived from the structure: at the design knowledge level, Bs^K represents evaluation of the existing geometry/structure; while at the rule algorithm level, Bs^R means evaluating the structure of the rule algorithm.

The relative cognitive effort expended on structure behaviour (Bs) at the two levels during the parametric design process is presented in Figure 6.17. Designers expended noticeably more cognitive effort on the design knowledge level than on the rule algorithm level during the whole design session when focusing on Bs. Design knowledge-related activities decrease from 100% to approximately 70% during the first third of the design session and then remain unchanged at 70%–80%; the rule algorithm-related activities increase from 0% to 30% during the first third of the design sessions and then remain unchanged at 20%–30%. From the results in Figure 6.17, we can also see that in terms of Bs, rule algorithm related activities Bs^R do not commence at the beginning of the design session. One of the possible reasons is that designers only start examining rule algorithm settings after their rule algorithm related concepts and development achieve a certain degree of maturity.

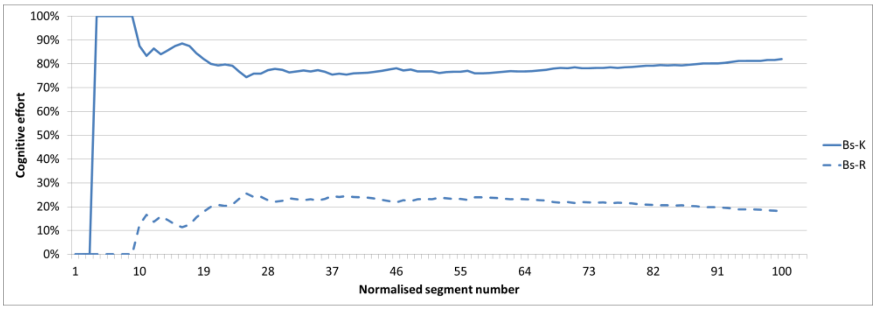

Figure 6.17. Relative cognitive effort expended on Bs.

4. *Relative effort on S of the two levels*

Structure (S) variables describe "the components of the object and their relationships, which mean 'what it is'" (Gero & Kannengiesser, 2004, p 374). At the design knowledge level, structure (S^K) refers to the elements or relationships of the geometries; while at the rule algorithm level (S^R), it is defined as the structure of the rule algorithm – the components of rules and their relationships for parameterisation.

The relative cognitive effort expended on structure (S) at the two levels during the parametric design process is shown in Figure 6.18. From the results in Figure 6.18, we can see that design knowledge-related activities dominate the design process during the early and mid-stages of the design sessions and then converge to a level similar to that of rule algorithm related activities. The cognitive effort expended on S^K decreases from 100% at the beginning of the sessions to approximately 50%; while rule algorithm-related activities increase from 0% to approximately 50%.

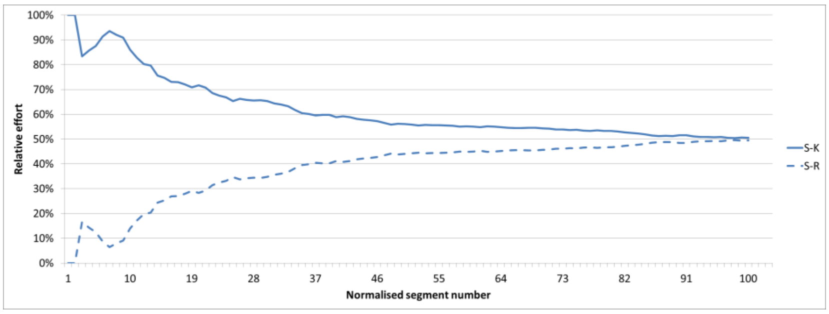

Figure 6.18. Relative cognitive effort expended on S.

Results of the relative effort analysis suggest that the division of the two design levels is useful in understanding designers' behaviour in the PDE. From these results, design knowledge related activities dominate the parametric design process for all cognitive issues. The overall cognitive effort expended on design knowledge is 100% of the effort at the outset of the design session and decreases to 60% towards the end of the design session. The cognitive effort expended on rule algorithm related activities is 0% at the commencement of the design session and rises to approximately 40% by the end of the design session.

The implications of these results, if they are found to be generalizable, is that practicing architects with experience in using parametric design tools make use of those tools very early in a design session and make increasing use of them as the design session proceeds. As expected the cognitive effort expended on the rule algorithm level as the design session proceeds increases at the expense of the effort expended on the design knowledge. This implies that designers are substituting rule algorithm for design knowledge. This opens up ways of encoding design patterns that can form the basis of reusable rules that allow a designer to develop a style of designing and, through the rule parameterisation, a style of designs. Each design generated through the use of these patterns but parameterised individually is unique and responds to each unique program but forms part of an overall style associated with an individual designer or design team.

Chapter 7: Analysis II – Markov model analysis of parametric design

This chapter presents results of the Markov model analysis of parametric design issues. Firstly, the analysis method of the Markov model is introduced in Section 7.1. Section 7.2 describes the transition probability analysis of design issues produced in the PDE and the GME based on the Markov model, which calculates the tendency of transition probability from current state to the future state. From results of the Markov model analysis, three typical design patterns in the PDE are identified and discussed in Section 7.3.

7.1 ANALYSIS METHOD: MARKOV MODEL

The Markov model describes the probabilities of moving from one state to another (Ching & Ng, 2006; Meyn & Tweedie, 2009); it demonstrates the tendency of future design moves. Kan and Gero adopt the Markov chain model using the FBS ontology to describe cognitive design processes (Kan & Gero, 2009b; Kan & Gero, 2010). In the context of the FBS ontology, the Markov matrix is a quantitative tool to study design activities based on the transition probabilities between design issues/design processes. In the FBS context, there are two types of Markov models: the 1st order Markov model and the 2nd order Markov model. The 1st order Markov model means the probability of moving to the future state only depends on the current state, without considering the past state (Figure 7.1). For example, as shown in Table 7.1, if the current design activity is requirement (R), in the GME the probability of the next step being function (F) is 0.18.

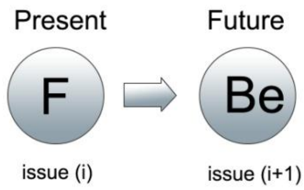

Figure 7.1. An example of the 1st order Markov model using the FBS ontology.

Figure 7.2 is an example of the 2nd order Markov model. The 2nd order Markov model is related to the memory of the past state. That means the future movement is dependent on both the current state and past state. As explained in Figure 7.2, if the current design activity is Be, and the previous one is F, which is a formulation design process, then we use the 2nd order Markov model to calculate the probability of the next state being S. Jiang (2012) applies both the 1st order and 2nd order Markov model to study multidisciplinary designers' behaviour. The result of his study shows that the main identified transitions model matches the original FBS ontological processes. Compared to the 1st order Markov model, the 2nd order Markov model presents a longer probability passage of transition which contains three sequential steps. This study adopts the 1st order Markov model for the transition probability analysis. That is because the 2nd order Markov model presents a longer passage that would significantly reduce the value of transition probabilities compared to the 1st order one. In this study, for a 40 minute design session with 200-300 segments, the data set would be too small to produce meaningful results using the 2nd order Markov model.

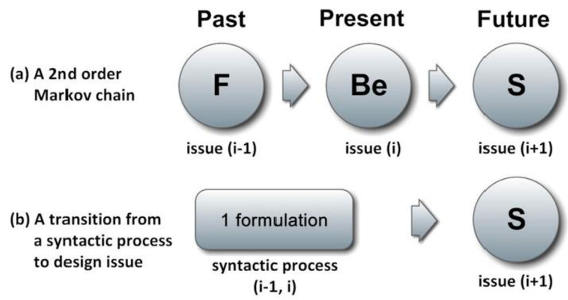

Figure 7.2. An example of the 2nd order Markov model using the FBS ontology (Jiang, 2012).

7.2 MARKOV MODEL ANALYSIS COMPARING THE GME AND THE PDE

7.2.1 1st order Markov model analysis in the GME and the PDE

The value of the Markov model is calculated using *Linkographer* software (Pourmohamadi & Gero, 2011). The matrix of the 1st order Markov model in the GME and the PDE is presented in Table 7.1. The numbers in the table are the average values of transition probabilities of the eight designers. Table 7.2 is the paired sample T-test of the 1st order Markov model. The analysis indicates that there is no significant difference between the two design environments except for S-Be ($p<0.05$) in the matrix, which is a reformulation II processes. In Section 5.4.1, the comparison results of syntactic design processes show that the reformulation II process has significant differences between the GME and the PDE. Therefore the tendency analysis complies with the actual comparison results. Other transition values are very similar between the GME and the PDE; we can infer that designers' tendency of design moves does not vary because of the method used.

Table 7.1. The 1st order Markov model analysis.

	R		F		Be		Bs		S	
	GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE
R	0.20	0.20	0.18	0.30	0.39	0.21	0.11	0.03	0.11	0.26
F	0.03	0.03	0.23	0.15	0.29	0.30	0.23	0.12	0.23	0.41
Be	0.03	0.01	0.10	0.06	0.18	0.20	0.24	0.31	0.46	0.43
Bs	0.02	0.01	0.06	0.05	0.22	0.24	0.25	0.26	0.45	0.44
S	0.01	0.01	0.05	0.03	0.14	0.23	0.40	0.34	0.41	0.41

Table 7.2. Paired Sample T-test of 1st order Markov model analysis.

	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
R-R	.0012500	.3651785	.1291101	.010	7	.993
R-F	-.1200000	.4798809	.1696635	-.707	7	.502
R-Be	.1825000	.3787479	.1339076	1.363	7	.215
R-Bs	.0825000	.1411939	.0499196	1.653	7	.142
R-S	-.1475000	.3932193	.1390240	-1.061	7	.324
F-R	-.0037500	.1016911	.0359532	-.104	7	.920
F-F	.0812500	.1623433	.0573970	1.416	7	.200
F-Be	-.0337500	.1429223	.0505307	-.668	7	.526
F-Bs	.1037500	.1813393	.0641131	1.618	7	.150
F-S	-.1475000	.2621750	.0926928	-1.591	7	.156
Be-R	.0200000	.0267261	.0094491	2.117	7	.072
Be-F	.0387500	.0464258	.0164140	2.361	7	.050
Be-Be	-.0125000	.0945289	.0334210	-.374	7	.719
Be-Bs	-.0700000	.1595529	.0564105	-1.241	7	.255
Be-S	.0262500	.0770783	.0272513	.963	7	.368
Bs-R	.0137500	.0238672	.0084383	1.629	7	.147
Bs-F	.0100000	.0627922	.0222004	.450	7	.666
Bs-Be	-.0200000	.0648074	.0229129	-.873	7	.412
Bs-Bs	-.0100000	.0800000	.0282843	-.354	7	.734
Bs-S	.0037500	.1771954	.0626480	.060	7	.954
S-R	0.0000001	.0119523	.0042258	.000	7	1.000
S-F	.0212500	.0502671	.0177721	1.196	7	.271
S-Be	-.0875000	.0972111	.0343693	-2.546	7	.038*
S-Bs	.0537500	.1008446	.0356540	1.508	7	.175
S-S	.0087500	.1320646	.0466919	.187	7	.857

*P<0.05

Figure 7.3 is the descriptive diagram of the 1st order Markov model analysis in the GME and the PDE. The circles labelled with the FBS codes represent the FBS design issues, and the size of circle represents the frequency occurrence of the design issue. Each arrow shows the transition from one state to the other, and the thickness of the line represents the transition probability between design issues. From Figure 7.3, we can see that the two Markov models are very similar for the two design environments. Compared to the GME, there are noticeably more transition probabilities from F to S and R to S, and less from R to Be in the PDE.

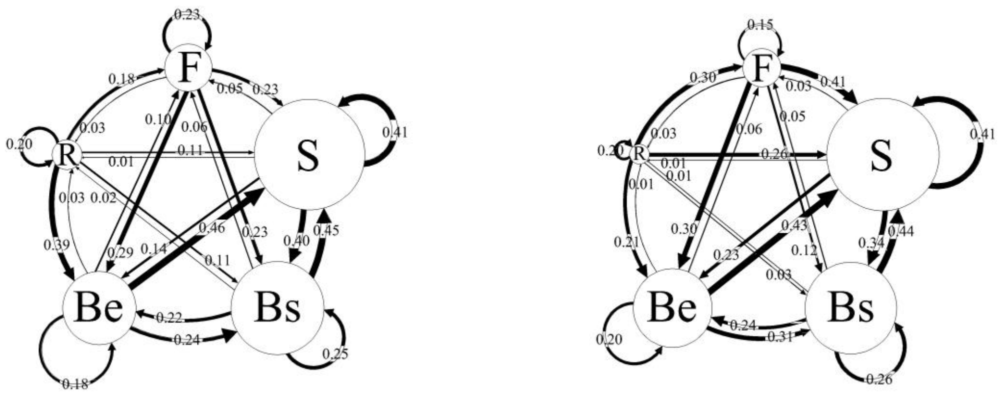

Figure 7.3. Left: the 1st order Markov model in the GME. Right: 1st order Markov model in the PDE.

7.2.2 1st order Markov model analysis across different design stages

To further explore these dynamic design processes, the whole design session is divided into three stages by equal segment number: early, mid and end design stages. The analysis of the 1st order Markov model across different design stages is described in Table 7.3. The transitions from R and F are active at the early design stage, and diminish towards the end. The transitions to S are active across the different design stages, while those to Bs are increasing towards the end.

Table 7.3. The 1st order Markov model analysis at different design stage.

		R		F		Be		Bs		S	
		GME	PDE	GME	PDE	GME	PDE	GME	PDE	GME	PDE
Early design stage	R	0.22	0.18	0.21	0.32	0.37	0.16	0.11	0.04	0.09	0.30
	F	0.05	0.05	0.22	0.17	0.36	0.32	0.15	0.00	0.22	0.46
	Be	0.06	0.02	0.16	0.10	0.22	0.14	0.17	0.28	0.40	0.46
	Bs	0.13	0.02	0.05	0.08	0.19	0.24	0.16	0.17	0.48	0.49
	S	0.02	0.02	0.14	0.06	0.20	0.27	0.28	0.29	0.36	0.37
Mid design stage	R	0.00	0.00	0.07	0.00	0.14	0.00	0.07	0.00	0.00	0.00
	F	0.00	0.00	0.15	0.07	0.17	0.21	0.34	0.02	0.20	0.27
	Be	0.01	0.00	0.08	0.04	0.13	0.26	0.28	0.26	0.50	0.44
	Bs	0.00	0.00	0.06	0.04	0.27	0.27	0.17	0.32	0.50	0.38
	S	0.00	0.00	0.03	0.01	0.10	0.21	0.41	0.35	0.46	0.43
End design stage	R	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	F	0.00	0.00	0.14	0.06	0.02	0.27	0.54	0.21	0.16	0.17
	Be	0.00	0.00	0.02	0.02	0.14	0.12	0.26	0.44	0.59	0.42
	Bs	0.00	0.00	0.06	0.06	0.21	0.20	0.31	0.24	0.41	0.50
	S	0.00	0.00	0.02	0.01	0.13	0.17	0.47	0.44	0.38	0.38

The diagrams in Figure 7.4 show the graphical Markov model analysis across different design stages. There are commonalities observed in both design environments including that R only appears at the early design stage, F and Be tend to decrease and Bs tends to increase towards the end of the design session. The differences between the GME and the PDE are described hereafter.

From Figure 7.4, we can see that at the early design stage, the main difference is that there are more F to S transitions in the PDE. At the mid design stage, the transition between Bs and S occurs more in the GME than in the PDE. That is, there are more design moves of analysis in the GME, which means designers conduct more reasoning from the model built in the GME. This tends to comply with the common design process in the context of the FBS ontology: firstly designers formulate expected behaviour from function or requirement, then they synthesise the structure from expected behaviour, by analysing the structure. After comparing the expectation and the existing structure, they may go back to the structure for revision, which is a reformulation I process. At the end design stage, there are more evaluation processes in the PDE, including evaluation of both the geometric model and the script. The F to Bs transition in GME is not a typically meaningful design process. This transition occurred frequently at the end of design sessions because most designers liked to summarise the function of their design in the end while they examined the model. At that time there was no further designing, designers were just describing what they had already achieved.

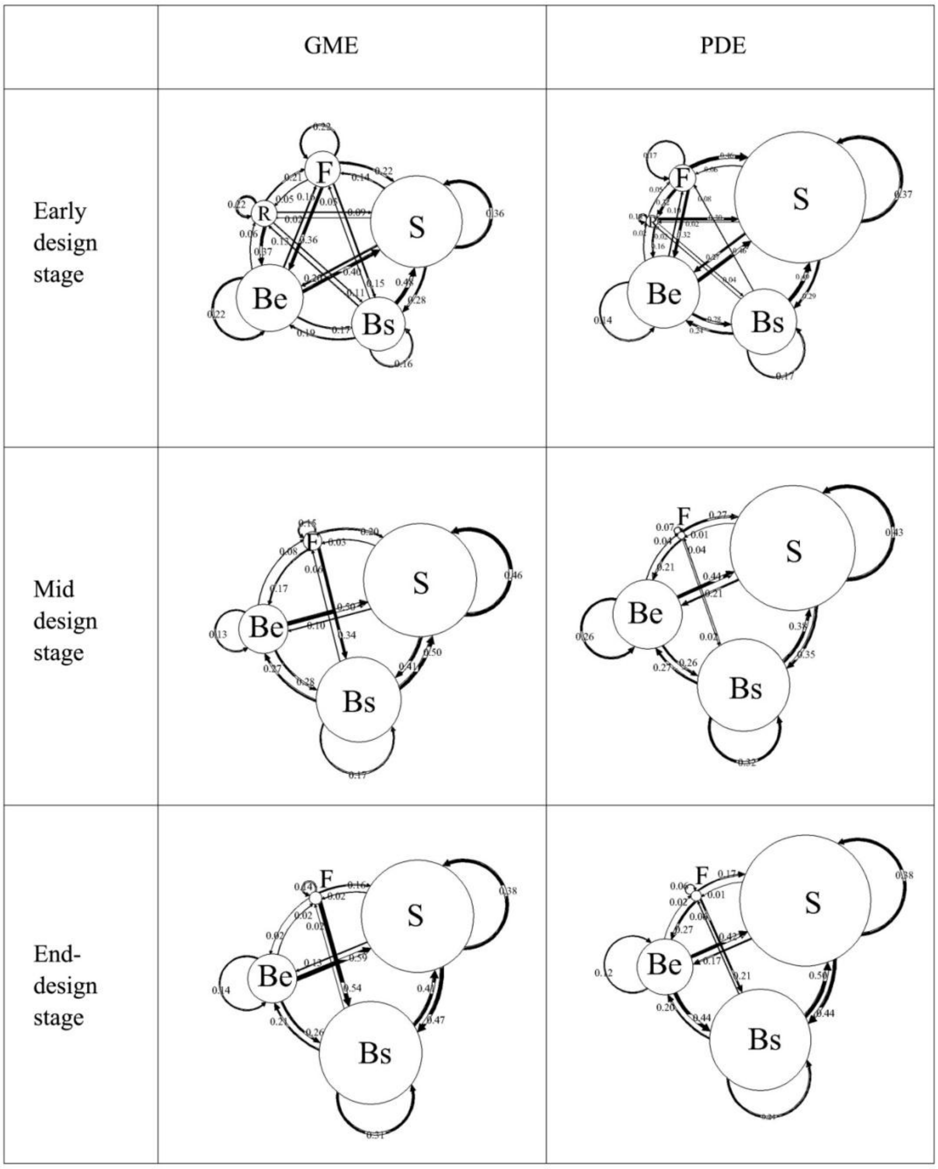

Figure 7.4. The 1st order Markov model in the GME and the PDE across different design stages.

7.3 DESIGN PATTERNS

7.3.1 Design patterns exhibited in the parametric design process

To demonstrate the main activities of the designers, the transitions with a probability value larger than 0.4 were selected, and these are highlighted in Figure 7.5. During the trial 0.3 was set as the threshold, but the Markov model, filtered with this threshold over 0.3, still contains too many transitions. Therefore, 0.4 is set as the threshold in order to further abstract the model. The diagram demonstrated in Figure 7.5 shows that the transition probabilities are very similar between the GME and the PDE. The apparent difference between the GME and the PDE is that the transition probability from F to S is much higher in the PDE.

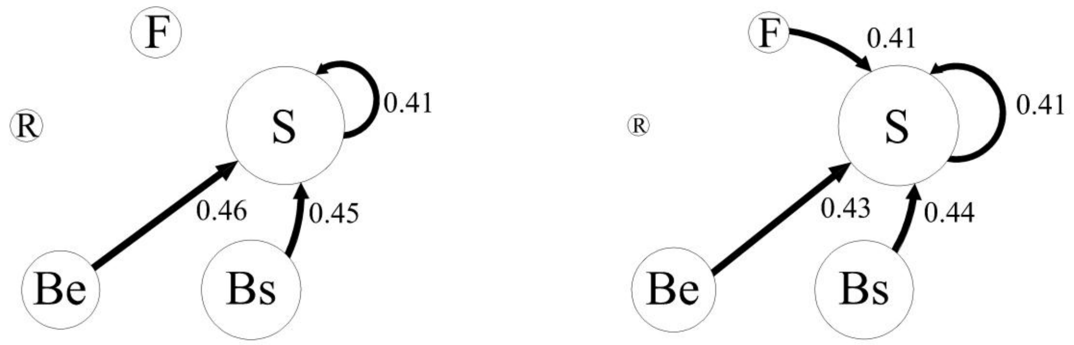

Figure 7.5. Left: main transitions of the 1st order Markov model in the GME. Right: main transitions of the 1st order Markov model in the PDE.

Within the context of the FBS ontology, this process directly from function (F) to structure (S) is excluded from routine paths of design (excluded from the eight design processes expressed in the FBS model). Previous research suggests that from the study of software designers' behaviour, F to S is a typical design process that occurs frequently (Kan et al., 2010). During the F to S process, designers select an existing structure/solution for the particular function/design problem based on their experience or knowledge, which is a process of picking up an existing design pattern for the problem. Since software designers use design patterns when programming and scripting (Gamma et al., 2002; Fowler, 2003), we can infer that when architects apply programming and scripting in their design, such as in a PDE, they would exhibit the similar characteristic of using design patterns. Design pattern is an important concept in both architectural design and software design. In software design, it assists software designers in working with more efficiency and makes the programming and scripting process traceable. In the PDE, if we can generalise some useful design patterns, it would be of great help for architects in their scripting process.

The idea of design patterns was introduced by Christopher Alexander who stated that "each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice." (Alexander et al., 1977). That is, a pattern is the documentation of a solution suitable for certain kinds of design problems which may occur frequently. Woodbury et al. observe that: "Patterns are a way to identify successful general strategies that exemplify a key concept in a memorable fashion that can easily be taught." (Woodbury et al., 2007, p 229).

Patterns come from designers' experience (Fowler, 2003), which can be seen as an "induction" process whereby designers generalise samples from their own design experience or from observation of other designers, abstract the problem-solution pair, and formalise the "patterns" which could be re-used. Those generated patterns could be improved or combined into a network of connections depending on design purpose (Alexander, 1979). A design expert has accumulated a large number of examples of problems and solutions in a specific domain (Razzouk & Shute, 2012). The pattern itself is abstract; when designers apply the patterns, they would revised the patterns to suit their own preference, or for the specific context for which they are designing (Alexander et al., 1977).

From the Markov model analysis, there are more design patterns (F-S) that occur in the PDE than in the GME. Parametric design is a combination of architectural design and rule algorithm design (Yu, et al., 2013). From observation of this experiment, when designers design in the PDE three types of design patterns that are related to both architectural design and software design programming and scripting repeatedly occur. As shown in Figure 7.6, design pattern 1 is at the design knowledge level, which means architectural design solutions that serve design functions. This type of design pattern is similar to those illustrated in Alexander's theory (Alexander et al., 1977); Design pattern 2 is across the two levels of activities, which is scripted structural solutions serving design functions. This type of design pattern is unique in the parametric design process; Design pattern 3 is at the rule algorithm level, it means scripted structural solutions serving script functions. This type of design pattern complies with Woodbury's parametric design patterns (Woodbury et al., 2007; Woodbury, 2010). In the next section, examples of each pattern from this experiment are presented.

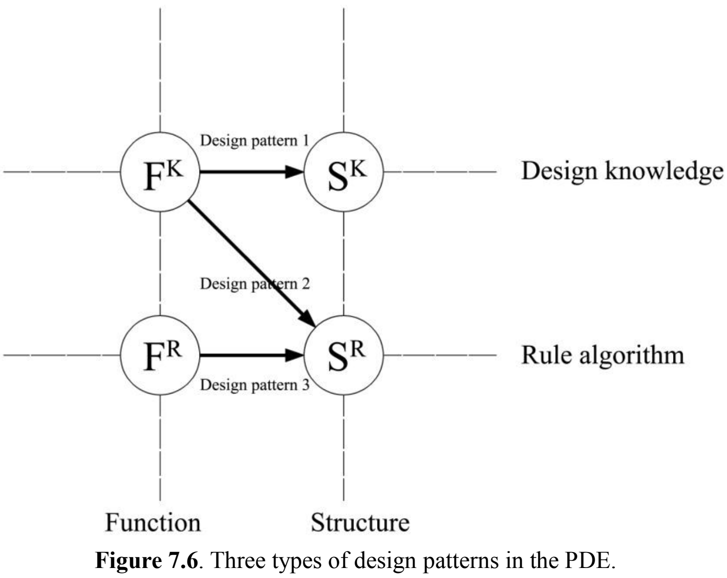

Figure 7.6. Three types of design patterns in the PDE.

7.3.2 Three types of design patterns in the PDE

1. ***Design Pattern 1: architectural design solutions serving design functions***

Identified as F^K-S^K, this type of design pattern is at the design knowledge level, which is similar to the design patterns illustrated by Alexander (Alexander et al., 1977). Design Pattern 1 is mainly based on the designers' expert knowledge in the field of architectural design. For example, in the present experiment one of the designers wanted to build a restaurant in the shopping centre (Figure 7.7), and chose to make it face the street. The street façade was then made of transparent glass, without much further reasoning, because to that designer this was already a fixed design pattern for a restaurant in a shopping centre. In such a case, the design pattern for the restaurant comes from the designer's professional experience. After selecting the pattern, this designer then adapted the pattern to the context of the current design. For instance, the restaurant was given two entrances, one facing the street, and the other from the inside of the shopping centre.

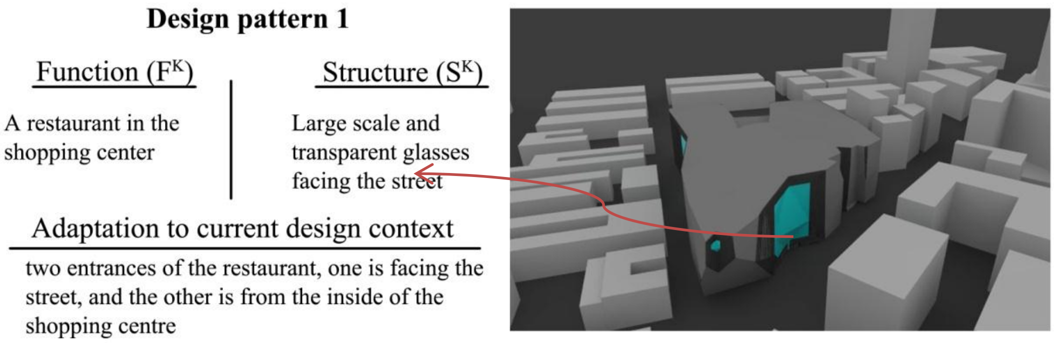

Figure 7.7. An example of design pattern 1.

2. ***Design Pattern 2: scripted structural solutions serving design functions***

Identified as F^K-S^R, this type of design pattern exhibits designers' behaviour of using rule algorithm (programming and scripting) to achieve architectural design purposes, which requires the ability to combine designers' architectural design knowledge and programming/scripting skills together. Compared to the other two patterns, this type does not occur often, however it reveals the unique characteristics of applying parametric design tools in architectural design. For example, one designer generated skylights which can be changed according to the local sunlight to make the building effective in terms of energy efficiency (Figure 7.8). In order to do that, the designer adopted existing scripts from a database, and then inputted the local information and connected the design model to the scripts.

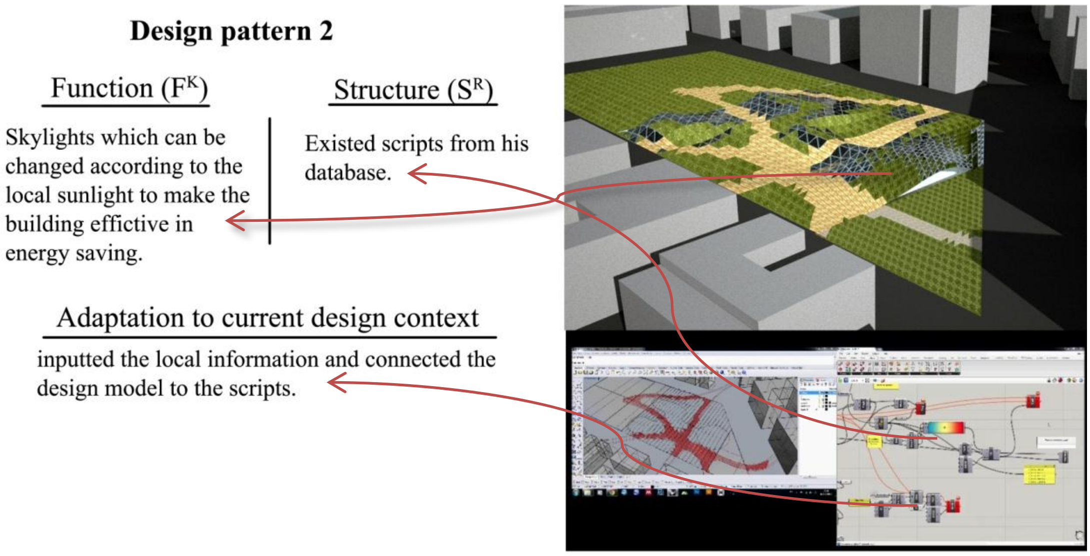

Figure 7.8. An example of Design Pattern 2.

3. *Design pattern 3: script structural solutions serving script functions*

Identified as F^R-S^R, this type of design pattern illustrates designers' activities on the rule algorithm level for the purpose of programming/scripting, which is the most frequently occurring pattern. In the present study, we do not have a F^R code (the function of rules) and it is categorised into Be^R. Software designers use the design pattern in a similar way when they program and script (Gamma et al., 2002; Fowler, 2003). When making geometries in the PDE, designers tend to use the existing structure of the script either from their experience or using scripts they have produced before. A more detailed explanation of this issue is found in the parametric design patterns proposed by Woodbury et al. (2007) who suggest that there are certain pathways that can be followed in order to make the modelling process traceable. "Design patterns in parametric modelling", as proposed by Woodbury et al. (2007), shows that parametric modelling can be transformed more easily by using design patterns, so that a general method can be adopted to solve particular design problems.

In 2007, the first three design patterns in parametric modelling were proposed. Among them, an example pattern – a 'jig' – was illustrated in detail to show how these patterns work in parametric modelling processes. Subsequently, in a companion paper, participant observation methods to discern the validity of using the pattern approach were described (Qian et al., 2007): a pattern named "place holder" (Figure 7.9) is claimed to be more productively applied by their participants. Detailed demonstration of the design patterns in parametric modelling are provided in Woodbury's "Elements of Parametric Design". In that book, parametric design patterns are proposed as an abstract and reusable tool in PDEs, which have significant influence on both design education and practice (Woodbury, 2010). By learning these patterns, architects and students are able to master the parametric modelling method more efficiently and skilfully.

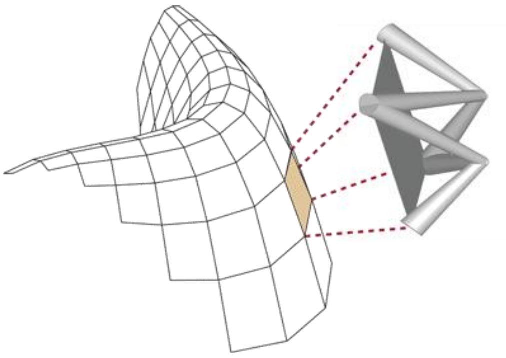

Figure 7.9. "Place holder" pattern (Woodbury, 2010).

Some add-ons such as *Kangaroo, Hoopsnake,* and *Wirebird* in Grasshopper can be seen as similar scripting patterns to Design Pattern 3 in this chapter. In the present experiment, these patterns occur frequently. Figure 7.10 shows one of the examples: the designer wanted to build a façade with randomly generated openings, and selected a previous script and connected it to the façade of the building. To adapt to the context, the designer adjusted the opening proportion according to the shape of the façade.

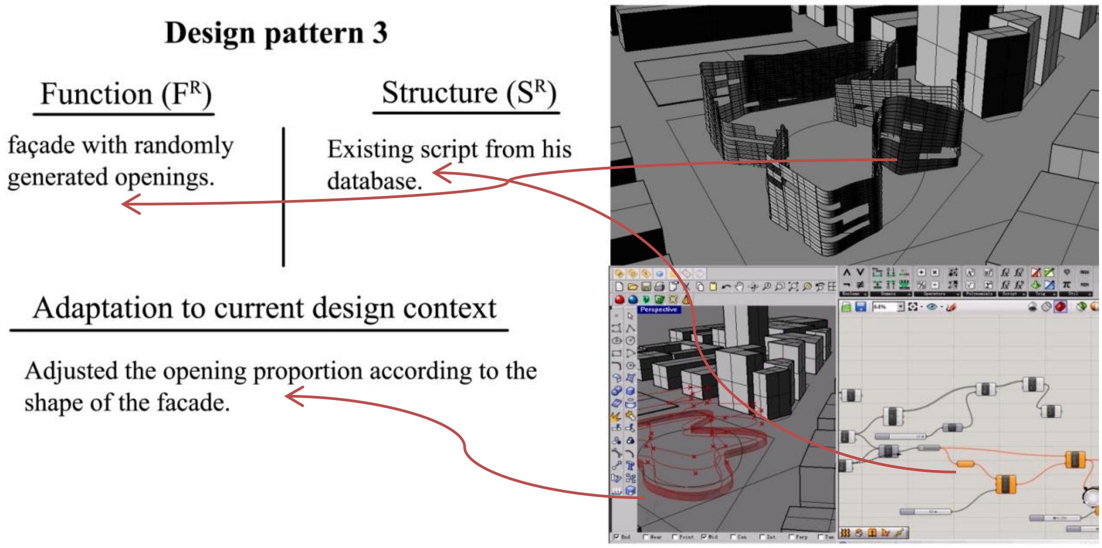

Figure 7.10. An example of Design Pattern 3.

7.3.3 Design patterns across different design stages

The diagram in Figure 7.11 shows the graphical Markov model across different design stages with transition probability values being over 0.4. From Figure 7.11, we can see that at the early design stage, the main difference is that there are more F to S transitions in the PDE. As described in Section 7.3.1, this transition is the design pattern based on designers' specialist knowledge and experience. As observed in the present experiment, in the PDE designers also build the parameters and their relationships and generate the rule algorithm early, at the beginning of the design stage. Design Patterns 1 and 2 tend to be adopted early in the process. Scholars have suggested that most of the important design decisions are made at the early design stage (Zeiler et al., 2007). Christians and Dorst (1992) state that expert designers tend to look for and build images of problems early in the design process. Meanwhile, early solution conjectures are beneficial for solution exploring (Cross, 2004). Rowe (1991) echoes this, observing that designers' directions for problem-solving are affected by their initial ideas because they tend to make an effort to make the initial ideas work rather than reject them and adopt new ideas. In the PDE, the early adoption of design patterns related to functional considerations at both the design knowledge level and across the two levels could be beneficial for later solution exploration.

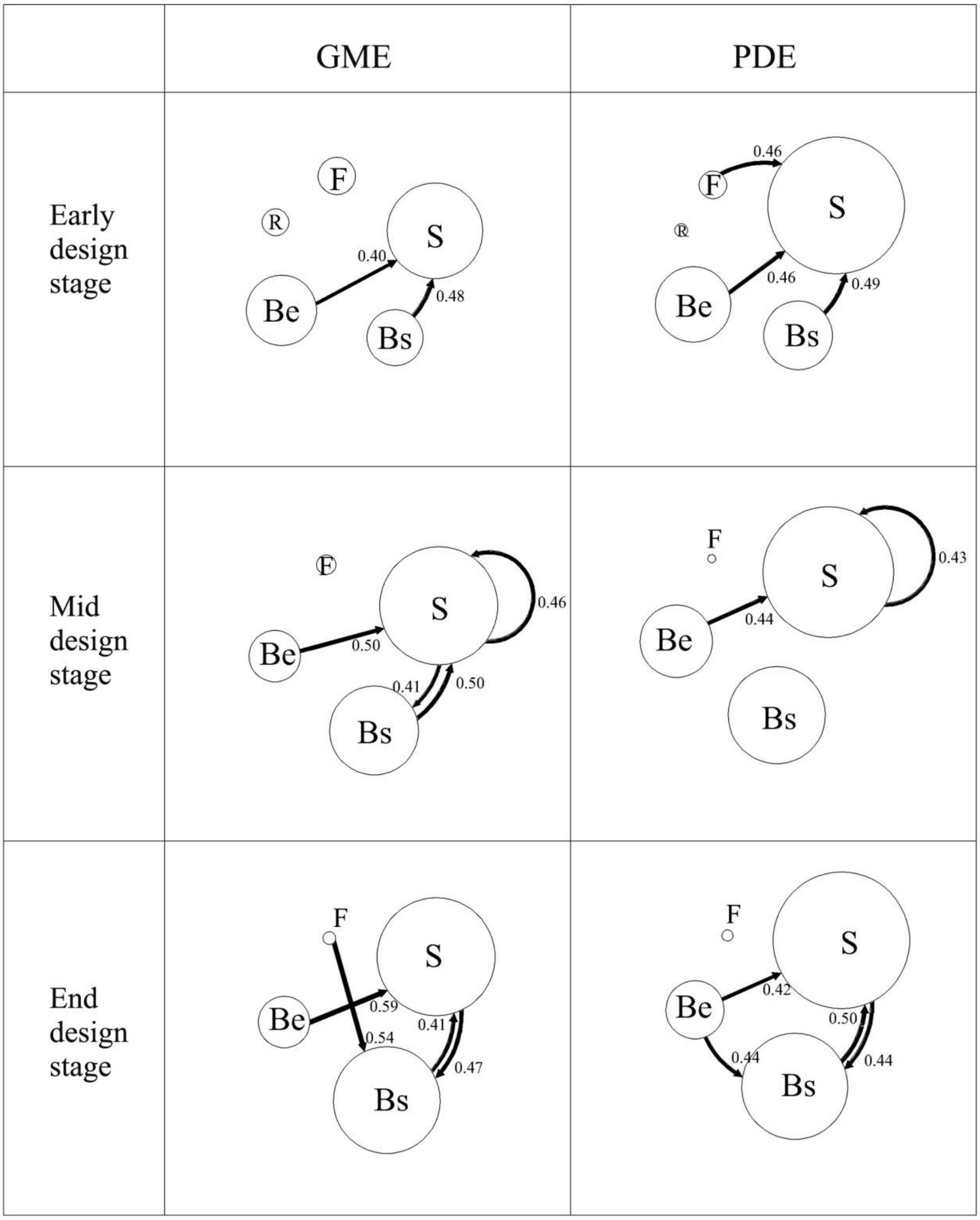

Figure 7.11. Main transitions of the1st order Markov model across different design stages.

Applying Markov model analysis, we find designers tend to use three main design patterns based on their experience in the PDE. Previous research (Barr et al., 2011) suggests that in a computational design environment, designers tend to formulate problems that enable them to use computers to solve them. Similarly, designers in a parametric design environment tend to use the scripts they are familiar with to serve both design knowledge and rule algorithm goals. These design patterns in the PDE, are on design knowledge level (Design Pattern 1), the rule algorithm level (Design Pattern 3) and across these two levels (Design Pattern 2). All of these design patterns have been observed in the present experiment. Among them, the design patterns at the design knowledge level and the rule algorithm level respectively comply with the design patterns illustrated in Alexander's "a pattern language" (Alexander et al., 1977) and Woodbury's "parametric design patterns" (Woodbury et al., 2007; Woodbury, 2010). These patterns are developed with some possible limitations as this study has only looked at the major activities which have a transition probability value over 0.4, and ignores those less significant ones. Meanwhile, in a 40 minute design session, designers may also use the design patterns they are familiar with, rather than making trials to test new approaches and new scripts. In actual practice with sufficient time and resources, the results may vary. Nevertheless, the identified design patterns reveal new information about the behaviour and style of conceptual design in the PDE. The proposed design patterns imply that the design processes in PDEs could be transferable and deliverable, and can be learned by architectural designers and students.

Chapter 8: Analysis III – Co-evolution of problem and solution spaces in parametric design

To further explore the design process in a broader context that combines individual design issues, in this chapter different variables are combined and categorised using two common design concepts: design problem and design solution. By exploring the co-evolution of the problem and solution spaces in the PDE, three particular characteristics of the co-evolution process in the PDE are identified. The results reveal designers' behaviour in terms of the interaction between problems and solutions when designing in PDEs.

8.1 DESIGN PROBLEM AND SOLUTION SPACES

8.1.1 Problem/solution driven design

Design is not just a process of finding solutions to an initial given task, it is also about redefining/reframing the design problems that have been provided (Schön & Wiggins, 1992). During the design process, designers continue redefining design problems and searching for solutions for these problems. Previous studies show that the expert design process also involves a close interaction between representations of the problems and solutions (Cross, 2011). Therefore, the notion of a design problem and solution space is one important way to conceptualise the design process.

Kruger and Cross (2006) divided different design approaches into "problem driven" and "solution driven" categories. Problem-driven design refers to the way designers focus on the challenges and use information to solve them. Solution-driven design describes the way designers focus on generating solutions, and use this information to develop a final resolution of the central issues in a design. For example, Kruger and Cross (2006) studied the design processes of nine product designers and their results show that most adopted either a solution-driven or a problem-driven design paradigm. The solution-driven designs expressed high level creativity but low overall quality. The problem–driven design approach was, on the contrary, low in creativity and high in overall quality. Significantly, in that study Kruger and Cross used an S-P index to quantify the two kinds of design approaches numerically and to measure the difference between a solution-driven and a problem-driven approach. Jiang et al. (2014) adopted a similar measurement to the S-P index in a study comparing the design approaches of industrial design and mechanical engineering students. Instead of the S-P index, in Jiang et al's study, they use a P-S (problem-solution) index, which is the ratio of problem related issues/processes to solution related issues/processes. Their study also applies the FBS ontology (Gero, 1990) for developing the coding scheme, and they further divided the FBS issues and processes into problem/solution related issues/processes, which enables the measurements. Using the P-S index, it is possible to identify the nature of a design approach as either problem-centred or solution-centred, quantitatively over time.

8.1.2 Co-evolution of design problem and solution

Architectural design is not a linear process; it involves the stages of proposition, testing, refinement, analysis, and rejection, but not necessarily sequentially. For example, in a study of Frank Gehry's office, Boland et al. (2008) describe Gehry's design process as existing in a "liquid" state for a long period before eventually becoming "frozen" into a proposition for a building. During the liquid state, drawings and models are made, tested and rejected, being refined until a "final" solution is crystallised. In this way Gehry and his colleagues explore and respond to different aspects of the design problem, alternatively shifting the focus from formal solutions to contextual problems, technological challenges and functional optimisation. For Gehry's team, this shift from problem definition and analysis to solution proposition and testing is often signalled by the decision to digitise a physical model for further refinement and development. While Gehry's forms and buildings may appear to be more challenging than those of many other architects, his team follows a much more common cyclical design process which reflects architects' thoughts, actions and behaviours as they shift their focus from considering design problems to testing design solutions. The parallel development of problems and solutions in this "liquid state", which many architects follow, is called co-evolution.

The main concept of co-evolution is that designers formulate design problems and explore ideas for solutions to these problems together; design is therefore an interactive process which involves the analysis, synthesis and evaluation of design problems and solutions (Lawson, 1997; Cross, 2011). Instead of seeing design as a process of progressive refinement (concept design, to schematic design, to developed design), design could be analysed through the way the cognitive effort shifts between the consideration of problems and solutions (Maher & Poon, 1996; Dorst & Cross, 2001). Design is a process which uses analysis, synthesis and evaluation as it shifts between the design problem and possible solutions (Asimow, 1962; Lawson, 1997; Cross, 2011). It is during this process that designers formulate critical questions and explore answers and thus the developing relationship between the "problem space" and the "solution space" is at the core of the co-evolution model of design. Maher and Poon (1996) and Dorst and Cross (2001) each use this model to suggest that the co-evolution of design problem and solution spaces has a close correlation with the occurrence of design creativity.

The concept of problem-solution co-evolution is described by Maher and Poon (1996) (Figure 8.1). Although it was developed for computational exploration (from an AI perspective), the model also describes a common design process. In the co-evolution model the problem space (P) and the solution space (S) interact over time (t) (Figure 8.1). Designers start by analysing the initial design requirements and formulating the design problem, $P(t)$. While exploring possible design solutions $S(t)$ for the problem $P(t)$, new intentions are added into the problem space over time $P(t+1)$. This is a core process for co-evolution in design, and particularly so when the solution does not satisfy a key requirement; by changing or adapting the requirements and intentions, a satisfactory problem and solution pair could be generated (Maher & Poon, 1996; Dorst & Cross, 2001).

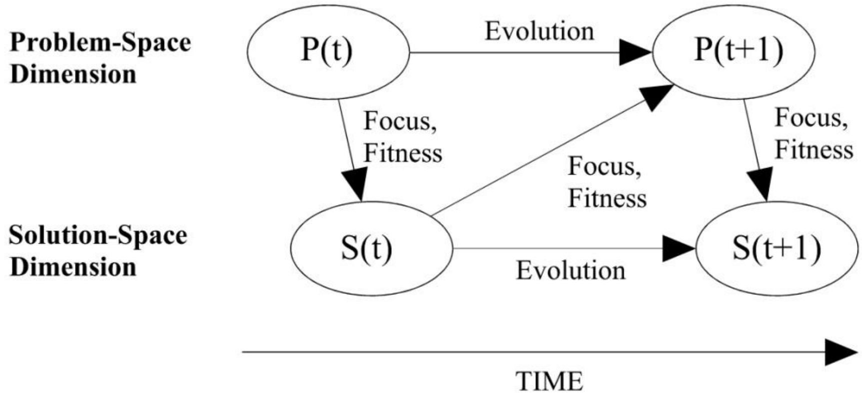

Figure 8.1. Maher and Poon's co-evolution model (Maher & Poon, 1996).

In a further development of Maher and Poon's co-evolution model, Dorst and Cross (2001) propose a refined version which further illustrates the creative process from a behavioural perspective. Their study employed the method of protocol analysis, in which nine industrial designers were observed. In their model (Figure 8.2), the designers start from a design problem space P(t), and develop a partially structured problem (P(t+1)), which is then used to develop a partially structured solution space (S(t+1)) of S(t). This process is repeated throughout the design progress, as Maher and Tang (2003) suggest, with the transition between design problem and solution occurring in cyclical iterations until a satisfactory solution is developed. Dorst and Cross further argue that this co-evolution process is vital to supporting the highest level of creative design (Cross & Cross, 1998; Dorst & Cross, 2001). While the focus of the present research is not explicitly on creativity in the design process, there are, as this past research suggests, several indicators of creative potential in the co-evolutionary design process, which the present research can consider in the context of PDEs.

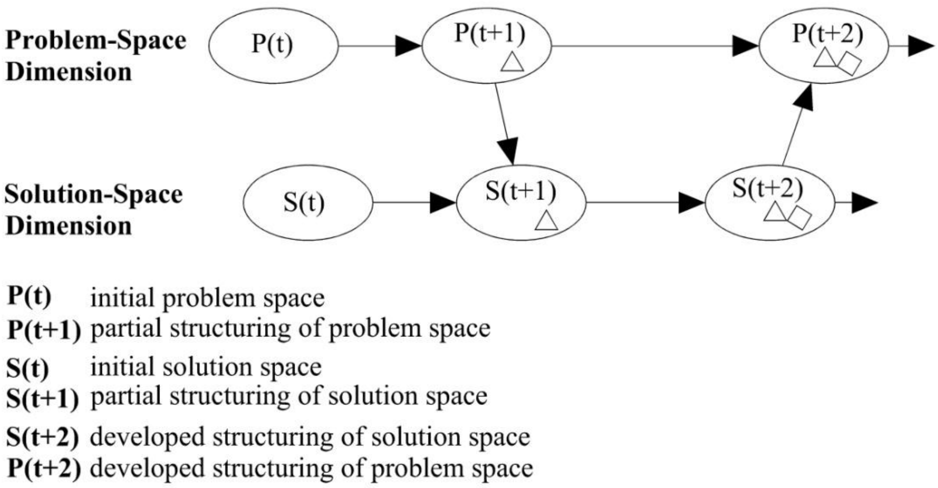

Figure 8.2. Dorst and Cross's co-evolution model (Dorst & Cross, 2001).

Some other studies on co-evolution include Kim and Maher (2005), who applied the concept of co-evolution in their protocol study comparing designers' spatial cognition in using tangible user interfaces (TUI) and graphical user interfaces (GUI) in design environments. Their results show that designers using TUIs have more interaction between design problem and solution spaces. Such studies also suggest that the co-evolution of a design problem and solution process has a close relationship with the occurrence of design creativity. A recent protocol study conducted by Helms and Goel (2012) examined the co-evolution processes of an inter-disciplinary cohort of students. Their results suggest that there is an "evaluation-pruning" function in the early design stage and that analogical strategies are important for generating problems at a similar time.

8.2 PROBLEM/ SOLUTION DRIVEN DESIGN IN THE GME AND THE PDE

8.2.1 Problem/Solution division using FBS ontology

In order to calculate the problem-solution (P-S) index, this study adopts the problem and solution division based on the FBS ontology (Jiang et al., 2014). Problem-related issues include design consideration about requirements, function (F), and expected behaviour (Be), while solution-related issues involve design considerations about structure (S) and behaviour derived from structure (Bs) (as shown in Table 8.1).

Table 8.1. Mapping FBS design issues onto the problem and solution spaces (Jiang et al., 2014).

Problem/Solution Space	Design Issue
Reasoning about problem	Requirement (R) Function (F) Expected behaviour (Be)
Reasoning about solution	Behaviour derived from structure (Bs) Structure (S)

8.2.2 Problem-solution index in the PDE and the GME

The P-S index indicates the ratio of the number of design problem related issues/processes to the number of design solution related issues, as shown in equation (1) (Jiang et al., 2014). The value of P-S index can be used to understand if designers' behaviour is problem-focused or solution-focused in style. According to Jiang et al. (2014), if the P-S index > 1, the design is classified as having problem-driven style; when it is <1, it is under a solution-driven design style.

$$\text{P-S index} = \frac{\sum \text{Problem related issues}}{\sum \text{Solution related issues}} = \frac{\sum(R,F,Be)}{\sum(Bs,S)} \qquad (1)$$

Figure 8.3 shows the sequential design issue P-S index [calculated using equation (1)] in the PDE and the GME. The horizontal axis records the whole design session, divided into ten sub-sessions, each with an equal number of segments. In the following description, we define the "early design stage" as the period from 1 to 3.3 on the horizontal axis, the "mid design stage" as from 3.4 to 6.6, and the "end design stage" as between 6.7 and 10. The descriptors are thus time-based, rather than a direct indicator of the degree to which a design has been developed or completed. Both environments show a similar decreasing trend towards the end of the design session. Thus, a similar degree of effort is invested on both the problem and solution spaces in the PDE and the GME. From Figure 8.3, we found designers progress into a solution-driven process (P-S index < 1) quicker in the PDE. The index starts with a higher value in the PDE, which lasts for a short time, and is followed by a period that is higher in the GME. Thus, during the early stage, designers spent more effort in the problem space when in the GME. The possible reason for this is that designers have to consider rule algorithm design in the PDE at the early design stage, which occupies a greater cognitive load. From the mid design stage, although the overall style is solution-driven, designers focus more on the problem space in the PDE than in the GME. This may be because designers constantly redefine the problem space by setting up the algorithmic goals in the PDE.

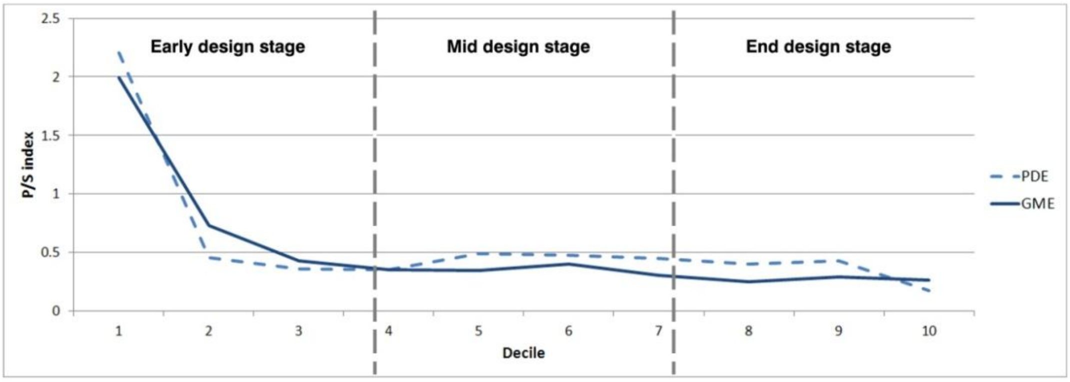

Figure 8.3. Sequential design issue P-S index in the PDE *vs.* the GME.

8.3 CO-EVOLUTION OF PROBLEM AND SOLUTION SPACES IN THE GME AND THE PDE

During the design process, designers continue to redefine their design intentions, searching for alternative resolutions. This iterative process, which requires designers to revisit both problems and solutions during the design process, should not simply be regarded as a cyclical series of events because with each recursion in the process, the parameters have evolved and shifted. Previous studies show that the expert design process also involves a close interaction between representations of problems and solutions (Cross, 2011). The calculation of transitions between the problem space and the solution space is a possible way to study the problem solution co-evolution process in design.

8.3.1 Discontinuity ratio in GME and PDE

Using the P-S index, we can identify whether the design process tends to be problem-focused or solution-focused. However, the interaction between the problem space and the solution space cannot be revealed in this way. This section presents the quantitative method for exploring co-evolution of the design problem and solution processes. Since co-evolution processes are the transitions between the design problem and solution spaces, the frequency of the transition will be a good indication for the co-evolution process. The frequency of the transition between the design problem space and the solution space can be calculated by the discontinuity ratio of designers' processes. A higher discontinuity ratio indicates a higher frequency of interaction between the design problem and solution spaces. Figure 8.4 is a section of an interactive graph which illustrates the co-evolution of one designer's cognitive activities between the design problem and solution spaces. Each red ellipse indicates a transition.

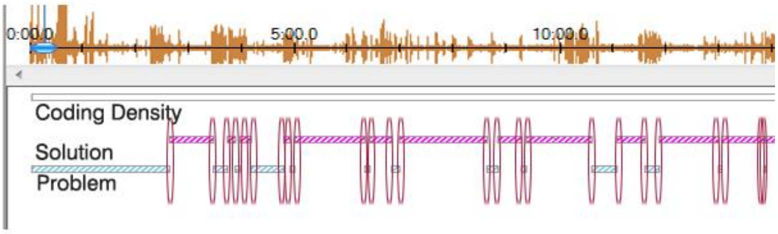

Figure 8.4. Examples of the co-evolution of the problem and solution spaces.

The discontinuity ratio is the ratio of transition number to overall number of segments [see equation (2)]. This ratio represents the frequency of transition between the problem and solution spaces in a certain design period.

$$\text{Discontinuity ratio} = \frac{\sum Transition\ number}{\sum overall\ segments\ number} \times 100\% \qquad (2)$$

Figure 8.5 is an example of the coding, demonstrating the discontinuity transition between the design problem and solution spaces. Each red curve represents a transition. There are 10 segments in this piece of the example coding, so the discontinuity ratio would be 5/10 × 100% = 50%.

42	So this circle needs to be bigger	Be	Problem
43	Pan on the rhino interface (Examine the model)	Bs	Solution
44	(Measure the radius of the circle) so that actually 7.8	Bs	Solution
45	(change parameters) so I will make this 40	S	Solution
46	Cool, say my radius is 40	Bs	Solution
47	Now in terms of height	S	Solution
48	I want to take a unit	Be	Problem
49	So I want to move it 10 m	S	Solution
50	I want to make it three stories	F	Problem
51	So 15 m	S	Solution

Figure 8.5. An example coding of the discontinuity transition between the design problem and solution spaces.

Figure 8.6 shows the comparison of the discontinuity ratios in both the PDE and the GME across the early, mid and end design stages. The vertical axis is the average of the eight participants' discontinuity ratios. From the figure, we can see that over the whole design session, there are similar discontinuity transitions in both the GME and the PDE. At the beginning of the design session, the PDE supports more discontinuity transition. The reason for this is possibly that in the beginning, designers consider the rule algorithm structure and knowledge based design function together, which requires them to keep shifting between the two design spaces. While in the middle and end stages, designers tend to focus more on form generation in the PDE and there is relatively less need for them to return to and revise the problem space.

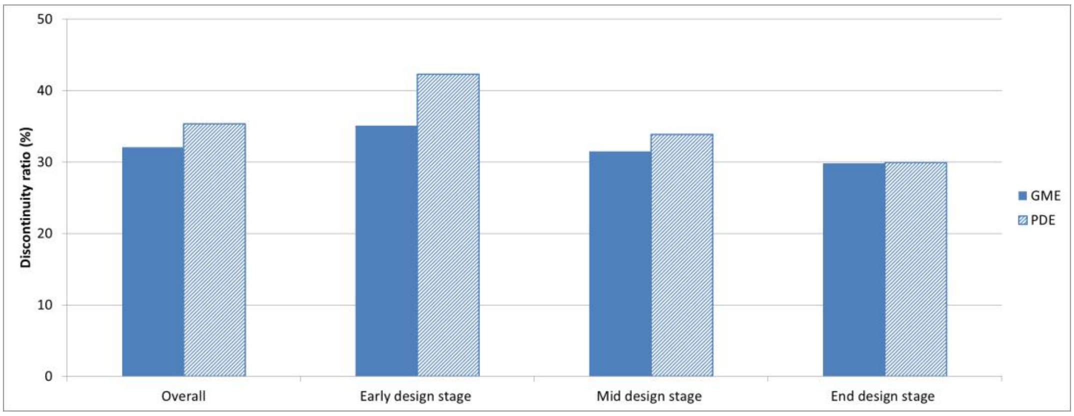

Figure 8.6. Discontinuity ratio comparison of the PDE *vs.* the GME at different design stages.

Figure 8.7 demonstrates a more dynamic comparison of the discontinuity ratio in the PDE and the GME. The horizontal axis is the whole design session divided into ten sub-sessions with an equal number of segments. The discontinuity ratio is relatively flat in the GME across all stages, which means designers keep a relatively stable rate of transition between the problem and solution spaces in the whole design session, while in the PDE the transition rate varies more significantly: the value starts being high at the beginning and then decreases for a period of time and, at the end of the design session, rises once more and then drops off. During sub-sessions 6–8 (end of the mid design stage to the middle of the end design stage), there is an observable higher discontinuity ratio in the PDE, which potentially indicates a period when designers actively engage in the co-evolution process.

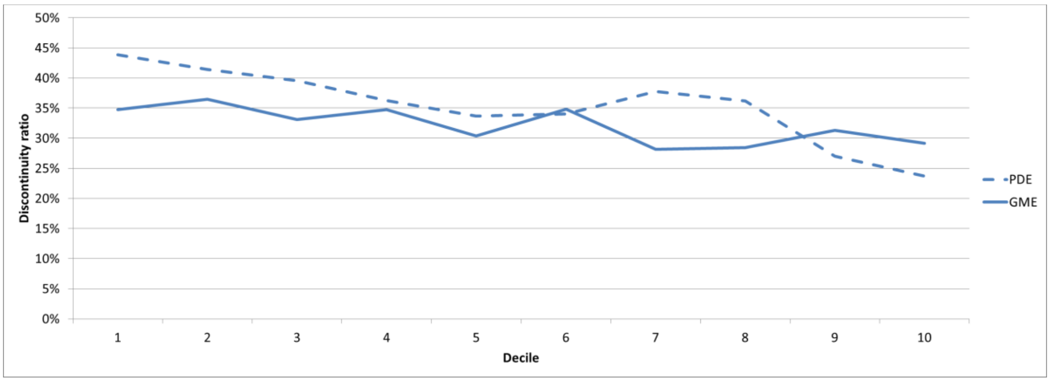

Figure 8.7. Discontinuity ratio of the problem and solution spaces in the PDE *vs.* the GME.

8.3.2 Comparing the co-evolution process in the GME and the PDE

Research into the design process suggests that designers constantly return to the design problem space to reformulate the problem (Simon, 1973). With the interaction or co-evolution between the design problem space and solution space, the design is progressed and a "satisfactory" solution (Maher & Tang, 2003) is expected to be identified. This study has compared designers' behaviour in the PDE and the GME from the perspective of the design problem and solution spaces. Two measurement methods are used in this study. The first is the P-S index, which examines the proportion of design problem and solution issues/processes. The second method measures the discontinuity ratio in order to study the co-evolution process in the PDE and the GME. The discontinuity ratio reveals the frequency of transition between the problem and solution spaces, an event which is beneficial for the emergence of design creativity (Dorst & Cross, 2001). The measurement of the discontinuity ratio complements the P-S index to provide a more complete understanding of the designers' cognitive activities in the PDE.

Considering the interaction between designers and the design environments, designers switch between the geometric interface and the scripting interface frequently in the PDE. Parametric design basically progresses by defining and changing logical parametric relationships, reflecting designers' concepts and intentions. This feature adds an extra layer of reasoning over the more traditional way of design thinking in the GME. The two types of interfaces facilitate the exchange of design information effectively. During the parametric design process, the designer shifts between the two types of interfaces, which potentially provoke more frequent interactions between designers and computers. The designers' intention is defined by a response/reflection to the instant feedback through the execution of an action (Schön, 1992; Goldschmidt & Porter, 2004). During the parametric design process, designers get inspiration from what they see on the screen; at the same time, they reflect on what they see and what they do by taking action through making rules. Schön describes this process as "seeing-moving-seeing" (Schön, 1992) – in the PDE the designer sees what is on the screen, adjusts model and script in relation to it, and sees what they have produced, a process which informs further design. The whole process is circular and recursive, continuously building up the design problem and solution spaces in order to inform and progress the design.

From our observation and analysis, designers put similar effort into the design problem space and solution space in the PDE and the GME. Designers exhibited more problem-driven design tactics at the early design stage of both the GME and PDE, when they tended to start with the analysis of the design brief. The main differences are found at the early stage wherein designers focused more on the problem space in the GME (on average at the early stage), and they stepped into a solution-driven process earlier in the PDE. Since solution-driven design is suggested to be beneficial for design creativity (Kruger & Cross, 2006), we can infer that the PDE may have potential benefit for the inspiration of design creativity at the early design stage.

From calculating the discontinuity ratio between the design problem space and the design solution space, the overall discontinuity ratio (indicating the design cognitive transition between problem and solution spaces) is similar in the PDE and the GME. However, different discontinuity ratios are found across the three design stages: in the early design stage, there are significantly more transitions in the PDE than in the GME, which indicates a stronger co-evolution design process in the early design stage of the PDE. Scholars have suggested that most of the important design decisions are made at the early design stage (Zeiler et al., 2007), and that early solution conjectures are beneficial for solution exploration (Cross, 2004). Therefore, more frequent interaction in the PDE at the early design stage creates more opportunities to generate a more comprehensive and better considered design solution within the same time frame. The detailed analysis presented above also provides reasons to assist us in better understanding designers' problem-solving processes in the PDE.

8.4 THE IMPACT OF RULE ALGORITHMS ON THE CO-EVOLUTION PROCESS IN THE PDE

After comparing the co-evolution of problem and solution process in the PDE and GME, this section focuses on the co-evolution process in the PDE, to critically understand the co-evolution process in terms of two levels of design activities in the PDE.

8.4.1 Transition patterns between the design problem and solution spaces in the PDE

Based on Jiang et al.'s problem and solution division, Table 8.1, and the understanding of the two levels of activities in the PDE, design problem-related issues and design solution-related issues are further divided into: problem-related issues at the design knowledge level (P_K) (including R^K, F^K, Be^K), problem-related issues at the rule algorithm level (P_R) (including Be^R); solution-related issues at the design knowledge level (S_K) (including Bs^K, S^K) and solution-related design issues at the rule algorithm level (S_R) (including Bs^R, S^R), as shown in Table 8.2. This division is consistent with the characteristics of parametric design in that designers not only think about problems from the design perspective, they also have to formulate problems using rule algorithm, which is essential in the PDE.

Table 8.2. Mapping FBS design issues onto problem and solution spaces in the PDE.

Problem/Solution space	**Design issue**
Reasoning about problem at design knowledge level (P_K)	Requirement (R^K) Function (F^K) Expected behaviour (Be^K)
Reasoning about problem at rule algorithm level (P_R)	Expected behaviour (Be^R)
Reasoning about solution at design knowledge level (S_K)	Behaviour derived from structure (Bs^K) Structure (S^K)
Reasoning about solution at rule algorithm level (S_R)	Behaviour derived from structure (Bs^R) Structure (S^R)

Figure 8.8 shows the transition between the design problem and solution spaces in the PDE. The numbers on the arrows represent the average (of eight participants) discontinuity ratios of each transition during the entire design process. Here we adopt the discontinuity ratio illustrated in section 8.3.1 [see equation (2)]. For instance, for Designer 4, the number of transitions from P_R to S_K is 11, the overall coded segment number is 243, thus the discontinuity ratio of P_R to S_K is 11/243=4.53%. Table 8.3 shows the quantitative analysis of

the transitions between design problem space and design solution space across the two levels of design knowledge and rule algorithm.

As shown in Figure 8.8 and Table 8.3, the discontinuity ratios of transition from the design problem space to solution space (18.29%) and from the design solution space to the problem space (18.39%) are similar. Within this the dominant ones are between P_K and S_K (with discontinuity ratios of 8.65% and 8.09%), and between P_R and S_R (with discontinuity ratios of 5.80% and 5.05%). From these we can infer that the transitions tend to remain within the design knowledge level or the rule algorithm level and less frequently occur across different levels. Although the transitions across different levels occur less frequently, it is an unusual type of co-evolution process which is potentially unique to design in PDEs. Among the transitions across different levels, there are relatively more transitions between P_R and S_K (with discontinuity ratios of 2.74% and 3.49%), which might mean that designers sometimes reframe the design problem space or requirements at the rule algorithm level based on design knowledge related considerations. One example of S_K to P_R that occurs frequently in the PDE is that designers set new rule algorithm related design goals based on the evaluation of the geometric model at the design knowledge level. The pattern that most infrequently appears is the transition between P_K and S_R (with discontinuity ratios of 1.66% and 1.20%). In particular, there is only a very small percentage for the occurrence of the transition from S_R to P_K (with discontinuity ratio of 1.20%), which suggests that designers rarely reframe design problems at the design knowledge level based on the rule algorithm solutions.

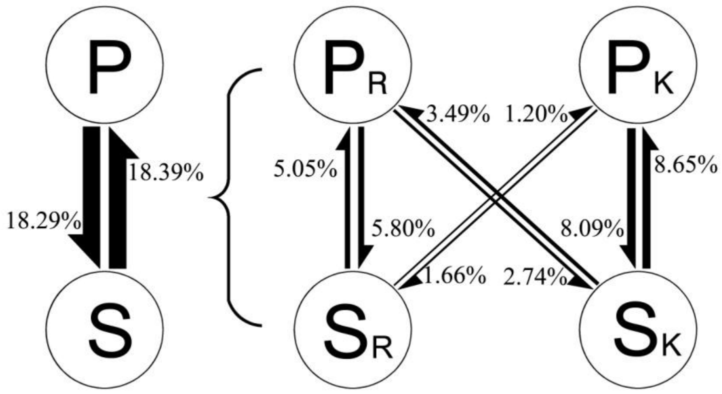

Figure 8.8. Discontinuity ratios between the design problem and solution spaces.

Table 8.3. Transition occurrences between the design problem space and the design solution space across the two levels of design knowledge and rule algorithm.

	Transition from problem to solution				Transition from solution to problem			
	P_R-S_R (%)	P_K-S_K (%)	P_R-S_K (%)	P_K-S_R (%)	S_R-P_R (%)	S_K-P_K (%)	S_K-P_R (%)	S_R-P_K (%)
Designer 1	3.57	4.46	0.89	2.23	2.68	5.36	2.23	0.89
Designer 2	8.05	8.62	3.45	1.72	8.62	9.20	4.02	1.15
Designer 3	0.00	6.47	1.49	0.50	0.00	5.97	1.49	1.00
Designer 4	9.47	4.12	4.53	1.65	9.47	4.94	4.53	1.23
Designer 5	8.15	5.15	3.43	1.72	7.73	6.01	4.29	0.43

Designer 6	7.45	12.16	3.53	1.18	3.92	11.37	6.67	2.35
Designer 7	3.60	13.51	1.35	2.25	2.25	14.86	1.80	1.35
Designer 8	6.15	10.25	3.28	2.05	5.74	11.48	2.87	1.23
Mean	5.80	8.09	2.74	1.66	5.05	8.65	3.49	1.20
SD	3.17	1.28	0.46	0.21	1.20	1.29	0.61	0.19

8.4.2 Transition patterns across the whole design session

In order to further articulate the eight types of transitions (as outlined in Figure 8.8 and Table 8.3) between the problem space and solution space across the design session, the distribution of the discontinuity ratio of each transition in the PDE is presented in Figure 8.9. The horizontal axis of the figure is the design session divided into ten sub-sessions, decile, with an equal number of segments, while the vertical axis represents the average discontinuity ratio (of the eight participants) of the transition patterns in each decile of the design session.

In the following description, we define the "early design stage" as the period from 1–3.3 on the horizontal axis, the "mid design stage" as 3.4–6.7, and the "end design stage" as between 6.7–10. The descriptors are thus time-based, rather than a direct indicator of the degree to which a design has been completed.

The eight types of transitions between the design problem space and design solution space, shown by the eight lines in Figure 8.9 respectively representing: P_R to S_R, P_K to S_K, P_R to S_K, P_K to S_R, S_R to P_R, S_K to P_K, S_K to P_R, and S_R to P_K. At the early design stage the dominant transition is between P_K and S_K. At the mid design session, the dominant transition is between P_R and S_R although the transition from S_K to P_K is still active. There are more transitions between P_R and S_R towards the end of the design session. Based on these, it can be inferred that, at the beginning of the design session, the co-evolution process is focused on the design knowledge level, at the mid design session, the co-evolution process is active at both design knowledge and rule algorithm levels, while at the end of the design session it is more focused on the rule algorithm level. The reason for this pattern may be that, at the beginning designers considered the brief from the design knowledge perspective, which is similar to the common architectural practice. Later, designers started using the rule algorithm process to implement their goals or concepts. During this process, designers continued to re-define the design problem while they were searching for solutions at the design knowledge level. This is supported by observations from the experiment which noted that designers tended to start from the brief, then analyse the site and then develop basic concepts. In the next stage, designers started considering the form or structure of their design, and the parametric rules to implement them. That is, they set rule algorithm goals and explored different ways to achieve them. Meanwhile, designers constantly returned to the design knowledge level to evaluate the current design and, in this way, the initial concept was developed and evolved gradually. At the end of the session, designers concentrated on the rule algorithm design and tried to finalise the design (geometric) model using parametric rules.

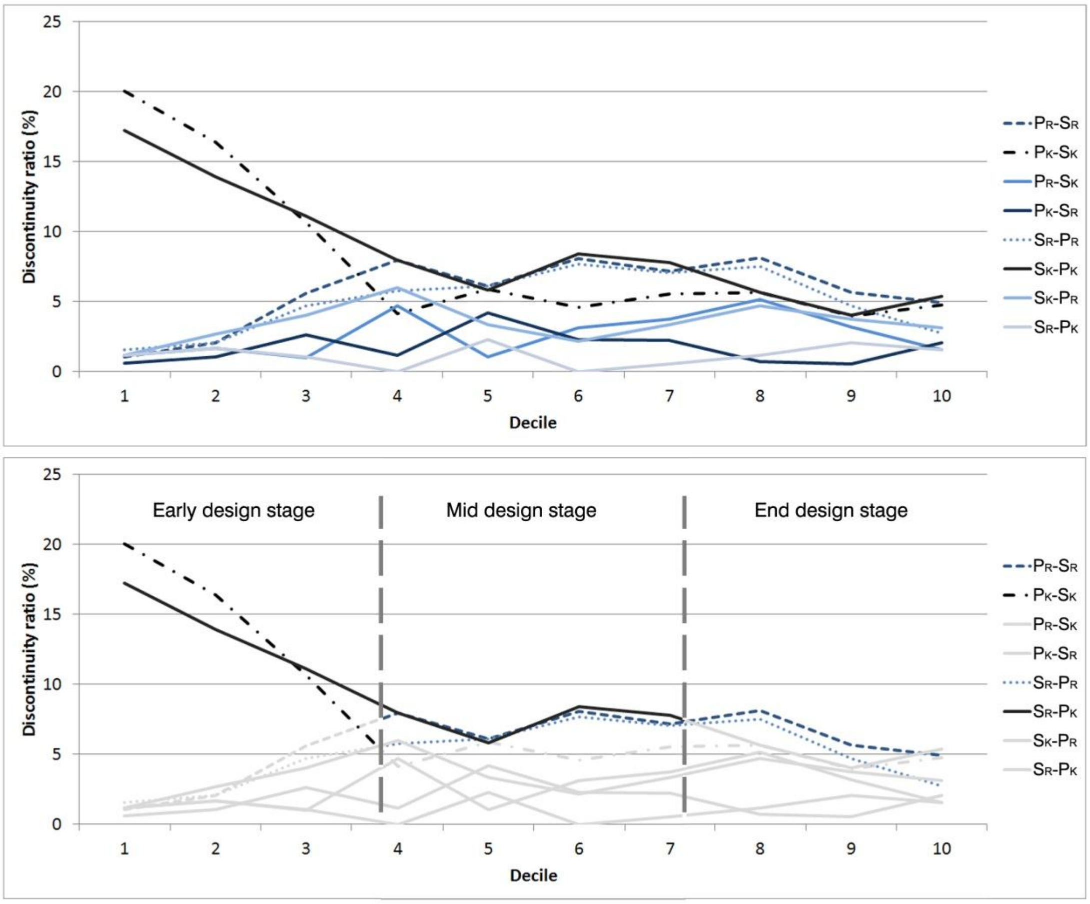

Figure 8.9. Distribution of the discontinuity ratios in the PDE, top: all transition distributions. Bottom: the main transitions at each design stage.

8.4.3 A model of the co-evolution process in the PDE

The transition processes between the design problem and solution spaces at both the design knowledge level and rule algorithm level are shown in Figure 8.10. The horizontal moves indicate the problem space (P) evolving from time "t" to time "t+1". The vertical moves are processes where "the problem leads to the solution" or "the solution refocuses the problem" (Maher & Poon, 1996). These moves comply with Maher and Kundu's (1993) finding that design requirements would change with the design solution: the solution space S(t) is not only a space where a design solution can be explored, but it also prompts new requirements in P(t+1) which were not in the original problem space P(t). Figure 8.10 illustrates a model of the co-evolution process in the PDE as identified from this study. The details of this model are further articulated in Figures 8.11, 8.12 and 8.13.

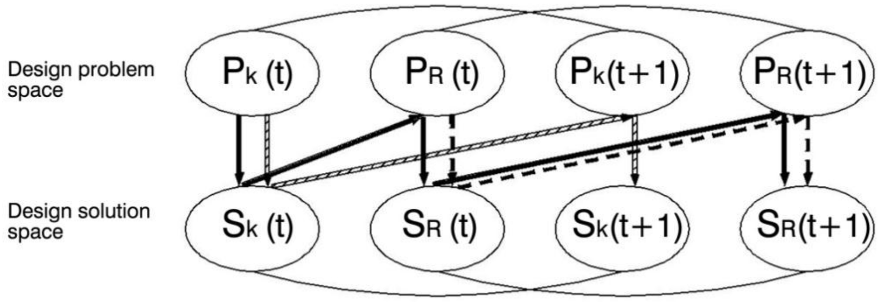

Figure 8.10. A model of the co-evolution process in the PDE.

1) Figure 8.11 presents the co-evolution of the problem and solution spaces at the rule algorithm level (indicated as dashed arrows). This co-evolution process frequently occurred in the PDE. Designers explored solutions for the rule algorithm goals/requirements, P_R (t), from the solution space S_R (t); they refined or added new requirements to reformulate the rule algorithm problem P_R (t+1).

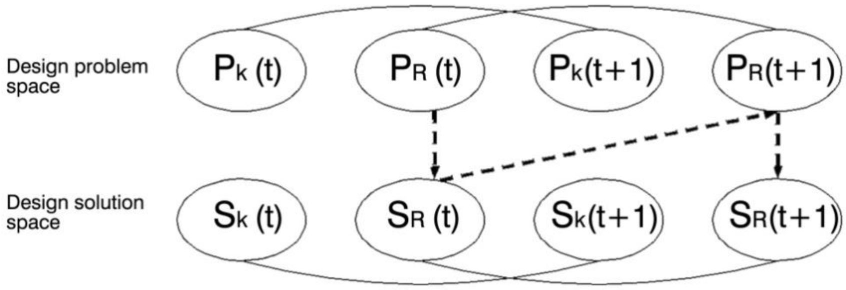

Figure 8.11. The co-evolution process at the rule algorithm level.

2) Figure 8.12 presents the co-evolution of the problem and solution spaces at the design knowledge level (indicated as solid dashed arrows). This is the most frequently occurring co-evolution process in the PDE. This behaviour is similar to that in traditional design environments (Maher & Poon, 1996; Dorst & Cross, 2001).

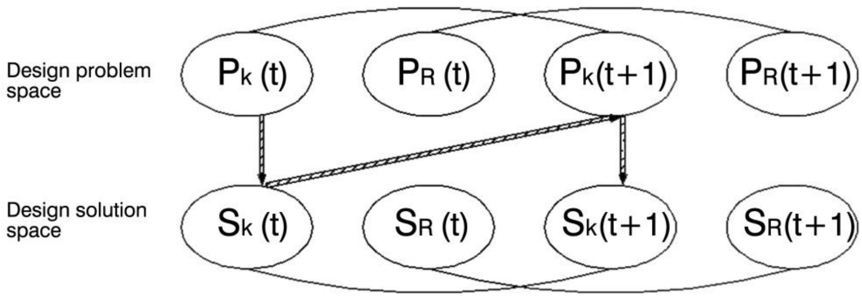

Figure 8.12. The co-evolution process at the design knowledge level.

3) Figure 8.13 presents the co-evolution process across the design knowledge level and the rule algorithm level (indicated as solid arrows). In this co-evolution process, designers started

from the problem space at the design knowledge level, P_K (t). During the exploration in the solution space S_K (t), there were new requirements emerging at the rule algorithm level. The design problem space at the rule algorithm level P_R (t) was refined. Then the exploration of a design problem and solution changed the direction to the rule algorithm level. This is a process in the PDE, in which designers explore the design solution and reformulate the problem across the design knowledge level and the rule algorithm level.

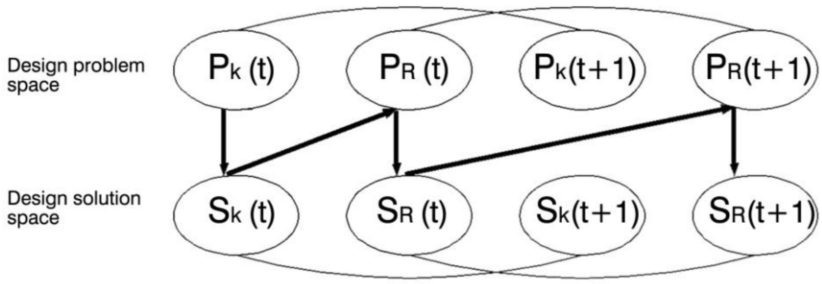

Figure 8.13 The co-evolution process across the design knowledge level and the rule algorithm level.

Design may be conceptualised as a special class of problem solving processes (Simon, 1969) where the problems are either not clearly defined (Maher et al., 1996; Chi, 1997) or ill-defined (Simon, 1973; Corne et al., 1993). This is why, in a design process, designers constantly return to the design problem space to reformulate the challenge they are facing (Simon, 1973). Through the interaction between cognitive activities in the design problem and solution spaces, the design is progressed until a "satisfactory" outcome is identified (Maher & Tang, 2003). As Cross (2011) and Schön (1983) have suggested, creative design is a process of exploration; during the process, problem and solution spaces are evolving and unstable until fixed by an "emergent" bridge, or a satisfactory problem-solution pair. This co-evolution process is significant for understanding the design process.

Parametric design differs from design using traditional geometrical modelling because it is reliant on the rule algorithm that must operate in parallel with other traditional design behaviours (Yu, Gero, et al., 2013). In this chapter, we have studied the co-evolution process in the PDE by examining empirical data derived from experiments with professional designers. From the results of the experiment, this division in terms of problem-solution in design is capable of capturing parametric design behaviours in a sufficiently comprehensive manner that can help us to understand the design process in this environment.

Based on the division of design activities into the two levels of design knowledge and rule algorithm, and by calculating the frequency of transitions between the design problem and solution spaces, three particular characteristics of the co-evolution process in the PDE have been identified. The first of these is that the co-evolution process typically occurs at the individual design knowledge level or rule algorithm level, and only relatively infrequently do transitions occur across the two levels. Secondly, the designers' co-evolution process is focused on the design knowledge level at the early design stage, while they use more cognitive effort at the rule algorithm level towards the end of the design session. The most representative activities of parametric design (activities on the rule-algorithm level) seems to play more important roles in design in the later stage of the design session rather than in the earlier stage of the design session. Finally, a model which illustrates the main co-evolution process in the PDE has been proposed. In this model, three main co-evolution sub-processes are identified – co-evolution at the rule algorithm level, co-evolution at the design knowledge level, and co-evolution across the design knowledge level and rule algorithm level.

Chapter 9: Discussion and conclusion

Designers' behaviours in the PDE and the GME have been revealed in Chapters 6–8. This chapter concludes the study and discusses the further implications of the research. Section 9.1 summaries the key findings from two aspects: the commonalities in design and impact of parametric design on designers' behaviour. Then the implications and contributions of this study are presented in Section 9.2. Finally Section 9.3 discusses potential future directions for research.

9.1 MAIN FINDINGS

This study set out to explore the impact of parametric design on architects' design behaviour. To achieve this, an experiment was conducted to collect empirical data from eight designers' interactions with a parametric design environment (PDE) and a geometric modelling environment (GME). A specific coding scheme which is capable of accommodating designers' behaviour in both the PDE and the GME was also developed. Applying the method of protocol analysis, the main patterns of designers' behaviour in the two design environments have been identified. By comparing those patterns, two main categories of findings have been identified: 1) Commonalities in both digital design environments. 2) The impact of rule algorithm on designers' behaviour in the PDE.

9.1.1 Commonalities in digital design

By comparing the protocol analysis results of designers' behaviour in the GME and the PDE, only limited differences were found between the two design environments. Therefore we can infer that designers' high level thinking does not vary significantly because of the digital technologies they use. That is, when designing in both PDEs and GMEs, to a certain extent, designers share some commonalities in digital design. These commonalities can be described by the following aspects:

- ***Distribution of design issues and design processes***

In both design environments, designers express similar distributions of design issues including that more cognitive effort is expended on the structure (S) than any other design issues. This is followed by structure behaviour (Bs), expected behaviour (Be), function (F), and the least effort is expended on requirements (R). In terms of syntactic design processes, in both design environments, more cognitive effort is expended on the analysis and reformulation I processes. These are followed by evaluation, synthesis, reformulation II, and the least effort is expended on formulation and reformulation III. From the statistical analysis of design issues and syntactic design processes distribution, there are few significant differences between the GME and PDE except for the consideration of function (F) and reformulation II processes. Other design issues (R, Be, Bs and S) and design processes (formulation, synthesis, evaluation, analysis, reformulation I and III) exhibit very similar distribution in the GME and the PDE. From this we can conclude that designers' thinking at the FBS level does not significantly change with the digital method used. This is because designers' high-level thinking from the perspective of FBS is more related to individual approaches to designing, which are not necessarily affected by the different design environments.

- ***The cumulative aggregations of design issues during the design process***

The cumulative analysis of designers' protocols exhibits similar aggregation processes in the GME and the PDE with most of the requirement (R), function (F) and expected behaviour (Be) issues occurring from the beginning of the design session, while structure behaviour (Bs) occurs later. Most R and F issues present a discontinuous and nonlinear cumulative curve, while the cumulative curve of Be, Bs and S are continuous and linear. This means that designers consider requirement (R) and function (F) at the beginning of the design session, but the effort on them tends to diminish towards the end of design session, while the occurrence of expected behaviour (Be), structure behaviour (Bs), and structure (S) design issues last to the very end of the design session. Other studies (Gero & Kannengiesser, 2014) on cumulative analysis of designers' behaviour express similar characteristics in terms of the cumulative aggregation of design issues. Therefore, in the context of the present research and its method, we can conclude that these are the common features of the cumulative aggregation of design issues in architectural design.

- ***Markov model analysis***

Analysis of the 1st order Markov model expresses similar transition probabilities in the GME and the PDE. The highest transition probabilities are between expected behaviour (Be), structure behaviour (Bs) and structure (S). In both design environments, the transitions which start from requirement (R) and function (F) have higher probabilities at the early design stage, and diminish towards the end. The transitions probabilities to S are high across the whole design session, while the transitions probabilities to structure behaviour (Bs) are consequently increasing towards the end of design session. The transition probability analysis indicates a similar tendency of design moves in both the GME and the PDE.

- ***Problem-solution index***

From the analysis of the design effort expended into the design problem and solution space, a decreasing problem-solution index is presented as the design progresses in both the GME and the PDE. This indicates that designers focus on formulating the design problem at the beginning of the design session; while the design proceeds, more efforts is invested into exploring the design solution space. The analysis suggests that the effort expended on design problem and solution space in the two design environments across the whole design session is similar: designers started with a problem-driven design approach, and gradually proceeded to a solution-driven design approach. From the mid-design stage, in both the GME and the PDE the problem-solution index curve remains flat for a relative long time, and then decreases at the end of design session. During this period, designers frequently switched between the design problem space and solution space, which indicates an active co-evolution process. The problem-solution index analysis suggests a similar design process in exploring the design problem and solution space in both the GME and the PDE.

9.1.2 Impact of rule algorithms on designers' behaviour

Since there are few significant differences found when comparing designers' behaviour between the PDE and the GME, we have explored the specific characteristics of designers' behaviour in the PDE in terms of the two levels of activities: design knowledge and rule algorithm.

- ***Impact of rule algorithms in terms of the distribution of design issues/design processes***

From the analysis of the design issues/design processes distribution, there are no significant differences found between the GME and the PDE except for the function (F) design issue and reformulation II design process. The relatively lower function (F) occurrence in the PDE session suggests that designers allocated a greater proportion of their effort to rule algorithm design. The higher occurrence of reformulation II shows that designers reformulated behaviour (Be) more frequently in the PDE. Thus, by reasoning using the existing geometric model or rule design, they frequently reset algorithmic goals or the way to achieve them in the PDE. Analysis of design issues distribution at the two levels of design activities shows that there was more cognitive effort expended on design knowledge in the GME than in the PDE. A comparison of the results suggests that although the total distribution of design issues in both environments is similar, the make-up of the design issues is different including that some of the knowledge related design issues are substituted by rule algorithm design issues in the PDE. This is particularly evident for the expected behaviour (Be) and structure (S). The possible reason is that, firstly, designers often consider ways to achieve algorithmic goals in the PDE; secondly, when designers make geometric models, they put more effort into the structure of rules and their relationships in the PDE.

- ***Relative cognitive effort spent on two levels of design activities***

From the analysis of the relative effort expended on the two levels of design activities, we can identify the impact of rule algorithms in the parametric design process. Initially the cognitive effort on design knowledge dominates that on rule algorithm. However, as the design proceeds, the cognitive effort on design knowledge drops from 100% to approximately 60% of the total. In parallel, as the design proceeds, the cognitive effort on rule algorithm increases from 0% to approximately 40% of the total. Therefore, we can infer that in the parametric design process, designers still expend most effort on design knowledge; parametric scripting is mainly used to support their intention of generating models. Designers start with considering design knowledge related issues, such as the client's requirement and building functions; when the design proceeds, they gradually spent more cognitive effort on scripting.

- ***Design patterns derived from comparing the Markov model in the GME and the PDE***

Applying Markov model analysis, the apparent difference between the GME and the PDE is that the transition probability from F to S is higher in the PDE. F to S is a typical design pattern wherein elements of designs are generated directly from designers' existing knowledge/experience without a reasoning process. From the Markov model results, designers tend to use the existing design patterns more frequently in the PDE. Barr et al. (2011) argue that in a computational design environment, designers tend to formulate problems that enable them to use a computer to solve them. Similarly in PDEs, designers formulate the design problem which is appropriate for solving with parametric tools. Experience in using parametric tools is the basis for designers to formulate design problems and solve them. Three types of design patterns in the PDE have been identified through observation in our study. They are design patterns at the design knowledge level, rule algorithm level and across the two levels. Among them, the design pattern across the two levels is unique in the PDE.

- ***The problem-solution co-evolution process in the PDE***

By calculating the discontinuity ratio, we found that in the early design stage, there are significantly more transitions between the design problem space and solution space in the PDE than in the GME, which indicates a good co-evolution design process in the early design stage in the PDE. Through exploring the co-evolution process in the PDE, three characteristics of problem-solution co-evolution in the PDE have been identified. Firstly, the co-evolution process typically occurs at the individual design knowledge level or the rule algorithm level, and only infrequently do transitions occur across the two levels. Secondly, the co-evolution process is focused on the design knowledge level at the early design stage, while more cognitive effort is used at the rule algorithm level towards the end of the design session. The most typical activities of parametric design (activities on the rule-algorithm level) seem to play more important roles in design in the later stage of the design session rather than in the earlier stage of the design session.

9.1.3 Summary

In summary, from the results of the three analyses conducted in this study, we conclude:

- ***When comparing the PDE and the GME using FBS ontology, designers' high level thinking does not significantly vary because of the digital design tools used.***

Designers' high level thinking in this research is interpreted using the FBS model, which is a way designers consider the design function, behaviour and structure, with iteration of formulation, synthesis, analysis, evaluation and reformulation processes (Gero, 1990). Designers' high level thinking, reflecting on and measured by the effort they spent on each design issues/processes, the tendencies of their design moves, the way they explore problems and solutions, etc. have not been significantly affected due to the use of PDEs.

- ***Designers expend most of their cognitive effort on applying design knowledge; parametric scripting is mainly used to support their intention of geometric***

modelling.

When designers design using parametric tools, it is expected that they would spend most of their cognitive effort on the parametric scripting. However, in this study we found that during the design experiment, designers spent most of their cognitive effort at the design knowledge level. At this level, designers considered how to adapt a building to the site, how to shape the way people use the building, and how to satisfy the requirements of their clients, etc. When designers use parametric scripting, most of the time it is about supporting geometric modelling. As Burry states, in most cases when using parametric tools the variables are "those that define the measurement of entities and distance along with their relative angles" (Burry, 2003, p 211), which indicates that the main variables in parametric design focus on geometrical elements.

- ***How designers design in PDEs to some extent depends on their previous experience – both the experience of architectural design and the experience of using parametric tools.***

The adoption of design patterns is a phenomenon which has been observed by a number of researchers (Alexander et al., 1977; Woodbury et al., 2007). It is based on designers' previous experience in design, both the experience of architectural design and the experience of using parametric tools. In PDEs, designers tend to use the scripts they are familiar with, and adapt them to the current design context. This can make parametric design tools both efficient and constraining.

9.2 FURTHER IMPLICATIONS FOR DESIGN

This study has compared designers' behaviour in a parametric design environment with their activities in a traditional geometric modelling environment. It provides the empirical evidence supporting our understanding of parametric design – both the unique characteristics of designing in PDEs and commonalities of digital design. The implications of this study include:

9.2.1 Implications for design education and practice

The main contribution of this study is that it enhances our understanding of parametric design. Generally, design is an abduction process in which both the final artefacts and their behaviour have been designed/defined (Dorst, 2011). Results of this study suggest designers' behavioural patterns shift between the two levels of activities – the design knowledge level and the rule algorithm level – in the PDE: designers started the design from the design knowledge level; as the design proceeded, their activities at the rule algorithm level rose while those at the design knowledge level decreased, but never ceased. This implies that although rule algorithm in parametric design can have many advantages such as flexibility (Fischer et al., 2003) and the capability of dealing with complexity (Leach, 2008), design knowledge still appears to be essential during parametric design.

The commonalities of digital design identified from this study support the arguments that in terms of high level thinking according to FBS, designers' cognitive behaviour does not significantly vary because of the digital tools adopted. These preliminary findings have implications for teaching parametric design in architectural education. While the technical training for programming/scripting skills are important, the training of design thinking is essential and a vital core in the curriculum design. Further, as designers substitute rule algorithm for design knowledge during parametric design, understanding and teaching how design knowledge is captured in the rule algorithm in parametric design is important.

From the designer's perspective, parametric design tools provide architects opportunities for designing through both design knowledge and rule algorithm, which opens up many possibilities: complex forms are able to be generated and managed efficiently; parameters and external data can be embedded and linked to a design to enable more rational and optimal solutions; design variations can be developed in parallel and changes at different stages of the design can be easily made and traced. At the same time, new challenges emerge: first and foremost the role of architects is changing, such that they need to be both architects and programmers. Using parametric tools, a designer's programming/scripting skill has an impact on design. Through qualitative observation of our experiment, designers appear to use the programming/scripting method or existing scripts they are familiar with. This can be both efficient and constraining. How designers use parametric tools is critical. Some characteristics of parametric design have been identified in this study, which can be used to develop guidelines for parametric designers.

9.2.2 Implications for parametric design software development

Oxman (2000) argues that the knowledge of design thinking is the foundation and resource for computational design environments. Understanding designers' cognitive activities in computational design environments can assist software developers in identifying the technical requirement of the computer software in order to better support these activities. In this research studying designers' behaviour in the PDE the following suggestions for parametric design software development were identified:

When using Grasshopper, designers develop rules by building relationships with visual programming components. From the perspective of a software developer, a good software interface will minimise the cognitive load on a designer (Turk, 1998). Compared to traditional programming/scripting interfaces where designers are required to deal with codes directly, the visual programming in Grasshopper is apparently more accessible for parametric designers who do not have a strong programming/scripting background but are familiar with graphical interfaces. Thus, more intuitive interfaces for architects to comfortably access and efficiently master programming/scripting in parametric design are urgently needed for the wider industry adoption of parametric design software.

The design patterns identified from the current study can be potentially customised for different design scenarios and embedded as generic components in the system to allow designers to apply parametric design more effectively. The protocol analysis results suggest that some designers currently define design patterns by themselves and repeatedly use them in a parametric design process. In this study three types of design patterns are identified: design patterns at the design knowledge level, at the rule algorithm level and across the two levels. Patterns at the design knowledge level are defined and applied based on designers' knowledge and experience and vary from case to case; these are not suitable to be predefined by parametric software developers. However, parametric design software development should consider means for designers to more easily and intelligently define and apply the other two types of patterns during parametric design. For design patterns at the rule algorithm level, currently there are new plug-in tools emerging frequently that deal with different aspects of form making in parametric design, however, better generalisation and integration of these individual patterns will better serve the designers. For design patterns across the design knowledge and the rule algorithm levels, currently there is little progress and few examples, and more development is needed.

9.2.3 Implications for cognitive design research

The research method applied in this study provides various references for future cognitive design studies. We adapted Gero's FBS ontology (Gero, 1990; Gero et al., 2012; Gero & Kannengiesser, 2014) to develop a coding scheme and two analysis methods specific to PDEs. These two specific analysis methods are 1) the relative cognitive effort analysis based on cumulative design issues (Section 6.3) and 2) the discontinuity ratio analysis based on the division of problem/solution (Section 8.2, Section 8.3). The adaptation and development of these research methods and tools are transferable to future cognitive design research to study designers' behaviour in future emerging design environments. Specific extensions of this research are discussed below.

9.3 FUTURE STUDY

The current study has some limitations due to the research method and cost/time constraints. To address these limitations in order to optimise the findings, future study will consider the following issues:

- ***Increased sample size***

Protocol analysis typically deals with small number of samples but enables detailed exploration into the design process. The current research is based on eight designers' protocols over sixteen design sessions, which is a relative large sample size for a protocol study and suitable for a PhD. Although we cannot generalise the results with this sample size, design patterns shared by designers have been identified in this study, which lead to a more comprehensive understanding of designers' behaviour in the PDE. However, if possible, future work may include a larger sample size to refine and solidify the results of this study.

- ***Expert vs. Novice***

By comparing design behaviour of expert and novice designers, ideally more superior design approaches and processes can be identified to provide common guidelines for more effective parametric design practise. The characteristics of novice designers can also be identified in order to better facilitate their learning process. Previous research suggests that in the traditional design environment, expert designers can exhibit characteristic of flexible uses of problem-solving strategy, solution-oriented approach, early design control, integrated design strategies, faster design activities, etc. (Christiaans & Dorst, 1992; Akin & Akin, 1996; Kavakli & Gero, 2002; Cross, 2011). These can be used for benchmarking future research. In parametric design, the expert designers should be experienced architects with specialist programming/scripting skills. There can be two types of novice designers – experienced architects with limited programming/scripting skill and student designers with both skill sets being limited.

- ***Correlation analysis of design process and design outcome***

The current study focuses on exploring and comparing the design process in the two design environments. The quality of the design outcome has not been thoroughly measured and considered. Through a correlation analysis of design process and design outcome, the relations between the characteristics of the design process (as identified from the current study) and the quality of the design product can begin to be established. We can further explore the design strategies and patterns, which can potentially benefit the completed design product. In addition, the correlation can also be explored and compared across both the GME and the PDE to enable a more comprehensive study.

- ***Visual representation and design situation in parametric design***

From the view of design situatedness, designers' cognitive behaviour is affected by their interaction with the design environment and in turn responds to the changing design situation (Gero, 1998). That is, designers tend to adapt and respond to the design situation as it continuously changes during the design process. The rule-based and dynamic design process that characterises parametric design enables rapid changes to the design situation in PDEs. This changing design situation indicates a rapid evolution of visual representation during the parametric design process. As the exploration of visual representation is a medium of developing design (Oxman, 2000), the interaction between visual reasoning and conceptual content is vital for studying the cognitive design process (Schön & Wiggins, 1992; Oxman, 1999). To explore the role of visual representation in the changing design situation would be another unique angle from which to understand parametric design.

- ***Design fixation in the parametric design process***

Design fixation is an important topic in design studies (Jansson & Smith, 1991). A person's existing knowledge is a factor that can create design fixation (Purcell & Gero, 1992). Results of the current research show that previous experience of parametric design (particularly scripting) certainly affects designers' performance. The hypothesis is that the designers' lack of programming/scripting skills or their reliance on existing scripts with which they are familiar, may create design fixation in concept development in PDEs. Future empirical study is needed to explore this issue.

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Appendix 1: Design brief

Task 1 Community centre

This community centre is designed for nearby residents. The main functions inside the building are activity rooms, classrooms, meeting rooms.

Issues for consideration:

1. For site design, consider the traffic route, parking area, and outdoor activity space

2. For the building design, consider the entrance and façade, do not focus on the detailed layout.

Size:

Building area is around $6000m^2$, one or two storeys.

Requirement:

The focus of the design task is conceptual design through form generation of the building and a simple site design. Do not worry about the detailed functions or layout.

You are expected to complete the design in 40 minutes, but you can continue until finish (it's better to limit the extension to within 20 minutes).

Required outcomes:

A 3D model

Two rendered images of the building to show the strength of your design.

Task 2 Shopping centre

The main functions:

1. Shopping area
2. Leisure area including café and restaurant ($1000m^2$)

Issues for consideration:

1. The two function areas can be put in the same building or separated.
2. For site design, consider the traffic route, parking area, etc.
3. For building design, consider the entrance and façade; do not focus on the detail layout.

Size:

Building area is around $6000m^2$, one or two storeys.

Requirement:

The focus of the design task is conceptual design through form generation of the building and a simple site design. Do not worry about the detailed functions or layout.

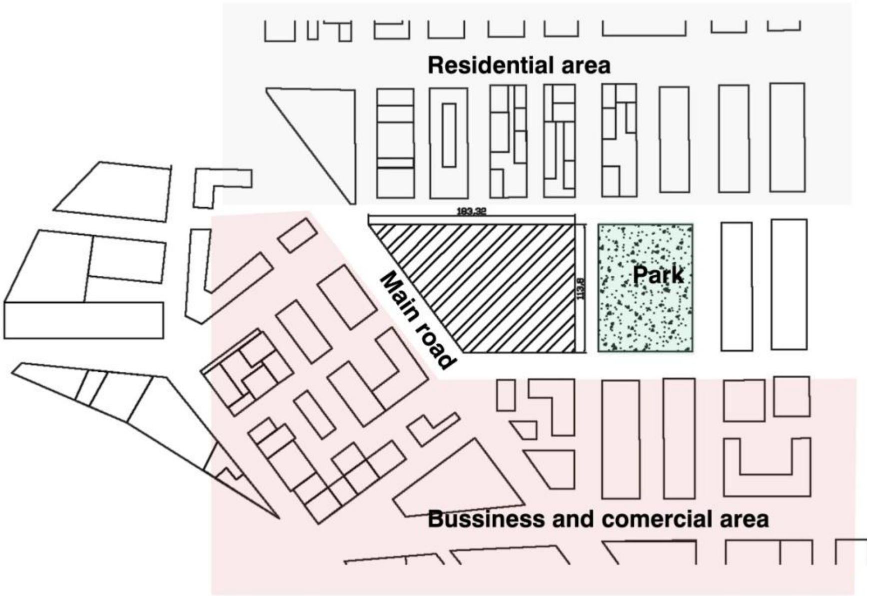
You are expected to complete the design in 40 minutes, but you can continue until finish (it’s better to limit the extension to within 20 minutes).

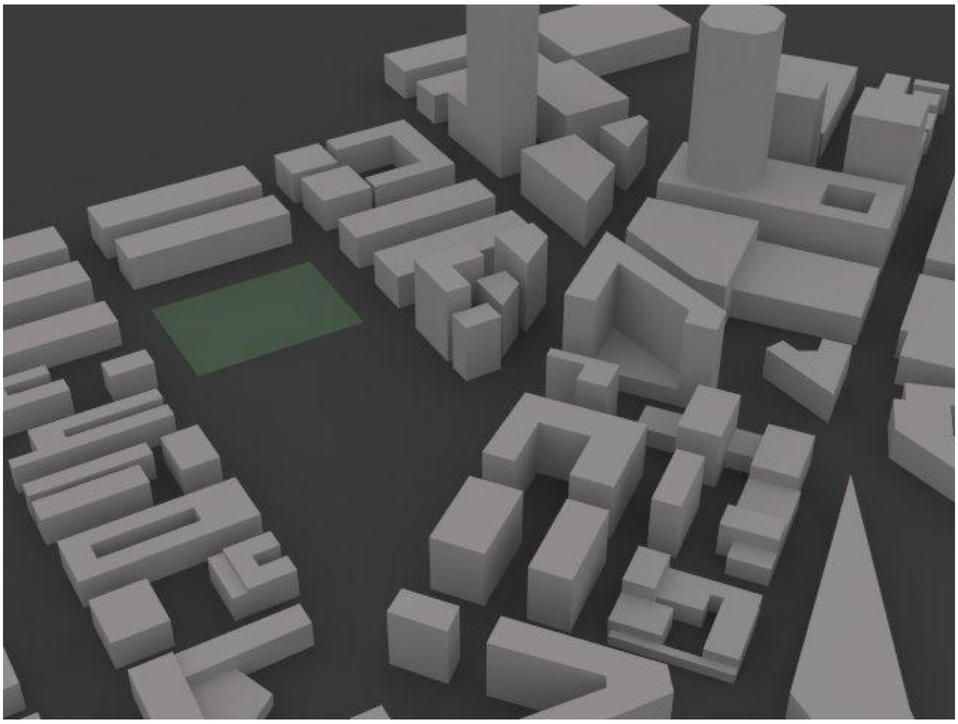
Required outcomes:

A 3D model

Two rendered images of the building to show the strength of your design.

Site:





The site is in Sydney. Cars drive on the left hand side, normal temperature.

Appendix 2: Ethics approval

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Doctor Ning Gu**
Cc Co-investigators / Research Students:	**Professor Michael Ostwald** **Miss Rongrong Yu**
Re Protocol:	**Evaluating Parametricism: Does parametric design environments enhance/hinder design creativity?**
Date:	**23-Feb-2012**
Reference No:	**H-2011-0384**
Date of Initial Approval:	**23-Feb-2012**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Ethics Administrator.

I am pleased to advise that the decision on your submission is **Approved** effective **23-Feb-2012**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2011-0384**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

Conditions of Approval

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

- ***Monitoring of Progress***

Other than above, the University is obliged to monitor the progress of research projects involving human participants to ensure that they are conducted according to the protocol as approved by the HREC. A progress report is required on an annual basis. Continuation of your HREC approval for this project is conditional upon receipt, and satisfactory assessment, of annual progress reports. You will be advised when a report is due.

- ***Reporting of Adverse Events***

1. It is the responsibility of the person **first named on this Approval Advice** to report adverse events.
2. Adverse events, however minor, must be recorded by the investigator as observed by the investigator or as volunteered by a participant in the research. Full details are to be documented, whether or not the investigator, or his/her deputies, consider the event to be related to the research substance or procedure.
3. Serious or unforeseen adverse events that occur during the research or within six (6) months of completion of the research, must be reported by the person first named on the Approval Advice to the (HREC) by way of the Adverse Event Report form within 72 hours of the occurrence of the event or the investigator receiving advice of the event.
4. Serious adverse events are defined as:
    - Causing death, life threatening or serious disability.
    - Causing or prolonging hospitalisation.
    - Overdoses, cancers, congenital abnormalities, tissue damage, whether or not they are judged to be caused by the investigational agent or procedure.
    - Causing psycho-social and/or financial harm. This covers everything from perceived invasion of privacy, breach of confidentiality, or the diminution of social reputation, to the creation of psychological fears and trauma.
    - Any other event which might affect the continued ethical acceptability of the project.

5. Reports of adverse events must include:
    - Participant's study identification number;
    - date of birth;
    - date of entry into the study;
    - treatment arm (if applicable);
    - date of event;
    - details of event;
    - the investigator's opinion as to whether the event is related to the research procedures; and
    - action taken in response to the event.

6. Adverse events which do not fall within the definition of serious or unexpected, including those reported from other sites involved in the research, are to be reported in detail at the time of the annual progress report to the HREC.

- ***Variations to approved protocol***

If you wish to change, or deviate from, the approved protocol, you will need to submit an *Application for Variation to Approved Human Research*. Variations may include, but are not limited to, changes or additions to investigators, study design, study population, number of participants, methods of recruitment, or participant information/consent documentation. **Variations must be approved by the (HREC) before they are implemented** except when Registering an approval of a variation from an external HREC which has been designated the lead HREC, in which case you may proceed as soon as you receive an acknowledgement of your Registration.

Linkage of ethics approval to a new Grant

HREC approvals cannot be assigned to a new grant or award (ie those that were not identified on the application for ethics approval) without confirmation of the approval from the Human Research Ethics Officer on behalf of the HREC.

Best wishes for a successful project.

Professor Allyson Holbrook
Chair, Human Research Ethics Committee

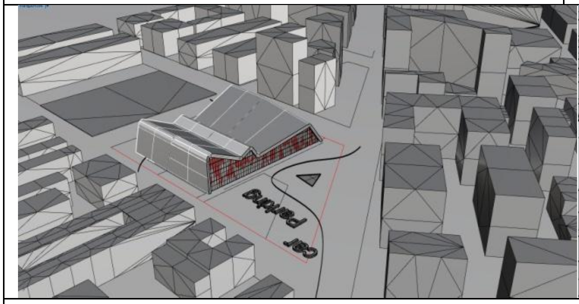
For communications and enquiries:
Human Research Ethics Administration

Research Services
Research Integrity Unit
HA148, Hunter Building
The University of Newcastle
Callaghan NSW 2308
T +61 2 492 18999
F +61 2 492 17164
Human-Ethics@newcastle.edu.au

Appendix 3: Design outcomes

Designer 1

GME



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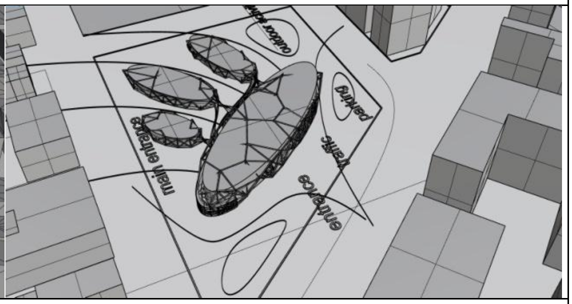
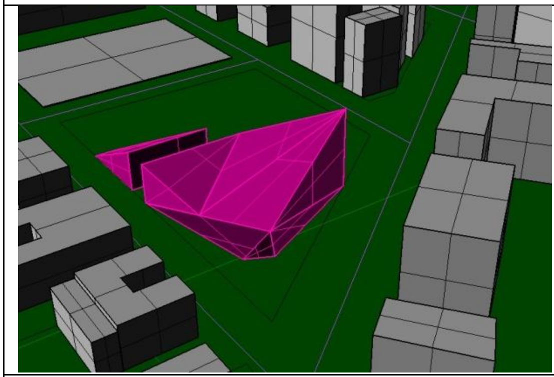


Designer 2

GME



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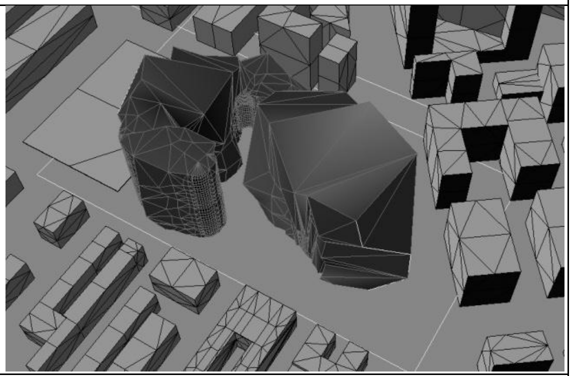

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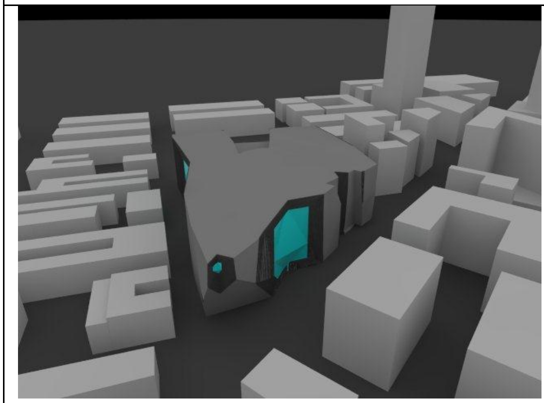

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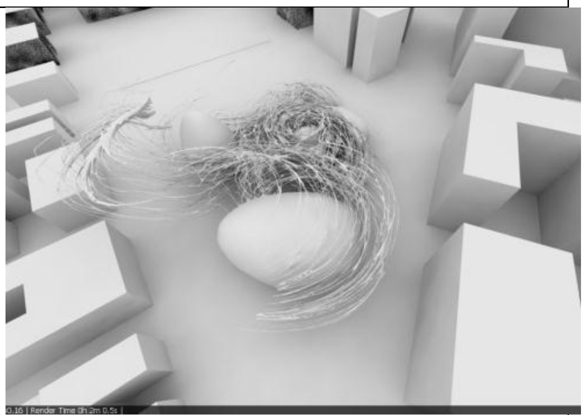
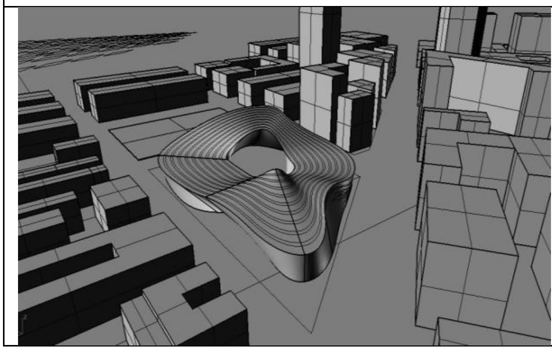


Designer 4

GME



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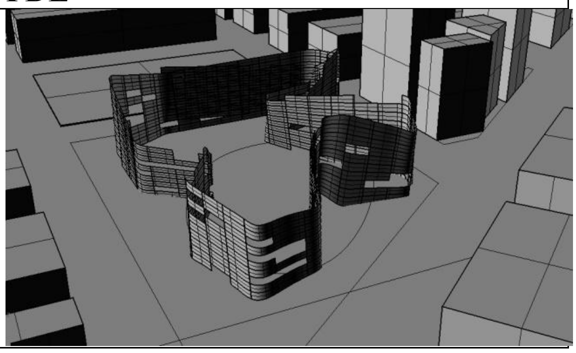
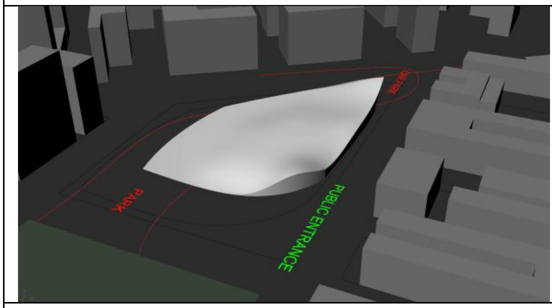
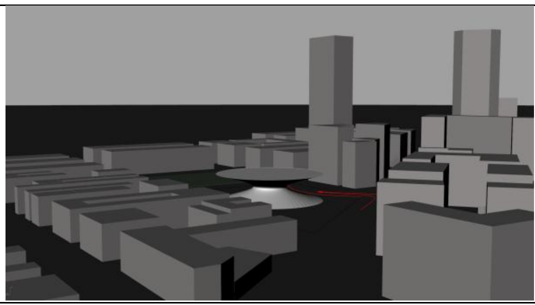
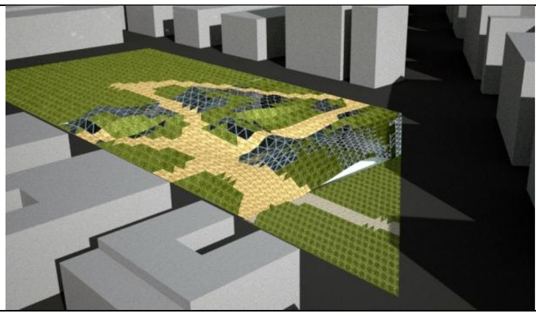
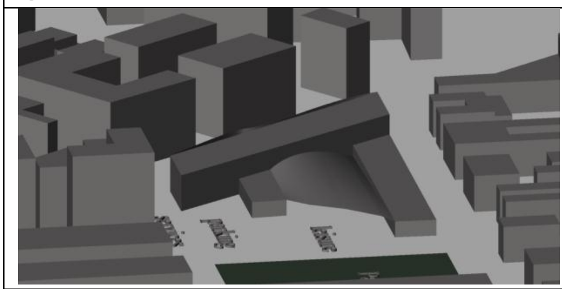
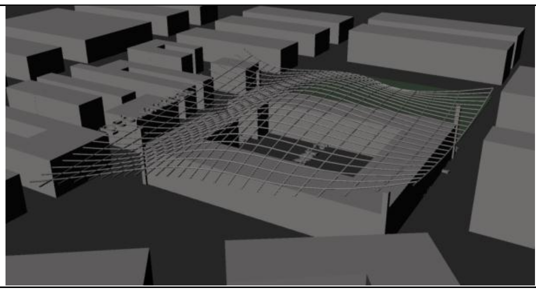
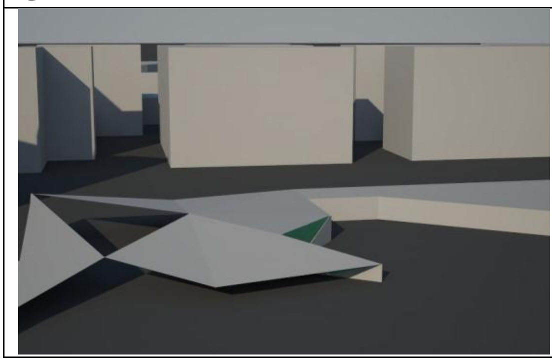
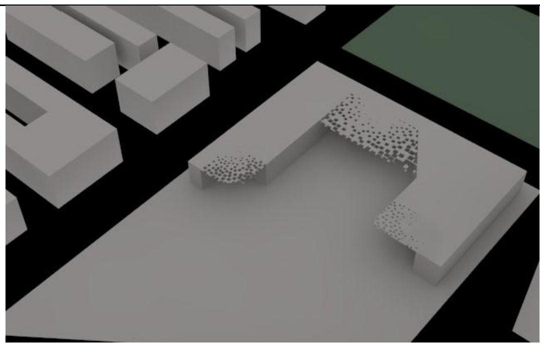


Designer 5	
GME	PDE
	
Designer 6	
GME	PDE
	
Designer 7	
GME	PDE
	
Designer 8	
GME	PDE
	

Appendix 4: Coding

Designer 1

PDE session

ID	Timespan	Content	1st Coding	2nd Coding	Final coding
1	0:00.0 - 0:53.3	reading brief	R-K	R-K	R-K
2	0:53.3 - 1:06.3	look at the site	R-K	R-K	R-K
3	1:06.3 - 1:55.3	draw traffic line "from main road"	Be-K	F-K	F-K
4	1:55.3 - 2:00.8	" there should be a consistent façade to face the main road"	Be-K	Be-K	Be-K
5	2:00.8 - 2:06.8	"so like this" draw building form	S-K	S-K	S-K
6	2:06.8 - 2:21.1	adjust traffic route, look at the relationship between building and traffic	Bs-K	Be-K	Be-K
7	2:21.1 - 2:40.9	"outdoor activity may be next to the park" draw curve	F-K	F-K	F-K
8	2:40.9 - 2:55.7	"main entrance	F-K	F-K	F-K
9		is from here"		Be-K	Be-K
10	2:55.7 - 3:38.6	"cars drive here" draw curve	Be-K	Be-K	Be-K
11	3:38.6 - 4:10.4	"rest is parking area"	F-K	F-K	F-K
12		draw curve		S-K	S-K
13	4:10.4 - 4:15.4	"maybe building will be like this"	Be-K	S-K	S-K
14		"building may be along the people flow route like this"		Be-K	Be-K
15		draw curve		S-K	S-K
16	4:35.1 - 4:52.4	draw connections between buildings	Be-K	Be-K	Be-K
17	4:52.4 - 5:01.5	" so this is outdoor activity area, near park"	F-K	F-K	F-K
18		draw curve		S-K	S-K
19	5:01.5 - 5:13.4	"so cars follow this way, people goes from here"	Be-K	Be-K	Be-K
20		zooming,	Bs-K	Bs-K	Bs-K
21	5:13.4 - 5:29.5	adjust the building location	S-K	S-K	S-K
22	5:29.5 - 5:59.0	we start grasshopper, save document	N	N	N
23	5:58.9 - 6:06.6	"I am trying to make these curve in grasshopper"	S-K	S-R	S-R
24	6:06.6 - 6:25.7	set parameters	S-R	S-R	S-R
25	6:25.7 - 6:34.4	set origin location	S-K	S-K	S-K
26	6:34.4 - 6:52.6	change parameters	S-R	S-R	S-R
27	6:52.6 - 7:33.5	set plane	S-K	Be-R	Be-R
28	7:33.5 - 7:39.9	connection	S-R	S-R	S-R

29	7:39.9 - 7:53.3	set parameters	S-R	S-R	S-R
30	7:53.3 - 8:06.1	"try rotate"	S-K	S-K	S-K
31	8:06.1 - 8:14.9	set parameter	S-R	S-R	S-R
32	8:14.9 - 8:26.1	change parameters	S-R	S-R	S-R
33	8:26.1 - 8:28.8	delete component	S-R	S-R	S-R
34	8:28.8 - 9:00.6	change parameters	S-R	S-R	S-R
35	9:00.6 - 9:09.2	set parameter	S-R	S-R	S-R
36	9:09.2 - 9:21.1	change parameters	S-R	S-R	S-R
37	9:21.1 - 9:58.7	make another building, copy components	S-K	S-K	S-K
38	9:58.7 - 10:58.5	change parameters	S-R	S-R	S-R
39	10:58.5 - 11:03.7	make another building	S-K	S-K	S-K
40	11:03.7 - 11:24.0	change parameters	S-R	S-R	S-R
41	11:24.0 - 11:31.9	zooming on the grasshopper interface	Bs-K	Bs-R	Bs-R
42	11:31.9 - 11:42.8	make another building	S-K	S-K	S-K
43	11:42.8 - 12:00.4	change parameters	S-R	S-R	S-R
44	12:00.4 - 13:23.5	"now we are going to adjust the traffic route"	Be-K	Be-K	Be-K
45		adjusting curve in rhino	S-K	S-K	S-K
46	13:23.5 - 13:32.1	" now we are going to adjust the ellipse location"	S-K	S-K	S-K
47		Check previous script	Bs-K	Bs-R	Bs-R
48	13:32.1 - 14:43.4	change parameters	S-R	S-R	S-R
49		change parameter	S-R	S-R	S-R
50	14:43.4 - 14:50.6	rotating	Bs-K	Bs-K	Bs-K
51	14:50.6 - 14:58.0	change parameters	S-R	S-R	S-R
52	14:58.0 - 15:00.9	rotating	Bs-K	Bs-K	Bs-K
53	15:00.9 - 15:54.1	change parameters	S-R	S-R	S-R
54	15:54.1 - 15:55.1	Check previous script	Bs-K	Bs-R	Bs-R
55	15:54.8 - 15:55.8	"this one can move downward a little bit"	S-K	S-K	S-K
56	15:55.4 - 16:30.7	change parameter	S-R	S-R	S-R
57	16:30.7 - 16:34.8	zooming on the grasshopper interface	Bs-R	Bs-R	Bs-R
58	16:34.8 - 16:46.1	"now we are going to extrude them" put extrude component	Be-K	S-K	S-K
59	16:46.1 - 16:55.7	rotating	Bs-K	Bs-K	Bs-K
60	16:55.7 - 17:03.2	set parameters	S-R	S-R	S-R
61	17:03.2 -	change parameters	S-R	S-R	S-R

	17:07.9				
62	17:07.9 - 17:24.5	rotating	Bs-K	Bs-K	Bs-K
63	17:24.5 - 17:45.6	copy component, connect	S-R	S-R	S-R
64		(set parameters)	S-R	S-R	S-R
65	17:45.6 - 18:16.4	connecting to extrude all the building	S-R	S-K	S-K
66	18:16.4 - 18:23.2	set component, " let's see how large the area is""2500"	Bs-K	Bs-K	Bs-K
67	18:30.7 - 18:44.7	" so the rest three building are single storey"	R-K	Be-K	R-K
68	18:44.7 - 19:13.2	set component, connection to cap the building	S-K	S-K	S-K
69	19:17.3 - 19:28.3	rotating "so the main building is like this"	Bs-K	Bs-K	Bs-K
70	19:28.3 - 20:10.9	calculating area	Bs-K	Bs-K	Bs-K
71		"maybe will exceed several hundred square metres, it's fine"	R-K	R-K	R-K
72	20:10.9 - 20:19.7	rotating "maybe some area can make single storey"	Be-K	Be-K	Be-K
73	20:19.7 - 20:29.9	"now we are going to make façade"	F-K	S-K	F-K
74	20:29.9 - 20:59.9	so the main entrance	F-K	F-K	F-K
75		should be here"		Be-K	Be-K
76	20:59.9 - 21:13.8	set component "to get this surface"	S-K	S-K	S-K
77	21:13.8 - 22:03.8	set parameters	S-R	S-R	S-R
78	22:03.8 - 22:11.9	change system setting	N	N	N
79	22:11.9 - 22:35.6	change parameters	S-R	S-R	S-R
80	22:35.6 - 23:06.2	set component	S-R	S-R	S-R
81	23:06.2 - 23:32.2	set parameters	S-R	S-R	S-R
82	23:32.2 - 23:50.5	delete	S-R	S-R	S-R
83	23:50.5 - 24:05.1	change parameters	S-R	S-R	S-R
84	24:05.1 - 24:44.8	rotating	Bs-K	Bs-K	Bs-K
85	24:44.8 - 25:12.4	close other layer	N	N	N
86	25:12.4 - 25:48.3	rotating	Bs-K	Bs-K	Bs-K
87	25:48.3 - 26:07.9	change parameters	S-R	S-R	S-R
88	26:07.9 - 26:12.9	rotating	Bs-K	Bs-K	Bs-K
89	26:12.9 - 26:39.3	change parameters	S-R	S-R	S-R
90	26:39.3 - 26:46.8	rotating	Bs-K	Bs-K	Bs-K
91	26:46.8 - 26:58.4	change parameter	S-R	S-R	S-R
92	26:58.4 - 27:02.7	rotating	Bs-K	Bs-K	Bs-K
93	27:02.6 -	change parameter	S-R	S-R	S-R

	27:53.8				
94	27:53.8 - 28:05.3	rotating	Bs-K	Bs-K	Bs-K
95	28:05.3 - 28:08.9	"so that we can show where the entrance is"	Bs-K	F-K	F-K
96	28:08.9 - 30:33.3	change parameters	S-R	S-R	S-R
97	30:33.3 - 30:51.6	set component to offset	S-K	S-K	S-K
98	30:51.6 - 31:32.4	rotating	Bs-K	Bs-K	Bs-K
99	31:32.4 - 32:47.5	set component	S-R	S-R	S-R
100	32:47.5 - 33:33.9	rotating	Bs-K	Bs-K	Bs-K
101	33:33.9 - 34:04.7	bake and render to see if the trim is success	Bs-K	Bs-K	Bs-K
102	34:04.7 - 34:43.6	rotating "give up"	Bs-K	Bs-K	Bs-K
103	34:43.6 - 34:57.3	"I am going to do the façade"	Be-K	S-K	S-K
104	34:57.3 - 35:25.6	set component, connection	S-R	S-R	S-R
105	35:45.8 - 35:52.2	set parameters	S-R	S-R	S-R
106	35:52.2 - 36:11.4	change parameters	S-R	S-R	S-R
107	36:11.4 - 36:41.6	set component to get the other three building	S-R	S-K	S-K
108	36:41.6 - 37:11.9	set parameters	S-R	S-R	S-R
109	37:23.1 - 37:31.3	change parameters	S-R	S-R	S-R
110	37:31.3 - 37:43.1	change parameters	S-R	S-R	S-R
111	37:43.1 - 37:46.3	rotating	Bs-K	Bs-K	Bs-K
112	37:46.3 - 37:53.9	change parameter	S-R	S-R	S-R
113	37:53.9 - 38:02.3	set component	S-R	S-R	S-R
114	38:02.3 - 38:12.5	rotating	Bs-K	Bs-K	Bs-K
115	38:12.5 - 38:21.5	copy and connect component	S-R	S-R	S-R
116	38:21.5 - 38:52.4	set parameters	S-R	S-R	S-R
117	38:52.4 - 38:56.4	change parameters	S-R	S-R	S-R
118	38:56.4 - 39:10.4	rotating	Bs-K	Bs-K	Bs-K
119	39:10.4 - 39:20.7	set components to generate pipe	S-K	S-K	S-K
120	39:20.7 - 39:30.5	rotating	Bs-K	Bs-K	Bs-K
121	39:30.5 - 39:31.9	"too large"	Bs-K	Bs-K	Bs-K
122	39:31.9 - 39:48.6	"set the radius smaller"	Be-K	Be-K	Be-K
123		set parameters	S-R	S-R	S-R
124	39:48.6 - 39:55.1	rotating	Bs-K	Bs-K	Bs-K

125	39:55.1 - 40:50.9	"that looks ok" rotating	Bs-K	Bs-K	Bs-K
126	0:00.0 - 0:19.4	"now I would like to make the entrance"	F-K	F-K	F-K
127	0:19.4 - 0:27.4	"we put it in a different layer, from here to here is entrance"	Be-K	Be-K	Be-K
128	0:27.4 - 0:36.3	"now we are going to make some frame on the window"	F-K	S-K	S-K
129	0:36.3 - 0:56.9	"so now make the iso-curve on the façade" set component	Be-R	Be-R	Be-R
130	0:56.9 - 1:09.0	set range	Be-R	Be-R	Be-R
131	1:09.0 - 1:15.5	set parameter	S-R	S-R	S-R
132	1:15.5 - 1:31.1	rotating	Bs-K	Bs-K	Bs-K
133	1:31.1 - 1:37.2	Re-parameterized	Be-R	Be-R	Be-R
134	1:37.2 - 1:51.6	set parameters in y direction	Be-R	Be-R	Be-R
135		"make it larger"	Be-K	Be-K	Be-K
136	1:51.6 - 1:56.1	change parameter,	S-R	S-R	S-R
137	1:56.1 - 2:04.9	rotating	Bs-K	Bs-K	Bs-K
138	2:04.9 - 2:21.0	"make x direction smaller, y larger"	Be-R	Be-R	Be-R
139		Change parameters.	S-R	S-R	S-R
140	2:21.0 - 2:33.5	change range	Be-R	Be-R	Be-R
141	2:33.5 - 2:38.3	change parameters	S-R	S-R	S-R
142		"it looks ok"	Bs-K	Bs-K	Bs-K
143	2:38.3 - 2:50.9	set component "I'll pipe the iso-curve"	S-K	S-K	S-K
144	2:50.9 - 2:58.0	set parameters	S-R	S-R	S-R
145	2:58.0 - 3:05.6	rotating,	Bs-K	Bs-K	Bs-K
146		change parameters	S-R	S-R	S-R
147	3:05.6 - 3:09.1	rotating	Bs-K	Bs-K	Bs-K
148	3:09.1 - 3:13.4	"looks large, make it smaller"	Be-K	Be-K	Be-K
149	3:13.4 - 3:18.3	change parameter	S-R	S-R	S-R
150	3:18.3 - 3:28.0	rotating	Bs-K	Bs-K	Bs-K
151	3:28.0 - 3:39.8	"now un-shade other object to look at it" un-shade object	Bs-K	Bs-K	Bs-K
152	3:39.8 - 3:51.5	"now I am going to connect these three small building with the main building"	Be-K	S-K	Be-K
153	3:51.5 - 3:58.8	"so make something like a bridge to connect these separate parts"	Be-K	Be-K	Be-K
154	3:58.8 - 4:13.7	rotating	Bs-K	Bs-K	Bs-K
155	4:13.7 - 4:41.0	"make some ellipse here and then to connect them" rotating	S-K	S-K	S-K
156	4:41.0 - 5:06.2	rotating	Bs-K	Bs-K	Bs-K
157	5:06.2 - 5:17.6	"make a point on this surface" set component	S-K	S-K	S-K

158	5:17.6 - 5:37.2	set parameters	S-R	S-R	S-R
159	5:37.2 - 5:57.3	change parameters	S-R	S-R	S-R
160	5:57.3 - 6:08.8	set range	Be-R	Be-R	Be-R
161	6:08.8 - 6:16.8	changing parameters	S-R	S-R	S-R
162		"so that we can make it to a proper position"		S-K	S-K
163	6:16.8 - 6:29.3	"now we want to have an ellipse from this point"	Be-K	S-K	S-K
164		set component	S-R	S-R	S-R
165	6:29.3 - 6:57.3	set parameter	S-R	S-R	S-R
166	6:57.3 - 7:02.2	change parameters	S-R	S-R	S-R
167	7:02.2 - 7:10.3	rotating	Bs-K	Bs-K	Bs-K
168	7:10.3 - 7:17.5	"now we are going to project it on this surface" connecting component	S-R	Be-R	Be-R
169	7:34.3 - 7:53.4	rotating	Bs-K	Bs-K	Bs-K
170	7:53.4 - 8:50.7	to see if the component is right	Bs-R	Bs-R	Bs-R
171	8:50.7 - 9:22.3	"we try this" connecting with another component,	S-R	S-R	S-R
172	9:22.3 - 10:39.5	waiting	N	N	N
173	10:39.5 - 10:56.7	rotating to look for problem "give up"	Bs-R	Bs-K	Bs-K
174	10:56.7 - 11:13.9	rotating	Bs-K	Bs-K	Bs-K
175	11:13.9 - 11:26.2	changing parameter	S-R	S-R	S-R
176	11:26.2 - 11:37.5	rotating	Bs-K	Bs-K	Bs-K
177	11:37.5 - 11:48.9	set parameter	S-R	S-R	S-R
178	11:48.9 - 11:54.5	rotating	Bs-K	Bs-K	Bs-K
179	11:54.5 - 12:16.6	set parameter	S-R	S-R	S-R
180	12:16.6 - 12:30.3	change parameter	S-R	S-R	S-R
181	12:30.3 - 12:36.2	delete slider	S-R	S-R	S-R
182	12:36.2 - 13:41.2	change parameter	S-R-Pc	S-R	S-R
183	13:41.2 - 13:55.2	rotating	Bs-K	Bs-K	Bs-K
184	13:55.2 - 14:02.0	change parameter	S-R	S-R	S-R
185	14:02.0 - 14:06.0	rotating	Bs-K	Bs-K	Bs-K
186	14:06.0 - 14:14.9	changing parameter	S-R	S-R	S-R
187	14:14.9 - 14:24.2	rotating	Bs-K	Bs-K	Bs-K
188	14:24.2 - 15:25.1	set component to get the part of building, copy component	S-R	S-R	S-R
189	16:35.8 - 16:42.5	set parameter	S-R	S-R	S-R

190	16:42.5 - 16:50.1	"we will get out the surface and get one point from the surface"	Be-R	S-K	S-K
191	16:50.1 - 16:59.8	change parameters	S-R	S-R	S-R
192	16:59.8 - 17:08.8	make connection the same height with previous building	Be-R	Be-K	Be-K
193	17:08.8 - 17:48.3	rotating	Bs-K	Bs-K	Bs-K
194	17:48.3 - 18:04.2	change parameters	S-R	S-R	S-R
195	18:04.2 - 18:13.5	rotating	Bs-K	Bs-K	Bs-K
196	18:13.5 - 18:55.2	Try "project" again	S-R	Be-R	Be-R
197	18:55.2 - 19:28.6	set parameter	S-R	S-R	S-R
198	19:28.6 - 19:34.1	rotating	Bs-K	Bs-K	Bs-K
199	19:34.1 - 19:44.6	set parameter	S-R	S-R	S-R
200	19:44.6 - 19:55.6	rotating	Bs-K	Bs-K	Bs-K
201	19:55.6 - 20:00.9	set component to loft the two ellipse	S-K	S-K	S-K
202	20:00.9 - 20:21.2	rotating	Bs-K	Bs-K	Bs-K
203	20:21.2 - 20:29.7	flatten	Be-R	Be-R	Be-R
204	20:29.7 - 21:10.9	rotating	Bs-K	Bs-K	Bs-K
205	21:10.9 - 21:21.0	"make this ellipse smaller"	Be-K	Be-K	Be-K
206		changing parameter	S-R	S-R	S-R
207	21:21.0 - 21:27.7	"so I will do the same thing to other parts"	Be-R	S-K	S-K
208	21:27.7 - 22:31.3	copy components	S-R	S-R	S-R
209	22:31.3 - 22:42.8	"I will do it one by one"	Be-R	N	Be-R
210	22:42.8 - 22:51.0	set parameters	S-R	S-R	S-R
211	23:02.6 - 23:11.2	rotating	Bs-K	Bs-K	Bs-K
212	23:11.2 - 23:16.9	set parameters	S-R	S-R	S-R
213	23:16.9 - 23:27.2	rotating	Bs-K	Bs-K	Bs-K
214	23:27.2 - 24:03.6	looking for component, copy	S-R	S-R	S-R
215	24:03.6 - 24:12.0	"now we are going to change y direction"	Be-R	Be-R	Be-R
216	24:12.0 - 24:40.1	changing parameters	S-R	S-R	S-R
217	24:40.1 - 25:19.4	looking for component	N	N	N
218	25:19.4 - 25:24.4	copy component, connection	S-R	S-R	S-R
219	25:24.4 - 25:33.1	set component "loft"	S-K	S-K	S-K
220	25:43.3 - 25:49.0	rotating	Bs-K	Bs-K	Bs-K
221	26:25.7 -	"now we reset it" copy component	S-R	S-R	S-R

	26:32.6				
222	26:32.6 - 26:40.7	changing parameters	S-R	S-R	S-R
223	26:40.7 - 26:44.7	rotating	Bs-K	Bs-K	Bs-K
224	26:44.7 - 26:50.2	changing parameter	S-R	S-R	S-R
225	26:50.2 - 27:05.2	rotating	Bs-K	Bs-K	Bs-K
226	27:05.2 - 27:12.7	"I am looking for the lowest ellipse"	Be-K	Be-R	Be-R
227	27:12.7 - 27:28.2	connection	S-R	S-R	S-R
228	27:28.2 - 27:42.6	rotating	Bs-K	Bs-K	Bs-K
229	27:42.6 - 27:55.3	"now we are going to tidy the component, make it easier to bake" getting all we need to bake component together	N	N	N
230	28:17.0 - 28:37.1	rotating	Bs-K	Bs-K	Bs-K

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:56.6	reading design brief	R-K	R-K	R-K
2	0:56.6 - 1:10.8	Switch to rhino interface, rotating.	Bs-K	N	Bs-K
3	1:10.8 - 1:16.7	"this is a park, this is residential area, this is the main road" rotating	R-K	R-K	R-K
4	1:16.7 - 1:55.5	drawing line, zooming	Bs-K	S-K	S-K
5	1:55.5 - 2:01.5	"this is a shopping centre,	R-K	R-K	R-K
6		so we may consider people comes from residential area most,	Be-K	Be-K	Be-K
7		so that the main entrance may be here"	Be-K	F-K	F-K
8	2:01.5 - 2:15.3	"so this is the main entrance,	F-K	F-K	F-K
9		there will be at least one entrance from the main road"	Be-K	Be-K	Be-K
10		drawing line	S-K	S-K	S-K
11	2:15.3 - 2:27.8	"not too many entrance from here, so that the traffic on the main road will not be influenced too much"	Be-K	Be-K	Be-K
12	2:27.8 - 2:41.6	"this is a park,	F-K	F-K	F-K
13		so that people from residential area may go to park follow this way"	Be-K	Be-K	Be-K
14		drawing a line	S-K	S-K	S-K
15	2:41.6 - 2:52.5	" parking will be near the main road"	F-K	F-K	F-K
16	2:52.5 - 3:01.5	"car will drive this way, and here is quiet, people follow this way"	Be-K	Be-K	Be-K
17	3:01.5 - 3:58.3	"now we redraw the traffic route" delete and redraw the curve"	S-K	S-K	S-K
18	3:58.3 - 4:14.7	"this area can be parking"	F-K	F-K	F-K
19	4:14.7 - 4:32.1	"this is entrance, this is park,	F-K	F-K	F-K
20		we may consider here is outdoor activity area"	F-K	F-K	F-K

21		drawing curve	S-K	S-K	S-K
22	4:32.1 - 4:46.1	"so here is our building"	F-K	F-K	F-K
23	4:46.1 - 5:14.9	"so this curve façade is facing the main road, so that it looks better from road"	Bs-K	Be-K	Be-K
24		drawing curve	S-K	S-K	S-K
25	5:14.9 - 5:49.6	"now I am adjusting the curve to make it look better" adjust curve	S-K	Be-K	S-K
26	5:49.6 - 5:57.7	"6000m2" revisit design brief	R-K	R-K	R-K
27	5:57.7 - 6:44.2	open grasshopper "to see how large the circle is"	Bs-K	Bs-K	Bs-K
28	6:44.2 - 6:49.8	"now 3000 m2"	Bs-K	Bs-K	Bs-K
29	6:49.8 - 6:58.1	"if it is two storeys, it's fine"	R-K	Bs-K	R-K
30	6:58.1 - 7:06.1	" I am trying to make the curve look better,	S-K	S-K	S-K
31		and move it downward a little bit to leave the entrance more space" move the curve	F-K	Be-K	F-K
32		adjusting the curve	S-K	S-K	S-K
33	7:35.1 - 7:45.1	"this is a pathway, and we can make a platform here"	F-K	F-K	F-K
34	7:45.1 - 7:55.7	"make people get into building conveniently, and go to the park follow this way"	Be-K	Be-K	Be-K
35	7:55.7 - 8:52.1	"not get out of building, not too large, or the first floor will not have any sunlight"	Be-K	Be-K	Be-K
36		drawing the boundary of platform	S-K	S-K	S-K
37	8:52.1 - 9:15.3	"from the platform, people can get into the second floor of the building"	Be-K	Be-K	Be-K
38		adjusting the platform	S-K	S-K	S-K
39	9:15.3 - 10:16.9	"the platform should not be so large,	Bs-K	Bs-K	Bs
40		or it will shade the light, that's fine,	Be-K	Be	Be
41		the first floor maybe can have some functions do not need too much sunlight"	Be-K	Be	Be
42		adjusting the platform	S-K	S	S
43	10:16.9 - 10:32.9	"make the curve smooth" adjusting the platform curve	S-K	S	S
44	10:32.9 - 10:54.5	" outdoor activity area is too large"	Bs-K	Bs	Bs
45	10:54.5 - 11:08.9	"we move it a little bit,	S-K	S	S
46		and also leaves more space for the entrance"	F-K	Be	F-K
47	11:08.9 - 11:26.3	"make the platform smaller"	Be-K	Be	Be
48		adjusting the platform curve	S-K	S-K	S-K
49	11:26.3 - 11:32.7	"so this is our building, and this is the platform"	F-K	F-K	F-K
50	11:32.7 - 11:40.8	make a new layer	N	N	N
51	11:40.8 - 11:50.5	put all the curve into the layer	N	N	N
52	11:50.5 - 12:06.1	make another new layer	N	N	N
53	12:06.1 - 12:25.4	shade the un-needed layer	N	N	N
54	12:25.4 - 12:31.9	"now we are going to model the main building"	Be-K	Be-K	Be-K
55	12:31.9 - 12:36.5	"it should be two layers"	N	Be-K	Be-K

56	12:36.5 - 12:51.1	"looks like a ship" rotating	Bs-K	Bs-K	Bs-K
57	12:51.1 - 12:59.9	"offset, 12m" offset the curve	S-K	S-K	S-K
58	12:59.9 - 13:02.8	"too much" ctrl z	Bs-K	Bs-K	Bs-K
59	13:02.8 - 13:11.9	redo it "8 m"	S-K	S-K	S-K
60	13:11.9 - 13:19.7	rotating	Bs-K	Bs-K	Bs-K
61	13:19.7 - 13:23.3	"there is a sharp edge,	Bs-K	Bs-K	Bs-K
62		let's rebuild the curve"	S-K	S-K	S-K
63	13:23.3 - 13:35.5	"look at how much control point of the outside curve,	Be-K	Bs-K	Be-K
64		and we make the same number to the inside curve" rebuild the curve	Be-K	Be-K	Be-K
65	13:35.5 - 13:59.6	"now we adjust the curve to make it looks smoother" adjust the control point of the curve	S-K	S-K	S-K
66	13:59.6 - 14:13.3	"still sharp"	Bs-K	Bs-K	Bs-K
67		adjust the control point	S-K	S-K	S-K
68	14:13.3 - 14:37.1	"now we move it to the ceiling height"	Be-K	Be-K	Be-K
69	14:37.1 - 15:03.7	"5m each floor, so 10m two storeys"	Be-K	Be-K	Be-K
70		move the curve	S-K	S-K	S-K
71	15:03.7 - 15:10.2	"the ceiling should be curved,	S-K	S-K	S-K
72		we assume this is the centre of the building"	F-K	Be-K	Be-K
73	15:10.2 - 15:25.5	"we lift it to 12 m" move it to 12m	S-K	S-K	S-K
74	15:25.5 - 15:48.2	ctrl z, copy, re-lift the point	S-K	S-K	S-K
75	15:48.2 - 16:01.3	rotating	Bs-K	Bs-K	Bs-K
76	16:01.3 - 16:06.1	"now we are going to make some sections for sweeping"	Be-K	Be-K	Be-K
77	16:06.1 - 16:28.8	drawing a curve	S-K	S-K	S-K
78	16:28.8 - 17:10.0	rotate and delete the curve	S-K	S-K	S-K
79		draw four curves	S-K	S-K	S-K
80	17:10.0 - 17:34.0	"now we are moving the point to the peak" moving the point	S-K	S-K	S-K
81	17:34.0 - 17:52.8	extrude curve,	S-K	S-K	S-K
82		rotating	Bs-K	Bs-K	Bs-K
83		"now we are going to draw the section"	Be-K	Be-K	Be-K
84	17:52.8 - 18:20.3	rotating	Bs-K	Bs-K	Bs-K
85	18:20.3 - 18:38.4	make the intersection between curve and surface	S-K	Be-K	S-K
86	18:38.4 - 18:53.6	"now we are going to make the section, set Cplane here"	Be-K	Be-K	Be-K
87	18:53.6 - 19:10.8	drawing the curve of first section	S-K	S-K	S-K
88	19:10.7 - 19:20.6	drawing another curve of second section	S-K	S-K	S-K
89	19:20.6 - 19:23.9	rotating, delete the curve	S-K	S-K	S-K

90	19:23.9 - 19:26.8	"forget to set Cplane"	N	Be-K	N
91	19:26.8 - 20:14.1	change Cplane, draw another section	S-K	S-K	S-K
92	20:14.1 - 20:19.2	"now we have four sections" rotating	Bs-K	Bs-K	Bs-K
93	20:19.2 - 20:25.4	delete the analyse surface	N	S-K	S-K
94	20:25.4 - 20:28.8	rotating	Bs-K	Bs-K	Bs-K
95		"now we are going to make the sweep"	Be-K	S-K	S-K
96	20:28.8 - 20:47.1	hide unused curve	N	N	N
97	20:47.1 - 21:05.6	making sweep	S-K	S-K	S-K
98	21:05.6 - 21:14.7	rotating	Bs-K	Bs-K	Bs-K
99	21:14.7 - 21:36.1	delete the surface, try another time	S-K	S-K	S-K
100	21:36.1 - 21:49.6	"another method is to split the curve" rotating, splitting the curve	S-K	S-K	S-K
101	22:23.8 - 22:38.7	"try another time" splitting	S-K	S-K	S-K
102	22:38.6 - 23:02.6	"we will redraw it" ctrl z and delete the section	S-K	S-K	S-K
103	23:02.6 - 24:51.7	redraw the section	S-K	S-K	S-K
104	24:51.7 - 24:59.3	delete the reference surface	S-K	S-K	S-K
105	24:59.3 - 25:12.5	make sweep and generate the façade	S-K	S-K	S-K
106	25:12.5 - 25:19.2	rotating	Bs-K	Bs-K	Bs-K
107	25:19.2 - 25:37.4	sweep the ceiling	S-K	S-K	S-K
108	25:37.4 - 26:04.8	match the two surfaces	Be-K	Be-K	Be-K
109	26:04.8 - 26:13.9	rotating	Bs-K	Bs-K	Bs-K
110		"so this is the main building"	F-K	F-K	F-K
111	26:13.9 - 26:22.2	"now we start to do the platform"	F-K	F-K	F-K
112	26:22.2 - 26:29.3	rotating	Bs-K	Bs-K	Bs-K
113	26:29.3 - 26:50.3	change back to xy plane	Be-K	Be-K	Be-K
114	26:50.3 - 27:28.0	adjusting the platform boundary	S-K	S-K	S-K
115	27:28.0 - 28:00.1	"these point do not move,	S-K	Bs-K	Bs-K
116		The highest point is on the second floor."	Be-K	Be-K	Be-K
117		moving points	S-K	S-K	S-K
118	28:00.1 - 28:23.5	"this point is on 2m" moving points	S-K	S-K	S-K
119	28:23.5 - 28:52.3	rotating	Bs-K	Bs-K	Bs-K
120	28:52.3 - 29:25.5	patch and change another layer	S-K	S-K	S-K
121	29:25.5 - 29:36.2	extrude "to 0.2m"	S-K	S-K	S-K
122	29:36.2 - 29:43.6	rotating "looks ok"	Bs-K	Bs-K	Bs-K

123	29:43.6 - 29:52.0	"the platform is like this" rotating	Bs-K	Bs-K	Bs-K
124		"cars should be able to go through under this"	Be-K	Be-K	Be-K
125	29:52.0 - 29:55.3	rotating "a little bit low"	Bs-K	Bs-K	Bs-K
126	29:55.3 - 30:13.6	ctrl z, I am going to lift this a little bit	Be-K	S-K	Be-K
127	30:13.6 - 30:21.6	rotating	Bs-K	Bs-K	Bs-K
128	30:21.6 - 30:37.6	lift the platform "1m"	S-K	S-K	S-K
129	30:37.6 - 30:47.5	rotating	Bs-K	Bs-K	Bs
130	30:47.5 - 30:56.2	"lift to 1m"	S-K	S-K	S-K
131		rotating	Bs-K	Bs-K	Bs-K
132		"it can only be like this"	Bs-K	Bs-K	Bs-K
133	30:56.2 - 31:03.0	patch	S-K	S-K	S-K
134	31:03.0 - 31:30.6	put it into a new layer	N	N	N
135	31:30.6 - 31:46.8	extrude	S-K	S-K	S-K
136	31:46.8 - 31:50.6	"now we are going to make the main entrance"	Be-K	F-K	F-K
137	31:50.6 - 32:10.4	hide unnecessary object	N	N	N
138	32:10.4 - 32:23.7	make the intersection curve	S-K	S-K	S-K
139	32:23.7 - 32:33.7	hide the platform	N	N	N
140	32:33.7 - 32:43.6	rotating	Bs-K	Bs-K	Bs-K
141	32:43.6 - 32:59.9	get the iso curve,	S-K	Be-K	S-K
142		"this height should be enough"	Bs-K	Bs-K	Bs-K
143		"make it smaller"	Be-K	Be-K	Be-K
144	32:59.9 - 33:19.2	get the iso curve on v-direction	Be-K	Be-K	Be-K
145	33:19.2 - 34:40.6	cannot find the curve rotating	N	Bs-K	N
146	34:40.6 - 35:31.3	select the curve, trim group	S-K	S-K	S-K
147	35:31.3 - 35:37.1	rotating	Bs-K	Bs-K	Bs-K
148		"so we got the entrance"	F-K	Bs-K	F-K
149	35:37.1 - 35:59.6	split the surface	S-K	S-K	S-K
150	35:59.6 - 36:09.6	copy	S-K	S-K	S-K
151	36:09.6 - 36:21.8	bend the surface "because we shade the platform, so we cannot see if it works"	S-K	Be-K	Be-K
152	36:21.8 - 36:27.2	rotating	Bs-K	Bs-K	Bs-K
153	36:27.2 - 36:33.3	rotating "it looks ok"	Bs-K	Bs-K	Bs-K
154	36:33.3 - 36:56.5	"so we offset the entrance, about 2m"	Be-K	S-K	S-K
155	36:56.5 - 37:05.0	rotating" it's fine"	Bs-K	Bs-K	Bs-K
156	37:05.0 -	"because we cannot see the entrance clearly, we are	Be-K	Be-K	Be-K

	37:16.5	going to cut it a little"			
157	37:16.5 - 37:32.0	split	S-K	S-K	S-K
158		rotating	Bs-K	Bs-K	Bs-K
159	37:32.0 - 37:39.2	"now we are going to blend the surface of entrance"	Be-K	S-K	S-K
160	37:39.2 - 37:59.4	blending,	S-K	S-K	S-K
161		rotating	Bs-K	Bs-K	Bs-K
162	37:59.4 - 38:10.1	"I do not want it too bent"	Be-K	Be-K	Be-K
163		adjusting	S-K	S-K	S-K
164	38:10.1 - 38:29.9	rotating	Bs-K	Bs-K	Bs-K
165	38:29.9 - 38:32.4	"too bent, I'll redo it"	Bs-K	Bs-K	Bs-K
166	38:32.4 - 39:03.3	re-blend the surface	S-K	S-K	S-K
167	39:03.2 - 39:06.7	rotating "looks too flat"	Bs-K	Bs-K	Bs-K
168	39:06.7 - 39:48.2	re-blend the surface, adjusting the angle	S-K	S-K	S-K
169		rotating "it looks fine"	Bs-K	Bs-K	Bs-K
170	39:48.2 - 39:53.4	rotating "looks good"	Bs-K	Bs-K	Bs-K
171	39:53.4 - 41:16.9	"do a sweep to the inside entrance" making sweep	Be-K	Be-K	Be-K
172		"not working"	Bs-K	Bs-K	Bs-K
173	41:16.9 - 41:44.6	"try blend surface" blend surface	S-K	S-K	S-K
174	41:44.6 - 41:51.4	rotating	Bs-K	Bs-K	Bs-K
175		"now we are trying to make some windows"	F-K	F-K	F-K
176	41:51.4 - 42:00.9	rotating	Bs-K	Bs-K	Bs-K
177	42:00.9 - 42:47.5	"I am trying to make a ceiling window"	F-K	F-K	F-K
178		splitting ceiling	S-K	S-K	S-K
179	42:47.4 - 43:26.9	"0.5m" making the ceiling	S-K	S-K	S-K
180		"too much"	Bs-K	Bs-K	Bs-K
181		" make it more flat"	Be-K	Be-K	Be-K
182	43:26.9 - 43:41.8	hide unneeded object	N	N	N
183	43:41.8 - 43:58.6	"now making façade window"	F-K	S-K	F-K
184	43:58.6 - 44:20.2	making curve	S-K	S-K	S-K
185	44:20.2 - 44:27.3	rotating	Bs-K	Bs-K	Bs-K
186	44:27.3 - 46:07.1	making window	S-K	S-K	S-K
187	46:07.1 - 46:26.5	"offset 0.5, almost ok"	S-K	S-K	S-K
188	46:26.5 - 47:04.5	blend surface	S-K	S-K	S-K
189	47:04.5 - 47:28.7	put into a layer	N	N	N
190	47:28.7 - 47:35.1	rotating	Bs-K	Bs-K	Bs-K

191	47:35.1 - 48:14.5	"now we are going to make some small window"	F-K	F-K	F-K
192	48:14.5 - 48:41.9	make a new layer	N	N	N
193	48:41.9 - 50:39.5	"make the shape 4 edge, draw some random window"	Be-K	Be-K	Be-K
194		drawing window	S-K	S-K	S-K
195	50:39.5 - 51:00.0	project it to the surface	N	Be-K	Be-K
196	51:00.0 - 51:08.6	rotating	Bs-K	Bs-K	Bs-K
197	51:08.6 - 51:22.1	split the surface	S-K	S-K	S-K
198	51:22.1 - 53:09.1	select the window and put it into an independent layer	N	N	N
199	53:09.1 - 53:18.0	unhide all objects and rotating "almost done"	N	Bs-K	Bs-K
200	53:18.0 - 53:27.8	rotating	Bs-K	Bs-K	Bs-K
201		"now I am going to make the site planning better"	Be-K	Be-K	Be-K
202	53:27.8 - 54:32.4	adjusting the curve	S-K	S-K	S-K
203		"this parking area makes it look better"	F-K	F-K	F-K
204	54:32.3 - 54:59.1	here maybe some landscape "now here should be one entrance" rotating	F-K	F-K	F-K
205	54:59.1 - 55:07.7	rotating	Bs-K	Bs-K	Bs-K
206	55:07.7 - 55:27.2	"this platform should not be exceeding the building"	Be-K	Be-K	Be-K
207	55:27.2 - 55:32.4	"now I am going to adjust the platform"	Be-K	S-K	S-K
208	55:32.4 - 55:43.8	hide unneeded object	N	N	N
209	55:43.8 - 56:02.0	rotating	Bs-K	Bs-K	Bs-K
210	56:02.0 - 56:41.9	try scale or move	S-K	S-K	S-K
211	56:41.9 - 56:49.0	Un-shade object	N	N	N
212	56:49.0 - 57:30.2	move platform	S-K	S-K	S-K
213	57:30.2 - 57:51.8	rotating	Bs-K	Bs-K	Bs-K
214	57:51.8 - 57:58.5	move	S-K	S-K	S-K
215	57:58.5 - 58:06.1	rotating	Bs-K	Bs-K	Bs-K
216	58:06.1 - 58:07.1	"give up"	N	N	N
217		change the curve	S-K	S-K	S-K
218	59:29.4 - 59:42.9	rotating	Bs-K	Bs-K	Bs-K
219	59:42.9 - 1:00:08.9	extrude the platform	S-K	S-K	S-K
220	1:00:08.9 - 1:03:10.5	making the entrance	S-K	F-K	F-K
221	1:03:10.5 - 1:04:17.1	writing text on site planning	N	N	N
222	1:04:17.1 - 1:06:30.5	extrude planning curve for rendering	N	S-K	S-K
223	1:06:30.5 - 1:07:00.0	rotating "almost finished"	Bs-K	Bs-K	Bs-K

Designer 2

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	6:33.3 - 6:42.3	(make a curve and then delete)	S-K	S-K	S-K
2	6:42.3 - 6:56.5	(rotate the site model)	R-K	R-K	R-K
3	6:56.5 - 7:02.0	(making curves)	S-K	S-K	S-K
4	7:02.0 - 7:04.6	I am just designing plan, you know. (make curves) I am mimicking the accesses, two parts, along the park	F-K	F-K	F-K
5	7:04.6 - 7:22.6	I am always doing this, this is my first approach. I am going nowhere without that, you know	S-K	N	N
6		(make curves)	S-K	S-K	S-K
7	7:22.6 - 7:43.9	(trim curves)	S-K	S-K	S-K
8	7:43.9 - 8:27.7	(rotate the model)	F-K	Bs-K	Bs-K
9		I am start thinking about the site,		F-K	F-K
10	8:27.7 - 9:00.3	Do you say this side is street? (chamfer the corner)	R-K	R-K	R-K
11	9:00.3 - 9:44.3	(chamfer the corner)	S-K	S-K	S-K
12	9:44.3 - 9:51.6	(rotate the model)	Bs-K	Bs-K	Bs-K
13		I am trying to make these rectangles to one of the main road,	Be-K	Be-K	Be-K
14		which is the access of the site	F-K	F-K	F-K
15	9:51.6 - 10:10.3	(extrude the curve)	S-K	S-K	S-K
16	10:10.3 - 10:58.4	(rotate the model)	Bs-K	Bs-K	Bs-K
17		I am thinking whether I can find form in plan.	Be-K	R-K	Be-K
18	10:58.4 - 11:07.7	Looks not so nice, doesn't work.	Bs-K	Bs-K	Bs-K
19	11:07.7 - 11:33.5	(cage the volume)	S-K	S-K	S-K
20	11:33.5 - 11:44.1	(rotate the model)	Bs-K	Bs-K	Bs-K
21	11:44.1 - 11:50.8	(adjust points)	S-K	S-K	S-K
22	11:50.8 - 11:57.6	There is the surface at the external face of the cages, and we can adjust the boundary of the cages	Be-K	S-K	Be-K
23	11:57.6 - 12:02.5	And there will be two dimensions on it.	Bs-K	Bs-K	Bs-K
24		(move points)	S-K	S-K	S-K
25	12:02.5 - 12:20.3	Absolutely higher on this side. (rotate the model)	Bs-K	Bs-K	Bs-K
26	12:20.3 - 12:34.2	I will make this wider	Be-K	Be-K	Be-K
27		(move the points)	S-K	S-K	S-K
28	12:34.2 - 12:38.0	and higher here	Be-K	Be-K	Be-K
29		(move the points)	S-K	S-K	S-K

30	12:38.0 - 12:47.9	(rotate the model)	Bs-K	Bs-K	Bs-K
31	12:47.9 - 12:52.7	(adjust the points)	S-K	S-K	S-K
32		I am playing with these control points to make it as more pleasing way	Be-K	Be-K	Be-K
33	12:52.7 - 13:10.0	(rotate the model)	S-K	Bs-K	Bs-K
34	13:10.0 - 13:16.6	(cage the model)	S-K	S-K	S-K
35	13:16.6 - 13:26.1	(rotate the model) I'd like to see the various aspects,	Bs-K	Bs-K	Bs-K
36		work with clashing form, at the moment just to fill that idea	Be-K	Be-K	Be-K
37	13:26.1 - 13:43.3	(turn on the points)	Be-K	N	N
38	13:43.3 - 13:50.5	(adjust the points)	S-K	S-K	S-K
39	13:50.5 - 13:55.5	(rotate the model)	Bs-K	Bs-K	Bs-K
40	13:55.5 - 13:58.9	(adjust the points)	S-K	S-K	S-K
41	13:58.9 - 14:04.6	(rotate the model)	Bs-K	Bs-K	Bs-K
42		I am thinking the fact that the road exists, what happens on the road	Be-K	F-K	F-K
43	14:04.6 - 14:08.3	(adjust the points)	S-K	S-K	S-K
44	14:08.3 - 14:11.0	(rotate the model)	Bs-K	Bs-K	Bs-K
45	14:11.0 - 14:14.3	(adjust the points)	S-K	S-K	S-K
46	14:14.3 - 14:15.9	(rotate the model)	Bs-K	Bs-K	Bs-K
47		thinking about the response to the site conditions	R-K	F-K	F-K
48	14:15.9 - 14:21.0	(adjust the points)	S-K	S-K	S-K
49	14:21.0 - 14:26.2	(rotate the model)	Bs-K	Bs-K	Bs-K
50	14:26.2 - 14:29.5	(adjust the points)	S-K	S-K	S-K
51		this rectangle, I just want it to be along the road	Be-K	Be-K	Be-K
52	14:29.5 - 15:13.7	(rotate the model)	Bs-K	Bs-K	Bs-K
53	15:13.7 - 15:24.3	(switch to grasshopper interface)	N	N	N
54	15:24.3 - 15:39.0	(set "brep" and define the mass)	S-R	S-K	S-K
55	15:39.0 - 15:46.3	(rotate the model)	Bs-K	Bs-K	Bs-K
56	15:46.3 - 16:12.3	here the mass is done	Bs-K	Bs-K	Bs-K
57	16:12.3 - 16:30.3	now what happens is I will change the façade use this	Be-R	Be-R	Be-R
58	16:30.3 - 16:34.9	nearly done (rotate the model)	Bs-K	Bs-K	Bs-K
59	16:34.9 - 16:45.8	I can make the points randomly	Be-R	Be-R	Be-R
60	16:45.8 - 17:10.0	I don't know the component logo. (set component)	Be-R	S-R	S-R
61	17:10.0 - 17:14.7	(delete the component "pressure")	S-R	S-R	S-R

62	17:14.7 - 17:30.4	Spring? Is that? (looking for component)	N	N	N
63	17:30.4 - 17:36.1	(set "pressure" component)	Be-R	Be-R	Be-R
64	17:36.1 - 17:38.8	(delete the component "pressure")	S-R	S-R	S-R
65	17:38.8 - 17:54.5	(set component)	S-R	S-R	S-R
66	17:54.5 - 17:56.0	(delete component)	S-R	S-R	S-R
67	17:56.0 - 18:23.5	(rotate the model)	Bs-K	Bs-K	Bs-K
68	18:23.5 - 19:08.4	(set component)	S-R	S-R	S-R
69	19:08.4 - 19:18.8	(set "move" component)	S-K	S-K	S-K
70	19:18.8 - 19:23.6	(set "custom mesh setting" component)	S-R	Be-R	Be-R
71	19:23.6 - 19:32.7	we want the curves on the façade	Be-R	S-K	S-K
72		(set "web-edge" component)	S-R	Be-R	Be-R
73	19:32.7 - 19:40.3	I am previewing what I have got (rotate the model)	Bs-K	Bs-R	Bs-R
74	19:40.3 - 19:47.6	(rotate the model)	Bs-K	Bs-K	Bs-K
75	19:47.6 - 19:54.1	(set "decompose" component)	Be-R	Be-R	Be-R
76	19:54.1 - 19:58.4	we are making all the rules	Be-R	Be-R	Be-R
77	19:58.4 - 20:10.0	(set "web-poly..," component)	S-R	S-K	S-R
78	20:10.0 - 20:13.6	(delete the component)	S-R	S-R	S-R
79	20:13.6 - 20:24.7	(set "offset" component)	S-K	S-K	S-K
80	20:24.7 - 20:32.4	(rotate the model)	Bs-K	Bs-K	Bs-K
81	20:32.4 - 20:42.6	(making "function" expression)	Be-R	Be-R	Be-R
82	20:42.6 - 20:52.2	chatting	N	N	N
83	20:52.2 - 21:05.7	(set component)	S-R	S-R	S-R
84	21:05.7 - 21:12.3	(connect components)	S-R	S-R	S-R
85	21:12.3 - 21:15.5	we'll put a "triangle" to see if the things would work (set "triangle" component)	Be-R	Be-R	Be-R
86	21:15.5 - 21:24.6	probably not, lots of mesh will be triangle	Bs-R	Bs-R	Bs-R
87		(connect components)	S-R	S-R	S-R
88	21:24.6 - 21:27.7	let’s just put it up (hide components)	N	S-R	N
89	21:27.7 - 21:32.6	I will use kangaroo (set "kangaroo" component)	Be-R	Be-R	Be-R
90	21:32.6 - 21:42.2	(check the previous script)	Bs-R	Bs-R	Bs-R
91	21:42.2 - 21:47.9	the data tree actually needs to be reorganised	Bs-R	Bs-R	Bs-R
92	21:47.9 - 21:52.0	(set "list item")	Be-R	Be-R	Be-R
93	21:52.0 - 21:59.4	"I will come back to the data"	Be-R	Be-R	Be-R

94		(connect components)	S-R	S-R	S-R
95	21:59.4 - 22:01.6	(copy component "list item")	Be-R	Be-R	Be-R
96	22:01.6 - 22:05.9	(connect components)	S-R	S-R	S-R
97	22:09.2 - 22:11.0	(copy component "list item")	Be-R	Be-R	Be-R
98	22:11.0 - 22:15.5	This is the three points on the same levels	Bs-R	Bs-R	Bs-R
99		(connect component)	S-R	S-R	S-R
100	22:15.5 - 22:23.0	That would come to the "force objects"	Be-R	Bs-R	Be-R
101		(connect component)	S-R	S-R	S-R
102	22:23.0 - 22:36.9	(check the grasshopper interface)	Bs-R	Bs-R	Bs-R
103	22:36.9 - 22:41.0	(rotate the model)	Bs-K	Bs-K	Bs-K
104		these vertical lines, I want to keep that	Be-K	Be-R	Be-K
105	22:41.0 - 22:50.3	(check the grasshopper interface) it's having a condition	Bs-R	Bs-R	Bs-R
106	22:50.3 - 22:54.0	(set "sort points" component)	Be-R	Be-R	Be-R
107	22:54.0 - 22:59.0	(delete component)	S-R	S-R	S-R
108	22:59.0 - 23:00.8	(check the grasshopper interface)	Bs-R	Bs-R	Bs-R
109	23:00.8 - 23:10.0	(rotate the model) it's got points on	Bs-K	Bs-K	Bs-K
110	23:10.0 - 23:16.7	what size it is	Bs-K	Bs-K	Bs-K
111	23:16.7 - 23:18.5	(rotate the model)	Bs-K	Bs-K	Bs-K
112	23:18.5 - 23:21.5	then, I'll use "pressure level"	Be-R	Be-R	Be-R
113	23:21.5 - 23:26.8	(set "toggle" component)	S-R	Be-R	Be-R
114	23:26.8 - 23:31.3	(connect component)	S-R	S-R	S-R
115	23:36.0 - 23:45.2	(set "timing")	S-R	Be-R	Be-R
116	23:45.2 - 23:57.6	(set parameters) set it by timing, probable 10	S-R	S-R	S-R
117	23:57.6 - 24:09.6	nothing I've done so far is more than façade	Bs-K	N	N
118	24:09.6 - 24:41.2	chatting	N	N	N
119	24:41.2 - 24:57.2	Is it the problem of kangaroo? It can't looks right on red,	Bs-R	Bs-R	Bs-R
120	24:57.2 - 25:08.7	I am going to use a toggle	Be-R	Be-R	Be-R
121	25:08.7 - 25:19.2	yes, all right	Bs-R	Bs-R	Bs-R
122	25:19.2 - 25:20.8	that's true (change parameters)	S-R	S-R	S-R
123		reduce the pressure inside the building	Be-K	Be-R	Be-R
124	25:20.8 - 25:29.9	it can't be all right like that	Bs-R	Bs-K	Bs-R
125		(set parameters)	S-R	S-R	S-R
126	25:29.9 - 25:44.1	I know time is running out, I can't keep on writing and writing	N	N	N

127	25:44.1 - 25:49.1	nice	Bs-K	Bs-K	Bs-K
128	25:49.1 - 25:58.6	(rotate the model)	Bs-K	Bs-K	Bs-K
129	25:58.6 - 26:29.8	(waiting)	N	N	N
130	26:29.8 - 26:43.3	(rotate the model) I am trying to get how it looks	Bs-K	Bs-K	Bs-K
131	26:43.3 - 26:46.1	not enough variation	Bs-R	Bs-R	Bs-R
132	26:46.1 - 26:53.6	(rotate the model)	Bs-K	Bs-K	Bs-K
133	26:53.6 - 27:09.9	(set "toggle")	Be-R	Be-R	Be-R
134	27:09.9 - 27:14.1	(rotate the model)	Bs-K	Bs-K	Bs-K
135	27:14.1 - 27:44.8	(waiting)	N	N	N
136	27:44.8 - 27:47.4	(change parameters)	S-R	S-R	S-R
137	27:47.4 - 27:49.8	(change parameters)	S-R	S-R	S-R
138		this is just trying to get some more interesting things	Be-K	Be-K	Be-K
139	27:49.8 - 28:07.9	(rotate the model)	Bs-K	Bs-K	Bs-K
140	28:07.9 - 28:21.4	(change parameters)	S-R	S-R	S-R
141		just trying to get some variation	Be-R	Be-R	Be-R
142	28:20.3 - 28:38.8	(rotate the model)	Bs-K	Bs-K	Bs-K
143	28:38.8 - 28:47.1	(check previous script)	Bs-R	Bs-R	Bs-R
144	28:47.1 - 28:51.0	(rotate the model)	Bs-K	Bs-K	Bs-K
145	28:51.0 - 28:57.9	(change properties of kangaroo)	Be-R	Bs-R	Bs-R
146		using kangaroo to generate the mesh, changing the mesh, inflate it in different ways and then change the "pressure" in it	Be-R	Be-R	Be-R
147	28:57.9 - 29:02.6	(rotate the model)	Bs-K	Bs-K	Bs-K
148	29:02.6 - 29:10.5	(change layer properties)	N	N	N
149	29:10.5 - 29:18.0	(save file)	N	N	N
150	29:18.0 - 29:22.8	exactly 40 mins	N	N	N
151	29:22.8 - 29:25.1	change parameters	S-R	S-R	S-R
152	29:25.1 - 29:28.4	yeah!(rotate the model)	Bs-K	Bs-K	Bs-K
153	29:28.4 - 29:34.5	(delete points)	S-K	S-K	S-K
154	29:34.5 - 29:43.2	(rotate the model)	Bs-K	Bs-K	Bs-K
155	29:43.2 - 29:48.3	(adjust points)	S-K	S-K	S-K
156	29:48.3 - 30:04.8	(rotate the model)	Bs-K	Bs-K	Bs-K
157	30:04.8 - 30:09.4	(adjust points)	S-K	S-K	S-K

158	30:09.4 - 30:11.7	(rotate the model)	Bs-K	Bs-K	Bs-K
159	30:11.7 - 30:16.7	(adjust points)	S-K	S-K	S-K
160		just get a bit more definition, it is just planning and boring, so I try to manually -bring out something	Be-K	Be-K	Be-K
161	30:16.7 - 30:28.7	(adjust points)	S-K	S-K	S-K
162	30:28.7 - 30:34.4	(rotate the model)	Bs-K	Bs-K	Bs-K
163	30:34.4 - 30:56.3	(adjust points)	S-K	S-K	S-K
164	30:56.3 - 31:04.4	(rotate the model)	Bs-K	Bs-K	Bs-K
165	31:04.4 - 31:07.4	(adjust points)	S-K	S-K	S-K
166	31:07.4 - 31:10.5	(rotate the model)	Bs-K	Bs-K	Bs-K
167	31:10.5 - 31:33.3	(adjust points)	S-K	S-K	S-K
168	31:33.3 - 31:42.0	(rotate the model)	Bs-K	Bs-K	Bs-K
169	31:42.0 - 31:46.0	(adjust points)	S-K	S-K	S-K
170	31:46.0 - 31:48.6	(rotate the model)	Bs-K	Bs-K	Bs-K
171	31:48.6 - 31:55.0	(adjust points)	S-K	S-K	S-K
172	31:55.0 - 32:15.0	(rotate the model)	Bs-K	Bs-K	Bs-K
173	32:15.0 - 32:21.6	(make ground)	S-K	F-K	F-K
174	32:21.6 - 32:30.4	(delete points)	S-K	S-K	S-K
175	32:30.4 - 32:41.0	(rotate the model)	Bs-K	Bs-K	Bs-K
176	32:41.0 - 32:47.1	(rendering)	Bs-K	Bs-K	Bs-K
177	32:47.1 - 32:51.0	(rotate the model)	Bs-K	Bs-K	Bs-K
178	32:51.0 - 32:55.7	(rendering)	Bs-K	Bs-K	Bs-K
179	32:55.7 - 33:01.6	(rotate the model)	Bs-K	Bs-K	Bs-K
180	33:01.6 - 33:08.5	the mesh and curve looks good	Bs-K	Bs-K	Bs-K
181	33:08.5 - 33:17.8	(rotate the model)	Bs-K	Bs-K	Bs-K
182	33:17.8 - 34:01.9	(duplicate points)	S-K	S-k	S-k
183	34:01.9 - 34:09.5	(rotate the model)	Bs-K	Bs-K	Bs-K
184	34:09.5 - 35:09.2	(duplicate points)	S-K	S-K	S-K
185	35:09.2 - 35:44.5	(rotate the model)	Bs-K	Bs-K	Bs-K
186	35:44.5 - 35:49.2	(change colour of the model)	S-K	S-K	S-K
187	35:49.2 - 35:59.6	(change colour of building mass)	S-K	S-K	S-K
188	35:59.6 - 36:12.5	(change properties of the layer)	N	N	N

189	36:12.5 - 36:24.9	(rotate the model)	Bs-K	Bs-K	Bs-K
190	36:24.9 - 38:07.1	(set camera, rendering) finished	N	N	N

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:40.8	Is this task 2? So this one is just using rhino. Can I start now?	R-K	R-K	R-K
2	0:40.8 - 0:58.3	(rotate the site model)	R-K	R-K	R-K
3	0:58.3 - 1:07.2	chatting	N	N	N
4	1:07.2 - 1:18.5	all right, here we go	N	N	N
5	1:18.5 - 1:47.7	task 1, shopping centre, design an ... (read design brief) 6000 metres, one or two storeys, ok	R-K	R-K	R-K
6	1:54.1 - 2:09.8	So, first, I would like to look at the access. Not so much.	F-K	Be-K	F-K
7		(draw curve)	S-K	S-K	S-K
8	2:09.8 - 2:14.2	main access	F-K	F-K	F-K
9		(draw curve)	S-K	S-K	S-K
10	2:14.2 - 2:23.5	access and transportation	F-K	Be-K	F-K
11		(rotate the model)	Bs-K	Bs-K	Bs-K
12	2:23.5 - 2:31.6	(draw curve)	S-K	S-K	S-K
13	2:31.6 - 2:38.1	I can refer to them when I'm designing the building	Be-K	Be-K	Be-K
14		(draw curve)	S-K	S-K	S-K
15	2:38.1 - 3:06.7	make a new layer, put curves in the layer	N	N	N
16	3:06.7 - 3:18.3	(rotate the model)	Bs-K	Bs-K	Bs-K
17	3:18.3 - 3:21.3	(delete the ground)	S-K	S-K	S-K
18	3:21.3 - 3:25.8	I am going to make a new layer	Be-K	N	N
19	3:25.8 - 3:33.2	it doesn't give it in a way.	Bs-K	Bs-K	Bs-K
20		(change the colour of the layer)	Be-K	N	N
21	3:33.2 - 3:40.2	(change the colour of the ground)	S-K	S-K	S-K
22	3:40.2 - 3:56.2	(put curves in a layer)	N	N	N
23	3:56.2 - 4:02.3	(rotate the model) well, I like it	Bs-K	Bs-K	Bs-K
24	4:02.3 - 4:15.9	now this is the park	F-K	F-K	F-K
25		(rotate the model)	Bs-K	Bs-K	Bs-K
26	4:15.9 - 4:24.9	(draw curves)	S-K	S-K	S-K
27	4:24.9 - 4:31.3	(rotate the model)	Bs-K	Bs-K	Bs-K
28	4:31.3 - 4:41.5	so we are going to draw the entrance to the access	Be-K	F-K	F-K

29		(draw curves)	S-K	S-K	S-K
30	4:41.5 - 4:55.0	(draw a circle)	S-K	S-K	S-K
31	4:55.0 - 4:57.4	(rotate the model) that's pretty good	Bs-K	Bs-K	Bs-K
32	4:57.4 - 5:00.2	maybe not	Bs-K	Bs-K	Bs-K
33		(delete the curve)	S-K	S-K	S-K
34	5:00.2 - 5:03.9	here we are (redraw the curve)	S-K	S-K	S-K
35	5:03.9 - 5:07.9	(rotate the model)	Bs-K	Bs-K	Bs-K
36	5:07.9 - 5:11.5	going to give this an access, too	Be-K	F-K	F-K
37	5:11.5 - 5:23.7	(draw curve)	S-K	S-K	S-K
38	5:23.7 - 5:33.3	(move the curve)	S-K	S-K	S-K
39	5:33.3 - 5:39.4	all right, let's make this point to this	Be-K	S-K	S-K
40		(extend curve)	S-K	S-K	S-K
41	5:43.1 - 5:49.1	still planning, which may be some baby in shell which provide direction for design	N	Be-K	N
42	5:49.1 - 5:54.3	And rooky... to do such thing (rotate the model)	Bs-K	Bs-K	Bs-K
43	5:54.3 - 5:58.1	but sometimes, it works	N	N	N
44	5:58.1 - 6:19.3	now we are going to bring some dimension according to this	Be-K	Be-K	Be-K
45	6:19.3 - 6:33.5	the tools outside geometry is a bit low	Bs-K	N	Bs-K
46		(draw curve)	S-K	S-K	S-K
47	6:33.5 - 6:51.7	still planning the design, oh, look at that, some interesting thing	Bs-K	Bs-K	Bs-K
48	6:51.7 - 7:18.9	(rotate the model)	Bs-K	Bs-K	Bs-K
49	7:18.9 - 7:27.1	(delete curves)	S-K	S-K	S-K
50	7:27.1 - 7:42.0	(trim curves)	S-K	S-K	S-K
51	7:42.0 - 7:57.9	(draw curves and move)	S-K	S-K	S-K
52	7:57.9 - 8:05.0	(trim curves)	S-K	S-K	S-K
53	8:05.0 - 8:13.6	(rotate the model)	Bs-K	Bs-K	Bs-K
54	8:13.6 - 8:22.5	all right, so now I am going to get some volumes, and try	Be-K	Be-K	Be-K
55	8:22.5 - 8:37.9	reference the height of the adjunct company	Be-K	Be-K	Be-K
56		(extrude curve)	S-K	S-K	S-K
57	8:37.9 - 8:53.3	(rotate the model)	Bs-K	Bs-K	Bs-K
58	8:53.3 - 8:56.7	(draw a curve)	S-K	S-K	S-K
59	8:56.7 - 9:02.2	(rotate the model)	Bs-K	Bs-K	Bs-K
60	9:02.2 - 9:26.1	kind of mirror it to the (mirror)	S-K	S-K	S-K
61	9:26.1 -	maybe not	S-K	Bs-K	S-K

	9:29.4				
62	9:29.4 - 9:38.7	(rotate the curve)	Bs-K	Bs-K	Bs-K
63	9:38.7 - 9:44.5	all right, that's look much better (rotate the model)	Bs-K	Bs-K	Bs-K
64	9:44.5 - 9:51.3	(rotate the model)	Bs-K	Bs-K	Bs-K
65	9:51.3 - 9:59.4	(make surface from curves)	S-K	S-K	S-K
66	9:59.4 - 10:04.4	(rotate the model)	Bs-K	Bs-K	Bs-K
67	10:04.4 - 10:06.7	right, I need much more now	Be-K	Be-K	Be-K
68	10:06.7 - 10:13.5	interesting geometry	Bs-K	Bs-K	Bs-K
69	10:13.5 - 10:24.8	(make surface from curves) here we go	S-K	S-K	S-K
70	10:24.8 - 10:29.8	(rotate the model)	Bs-K	Bs-K	Bs-K
71		I wish it can get sharper	Be-K	Be-K	Be-K
72	10:29.8 - 10:35.3	(delete the surface)	S-K	S-K	S-K
73	10:35.3 - 10:41.8	(planar surface)	S-K	S-K	S-K
74	10:41.8 - 10:45.5	not much more towards it exactly	Bs-K	Be-K	Be-K
75		(delete the surface)	S-K	S-K	S-K
76	10:45.5 - 10:48.0	I will set this exaggerate	Be-K	Be-K	Be-K
77	10:48.0 - 10:52.7	sort of "under craft" area	F-K	Bs-K	F-K
78		(rotate the model)	Bs-K	Bs-K	Bs-K
79	10:52.7 - 11:13.9	(changing curves)	S-K	S-K	S-K
80	11:11.5 - 11:22.1	it's totally looks good (rotate the model)	Bs-K	Bs-K	Bs-K
81	11:22.1 - 11:25.2	(delete curves)	S-K	S-K	S-K
82	11:25.3 - 11:28.6	(rotate the model)	Bs-K	Bs-K	Bs-K
83	11:28.6 - 11:32.1	(make surface from points)	S-K	S-K	S-K
84	11:32.1 - 11:40.2	It’s a bit shape–. Under cross-. (rotate the model)	Bs-K	Bs-K	Bs-K
85	11:40.2 - 11:46.2	(make surface from points)	S-K	S-K	S-K
86	11:46.2 - 12:22.4	not bad (rotate the model)	Bs-K	Bs-K	Bs-K
87	12:22.4 - 12:46.5	yes, it seems symmetry to the street	Be-K	Bs-K	Bs-K
88		(rotate the model)	Bs-K	Bs-K	Bs-K
89	12:46.5 - 12:51.3	some odd things here, not quite right (rotate the model)	Bs-K	Bs-K	Bs-K
90	12:51.3 - 13:03.4	not so... like this (rotate the model)	Bs-K	Bs-K	Bs-K
91	13:03.4 - 13:10.1	under crafty at the moment (rotate the model)	Bs-K	Bs-K	Bs-K
92	13:10.1 - 13:24.5	I am just trying a bit more brand.-	Be-K	Be-K	Be-K
93		(connect points)	S-K	S-K	S-K

94	13:24.5 - 13:36.4	(make a surface)	S-K	S-K	S-K
95	13:36.4 - 13:52.5	it's all symmetry	Be-K	Bs-K	Bs-K
96		(draw a circle)	S-K	S-K	S-K
97	13:52.5 - 14:07.5	it is the wall inside the shopping centre	F-K	F-K	F-K
98		(make surface)	S-K	S-K	S-K
99	14:07.5 - 14:14.4	I am going to split the hole, the shape (split)	S-K	S-K	S-K
100	14:14.4 - 14:17.3	(delete curve)	S-K	S-K	S-K
101	14:17.3 - 14:20.1	And I am going to patch it up (patch).	S-K	S-K	S-K
102	14:26.4 - 14:48.4	Here we go, I like that (rotate the model).	Bs-K	Bs-K	Bs-K
103	14:49.2 - 15:02.5	now just come to planning	Be-K	Be-K	Be-K
104	15:02.5 - 15:31.3	(rotate the model)	Bs-K	Bs-K	Bs-K
105	15:31.3 - 15:40.5	now I am trying to do something with this side of the building	Be-K	Be-K	Be-K
106	15:40.5 - 15:50.3	just we can sort of make the pedestrians walk	F-K	F-K	F-K
107		into this	Be-K	S-K	S-K
108	15:50.7 - 16:24.4	(rotate the model) that looks not nice	Bs-K	Bs-K	Bs-K
109	16:37.9 - 16:44.5	it's pretty weird, (rotate the model)	Bs-K	Bs-K	Bs-K
110	17:00.4 - 17:24.4	(extrude a curve to make a planar) extruding the boundary of the site,	S-K	S-K	S-K
111		this is the entrance space, this is probably coffee area, meeting points, entrance points	F-K	F-K	F-K
112	17:24.4 - 17:43.6	I need to make this across the street,	Be-K	Be-K	Be-K
113		here is the junction of the street,	F-K	F-K	F-K
114		It will create more isolated space at the back.	Be-K	F-K	F-K
115		That's probably away from these centre energy. For giving… actually having grounds to the access to the property.	Bs-K	Be-K	Be-K
116	17:43.6 - 17:51.2	(rotate the surface) yes, ok	Bs-K	Bs-K	Bs-K
117	17:51.2 - 18:30.0	(rotate again) I think I’m going to get it	Bs-K	Bs-K	Bs-K
118	18:30.0 - 18:44.7	Ok. again, I am going to make a surface	S-K	S-K	S-K
119	18:45.3 - 18:53.0	I am just interacting with the site conditions	F-K	Be-K	F-K
120	18:53.0 - 19:03.3	(rotate the model)	Bs-K	Bs-K	Bs-K
121	19:03.3 - 19:15.7	(make a surface)	S-K	S-K	S-K
122	19:24.2 - 19:29.1	(rotate the model)	Bs-K	Bs-K	Bs-K
123	19:29.1 - 19:35.3	(extend the surface)	S-K	S-K	S-K
124	19:41.0 - 20:36.4	(rotate the model)	Bs-K	Bs-K	Bs-K
125	20:36.4 - 20:41.6	(extend the surface)	S-K	S-K	S-K

126	20:41.6 - 20:43.8	(rotate the model)	Bs-K	Bs-K	Bs-K
127	20:43.8 - 20:48.8	(extend the surface)	S-K	S-K	S-K
128	20:48.3 - 21:01.6	(rotate the model)	Bs-K	Bs-K	Bs-K
129	21:01.6 - 21:10.7	(delete a surface)	S-K	S-K	S-K
130	21:15.9 - 21:22.9	(rotate the model)	Bs-K	Bs-K	Bs-K
131	21:22.9 - 21:26.2	(delete a surface)	S-K	S-K	S-K
132	21:26.2 - 21:32.3	now I am thinking this façade	F-K	S-K	F-K
133		(delete a surface)	S-K	S-K	S-K
134	21:32.3 - 21:40.7	it becomes... on the west side	Bs-K	Be-K	Be-K
135	21:40.7 - 21:47.7	this side (rotate the model)	Bs-K	Bs-K	Bs-K
136	21:47.7 - 21:49.6	(make a surface)	S-K	S-K	S-K
137	21:49.9 - 21:57.2	(rotate the model)	Bs-K	Bs-K	Bs-K
138	21:57.2 - 22:21.1	this is now sort of meeting point	F-K	F-K	F-K
139		(make a surface)	S-K	S-K	S-K
140	22:21.1 - 22:31.4	Requirement matches the condition of properties. (Rotate the model).	Bs-K	Bs-K	Bs-K
141	22:31.3 - 22:34.1	but it is provided some pitch roof or skirted roof	F-K	F-K	F-K
142	22:34.1 - 22:40.7	so this provide some slots	F-K	Bs-K	F-K
143	22:40.7 - 22:47.4	so you get saints soon, ... roof forms	N	F-K	F-K
144	22:47.4 - 23:00.8	(make a surface)	S-K	S-K	S-K
145	23:01.6 - 23:08.5	it looks quite good (rotate the model)	Bs-K	Bs-K	Bs-K
146	23:08.5 - 23:17.0	(make a surface)	S-K	S-K	S-K
147	23:17.0 - 23:22.0	(rotate the model)	Bs-K	Bs-K	Bs-K
148	23:22.0 - 23:30.4	People take some transport to get there, there...	Be-K	Be-K	Be-K
149	23:30.4 - 23:40.5	(rotate the model)	Bs-K	Bs-K	Bs-K
150	23:40.5 - 23:44.6	(delete a surface)	S-K	S-K	S-K
151	23:44.6 - 24:08.0	(rotate the model)	Bs-K	Bs-K	Bs-K
152	24:08.0 - 24:14.6	(delete a surface)	S-K	S-K	S-K
153	24:11.5 - 24:17.3	I would say I am not happy with that.	Bs-K	Bs-K	Bs-K
154	24:17.3 - 24:21.6	That big bare wall.	F-K	Bs-K	Bs-K
155	24:21.6 - 24:26.3	(rotate the model) it is really boring, the big rectangle what we are in expose.	Bs-K	Bs-K	Bs-K
156		And I want to stretch it from massive levels.	Be-K	Be-K	Be-K
157	24:26.3 - 24:32.0	I am going to get down from there	Be-K	Be-K	Be-K

158		(Make surface).	S-K	S-K	S-K
159	24:32.0 - 24:37.0	(Rotate the model).	Bs-K	Bs-K	Bs-K
160	24:37.0 - 24:39.1	(delete a surface)	S-K	S-K	S-K
161	24:39.1 - 24:41.5	(delete a surface)	S-K	S-K	S-K
162	24:41.5 - 24:45.3	(Rotate the model).	Bs-K	Bs-K	Bs-K
163	24:45.3 - 24:47.3	(delete a surface)	S-K	S-K	S-K
164	24:47.3 - 24:56.6	(making surface)	S-K	S-K	S-K
165	24:56.6 - 25:04.6	(making surface)	S-K	S-K	S-K
166	25:04.6 - 25:15.7	(Rotate the model).	Bs-K	Bs-K	Bs-K
167		I want to take it out of the ground, facing the street	Be-K	Be-K	Be-K
168	25:15.7 - 25:22.2	(making surface)	S-K	S-K	S-K
169	25:22.2 - 25:29.2	(rotate the model) looking good now	Bs-K	Bs-K	Bs-K
170	25:29.2 - 25:31.5	looking very good (rotate the model)	Bs-K	Bs-K	Bs-K
171	25:41.5 - 25:48.6	so now just making a pink. (make layers)	S-K	Be-K	N
172	25:48.6 - 26:00.8	(rotate the model)	Bs-K	Bs-K	Bs-K
173	26:00.8 - 26:03.8	Here we are	N	N	N
174	26:03.8 - 26:07.0	(change colours)	S-K	S-K	S-K
175	26:07.0 - 26:10.7	continue the external wall	S-K	S-K	S-K
176	26:10.7 - 26:19.7	maybe reduce the channel	Be-K	S-K	Be-K
177		(copy surfaces)	S-K	S-K	S-K
178	26:19.7 - 26:26.3	we can put it here so that everyone could access	Be-K	Be-K	Be-K
179	26:26.3 - 26:30.3	(measure distance) 12 metres	Bs-K	Bs-K	Bs-K
180	26:30.3 - 26:32.6	it's huge	Bs-K	Bs-K	Bs-K
181	26:32.6 - 26:37.2	that's a big lane	F-K	Bs-K	Bs-K
182	26:37.2 - 26:43.7	it's 91 metres long, that is a huge building	Bs-K	Bs-K	Bs-K
183	26:47.4 - 26:58.0	so that we need somehow to check	Be-K	Be-K	Be-K
184	26:58.8 - 27:08.4	You don't want to scale your whole buildings because I did it for two storeys.	Be-K	Be-K	Be-K
185		(rotate the model)	Bs-K	S-K	Bs-K
186	27:08.4 - 27:17.5	It is two storeys, but now...	F-K	Bs-K	Bs-K
187	27:17.5 - 27:20.2	check the scale (as said)	Be-K	Bs-K	Bs-K
188	27:20.2 - 27:24.2	10000 metres, that's huge	Bs-K	Bs-K	Bs-K
189	27:24.2 - 27:29.8	at least 4 storeys there (rotate the model)	Bs-K	Bs-K	Bs-K

190	27:29.8 - 27:40.1	I say, it's ok anyway, so it does not need too much footprint	N	Be-K	Be-K
191	27:40.1 - 27:43.2	so I start to build the building for pint now (rotate the model) because I do worry that the scale a bit	Be-K	Be-K	Be-K
192	27:51.0 - 28:01.2	so again, let's make these channel (copy surface)	S-K	S-K	S-K
193	28:01.2 - 28:03.9	(rotate the model)	Bs-K	Bs-K	Bs-K
194	28:03.9 - 28:06.7	scale the channel a bit (scale)	S-K	S-K	S-K
195	28:06.7 - 28:11.3	the wall coming out of the earth, that gives our concept	Be-K	Be-K	Be-K
196	28:14.4 - 28:20.0	(scale)	S-K	S-K	S-K
197	28:20.0 - 28:31.4	(rotate the model)	Bs-K	Bs-K	Bs-K
198	28:31.4 - 28:36.9	maybe copy this (copy)	S-K	S-K	S-K
199	28:36.9 - 28:41.1	extend on this line directly, I suppose	Be-K	Be-K	Be-K
200	28:41.1 - 28:50.2	Some new building (extend the wall)	S-K	S-K	S-K
201	28:50.2 - 28:57.8	that tends to be attached to the building, though	Be-K	Bs-K	Be-K
202		(rotate the model)	Bs-K	Bs-K	Bs-K
203	28:57.8 - 29:31.0	(split the surface)	S-K	S-K	S-K
204	29:31.0 - 29:39.7	very nice,	Bs-K	Bs-K	Bs-K
205		to trimming (trim surface)	S-K	S-K	S-K
206	29:39.7 - 29:44.6	(rotate the model)	Bs-K	Bs-K	Bs-K
207	29:44.6 - 29:55.9	(scale the surface)	S-K	S-K	S-K
208	29:55.9 - 29:59.2	(trim)	S-K	S-K	S-K
209	29:59.2 - 30:02.1	here we go (rotate the model)	Bs-K	Bs-K	Bs-K
210	30:02.1 - 30:03.6	(trim)	S-K	S-K	S-K
211	30:03.6 - 30:13.5	(make a surface)	S-K	S-K	S-K
212	30:13.5 - 30:27.4	maybe we can actually dig the edge of that and have a running straight into the ground	Be-K	Be-K	Be-K
213	30:27.4 - 30:37.2	I expect a wall extend on the ground	Be-K	Be-K	Be-K
214		(draw curves)	S-K	S-K	S-K
215	30:37.2 - 30:44.2	it goes as far as I want	Be-K	Bs-K	Be-K
216		(extend the curve)	S-K	S-K	S-K
217	30:44.2 - 30:52.8	(draw curves)	S-K	S-K	S-K
218	31:07.2 - 31:14.1	(trim)	S-K	S-K	S-K
219	31:14.1 - 31:23.2	(make a surface)	S-K	S-K	S-K
220	31:23.2 - 31:43.8	(rotate the model)	Bs-K	Bs-K	Bs-K
221	31:43.8 - 31:57.9	(copy curves)	S-K	S-K	S-K

222	31:57.9 - 32:00.6	(delete curves)	S-K	S-K	S-K
223	32:00.6 - 32:10.7	(rotate the model)	Bs-K	Bs-K	Bs-K
224	32:10.7 - 32:13.6	isn't it good?(rotate the model)	Bs-K	Bs-K	Bs-K
225	32:24.4 - 32:27.3	(delete curves)	S-K	S-K	S-K
226	32:34.3 - 32:37.0	just move that to there (move the surface)	S-K	S-K	S-K
227	32:39.5 - 32:43.5	looks good (rotate the model)	Bs-K	Bs-K	Bs-K
228	32:43.5 - 32:50.2	(draw curves)	S-K	S-K	S-K
229	32:50.2 - 33:05.0	(delete the curve)	S-K	S-K	S-K
230	33:05.0 - 33:07.8	(delete the surface)	S-K	S-K	S-K
231	33:07.8 - 33:10.0	(rotate the model)	Bs-K	Bs-K	Bs-K
232	33:10.0 - 33:13.9	(delete the surface)	S-K	S-K	S-K
233	33:13.9 - 33:20.7	(make a surface)	S-K	Bs-K	S-K
234	33:29.1 - 33:32.6	(delete the surface)	S-K	S-K	S-K
235	33:32.6 - 33:51.4	(rotate the curve)	Bs-K	Bs-K	Bs-K
236	33:51.4 - 34:04.3	(make a surface)	S-K	S-K	S-K
237	34:04.3 - 34:06.9	oh, a hole happened there	Bs-K	Bs-K	Bs-K
238	34:06.9 - 34:08.2	(delete the surface)	S-K	S-K	S-K
239	34:08.2 - 34:14.3	(make a surface)	S-K	S-K	S-K
240	34:14.3 - 34:20.1	(rotate the model)	Bs-K	Bs-K	Bs-K
241	34:20.1 - 34:23.8	(make a surface)	S-K	S-K	S-K
242	34:23.8 - 34:25.6	it's strange (rotate the model)	Bs-K	Bs-K	Bs-K
243	34:25.6 - 34:30.5	just try to repair the hole there	Be-K	S-K	Be-K
244		(delete the surface)	S-K	S-K	S-K
245	34:30.5 - 34:37.1	(make a surface)	S-K	S-K	S-K
246	34:37.1 - 34:40.4	yes, it's what I want	Bs-K	Bs-K	Bs-K
247	34:40.4 - 34:45.1	(Rotate the model) ok, that's it.	Bs-K	Bs-K	Bs-K
248	34:45.1 - 34:49.5	a huge building, it's big (measure distance) it's 100 metres long, so that is much bigger than that	Bs-K	Bs-K	Bs-K
249	34:54.0 - 34:58.1	we can get the park, and the kids plays at the back	F-K	F-K	F-K
250	34:58.1 - 35:05.3	looks good (rotate the model) looks like a waddle, good (rotate the model)	Bs-K	Bs-K	Bs-K

Designer 3

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:39.6	Evaluate the site, read brief	R-K	R-K	R-K
2	0:39.6 - 0:42.2	put a point on site	Be-R	S-K	S-K
3	0:42.2 - 1:06.2	draw the site boundary	R-K	R-K	R-K
4	1:06.2 - 1:23.0	"so in top view, up is north?"	F-K	F-K	F-K
5	1:23.0 - 1:35.4	zoom in, set another point, set multiple points,	S-K	S-K	S-K
6	1:35.4 - 1:49.7	"those points become attractors to the script, to put the points where the .. know what script do"	Be-R	Be-R	Be-R
7	1:49.7 - 2:09.8	change to perspective view	Bs-K	Bs-K	Bs-K
8	2:09.8 - 2:11.9	move up points	S-K	S-K	S-K
9	2:11.9 - 2:17.7	"I would like to put these points into the location where you could potentially drag people into the building"	Be-K	Be-K	Be-K
10	2:17.7 - 2:22.4	rotate	Bs-K	Bs-K	Bs-K
11	2:22.4 - 2:27.3	move up points	S-K	S-K	S-K
12	2:27.3 - 2:46.6	"maybe you could ask questions"	N	N	N
13	2:46.6 - 3:04.5	"I am just going to drag this"	S-K	Be-K	S-K
14	3:04.5 - 3:36.3	copy points	S-K	S-K	S-K
15	3:36.3 - 3:41.6	change the location of points	S-K	S-K	S-K
16	3:41.6 - 3:52.6	copy and drag points	S-K	S-K	S-K
17	3:52.6 - 3:55.6	rotate the model	Bs-K	Bs-K	Bs-K
18	3:55.6 - 4:27.0	import existing grasshopper definition	S-R	S-R	S-R
19	4:27.0 - 4:39.2	"we have to use grasshopper, do we?"	R-K	R-K	R-K
20	4:39.2 - 4:59.0	pan on the script interface	Bs-R	Bs-R	Bs-R
21	4:59.0 - 5:10.4	previewing	Bs-R	Bs-R	Bs-R
22	5:10.4 - 5:17.1	change the relationship	S-R	S-R	S-R
23	5:17.1 - 5:25.4	previewing	Bs-R	Bs-R	Bs-R
24	5:25.4 - 5:35.7	"adjust the nest"	Be-K	Be-K	Be-K
25	5:35.7 - 5:41.6	switch to rhino interface, scale the points	S-K	S-K	S-K
26	5:41.6 - 5:48.4	go back to grasshopper interface, pick up new points	S-K	S-K	S-K
27	5:48.4 - 6:13.8	previewing	Bs-R	Bs-R	Bs-R
28	6:13.4 - 6:20.3	import external data	S-R	S-R	S-R
29	6:13.8 - 6:14.6	undo scale	S-K	S-K	S-K
30	6:20.3 -	"is it ok mostly or cannot use rhino or use other	R-K	R-K	R-K

	6:29.9	things"?"			
31	6:29.9 - 6:32.6	(select points)	S-K	N	S-K
32	6:32.6 - 6:39.6	change "Toggle-true to false"	Be-R	Be-R	Be-R
33	6:39.6 - 6:43.3	preview	Bs-K	Bs-R	Bs-K
34	6:43.3 - 6:51.8	change parameter	S-R	S-R	S-R
35	6:51.8 - 6:55.3	preview	Bs-R	Bs-R	Bs-R
36	6:55.3 - 7:00.5	change relationship	S-R	S-R	S-R
37	7:00.5 - 7:06.5	preview	Bs-R	Bs-R	Bs-R
38	7:06.5 - 7:09.4	change parameter (three)	S-R	S-R	S-R
39	7:09.4 - 7:16.9	preview	Bs-R	Bs-R	Bs-R
40	7:16.9 - 7:27.2	change parameter	S-R	S-R	S-R
41	7:27.2 - 7:31.0	preview	Bs-R	Bs-R	Bs-R
42	7:31.1 - 7:35.9	change parameter	S-R	S-R	S-R
43	7:35.9 - 7:37.7	change relationship	S-R	S-R	S-R
44	7:37.7 - 7:41.5	preview	Bs-R	Bs-R	Bs-R
45	7:41.5 - 7:49.2	change parameter	S-R	S-R	S-R
46	7:49.2 - 8:00.7	preview	Bs-R	Bs-R	Bs-R
47	8:00.7 - 8:05.3	change parameter	S-R	S-R	S-R
48	8:05.3 - 8:14.8	"there we go" preview	Bs-R	Bs-R	Bs-R
49	8:14.8 - 8:20.1	check previous definition	Bs-R	Bs-R	Bs-R
50	8:20.1 - 8:28.8	import external definition	S-R	S-R	S-R
51	8:28.8 - 8:38.0	preview	Bs-R	Bs-R	Bs-R
52	8:38.0 - 9:01.1	import external definition	S-R	S-R	S-R
53	9:01.1 - 9:05.6	write new note	Be-R	N	N
54	9:05.6 - 9:12.4	rotate model	Bs-K	Bs-K	Bs-K
55	9:12.4 - 9:15.3	"I just need some golden nest"	Be-K	Be-K	Be-K
56	9:15.3 - 9:30.7	"no, I am still doing the golden nest" rotate model	Bs-K	Bs-K	Bs-K
57	9:30.7 - 9:43.1	"try to figure out the capacity of the shopping centre"	Be-K	F-K	Be-K
58	9:43.1 - 9:56.1	rotate the model	Bs-K	Bs-K	Bs-K
59	9:56.1 - 10:03.4	"I am designing a shopping centre"	F-K	F-K	F-K
60	10:03.4 - 10:11.3	draw a curve in rhino	S-K	S-K	S-K
61	10:11.3 -	rotating the model	Bs-K	Bs-K	Bs-K

	10:15.8				
62	10:15.8 - 10:20.0	revolve the curve	S-K	S-K	S-K
63	10:20.0 - 10:29.5	change the colour of egg	S-K	S-K	S-K
64	10:29.5 - 10:32.9	rotate the model	Bs-K	Bs-K	Bs-K
65	10:32.9 - 10:41.3	delete the egg	S-K	S-K	S-K
66	10:41.3 - 10:45.2	Set “curve" component in grasshopper	S-K	S-K	S-K
67	10:45.2 - 10:49.0	set "end" component in grasshopper	S-K	Be-R	Be-R
68	10:49.0 - 10:56.1	set "revaluation srf" component	S-K	S-K	S-K
69	10:56.1 - 10:59.9	set "line" component	S-K	S-K	S-K
70	10:59.9 - 11:03.2	connected	S-R	S-R	S-R
71	11:03.2 - 11:06.8	adjust control point in Rhino	S-K	S-K	S-K
72	11:06.8 - 11:19.4	rotate the model (look at the geometry of the egg)	Bs-K	Bs-K	Bs-K
73	11:19.4 - 11:34.1	adjust control point in Rhino	S-K	S-K	S-K
74	11:34.1 - 11:39.5	bake	N	N	n
75	11:39.5 - 11:49.1	rotate the model	Bs-K	Bs-K	Bs-K
76	11:49.1 - 12:16.7	(looking for the place to put the egg)	S-K	S-K	S-K
77	12:16.7 - 12:26.9	change to another layer	N	N	n
78	12:26.9 - 12:45.4	pan on the grasshopper interface	Bs-R	Bs-R	Bs-R
79	12:45.4 - 13:04.0	rotate the model	Bs-K	Bs-K	Bs-K
80	13:04.0 - 13:13.6	shade the model and rotate	Bs-K	Bs-K	Bs-K
81	13:13.6 - 13:27.1	scale the points	S-K	S-K	S-K
82	13:27.1 - 13:29.2	change the note in grasshopper	Be-R	N	N
83	13:29.2 - 13:34.0	preview	Bs-R	Bs-R	Bs-R
84	13:34.0 - 13:37.9	save to document	N	N	N
85	13:37.9 - 13:42.5	make new layer in rhino	N	N	N
86	13:42.5 - 13:45.6	bake	N	N	N
87	13:45.6 - 13:50.5	rotate	Bs-K	Bs-K	Bs-K
88	13:50.5 - 14:03.2	"adjust the nest"	Be-K	Be-K	Be-K
89	14:03.2 - 14:18.9	select the nest, scale the nest in rhino	S-K	S-K	S-K
90	14:18.9 - 14:21.5	move the nest	S-K	S-K	S-K
91	14:21.5 - 14:33.5	rotate the model	Bs-K	Bs-K	Bs-K
92	14:33.5 -	move the nest	S-K	S-K	S-K

	14:43.8				
93	14:43.8 - 14:53.6	rotate the model	Bs-K	Bs-K	Bs-K
94	14:53.6 - 14:57.8	close the layer	N	N	N
95	14:57.8 - 15:03.0	change the relationship	S-R	S-R	S-R
96	15:03.0 - 15:17.7	rotate the model	Bs-K	Bs-K	Bs-K
97	15:17.7 - 15:26.4	manage document	N	N	N
98	15:26.4 - 15:28.5	preview	Bs-R	Bs-R	Bs-R
99	15:28.5 - 15:32.8	make new layer	N	N	N
100	15:32.8 - 15:40.8	rotate the model	Bs-K	Bs-K	Bs-K
101	15:40.8 - 15:49.8	scale in rhino	S-K	S-K	S-K
102	15:49.8 - 15:53.2	move the nest	S-K	S-K	S-K
103	15:53.2 - 16:01.9	rotate the model	Bs-K	Bs-K	Bs-K
104	16:01.9 - 16:05.3	move the nest	S-K	S-K	S-K
105	16:05.3 - 16:09.4	rotate the model	Bs-K	Bs-K	Bs-K
106	16:09.4 - 16:18.2	move the egg into the nest	S-K	S-K	S-K
107	16:18.2 - 16:23.3	rotate the model	Bs-K	Bs-K	Bs-K
108	16:23.3 - 16:25.1	move the egg	S-K	S-K	S-K
109	16:25.1 - 16:28.0	move the egg	S-K	S-K	S-K
110	16:28.0 - 16:34.3	rotate the model	Bs-K	Bs-K	Bs-K
111	16:34.3 - 16:38.2	rotate egg	S-K	S-K	S-K
112	16:38.2 - 16:45.6	move egg	S-K	S-K	S-K
113	16:45.6 - 16:49.8	"smaller"	Be-k	Be-K	Be-k
114	16:49.8 - 16:52.3	scale the egg	S-K	S-K	S-K
115	16:52.3 - 17:01.8	rotate the model (to see the location of egg)	Bs-K	Bs-K	Bs-K
116	17:01.8 - 17:05.2	copy egg	S-K	S-K	S-K
117	17:05.2 - 17:11.6	rotate egg	S-K	Bs-K	S-K
118	17:11.6 - 17:20.9	move the egg	S-K	S-K	S-K
119	17:20.9 - 17:26.1	move the egg	S-K	S-K	S-K
120	17:26.1 - 17:29.8	rotate the egg	S-K	S-K	S-K
121	17:29.8 - 17:34.3	move the egg	S-K	S-K	S-K
122	17:34.3 - 17:35.9	rotate the model	Bs-K	Bs-K	Bs-K
123	17:35.9 -	adjust angle of rotating	S-K	S-K	S-K

	17:45.5				
124	17:45.5 - 17:51.6	scale the egg again	S-K	S-K	S-K
125	17:51.6 - 17:58.0	move the egg again	S-K	S-K	S-K
126	17:58.0 - 18:01.6	scale the egg again	S-K	S-K	S-K
127	18:01.6 - 18:04.8	move the egg again	S-K	S-K	S-K
128	18:04.8 - 18:08.3	rotate the model to see the egg location	Bs-K	Bs-K	Bs-K
129	18:08.3 - 18:12.1	copy egg	S-K	S-K	S-K
130	18:12.1 - 18:16.4	rotate the egg	S-K	Bs-K	S-K
131	18:16.4 - 18:19.1	move the egg	S-K	S-K	S-K
132	18:19.1 - 18:25.0	move the egg again	S-K	S-K	S-K
133	18:25.0 - 18:26.2	rotate the model to see the egg location	Bs-K	Bs-K	Bs-K
134	18:26.2 - 18:30.8	rotate the egg again	S-K	S-K	S-K
135	18:30.8 - 18:37.9	scale the egg again	S-K	S-K	S-K
136	18:37.9 - 18:46.9	move the egg again	S-K	S-K	S-K
137	18:46.9 - 18:47.7	rotate the egg again	S-K	S-K	S-K
138	18:47.7 - 18:51.3	move the egg again	S-K	S-K	S-K
139	18:51.3 - 18:58.0	rotate the model	Bs-K	Bs-K	Bs-K
140	18:58.0 - 19:04.1	rotate the egg again	S-K	S-K	S-K
141	19:04.1 - 19:06.5	rotate the model	Bs-K	Bs-K	Bs-K
142	19:06.5 - 19:23.6	move the egg again	S-K	S-K	S-K
143	19:23.6 - 19:34.4	"see the location of egg"	Be-K	Be-K	Be-K
144	19:34.4 - 19:38.8	rotate the model to	Bs-K	Bs-K	Bs-K
145	19:38.8 - 19:41.8	"see the relationship between eggs"	Be-K	Be-K	Be-K
146	19:41.8 - 19:47.0	rotate the model	Bs-K	Bs-K	Bs-K
147	19:47.0 - 19:53.2	copy the egg	S-K	S-K	S-K
148	19:53.2 - 19:59.0	rotate the egg	S-K	S-K	S-K
149	19:59.0 - 20:13.0	rotate the model	Bs-K	Bs-K	Bs-K
150	20:13.0 - 20:21.7	scale the egg	S-K	S-K	S-K
151	20:21.7 - 20:41.1	move the egg	S-K	S-K	S-K
152	20:41.1 - 21:03.9	rotate the model	Bs-K	Bs-K	Bs-K
153	21:03.9 - 21:06.2	"Pretty awesome, isn't it?"	Bs-K	Bs-K	Bs-K
154	21:06.2 -	"we just figure out how can it be a shopping centre"	F-K	F-K	F-K

	21:13.6				
155	21:13.6 - 21:22.5	"so how"	Be-K	Be-K	Be-K
156	21:22.5 - 21:28.1	rotate the model	Bs-K	Bs-K	Bs-K
157	21:28.1 - 21:35.1	rotate the model" it is kind of like a whole stuff, touch the ground,	Bs-K	Bs-K	Bs-K
158	21:35.1 - 21:37.0	and we play with it.."	Be-K	Be-K	Be-K
159	21:37.0 - 21:40.3	rotate the model	Bs-K	Bs-K	Bs-K
160	21:40.3 - 21:43.1	rotate the nest	S-K	S-K	S-K
161	21:43.1 - 21:50.0	move the nest	S-K	S-K	S-K
162	21:50.0 - 21:54.7	rotate the model	Bs-K	Bs-K	Bs-K
163	21:54.7 - 22:03.1	move the model again	S-K	S-K	S-K
164	22:03.1 - 22:11.4	rotate the model	Bs-K	Bs-K	Bs-K
165	22:11.4 - 22:20.0	rotate the nest again	S-K	S-K	S-K
166	22:20.0 - 22:24.4	move the nest again	S-K	S-K	S-K
167	22:24.4 - 22:31.9	rotate the model	Bs-K	Bs-K	Bs-K
168	22:31.9 - 22:40.9	undo the move	S-K	S-K	S-K
169	22:40.9 - 22:45.1	scale the model	S-K	S-K	S-K
170	22:45.1 - 22:54.1	rotate the nest again	S-K	S-K	S-K
171	22:54.1 - 22:59.4	rotate the model	Bs-K	Bs-K	Bs-K
172	22:59.4 - 23:02.2	move the model again	S-K	S-K	S-K
173	23:02.2 - 23:14.1	rotate the model	Bs-K	Bs-K	Bs-K
174	23:14.1 - 23:24.5	scale the model again	S-K	S-K	S-K
175	23:24.5 - 23:32.8	rotate the model	Bs-K	Bs-K	Bs-K
176	23:32.8 - 23:38.2	change layer	N	N	N
177	23:38.2 - 23:51.0	make a surface in rhino	S-K	S-K	S-K
178	23:51.0 - 24:03.5	rotate the model	Bs-K	Bs-K	Bs-K
179	24:03.5 - 24:14.7	scale one of the eggs again	S-K	S-K	S-K
180	24:14.7 - 24:29.9	move the egg again	S-K	S-K	S-K
181	24:29.9 - 24:47.9	select the nest, export the nest	N	S-K	N
182	24:47.9 - 24:55.6	"How long do we have to go? 20mins?"	N	N	N
183	24:55.6 - 25:03.3	change thickness of the nest	S-K	Bs-K	Bs-K
184	25:03.3 - 25:08.6	change parameters	S-R	S-R	S-R
185	25:08.6 -	change parameters	S-R	S-R	S-R

	25:16.3				
186	25:16.3 - 25:31.1	extract pipe the nest	S-K	S-K	S-K
187	25:31.1 - 25:43.8	change layer	N	N	N
188	25:43.8 - 26:14.7	shade, rotate the model	Bs-K	Bs-K	Bs-K
189	26:14.7 - 27:09.8	hide layer	N	N	N
190	27:09.8 - 27:13.3	change parameters	S-R	S-R	S-R
191	27:13.3 - 27:54.8	change parameters	S-R	S-R	S-R
192	27:54.8 - 27:59.1	change parameters	S-R	S-R	S-R
193	27:59.1 - 28:09.5	change layer	N	N	N
194	28:09.5 - 28:31.2	rotate the model	Bs-K	Bs-K	Bs-K
195	28:31.2 - 28:34.5	export the nest, scale the nest	S-K	S-K	S-K
196	28:34.5 - 29:06.1	export again, scale the nest again	S-K	S-K	S-K
197	29:06.1 - 29:28.9	close the program, open again	N	N	N
198	29:28.9 - 29:33.8	scale the nest again	S-K	S-K	S-K
199	29:33.8 - 30:08.3	rotate the model	Bs-K	Bs-K	Bs-K
200	30:08.3 - 30:37.0	open the file again	N	N	N
201	30:37.0 - 30:49.3	scale again	S-K	S-K	S-K
202	30:49.3 - 31:39.3	"almost finished" open file again, “just a couple of more tricks", open the programme	N	N	N
203	31:39.3 - 31:56.4	rotate the model	Bs-K	Bs-K	Bs-K
204	31:56.4 - 31:59.8	change parameters	S-R	S-R	S-R
205	31:59.8 - 33:16.2	rotate the model	Bs-K	Bs-K	Bs-K
206	33:16.2 - 33:21.4	make new layer	N	N	N
207	33:21.4 - 33:38.2	hide nest, rotate the model	Bs-K	Bs-K	Bs-K
208	33:38.2 - 33:50.6	open the program	N	N	N
209	33:50.6 - 34:18.4	scale the model	S-K	S-K	S-K
210	34:18.4 - 34:34.6	rotate the model	Bs-K	Bs-K	Bs-K
211	34:34.6 - 35:06.9	change parameters	S-R	S-R	S-R
212	35:19.2 - 35:46.1	make layer	N	N	N
213	35:46.1 - 35:54.0	save document	N	N	N
214	35:54.0 - 36:01.2	make layer	N	N	N
215	36:01.2 - 36:24.7	scale the model	S-K	S-K	S-K
216	36:24.7 -	rotate the model	Bs-K	Bs-K	Bs-K

	36:37.6				
217	36:37.6 - 37:06.6	save document "almost done", open the program	N	N	N
218	37:06.6 - 37:48.5	change parameters	S-R	S-R	S-R
219	37:48.5 - 38:00.6	rotate the model,	Bs-K	Bs-K	Bs-K
220	38:00.6 - 38:10.4	change parameters	S-R	S-R	S-R
221	38:10.4 - 38:18.0	rotate the model	Bs-K	Bs-K	Bs-K
222	38:18.0 - 38:42.3	open the program	N	N	N
223	38:42.3 - 38:48.9	change parameter	S-R	S-R	S-R
224	38:48.9 - 39:00.8	rotate model,	Bs-K	Bs-K	Bs-K
225	39:00.8 - 39:08.7	change parameter	S-R	S-R	S-R
226	39:08.7 - 39:30.6	rotate model	Bs-K	Bs-K	Bs-K
227	39:30.0 - 39:45.6	save document	N	N	N
228	39:45.6 - 40:18.0	"didn't work" rotate the model	Bs-K	Bs-K	Bs-K
229	40:18.0 - 43:08.0	rendering	N	Bs-K	Bs-K

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 1:18.4	So pretty much the similar task, right?	R-K	R-K	R-K
2	0:05.8 - 0:05.9	"so let us start by extracting the whole site"	Be-K	Be-K	Be-K
3		"I will start a new layer called "mass" (set new layer)	Be-K	Be-K	Be-K
4	1:18.4 - 1:31.5	extrude the boundary of site	F-K	S-K	S-K
5	1:31.5 - 1:41.4	"and then I would like to cap it"	S-K	Be-K	S-K
6	1:41.6 - 1:48.6	"oh, it's not right" delete	S-K	Bs-K	Bs-K
7	1:48.6 - 2:09.6	"who drew the site?" redraw the boundary of site	S-K	R-K	R-K
8	2:09.6 - 2:14.7	extrude	S-K	S-K	S-K
9	2:14.7 - 2:31.6	"yeah, community centre done"	N	F-K	N
10	2:31.6 - 2:36.7	"So I have to consider traffic route, parking area, residential area, façade,..."	R-K	R-K	R-K
11	2:36.7 - 2:39.8	it's just to get a mass to operate on, rather than use an attitude first to design a building,	Be-K	Be-K	Be-K
12	2:39.8 - 2:56.5	I will design it as some attractive process.	Be-K	Be-K	Be-K
13	2:56.5 - 3:03.5	"No other things to consider, right? OK, let's just do this"	R-K	R-K	R-K
14	3:03.5 - 3:12.2	Rotate the model.	Bs-K	Bs-K	Bs-K
15	3:12.2 - 3:19.4	"and we can chamfer from the corner a bit"	Be-K	S-K	Be-K

16	3:19.4 - 3:27.9	Draw curve to chamfer the corner.	S-K	S-K	S-K
17	3:27.4 - 3:38.4	Make a surface used to chamfer the corner.	S-K	S-K	S-K
18	3:38.3 - 3:42.6	"I am going to chamfer the corner"	S-K	Be-K	Be-K
19	3:42.6 - 3:53.1	rotate the model	Bs-K	Bs-K	Bs-K
20	3:53.1 - 4:04.7	"I am going to try, anyway." trim the corner	S-K	Be-K	S-K
21	4:04.7 - 4:11.5	delete the surface	S-K	Bs-K	S-K
22	4:11.5 - 4:15.2	" about the thinking, modelling in Rhino has nothing to do with .."	N	Be-K	N
23	4:15.2 - 4:22.0	trim the corner	S-K	S-K	S-K
24	4:22.8 - 4:36.4	"OK, now it looks great" rotate the model	Bs-K	Bs-K	Bs-K
25		"in front of the corner, that's considering an entrance"	F-K	F-K	F-K
26	4:36.4 - 5:07.0	" now I am going to consider the traffic route"	F-K	Be-K	F-K
27	5:07.0 - 5:20.6	"all right, some make it cracking"	Be-K	N	Be-K
28	5:20.6 - 5:28.7	rotate the model	Bs-K	Bs-K	Bs-K
29	5:28.7 - 5:35.0	draw curve on the façade	S-K	S-K	S-K
30	5:35.0 - 5:55.9	evaluating	Bs-K	Bs-K	Bs-K
31	5:55.9 - 6:11.7	draw curve on the façade	S-K	S-K	S-K
32	6:11.7 - 6:23.9	rotate the model	Bs-K	Bs-K	Bs-K
33	6:23.9 - 6:44.4	extrude	S-K	S-K	S-K
34	6:44.4 - 6:51.0	Boolean difference	S-K	S-K	S-K
35	6:51.0 - 7:02.3	draw curve on the façade	S-K	S-K	S-K
36	7:02.3 - 7:29.3	"Just thinking that to make it as a different front."	Be-K	F-K	F-K
37	7:29.3 - 7:54.2	rotate the model	Bs-K	Bs-K	Bs-K
38	7:54.2 - 8:26.8	split the façade	S-K	S-K	S-K
39	8:26.8 - 8:44.4	extrude	S-K	S-K	S-K
40	8:44.4 - 9:15.4	delete duplicate surface	S-K	S-K	S-K
41	9:15.4 - 9:21.4	rotate the model	Bs-K	Bs-K	Bs-K
42	9:21.4 - 9:34.9	"kind of looking at it while you are thinking"	N	Be-K	N
43	9:34.9 - 9:53.9	joint the model	S-K	S-K	S-K
44	9:53.9 - 10:18.6	move the ground surface	S-K	S-K	S-K
45	10:18.6 - 10:45.4	"I am making the ground different to the top."	Be-K	Be-K	Be-K
46	10:45.4 - 10:53.8	rotate the model	Bs-K	Bs-K	Bs-K

47	10:53.8 - 11:19.3	offset the plane	S-K	S-K	S-K
48	11:19.3 - 11:50.7	rotate the model	Bs-K	Bs-K	Bs-K
49	11:50.7 - 12:07.3	shade points,	N	N	N
50	12:07.3 - 12:14.9	rotate the model	Bs-K	Bs-K	Bs-K
51	12:14.9 - 12:38.1	"you can see how I really shut that"	Be-K	Be-K	Be-K
52	12:37.9 - 12:52.3	draw curve on the façade	S-K	S-K	S-K
53	12:52.3 - 12:57.4	draw curve and then joint them together	S-K	S-K	S-K
54	12:57.4 - 13:03.9	extrude the plane on the surface	S-K	S-K	S-K
55	13:03.9 - 13:10.8	"I am making part of the façade flush with the ."	S-K	Be-K	Be-K
56	13:10.8 - 13:16.6	. From the ground level, central to the corner.	F-K	S-K	F-K
57	13:16.6 - 13:27.5	rotate the model	Bs-K	Bs-K	Bs-K
58	13:27.5 - 13:41.9	joint the model,	S-K	S-K	S-K
59	13:41.9 - 13:47.8	"We need to take the whole..."	Be-K	Be-K	Be-K
60	13:47.8 - 13:56.3	rotate the model	Bs-K	Bs-K	Bs-K
61	13:56.3 - 14:02.2	select bottom surface	S-K	S-K	S-K
62	14:02.2 - 14:18.3	"just thinking about what to do next"	N	N	N
63	14:18.3 - 14:23.4	joint the model	S-K	S-K	S-K
64	14:23.4 - 14:28.1	delete duplicate curve	S-K	S-K	S-K
65	14:28.1 - 14:50.1	"it's pretty un exciting"	Bs-K	Bs-K	Bs-K
66	14:50.1 - 14:55.9	offset the curve	S-K	S-K	S-K
67	14:55.9 - 15:05.7	make planar	S-K	S-K	S-K
68	15:05.7 - 15:33.4	delete duplicate curves	S-K	S-K	S-K
69	15:33.4 - 15:58.2	extrude the bottom surface	S-K	S-K	S-K
70	15:58.2 - 16:02.5	planar surface	S-K	S-K	S-K
71	16:02.5 - 16:14.3	joint the model	S-K	S-K	S-K
72	16:14.3 - 16:34.8	Boolean the façade	S-K	S-K	S-K
73	16:34.8 - 16:49.6	"too thick",	Bs-K	Bs-K	Bs-K
74		delete the Boolean surface	S-K	S-K	S-K
75	16:49.6 - 16:58.9	redo the Boolean again	S-K	S-K	S-K
76	16:58.9 - 17:05.2	rotate the model	Bs-K	Bs-K	Bs-K
77	17:05.2 - 17:14.0	cap the surface	S-K	S-K	S-K
78	17:14.0 -	"the consideration of here is when I articulate the	Bs-K	Bs-K	Bs-K

	17:30.8	circular more, I found it's treatment façade as segments and layers of tree or sth,			
79	17:30.8 - 18:03.9	And then you can slice layers and layers and review, and make the façade more interesting.	Be-K	Be-K	Be-K
80	18:03.9 - 18:16.2	Making windows even more exactly some performance than shapes.	F-K	Be-K	F-K
81	18:16.2 - 18:20.8	Getting more executed that funny shape,.….	Be-K	S-K	Be-K
82	18:20.8 - 18:35.8	rotate the model	Bs-K	Bs-K	Bs-K
83	18:35.8 - 18:53.5	move the model	S-K	S-K	S-K
84	18:53.5 - 19:11.5	save document	N	N	N
85	19:11.5 - 19:23.0	explode the model as mesh	S-K	Be-K	Be-K
86	19:23.0 - 19:31.3	"I spend lots of time to make lots of layers, when you set that shape, it's kind of that adjust the angles, it match the interesting process to creating performance less uniform.	Be-K	Be-K	Be-K
87	19:31.3 - 19:52.8	offset mesh	S-K	S-K	S-K
88	19:52.8 - 20:33.4	change the thickness of mesh	S-K	S-K	S-K
89	20:33.4 - 20:39.9	offset mesh again	S-K	S-K	S-K
90	20:39.9 - 20:48.0	repeat the command	S-K	S-K	S-K
91	20:48.0 - 20:51.0	rotate the model	Bs-K	Bs-K	Bs-K
92	20:51.0 - 21:02.2	"I am looking at the layers and trying to think of the way.	Be-K	Be-K	Be-K
93	21:02.2 - 21:10.4	then change mind: chop it into pieces.	S-K	Be-K	S-K
94	21:10.4 - 21:14.4	select the mesh	S-K	S-K	S-K
95	21:14.4 - 21:40.1	rotate the model	Bs-K	Bs-K	Bs-K
96	21:40.1 - 21:58.8	change to wire frame view, back to shade view	N	N	N
97		make a plane	S-K	S-K	S-K
98	21:58.8 - 22:13.3	make a polyline	S-K	S-K	S-K
99	22:13.3 - 22:27.1	"I am splitting the mesh with that curve, so because that is lots of layers, that is kind of .."	S-K	Be-K	Be-K
100	22:27.1 - 22:39.5	"how much time do I have left"	N	N	N
101	22:39.5 - 23:07.9	extrude the polyline	S-K	S-K	S-K
102		intersect	S-K	S-K	S-K
103	23:07.9 - 23:30.3	mesh split	S-K	S-K	S-K
104	23:30.3 - 23:42.0	rotate the model	Bs-K	Bs-K	Bs-K
105	23:42.0 - 24:12.1	"I think you could find quite interesting things about what we could do in rhino"	Bs-K	Bs-K	Bs-K
106	24:12.1 - 24:19.1	delete duplicate curve	S-K	S-K	S-K
107	24:19.1 - 24:25.2	rotate the model	Bs-K	Bs-K	Bs-K
108	24:25.2 - 24:39.6	"I am looking at the edges, trying to see if the layer express enough, it wasn't express enough, so take	Bs-K	Bs-K	Bs-K

		exaggerate, somehow."			
109	24:39.6 - 24:52.6	select mesh edge "how long left, 15 mins"	S-K	S-K	S-K
110	24:52.6 - 25:09.2	make another layer	N	N	N
111		mesh the window	S-K	S-K	S-K
112	25:09.2 - 25:19.1	change the colour	S-K	S-K	S-K
113	25:19.1 - 25:33.5	"it's a kind of cool"	Bs-K	Bs-K	Bs-K
114	25:33.5 - 25:41.5	"it's like mass, a bunch of stuff, cut off it"	Bs-K	Bs-K	Bs-K
115	25:41.5 - 25:48.1	render view port	Bs-K	N	Bs-K
116	25:48.1 - 26:08.2	rotate the model, shade view port	Bs-K	Bs-K	Bs-K
117	26:08.2 - 26:31.9	make the mesh of windows	S-K	S-K	S-K
118	26:31.9 - 26:35.5	select windows and then un-wield	S-K	S-K	S-K
119		rotate the model	Bs-K	Bs-K	Bs-K
120	26:35.5 - 26:44.8	"just convert the mesh, if you use the command to duplicate the edges, the supposed surface, so I can quickly get the edges again"	Be-K	Be-K	Be-K
121	26:44.8 - 26:55.7	delete duplicate mesh edge	S-K	S-K	S-K
122		convert mesh to nurbs	S-K	S-K	S-K
123	26:55.7 - 27:13.6	rotate the model	Bs-K	Bs-K	Bs-K
124	27:13.6 - 27:25.8	"yeah, it has curve...again"	Bs-K	Bs-K	Bs-K
125	27:25.8 - 27:45.3	pipe the mesh edge	S-K	S-K	S-K
126	27:07.1 - 27:14.2	"how the edges expressed, because it rather like a surface rather in grasshopper	Bs-K	S-K	Bs-K
127	27:14.2 - 27:25.4	change the radius of the pipe	S-K	S-K	S-K
128	27:25.4 - 27:48.6	change the angle	S-K	S-K	S-K
129	27:48.6 - 28:00.1	change to render view port and rotate the model	Bs-K	Bs-K	Bs-K
130	28:03.8 - 28:15.9	change the colour of pipe	S-K	S-K	S-K
131	28:15.9 - 28:20.3	rotate the model	Bs-K	Bs-K	Bs-K
132	28:20.3 - 28:26.1	change the colour of the window	S-K	S-K	S-K
133	28:26.1 - 28:39.8	rotate the model	Bs-K	Bs-K	Bs-K
134		delete pipes	S-K	S-K	S-K
135	28:39.8 - 28:54.3	change to shade view port	Bs-K	N	Bs-K
136	28:54.3 - 29:01.9	"It’s like Federation Square, yes."	Bs-K	Bs-K	Bs-K
137	29:01.9 - 29:14.1	change the radius of pipes	S-K	S-K	S-K
138	29:14.1 - 31:10.3	"all right, I mean, we are done"	N	N	N
139	31:10.3 - 31:13.4	change the colour of window	S-K	S-K	S-K

140	31:13.4 - 31:17.0	"I'll put it back on the site"	S-K	S-K	S-K
141	31:17.0 - 31:28.9	move the model on the site	S-K	S-K	S-K
142	31:28.9 - 31:49.4	change to render view port, change camera	Bs-K	Bs-K	Bs-K
143	31:49.4 - 31:52.9	rotate the model	Bs-K	Bs-K	Bs-K
144	31:52.9 - 31:58.3	"It's like weird window, isn't it?"	Bs-K	Bs-K	Bs-K
145	31:58.3 - 32:10.1	Rotate the model "OK."	Bs-K	Bs-K	Bs-K

Designer 4

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	1:28.8 - 2:02.0	read brief	R-K	R-K	R-K
2	2:02.0 - 2:13.1	ok, (rotate the site model)	R-K	Bs-K	R-K
3	2:13.1 - 2:25.2	It's a little bit tricky, because I am always start with something manually done, and then I did something detail in grasshopper. never use grasshopper in the beginning	N	N	N
4	2:25.2 - 2:35.0	maybe I will just start with a curve (drawing a curve in rhino)	S-K	Be-K	Be-K
5	2:35.5 - 2:50.8	(making curve)	S-K	S-K	S-K
6	2:50.8 - 2:56.1	(set component in grasshopper) (curve)	S-K	S-K	S-K
7	2:56.1 - 3:03.1	(set component in grasshopper)(move and unit z)	S-R	S-R	S-R
8	3:03.1 - 3:10.8	(set parameters)	S-R	S-R	S-R
9	3:10.8 - 3:17.7	I am start with this simple curve, and these are our basic mass	F-K	F-K	F-K
10	3:17.7 - 3:25.0	and I am going to think about the façade a bit more	F-K	Be-K	F-K
11	3:25.0 - 3:30.4	because I am not only focus on massing	Be-K	Be-K	Be-K
12	3:30.4 - 3:33.1	somewhere start with the façade is worthwhile for change	Be-K	Be-K	Be-K
13	3:33.1 - 3:35.9	so draw a very simple curve (set component)	S-K	S-K	S-K
14	3:35.9 - 3:40.3	put it on the site and not really considering what's on the site	Be-K	Be-K	Be-K
15	3:40.3 - 3:46.9	(set "loft") component	S-K	S-K	S-K
16	3:45.8 - 3:50.3	Just try to get a simple mass of it.	F-K	Be-K	F-K
17	3:50.3 - 3:54.8	so we are going to loft the curve we created and the curve we moved (connect component)	S-K	S-K	S-K
18	3:54.8 - 3:59.6	so we can basically play with height a bit	Be-R	Be-K	Be-R
19	3:59.4 - 4:06.4	(changing parameters)	S-R	S-R	S-R
20	4:06.4 - 4:13.4	(set "domain" component)	Be-R	Be-R	Be-R

21	4:13.4 - 4:35.5	(looking for components)	N	N	N
22	4:35.5 - 4:43.5	(set "sframes" components)	Be-R	Be-R	Be-R
23	4:43.5 - 4:51.0	I am going to make a surface of this loft and	S-K	Be-K	S-K
24	4:51.0 - 4:57.6	I am going to re-parameterize it.	Be-R	Be-R	Be-R
25	4:57.6 - 5:04.3	(connect "surface" and re-parameterized)	S-R	S-R	S-R
26	5:04.3 - 5:14.6	and I would like some surface frames from UV coordinates	Be-R	Be-R	Be-R
27	5:14.6 - 5:18.5	(connect components) and	S-R	S-R	S-R
28	5:18.5 - 5:27.5	I am going to change scales of the frame	Be-R	Be-R	Be-R
29	5:27.5 - 5:31.2	(change parameters) maybe to one, here we go	S-R	S-R	S-R
30	5:31.2 - 5:32.6	take a preview see what I have done (rotating the model)	Bs-K	Bs-K	Bs-K
31	5:32.6 - 5:37.3	(rotating the model)	Bs-K	Bs-K	Bs-K
32	5:37.3 - 5:40.3	(set parameter)	S-R	S-R	S-R
33	5:40.3 - 5:50.6	(change parameter)	S-R	S-R	S-R
34	5:50.6 - 5:53.1	(connect slider with UV)	S-R	Be-R	Be-R
35	5:53.1 - 5:59.3	(rotating model)	Bs-K	Bs-K	Bs-K
36	5:59.3 - 6:08.0	(disconnect parameter, and set new parameter)	S-R	S-R	S-R
37	6:08.0 - 6:16.4	(change parameter)	S-R	S-R	S-R
38	6:16.4 - 6:20.9	ok, put grasshopper down for a second and see what I have done (hide grasshopper and rotate model)	Bs-K	Bs-K	Bs-K
39	6:20.9 - 6:28.0	briefly create a mass and a bunch of UV coordinates on the surface	Bs-K	Bs-K	Bs-K
40	6:28.0 - 6:33.5	ok (rotate model)	Bs-K	Bs-K	Bs-K
41	6:33.5 - 6:40.9	I am going to create something to give some façade treatment	Be-K	Be-K	Be-K
42	6:40.9 - 6:46.8	let's start with a simple circle	S-K	S-K	S-K
43	6:46.8 - 6:54.3	(set "circle" component)(connect component) ok, so.	S-R	S-K	S-K
44	6:54.3 - 7:03.4	quickly get a bunch of circle, just to get a preview,	Bs-K	Bs-K	Bs-K
45	7:03.4 - 7:07.9	something to responds to	Be-R	Be-R	Be-R
46	7:07.9 - 7:12.2	(rotate model)	Bs-K	Bs-K	Bs-K
47	7:12.2 - 7:16.8	I want to adjust the size of these circles	S-K	S-K	S-K
48	7:16.8 - 7:20.6	and we will do that by actually rearrange the frame we have (set "list length" component)	Be-R	Be-R	Be-R
49	7:20.6 - 7:25.9	(set "panel")	Bs-R	Bs-R	Bs-R
50	7:25.9 - 7:41.9	so we got 1200	Bs-R	Bs-R	Bs-R
51	7:41.9 - 7:48.3	now we are giving them a random size (set "random" component)	Be-R	Be-R	Be-R

52	7:48.3 - 7:56.3	ok, we need a slider (set parameter)	S-R	S-R	S-R
53	7:56.3 - 8:05.1	I need a range, so domain (set "domain" component)	Be-R	Be-R	Be-R
54	8:05.1 - 8:14.5	(set parameter)	S-R	S-R	S-R
55	8:14.5 - 8:22.2	(delete parameter and set again)	S-R	S-R	S-R
56	8:22.2 - 8:28.1	I am going to set the minimum--0.1 (set parameter)	S-R	S-R	S-R
57	8:28.1 - 8:32.2	(change parameter)	S-R	S-R	S-R
58	8:32.2 - 8:34.0	I am going to turn off the surface, just to see around (un-review the "loft")	Bs-K	Bs-K	Bs-K
59	8:34.0 - 8:38.9	(rotating the model)	Bs-K	Bs-K	Bs-K
60	8:38.9 - 8:46.2	(change parameters)	S-R	S-R	S-R
61	8:46.2 - 8:48.7	(rotating the model)	Bs-K	Bs-K	Bs-K
62	8:48.7 - 9:12.7	(flatten the circle points)	Be-R	Be-R	Be-R
63	9:12.7 - 9:18.2	(bake)	N	N	N
64	9:18.2 - 9:30.1	cancel, I may do an extrusion (set "extrude" component)	S-K	S-K	S-K
65	9:30.1 - 9:38.4	(checking previous number on grasshopper)	Bs-R	Bs-R	Bs-R
66	9:38.4 - 9:42.4	that's usually as normal there	N	N	n
67	9:42.4 - 9:50.2	(rotating the model,	Bs-K	Bs-K	Bs-K
68	9:50.4 - 9:56.9	delete "extrude" component)	S-K	S-K	S-K
69	9:56.9 - 10:03.1	(set "planar surface" Component)	S-K	S-K	S-K
70	10:03.1 - 10:14.7	(delete)	S-K	S-K	S-K
71	10:14.7 - 10:22.3	(set "planar" component)	S-K	S-K	S-K
72	10:22.3 - 10:26.1	(rotating)	Bs-K	Bs-K	Bs-K
73	10:26.1 - 10:31.6	I will bake that (bake)	N	N	N
74	10:31.6 - 10:46.1	to preview what I have done, very quickly, some odd things happened there (rotating)	Bs-K	Bs-K	Bs-K
75	10:46.1 - 11:01.0	probably something to do with grasshopper definition (rotating)	Bs-K	Bs-R	Bs-K
76	11:01.0 - 11:06.6	We are going to just quickly, you know, try something out. (rotating) just I can think about what it will look like	Be-K	Bs-K	Bs-K
77	11:06.6 - 11:20.4	and again, give this a new layer, and we are going to treat it as a new variation (create a new layer)	Be-R	Be-R	Be-R
78	11:20.4 - 11:28.9	(hide layer)	N	N	N
79	11:28.9 - 11:32.2	(pan on grasshopper and view previews definition)	Bs-R	Bs-R	Bs-R
80	11:32.2 - 11:39.0	(hide some components)(hide model)	N	N	N
81	11:39.0 - 11:43.9	we will group this all (group component)	N	N	N
82	11:43.9 -	and this is pre...definition, and I am going to start	Be-R	Be-R	Be-R

	11:47.5	again playing with this			
83	11:47.5 - 11:52.6	(pan on grasshopper interface)	Bs-R	Bs-R	Bs-R
84	11:52.6 - 11:56.6	this is the single curve I start with (rotate model)	Bs-K	Bs-K	Bs-K
85	11:56.6 - 11:57.6	and this time, I am going to do something a bit different to the "massing"	Be-K	Be-K	Be-K
86	11:57.2 - 12:02.7	I want to create a bit...of	Be-R	Be-K	Be-R
87	12:02.7 - 12:10.7	(set "offset" component)	S-K	S-K	S-K
88	12:16.7 - 12:21.1	(set parameters)	S-R	S-R	S-R
89	12:21.1 - 12:25.2	(connect component, and change parameters)	S-R	S-R	S-R
90	12:25.2 - 12:28.6	(set "move" component)	S-K	S-K	S-K
91	12:28.6 - 12:31.4	(another "move")	S-K	S-K	S-K
92	12:31.4 - 12:36.4	(set "z" direction)	S-K	S-R	S-K
93	12:36.4 - 12:47.3	(set parameter)	S-R	S-R	S-R
94	12:47.3 - 12:55.5	(connect component)	S-R	S-R	S-R
95	12:55.5 - 12:59.7	(rotate model)	Bs-K	Bs-K	Bs-K
96	12:59.7 - 13:02.1	(set "loft" component)	S-K	S-K	S-K
97	13:02.1 - 13:06.2	I am going to do a "loft" (set "loft" component)	S-K	S-K	S-K
98	13:11.1 - 13:21.7	(delete component)	S-K	S-K	S-K
99	13:21.7 - 13:27.6	(set another "move")	S-K	S-K	S-K
100	13:27.6 - 13:35.8	(set parameter)	S-R	S-R	S-R
101	13:35.8 - 13:46.7	(set "z" unit)	S-K	Be-R	S-K
102	13:48.8 - 13:53.1	(set "loft" component)	S-K	S-K	S-K
103	13:53.1 - 13:57.0	ok, here we go (rotating model)	Bs-K	Bs-K	Bs-K
104	13:57.0 - 14:00.4	so now... (rotating)	Bs-K	Bs-K	Bs-K
105	14:00.4 - 14:04.4	so we are going to overhand the whole building	Be-K	Be-K	Be-K
106	14:04.4 - 14:20.1	play with the height, and just massing	Be-K	Be-R	Be-K
107	14:20.1 - 14:23.7	(change parameters)	S-R	S-R	S-R
108	14:23.7 - 14:37.8	(change parameters)	S-R	S-R	S-R
109	14:37.8 - 14:48.1	so design second we just leave it like that	Be-K	Be-K	Be-K
110	14:48.1 - 14:53.7	work out the façade	Be-K	F-K	Be-K
111	14:53.7 - 14:56.8	(pan the grasshopper interface)	Bs-R	Bs-R	Bs-R
112	14:56.8 - 15:02.5	(rotate the model)	Bs-K	Bs-K	Bs-K
113	15:02.5 -	it's where we are getting a mental block	N	N	N

	15:07.6				
114	15:16.5 - 15:21.8	I am trying some windows and façade this time	F-K	F-K	F-K
115	15:24.4 - 15:28.9	I am setting divide surface (set "dividesur" component)	Be-R	Be-R	Be-R
116	15:28.9 - 15:39.7	that's the main façade	F-K	F-K	F-K
117	15:39.7 - 15:45.4	a slider (set parameter)	S-R	S-R	S-R
118	15:45.4 - 15:48.7	(set "iso-srf" component)	S-K	Be-R	Be-R
119	15:48.7 - 15:55.6	(delete component) this one I forgot to do, is re-parameterized the surface (set "srf" component)(re-parameterized and connect)	Be-R	Be-R	Be-R
120	15:55.6 - 16:06.7	so we need 2-d domain	Be-R	Be-R	Be-R
121	16:03.9 - 16:08.6	and that's quick a lot than I did in manual modelling	N	Bs-R	N
122	16:08.6 - 16:13.0	and it's capable to do multiple solutions very quickly	Be-R	Bs-R	Be-R
123	16:13.0 - 16:25.6	ok, domain is.. (set "domain" component)	Be-R	Be-R	Be-R
124	16:25.6 - 16:40.9	(set parameters)	S-R	S-R	S-R
125	16:40.9 - 16:46.3	(rotating model	Bs-K	Bs-K	Bs-K
126	16:46.3 - 17:02.0	change parameter)	S-R	S-R	S-R
127	17:02.0 - 17:33.2	(examine previews data showed on component)	Bs-R	Bs-R	Bs-R
128	17:33.2 - 17:45.3	(delete, set and connect other components)	S-R	S-R	S-R
129	17:45.3 - 17:49.5	(rotate model)	Bs-K	Bs-K	Bs-K
130	17:58.0 - 18:04.4	this is the dilemma, the usual dilemma but you waste your time trying to get something to work produce results because the biggest problem in parametric design is that you know what you want to do	N	N	N
131	18:04.4 - 18:16.3	(set "domain" component)	Be-R	Be-R	Be-R
132	18:22.9 - 18:29.2	(delete and reset "domain2")	Be-R	Be-R	Be-R
133	18:29.2 - 18:35.0	(connect to a panel to check)	Bs-R	Bs-R	Bs-R
134	18:35.0 - 18:50.4	(pan on the Grasshopper interface)	Bs-R	Bs-R	Bs-R
135	18:50.4 - 18:57.2	(set MD slider)	S-R	Be-R	Be-R
136	18:57.2 - 19:05.1	"we do need a single" (check the interpretation of component)	Bs-R	Bs-R	Bs-R
137	19:05.1 - 19:19.5	(rotate the model)	Bs-K	Bs-K	Bs-K
138	19:19.5 - 19:26.1	(pan on the grasshopper interface)	Bs-R	Bs-R	Bs-R
139	19:26.1 - 19:57.3	"I tried it yesterday, I already forget how to...""I do spend a lot of time making things work on testing" (delete MD slider and make looking for component)	N	N	N
140	19:57.3 - 20:03.4	(delete a component) "I got a surface, and I got sub-surfaces"	Bs-K	Bs-K	Bs-K
141	20:03.4 - 20:08.2	(checking the component) "oh, here it is"	Bs-R	Bs-K	Bs-R
142	20:08.0 -	(set "range" component and connect)	Be-R	Be-R	Be-R

	20:21.6				
143	20:21.6 - 20:24.0	(rotate the model) "do that work"	Bs-K	Bs-K	Bs-K
144	21:35.8 - 21:41.3	(set data related component, connect) "I did it yesterday, why it does not work, oh, wrong one"	Be-R	S-R	Be-R
145	21:41.3 - 21:56.8	(set parameters)	S-R	S-R	S-R
146	21:56.8 - 22:07.9	"oh, is it problem?"	Bs-R	Bs-K	Bs-R
147	22:07.7 - 22:13.5	"while grasshopper is good at making multiple task, when you know, it get complicated, "the computer has to..."	N	N	N
148	22:13.5 - 22:22.7	waiting calculating	N	N	N
149	22:22.7 - 22:29.8	"we need to cancel it "ok, so delete that"	Be-R	S-R	Be-R
150	22:29.8 - 22:44.1	(delete a slider) "and we set a smaller number"	Be-R	S-R	Be-R
151	22:44.1 - 22:47.3	(rotate the model)	Bs-K	Bs-K	Bs-K
152	22:47.3 - 22:51.7	"so we are going to divide it"	Be-R	S-K	S-K
153	22:51.7 - 23:06.7	(set parameter)	S-R	S-R	S-R
154	23:06.7 - 23:11.2	(save document)	N	N	N
155	23:11.2 - 23:27.3	(connect parameter)	S-R	S-R	S-R
156	23:32.9 - 23:38.1	"I am going to turn off the preview" (turn off preview)	N	Bs-K	N
157	23:38.1 - 23:50.2	"façade is divided up to the panels"	Be-R	Be-R	Be-R
158	23:50.2 - 23:55.1	"I am just trying to remove something"	S-K	Be-K	Be-K
159	23:55.1 - 24:02.7	(set component “cull")	Be-R	Be-R	Be-R
160	24:02.7 - 24:16.0	"I am going to use a tool that I used – so that is "random selection" (set "random" component)	Be-R	Be-R	Be-R
161	24:16.0 - 24:33.6	"it is one of the quickest ways to get variations, especially when you just have some idea" (set "list length" component)	Be-R	Be-R	Be-R
162	24:33.6 - 24:40.9	(set panel to check) "300"	Bs-R	Bs-R	Bs-R
163	24:40.9 - 24:47.5	(set "random" component)	S-R	Be-R	Be-R
164	24:47.5 - 24:56.8	(set parameters)	S-R	S-R	S-R
165	24:56.8 - 25:05.5	(set parameter)	S-R	S-R	S-R
166	25:05.5 - 25:16.5	(set "divide" component and then delete)	S-K	S-R	S-R
167	25:27.5 - 25:32.4	(set "multiply" component and then connect to the slider)	Be-R	Be-R	Be-R
168	25:32.4 - 25:38.3	"I will set up this so that I can control how many windows it will be"	Be-K	Be-R	Be-R
169	25:38.3 - 25:54.3	(connect)	S-R	S-R	S-R
170	25:54.3 - 26:01.5	"so now I got 25% façade of windows" (rotate the model)	Bs-R	Bs-R	Bs-R
171	26:01.5 - 26:06.4	" and I can control it, but I do not want it too much"	Be-R	Be-R	Be-R
172	26:06.4 -	(change parameters)	S-R	S-R	S-R

	26:10.4				
173	26:10.4 - 26:22.5	"it's random seed number, this is what I found interesting	Bs-R	Be-R	Bs-R
174	26:22.5 - 26:33.6	"so I will change this to 20" "(change parameters)	S-R	S-R	S-R
175	26:33.6 - 26:38.4	"it's ok"	Be-K	Bs-K	Bs-K
176	26:51.4 - 27:03.0	"I am going to bake it." (bake)	N	N	N
177	27:01.6 - 27:21.9	(make a new layer) "and we call this façade 20%"	Be-K	N	N
178	27:21.9 - 27:23.6	"and then we are going to make a new layer, turn this off, and go to the grasshopper" (turn off the layer, switch to grasshopper interface)	N	N	N
179	27:23.6 - 27:29.2	"to change it as 0.35"	S-R	S-R	S-R
180	27:59.0 - 28:03.4	"the random seed, and we are going to do another bake"	N	Be-R	Be-R
181	28:03.4 - 28:10.8	"and we call this façade 30%"(bake and make new layer)	Bs-R	N	N
182	28:10.8 - 28:21.7	"ok, and we are going to change the number" (change parameter)	S-R	S-R	S-R
183	28:21.7 - 28:34.8	(change parameter) "change random seed one more time"	S-R	S-R	S-R
184	28:34.8 - 28:50.0	(bake and go to rhino interface, make another layer) "and call this 50%"	Bs-R	N	N
185	28:50.0 - 28:56.1	"so I would just run through these different layers, with simply design, just variations changes"	Be-R	Be-R	Be-R
186	28:55.8 - 29:04.8	(change layers and rotate the model)(rotating and change layers to select better solution)	Bs-K	Bs-K	Bs-K
187	29:04.8 - 29:15.1	"so maybe we play with the openings"(rotating)	F-K	F-K	F-K
188	29:15.1 - 29:33.2	"so far I don't like is the windows are too big" (rotating)	Bs-K	Bs-K	Bs-K
189	29:33.2 - 29:38.0	"I am going to create a new layer and put these into sub-layer, call this task 01, and this is task 02" (change layers)	Be-R	Be-K	Be-R
190	29:38.0 - 29:45.2	Switch to grasshopper interface (change parameters) "I am going back here, and I am going to change the division from 30 to 60."	S-R	S-R	S-R
191	29:45.2 - 29:51.7	"and now we are doing exactly the same thing change the seed and bake" (change the seed and bake)	S-R	S-R	S-R
192	29:51.7 - 30:05.8	(make new layer)	N	N	N
193	30:15.5 - 30:33.2	(switch back to grasshopper interface)(change parameters) "change the façade, this one is 80"	S-R	S-R	S-R
194	30:33.2 - 30:38.8	"and again, back"(back)"so the way I use grasshopper is not design resolve it, it is really just an experiment, to see what the possibilities are, as quickly as possible, and later on, to see what option is the best to pursue" (make a new layer)	N	N	N
195	30:39.2 - 30:49.9	(rotate the model)	Bs-K	Bs-K	Bs-K
196	30:49.9 - 30:58.7	(turn off the layer and switch back to grasshopper interface)(change parameters)	S-R	S-R	S-R
197	30:58.7 - 31:16.0	(bake and make new layer)"turn off the preview" (rotate the model and turn off one layer)"and circle freedom" (turn on layer and rotating model)	Bs-K	Bs-K	Bs-K
198	31:16.0 - 31:22.1	"now what I am not happy with is the actual circle here" (turn off the layer)	Bs-K	Bs-K	Bs-K
199	31:22.1 - 31:29.6	"so what I am going to do is to go back to grasshopper, and turn this off"(go to grasshopper, turn	Be-K	Be-K	Be-K

		off the preview)(go to Rhino, turn off/on the layer), (make new curve, and make new layer) "and call this test 3"			
200	31:29.6 - 31:33.5	rotate the model	Bs-K	Bs-K	Bs-K
201	31:46.2 - 31:53.0	"this time I am going to build a more ambitious form"	Be-K	Be-K	Be-K
202	31:53.0 - 32:22.8	(draw another curve in Rhino)	S-K	S-K	S-K
203	32:22.8 - 32:27.8	(rotate the model and switch back to grasshopper interface)	Bs-K	Bs-K	Bs-K
204	32:27.8 - 32:36.2	"what I am going to do is copy that completely" (copy previous definition)	S-R	S-K	S-R
205	32:36.2 - 32:42.8	"clear the value of original and set a new curve" (pick up the curve into "curve" component)	S-R	S-K	S-R
206	32:42.8 - 32:47.7	"so I am trying to keep as much of original as possible" (turn off some preview)	Be-R	Be-R	Be-R
207	32:47.7 - 32:52.6	(rotate the model)	Bs-K	Bs-K	Bs-K
208	32:52.6 - 33:08.2	"good, I am going back here" (turn on loft component)	S-K	Bs-K	Bs-K
209	33:36.9 - 33:44.7	"and we wait"	N	N	N
210	33:44.7 - 33:52.2	(rotate the model)	Bs-K	Bs-K	Bs-K
211	33:52.2 - 33:54.3	"we change the value again" (change parameters)	S-R	S-R	S-R
212	33:54.3 - 34:00.7	(rotate the model) "so the way of my work is that I do manual model quite a bit, but I do make a whole bunch of evaluation in Grasshopper." and again, we do interactions very similar" (rotate the model)	Bs-K	Bs-K	Bs-K
213	34:00.7 - 34:06.4	the design style is similar, where when I'm in manual model, ..."	N	N	N
214	34:06.4 - 34:11.2	"I am going to play with the mass again"	F-K	Be-K	F-K
215	34:11.2 - 34:16.0	(turn off the loft component, rotate the model)	Bs-K	Bs-K	Bs-K
216	34:16.0 - 34:22.5	(set CP component)	Be-R	Be-R	Be-R
217	34:22.5 - 34:27.4	"move this from control points again" (set "move" component)	S-K	S-K	S-K
218	34:27.4 - 34:36.8	(set z vector)	S-K	Be-R	S-K
219	34:36.8 - 34:42.0	"these control points are moved up" (rotate the model)	Bs-K	Bs-K	Bs-K
220	34:42.0 - 39:28.1	"create polyline from these" (set "polyline" component)	S-K	S-K	S-K
221	39:28.1 - 39:39.5	(rotate the model)	Bs-K	Bs-K	Bs-K
222	39:39.5 - 39:41.6	(set "loft" component)	S-K	S-K	S-K
223	39:41.6 - 39:53.7	"we can see what does that look like" (connect)"it works" (fixing problem)	Bs-K	Bs-R	Bs-K
224	39:53.7 - 40:01.9	"so now what I am going to do is .. instead of doing it by 10, I am going to do it randomly" (set random component)	Be-R	Be-R	Be-R
225	40:01.9 - 40:05.9	(set "list length" component and connect)"need a range, so domain" (set domain component)	Be-R	Be-R	Be-R
226	40:14.3 - 40:23.2	(set parameter)	S-R	S-R	S-R
227	40:23.2 - 40:30.1	(set parameters)	S-R	S-R	S-R

228	40:30.1 - 40:36.5	(change parameters)	S-R	S-R	S-R
229	40:36.5 - 40:43.4	(set parameters)	S-R	S-R	S-R
230	40:43.4 - 40:51.2	(change parameters)	S-R	S-R	S-R
231	40:51.2 - 40:55.7	(change parameters)	S-R	S-R	S-R
232	40:55.7 - 40:59.6	(set panel component to examine) "that's 20, between 1 and 1	Bs-R	Bs-R	Bs-R
233	40:59.6 - 41:10.4	"and now I would like to plug that into"(plug the random into z vector)	S-R	S-R	S-R
234	41:10.4 - 41:34.7	"should go here" (set parameters)	S-R	S-R	S-R
235	41:34.7 - 41:39.9	"I need to adjust it, here it is, the problem is now we need loft"	S-K	S-K	S-K
236	41:39.9 - 41:46.4	(change parameters)	S-R	S-R	S-R
237	42:04.4 - 42:13.4	"so maybe I do the same thing" (delete a slider) (copy component)	Be-R	Be-R	Be-R
238	42:13.4 - 42:27.4	(set parameters)	S-R	S-R	S-R
239	42:27.4 - 42:32.3	"here we go" (change parameters)	S-R	S-R	S-R
240	42:32.3 - 42:45.5	"set it 20" (change parameters)	S-R	S-R	S-R
241	42:45.5 - 42:57.2	" and bake out" (bake)	N	N	N
242	42:57.2 - 43:03.4	(rotate the model) "you can quickly see what we have done"	Bs-K	Bs-K	Bs-K
243	43:03.4 - 43:11.8	(make new layer)	N	N	N
244	43:11.8 - 43:17.8	(switch back to grasshopper session and then change the parameters)	S-R	S-R	S-R
245	43:17.8 - 43:35.2	"and make another variation, again, everything we are doing is just test the possibilities" (bake)	Be-R	Be-R	Be-R
246	43:35.2 - 43:43.0	"it's kind of like what I want now" (rotate the model)	Bs-K	Bs-K	Bs-K
247	43:43.0 - 43:55.7	"some interesting things happen" (rotate the model)	Bs-K	Bs-K	Bs-K
248	43:55.7 - 43:57.7	"I have to drag this curve down" (set "move" component)	S-K	S-K	S-K
249	43:57.7 - 44:02.9	(set parameters)	S-R	S-R	S-R
250	44:02.9 - 44:09.9	(set constraints)	S-R	Be-R	Be-R
251	44:09.9 - 44:13.3	"make a new layer" (make a new layer)	N	N	N
252	44:13.3 - 44:16.4	"keep testing what we've done previously"	Bs-K	Be-R	Bs-K
253	44:16.4 - 44:27.6	"turn off the layer and then	N	N	N
254	44:27.6 - 44:34.0	(change parameters)	S-R	S-R	S-R
255	44:34.0 - 44:53.5	(change parameters)	S-R	S-R	S-R
256	44:53.5 - 45:00.6	(bake)	N	N	N
257	45:00.6 - 45:24.6	(rotate) "this is interesting, the façade, and the other is opening" (rotate the model)	Bs-K	Bs-K	Bs-K
258	45:24.6 - 45:35.2	"ok, so I am a kind of like it,"(rotate the model)	Bs-K	Bs-K	Bs-K

259	45:35.2 - 45:43.4	Some windows there and double up.	Bs-K	Bs-K	Bs-K
260	45:43.4 - 45:48.4	"for now, I just bring back the façade and test it out"	S-K	Be-R	Be-R
261	45:48.4 - 45:55.7	"now, so far I have done 9 alternations"	Bs-R	Bs-K	Bs-R
262	45:55.7 - 45:59.6	"but it is very massy" (go back to grasshopper interface) "again, this is something we do very, very quickly, just to get the results"	N	Bs-K	Bs-K
263	45:59.6 - 46:19.1	"bring all these out, make the surface working" (tidy the interface, and set "surface" component)	S-K	S-K	S-K
264	46:19.1 - 46:29.6	(copy components)	S-R	S-R	S-R
265	46:29.6 - 46:39.3	(plug-in the surface)	S-R	S-R	S-R
266	46:51.8 - 46:58.8	"call this test 4" (make new layer) "turn off previous, so we can isolate it" (turn off the layer and then switch to grasshopper interface)	N	Be-R	N
267	46:58.8 - 47:07.6	(check previous component on grasshopper interface)	Bs-R	Bs-R	Bs-R
268	47:07.6 - 47:10.8	"so now we just do a quick bake"（bake)	N	N	N
269	47:10.8 - 47:25.5	"to preview in grasshopper is not good, but in rhino is a bit better" (rotate the model)	Bs-K	Bs-K	Bs-K
270	47:25.5 - 47:32.5	"yes, very quickly we do something, if I continue to do this, maybe I will continue with the roof" (rotate the model)	F-K	Be-K	F-K
271	47:32.5 - 47:45.5	"I don't really like where the windows are,	Bs-K	Bs-K	Bs-K
272	47:45.5 - 47:51.9	so I want to do more quick revision" (rotate the model, turn off layer)	Be-K	Be-K	Be-K
273	47:51.9 - 47:56.2	"I might change this to point 15%" (change parameters)	S-R	S-R	S-R
274	47:56.2 - 48:03.5	"and change this to 13" (change parameters)	S-R	S-R	S-R
275	48:03.5 - 48:11.2	"bake for the last time"(bake)(turn off the preview)	N	N	N
276	48:11.2 - 48:33.8	"Yes, that is, is that angle better? ok, cool" (rotate the model)	Bs-K	Bs-K	Bs-K

GME session

ID	TIMESPAN	CONTENT	1st Coding	2nd Coding	Final coding
1	0:00.0 - 0:14.5	"the command is different"	N	N	N
2	0:14.5 - 0:21.2	"draw site curve"	R-K	R-K	R-K
3	0:21.2 - 0:32.2	"Measure the site. Didn't work"	Be-K	Be-K	Be-K
4	0:32.2 - 0:44.7	"how large is the site?" "almost this big"	R-K	R-K	R-K
5	0:44.7 - 0:50.7	"ok, two storeys"	R-K	F-K	F-K
6	0:50.7 - 0:58.0	"main shopping area, leisure area, including coffee"	R-K	F-K	R-K
7	0:58.0 - 1:01.7	"2000 square meters, start by looking what"	R-K	Be-K	Be-K
8	1:01.7 - 1:35.9	(draw a rectangle-2000m)	S-K	S-K	S-K
9	1:35.9 - 1:41.1	(rotating)	Bs-K	Bs-K	Bs-K

10	1:41.1 - 1:52.5	(delete the curve)	S-K	S-K	S-K
11	1:52.5 - 2:08.7	(draw another rectangle-200m)	S-K	S-K	S-K
12	2:08.7 - 2:15.6	(check the area)	Bs-K	Bs-K	Bs-K
13	2:15.6 - 2:33.8	(rotate the model)	Bs-K	Bs-K	Bs-K
14	2:33.8 - 2:44.6	"I start by trying to understand the scale of the site"	Be-K	Be-K	Be-K
15	2:44.6 - 2:52.4	"I am thinking about the 1000 square meter of leisure area"	F-K	F-K	F-K
16	2:52.4 - 3:01.0	“and now I am just moving it around the site, trying to understand what scale it is".	Be-K	Be-K	Be-K
17		(moving the rectangle)	S-K	S-K	S-K
18	3:01.0 - 3:13.4	(rotate the model)	Bs-K	Bs-K	Bs-K
19	3:13.4 - 3:22.8	move the rectangle, “wrong button"	S-K	S-K	S-K
20	3:22.8 - 3:31.7	"the next stage would be consider the traffic and parking area"	F-K	F-K	F-K
21	3:31.7 - 3:46.8	"so looking at the site parameters.." (revisit the design brief)"park, leisure area, main road and commercial business area"	R-K	R-K	R-K
22	3:46.8 - 4:02.7	"so that quickly analyse that the biggest traffic is people come from commercial area to business area, or from the main road" (zoom in)	Be-K	Be-K	Be-K
23	4:02.7 - 4:09.1	"so that would be the southwest corner that would have the highest traffic"	Be-K	Be-K	Be-K
24	4:09.1 - 4:28.6	"i will show that traffic""	S-K	S-K	S-K
25		so from the assumption, here probably where i will put my leisure area"	F-K	F-K	F-K
26	4:28.6 - 4:56.9	"next step i will start doing some massing on the site, just trying to understand the site and what i can do on the site"	Be-K	Be-K	Be-K
27	4:56.9 - 5:33.4	(draw a curve)	S-K	S-K	S-K
28	5:33.4 - 5:51.7	(offset to the other side)	S-K	S-K	S-K
29	5:51.7 - 6:00.9	"so to start, i just draw the mass, to start" (draw another curve on the boundary of site)	Be-K	S-K	Be-K
30	6:00.9 - 6:09.3	"and I am doing this in very basic way, just draw polyline and offset them" (draw polyline)	S-K	Be-K	Be-K
31	6:09.3 - 6:14.1	(offset)	S-K	S-K	S-K
32	6:14.1 - 6:23.9	"with no regard of what going to happen internally"	Be-K	N	Be-K
33	6:23.9 - 6:28.3	(trim the curve)	S-K	S-K	S-K
34	6:28.3 - 6:51.5	(extend the curve)	S-K	S-K	S-K
35	6:51.5 - 7:02.5	"i think this is also the rhino problem..."	N	N	N
36	7:02.5 - 7:07.4	(trim) "probably everyone has his own way of working with rhino"	S-K	S-K	S-K
37	7:07.4 - 7:29.6	"ok, so I have got mass,	Bs-K	Bs-K	Bs-K
38	7:29.6 - 7:42.5	And i am just going to give it 10 meters." (extrude the curve)	S-K	S-K	S-K
39		(rotate the model)	Bs-K	Bs-K	Bs-K

40	0:00.0 - 0:21.2	"Ok, the way I will treat this, is this because it is all mass site, and then learn from the site."	Be-K	Be-K	Be-K
41		(make new layer, rotate)	Bs-K	Bs-K	Bs-K
42	0:21.2 - 0:29.4	"so what I realise is that I forgot to make a path, pedestrian path." (make new layer)	F-K	F-K	F-K
43	0:29.4 - 0:31.3	"so I am going to start that now"	Be-K	N	N
44	0:31.3 - 0:46.5	"we are going to get the outline again"(draw outline of the site)	S-K	S-K	S-K
45	0:46.5 - 0:54.5	"and then offset it by 3m" (offset)	S-K	S-K	S-K
46	0:54.5 - 1:01.8	"and treat that as a step back"	S-K	Be-K	Be-K
47	1:01.8 - 1:07.4	"secondly, we are going to think about the other side of the site, which is park area" (rotate the model)	F-K	F-K	F-K
48	1:07.4 - 1:14.4	"and consider the traffic, how can you get people from this site to the park"	Be-K	Be-K	Be-K
49	1:14.4 - 1:20.2	"and how relate to the main road"	Be-K	Be-K	Be-K
50	1:20.2 - 1:25.8	"I will think about that in terms of how i do my massing here"	S-K	Be-K	Be-K
51	1:25.8 - 1:32.0	(rotate the model)	Bs-K	Bs-K	Bs-K
52		"maybe it is the case that the traffic comes from here, and exit come through the building"	Be-K	Bs-K	Bs-K
53	1:25.8 - 1:32.0	"so I am just going to copy that into this layer" (copy to a new layer)	S-K	N	N
54	1:32.0 - 1:48.1	"I am going to offset again by 3m" (offset)	S-K	S-K	S-K
55	1:48.1 - 1:55.4	"and delete that" (delete)	S-K	S-K	S-K
56	1:55.4 - 1:57.7	(rotate)	Bs-K	Bs-K	Bs-K
57	1:57.7 - 2:08.5	"i am going to rebuild the curve" (rebuild)	S-K	Be-K	Be-K
58	2:08.5 - 2:25.0	"it's a bit rough, but you know, it's a test" (rotate)	Bs-K	Bs-K	Bs-K
59	2:25.0 - 2:32.6	"and I am going to playing with these curve and see what i can do with these" (turn on control points)"and again, treating this as just test"(select points)	Be-K	Be-K	Be-K
60	2:32.6 - 2:35.8	(turn on and off layer)	N	N	N
61	2:35.8 - 2:44.2	(turn on and select points)"I am going to move these points up	S-K	S-K	S-K
62	2:44.2 - 3:05.9	by a floor height, say 3m"	Be-K	Be-K	Be-K
63	3:05.9 - 3:13.1	(move up the points)	S-K	S-K	S-K
64	3:13.1 - 3:19.5	(rotate)	Bs-K	Bs-K	Bs-K
65	3:19.5 - 3:25.1	"i will do that a bit more, two storeys"	Be-K	Be-K	Be-K
66		(move these points again)	S-K	S-K	S-K
67		"and i will do another extrusion to get the mass"	Be-K	Be-K	Be-K
68	3:25.1 - 3:30.1	(extrude the curve)	S-K	S-K	S-K
69	3:30.1 - 3:40.7	"since before, i gave it two storeys, so i just make it 8 meters)	Be-K	Be-K	Be-K
70	3:40.7 - 3:50.4	(extrude 8m)	S-K	S-K	S-K

71	3:50.4 - 4:03.3	"ok, come across the first problem that is extrusion" "and then i am going to give a cap, so i am going to do it manually patch it up" (rotating)	S-K	Be-K	S-K
72	4:03.3 - 4:08.6	(rotating)"just quite annoy"	Bs-K	Bs-K	Bs-K
73	4:08.6 - 4:32.9	(cap the surface)	S-K	S-K	S-K
74	4:32.9 - 4:43.2	(rotating)	Bs-K	Bs-K	Bs-K
75	4:43.2 - 5:47.3	(patch)"so manually continue, to patch these extrusion together" (path another surface)	S-K	S-K	S-K
76	5:47.3 - 5:51.9	"so now i have second interaction"	Be-K	Be-K	Be-K
77	5:51.9 - 5:56.7	"make a new layer"	N	N	N
78	5:56.7 - 6:00.6	"at this stage now, i will go back and look at the brief" "think about what i actually done and what is the question"	R-K	R-K	R-K
79	6:00.6 - 6:06.0	"so far i have considered the public area and actual mass of the shopping centre"	F-K	F-K	F-K
80	6:06.0 - 6:17.0	(rotating)	Bs-K	Bs-K	Bs-K
81	6:17.0 - 6:26.3	"and i didn't consider things like parking area,	F-K	F-K	F-K
82	6:26.3 - 6:31.8	and i just simply consider the traffic route"	Be-K	Be-K	Be-K
83	6:31.8 - 6:38.0	(rotating)	Bs-K	Bs-K	Bs-K
84	6:38.0 - 6:45.6	"so i create this huge cover space" (rotating)	Bs-K	Bs-K	Bs-K
85	6:45.6 - 7:00.1	"so i will close that"	Be-K	Be-K	Be-K
86	7:00.1 - 7:13.4	(copy points)	S-K	S-K	S-K
87	7:13.4 - 7:23.8	(join the cap together)	S-K	S-K	S-K
88	7:23.8 - 7:28.8	(join the whole mass)	S-K	S-K	S-K
89	7:28.8 - 8:21.2	"and we have one massing joint" (rotating)	Bs-K	Bs-K	Bs-K
90	8:21.2 - 8:26.7	(looking for tools)	N	N	N
91	8:26.7 - 8:45.7	"so now i am going to this mass, and start to playing with it"	Be-K	Be-K	Be-K
92	8:45.7 - 9:01.4	(adjust corners)	S-K	S-K	S-K
93	9:01.4 - 9:16.5	(rotating)	Bs-K	Bs-K	Bs-K
94	9:16.5 - 9:24.2	"at this stage, i just looking at the site, which i think it visually good" (rotating)	Bs-K	Bs-K	Bs-K
95	9:24.2 - 9:37.0	(adjust the corners)	S-K	S-K	S-K
96	9:37.0 - 9:49.8	"i am just playing around until i start to understand the site itself"	Be-K	Be-K	Be-K
97	9:49.8 - 10:09.7	(rotate)	Bs-K	Bs-K	Bs-K
98	10:09.7 - 10:16.2	(make new layer)	N	N	N
99	10:16.2 - 10:20.4	(draw a rectangle)	S-K	S-K	S-K
100	10:20.4 - 10:27.1	(adjust the rectangle into the site)	S-K	S-K	S-K

101	10:27.1 - 10:30.2	(check the area of rectangle)	Bs-K	Bs-K	Bs-K
102	10:30.2 - 10:36.2	"that's about 3000 square meters of open public place,	F-K	F-K	F-K
103	10:36.2 - 10:58.3	which is a bit too much"	Bs-K	Bs-K	Bs-K
104	10:58.3 - 11:10.5	"so what i am doing is to scale the actual massing itself"	Be-K	Be-K	Be-K
105	11:10.5 - 11:20.9	"i will copy this into a new layer, that can always keeping existing scheme"	Be-K	Be-K	Be-K
106	11:20.9 - 11:28.7	"scale, from the centre"(scale)	S-K	S-K	S-K
107	11:28.7 - 11:33.4	"just preview what i have done" (change view)(rotate)	Bs-K	Bs-K	Bs-K
108	11:33.4 - 11:38.8	"at this stage with massing, i will try something completely different"	Be-K	Be-K	Be-K
109	11:38.8 - 11:44.7	(turn off the layer)(make a new layer)	N	N	N
110	11:44.7 - 12:21.7	(draw a curve) "so i come across mental block"	S-K	S-K	S-K
111	12:21.7 - 13:27.8	yes, we use lots of Revit and micro station, but even in micro station, there are things like something conflict, you want to change" "the way i use rhino is, like sketch tool, so thing is rough, i have never use it like something that is buildable, so i treat it very much like sketch up. yes, like quickly do interacting, a tool of sketch, not like model accurate"	N	N	N
112	13:27.8 - 13:33.4	"ok, what else shall i do"	N	N	N
113	13:33.4 - 13:47.7	(delete the curve)	S-K	S-K	S-K
114	13:47.7 - 13:53.9	(draw curve)	S-K	S-K	S-K
115	13:53.9 - 14:08.7	"after doing lots of grasshopper, you will find manually model becomes difficult" (delete the curve)	S-K	S-K	S-K
116	14:08.7 - 14:39.2	"at this stage, when i am in the mental block, it step away from using rhino and start to thinking what i am going to do, what i want to achieve"	Be-K	Bs-K	N
117	14:39.2 - 14:44.2	(turn on previous layer)	N	N	N
118	14:44.2 - 14:51.5	"thinking something completely different" (turn off the layer)	Be-K	Be-K	Be-K
119	14:51.5 - 14:55.7	(draw curve)	S-K	S-K	S-K
120	14:55.7 - 15:09.6	(offset)	S-K	S-K	S-K
121	15:09.6 - 15:18.3	(rebuild the curve)	Be-K	Be-K	Be-K
122	15:45.3 - 16:03.3	(move up the points)	S-K	S-K	S-K
123	16:03.3 - 16:06.5	(rotate the model)	Bs-K	Bs-K	Bs-K
124	16:06.5 - 16:12.6	"i am just trying to make the massing again, but this time using something a bit different"	Be-K	Be-K	Be-K
125		"seeing these curves, and see how it looking on the site"	Bs-K	Bs-K	Bs-K
126	16:12.6 - 16:15.9	(move up some points)	S-K	S-K	S-K
127	16:15.9 - 16:23.4	(rotating)	Bs-K	Bs-K	Bs-K
128	16:23.4 - 16:30.1	(extrude curve)	S-K	S-K	S-K

129	16:30.1 - 16:35.5	(rotating)	Bs-K	Bs-K	Bs-K
130	16:35.5 - 16:45.0	"i am going to copy these curves" (copy curves)	Be-K	S-K	Be-K
131	16:45.0 - 17:03.1	(adjust control points)	S-K	S-K	S-K
132	17:03.1 - 17:37.6	"and I will do a quick test, see what these curves looks like,	Be-K	Be-K	Be-K
133	17:37.6 - 17:45.5	so loft for the facade" (loft)	S-K	S-K	S-K
134	17:45.5 - 17:53.1	"and my preview is always from the street view"(rotate)	Bs-K	Bs-K	Bs-K
135	17:53.1 - 17:56.2	"see what it looks like, it starts to be interesting"	Bs-K	Bs-K	Bs-K
136	17:56.2 - 18:10.5	(loft)	S-K	S-K	S-K
137	18:10.5 - 18:15.9	"it starts to get interesting" (rotate)	Bs-K	Bs-K	Bs-K
138	18:15.9 - 18:32.6	loft)	S-K	S-K	S-K
139	18:32.6 - 18:37.8	"another way for preview is set the camera" (rotate)	Bs-K	Bs-K	Bs-K
140	18:37.8 - 18:50.8	"this stage now, come in and start to look at what i have done"(set camera)	Bs-K	Bs-K	Bs-K
141	18:50.8 - 18:58.8	"so it is getting a bit more interesting" (rotate)	Bs-K	Bs-K	Bs-K
142	18:58.8 - 19:02.6	"and i am more happy with this form than previous" (rotate)	Bs-K	Bs-K	Bs-K
143	19:02.6 - 19:05.9	"so it does looks a bit unfeasible"	Bs-K	Bs-K	Bs-K
144	19:05.9 - 19:14.8	"so i am going to see what realistic response it will look like" (rotate)	Be-K	Be-K	Be-K
145	19:14.8 - 19:18.9	"so i would like to add some columns, before i do that"	S-K	Be-K	S-K
146	19:18.9 - 19:32.1	"i am going to use possible parametric tool in rhino, that is called record history, something going to record all these"	Be-K	Be-K	Be-K
147	19:32.1 - 19:44.7	(delete surfaces)	S-K	S-K	S-K
148	19:44.7 - 19:49.4	"i am hit the record history button" (ctrl+z)	S-K	S-K	S-K
149	19:49.4 - 20:03.8	"we quickly select the points" "copy to a new layer" (copy to a new layer)	S-K	S-K	S-K
150	20:03.8 - 20:07.8	"now i am going to select the surface"(select)	S-K	S-K	S-K
151	20:07.8 - 20:14.0	(delete)	S-K	S-K	S-K
152	20:14.0 - 20:23.7	"so now i am going to record history because it is a sort of parametric but working without parametric is so difficult"	Be-K	Be-K	Be-K
153	20:23.7 - 20:35.9	"record history again, it is still tedious process, but it helped" (record history)	Be-K	Be-K	Be-K
154	20:35.9 - 20:48.4	"loft again"(loft)	S-K	S-K	S-K
155	20:48.4 - 21:10.2	(record history and then loft)	S-K	S-K	S-K
156	21:10.2 - 21:17.3	"so it is a quick test, so how this works"	Bs-K	N	Bs-K
157	21:17.3 - 21:23.4	"see this curve, turn on control points and move" (as verbalization)	S-K	S-K	S-K
158		"so using this tool, it achieving..."(move a control point)	Be-K	S-K	S-K

159	21:23.4 - 21:33.8	"sub-modelling is just moving" (rotate)	Bs-K	Bs-K	Bs-K
160		(move a control point)	S-K	S-K	S-K
161	21:33.8 - 21:41.2	"modelling what i think should be for the facade"	Be-K	Be-K	Be-K
162		(rotating and	Bs-K	Bs-K	Bs-K
163		move a control point)	S-K	S-K	S-K
164	21:41.2 - 21:44.2	"i am going to bring facade where it should come in"	Be-K	F-K	Be-K
165	21:44.2 - 21:50.6	(move a control point)	S-K	S-K	S-K
166	21:50.6 - 22:04.8	"at the same time, always previewing what happens" (rotate)	Bs-K	Bs-K	Bs-K
167	22:04.8 - 22:15.4	"so i can see these new connections coming in on site" (rotate)	Bs-K	Bs-K	Bs-K
168	22:15.4 - 22:28.9	"I am more happy with this than previous generation, but it took stupid massing to get to this stage"	Bs-K	Bs-K	Bs-K
169	22:28.9 - 22:32.3	(moving control point)	S-K	S-K	S-K
170	22:32.3 - 22:44.7	"it's a kind like that"(rotating)	Bs-K	Bs-K	Bs-K
171	22:44.8 - 22:54.3	"so i am selecting the next curve, start to adjusting" (select curve)	S-K	S-K	S-K
172	22:54.3 - 23:04.1	(moving control points)	S-K	S-K	S-K
173	23:04.1 - 23:08.6	"I am still treating it as sketch.." (moving control points)	S-K	S-K	S-K
174	23:08.6 - 23:17.2	"because these corners tends to be huge" (rotating)	Bs-K	Bs-K	Bs-K
175	23:17.2 - 23:29.7	" so now i have got something specular" I bring that a bit"	Be-K	Bs-K	Be-K
176	23:29.7 - 23:34.6	(rotating)	Bs-K	Bs-K	Bs-K
177	23:34.6 - 23:41.0	(change to wireframe view)	Bs-K	N	Bs-K
178		(move points)	S-K	S-K	S-K
179	23:41.0 - 23:44.8	(change to shade view)(rotating)	Bs-K	Bs-K	Bs-K
180	23:53.2 - 23:59.7	"I am working internal" "preview now"（rotating)	Bs-K	Bs-K	Bs-K
181	24:04.5 - 24:10.5	(move points)	S-K	S-K	S-K
182	24:10.5 - 24:21.5	"and I relay on this record history, which is my parametric tool"	Be-K	Be-K	Be-K
183		(move points)	S-K	S-K	S-K
184	24:33.9 - 24:41.3	"and again, I am just using this as a mould way, something like 3dmax or Maya" (rotating)	Bs-K	Bs-K	Bs-K
185		moving points	S-K	S-K	S-K
186	24:41.3 - 24:46.3	"ok, I am pretty happy with that" (rotating)	Bs-K	Bs-K	Bs-K
187	24:46.3 - 24:52.6	"and at this stage, I am starting to do the facade, and consider a treatment on that"	Be-K	Be-K	Be-K
188		(rotating)	Bs-K	Bs-K	Bs-K
189	24:52.6 - 25:02.8	"maybe the way I can do that is to make a simple pattern"	Be-K	Be-K	Be-K
190		(draw a rectangle)	S-K	S-K	S-K
191	25:02.8 - 25:19.6	"do array,10,10,1" (array)	S-K	S-K	S-K
192	25:19.6 -	"and apply this pattern to the surface" (apply cur)	S-K	S-K	S-K

	25:32.5				
193	25:32.5 - 25:38.5	"so that you can see what it looks like when i do it"(zoom in)	Bs-K	Bs-K	Bs-K
194	25:38.5 - 25:52.7	"so again, at each stage, I am previewing what I do, I am treating this pretty much from massing, and ..." (rotating)	Bs-K	Bs-K	Bs-K
195	25:52.7 - 26:12.6	"so I don't like it"	Bs-K	Bs-K	Bs-K
196	26:12.6 - 26:17.8	"so I might undo, and at the same time, I might copy all"	Be-K	Be-K	Be-K
197	26:17.8 - 26:23.0	(copy to new layer) "and copy to a new layer, I will call this pre-interaction "	Be-K	Be-K	Be-K
198	26:23.0 - 26:35.8	(turn off the layer and rotate the model)	Bs-K	Bs-K	Bs-K
199	26:35.8 - 26:44.9	(delete the facade curve)	S-K	S-K	S-K
200	26:44.9 - 26:51.6	(rotating)	Bs-K	Bs-K	Bs-K
201	26:51.6 - 27:01.4	"to see what happens by apply these curves to the roof of the building"	Be-K	Bs-K	Be-K
202	27:01.4 - 27:06.0	(apply cur)	S-K	S-K	S-K
203	27:06.0 - 27:09.8	"they do get some interesting effects" (rotating)	Bs-K	Bs-K	Bs-K
204	27:09.8 - 27:14.8	"try again"(flow-surface)	S-K	S-K	S-K
205	27:14.8 - 27:30.9	"it start to looks interesting" (rotate)	Bs-K	Bs-K	Bs-K
206	27:30.9 - 27:38.7	(rotate the curve)	S-K	S-K	S-K
207	27:38.7 - 27:56.3	"I am playing with the pattern" (copy curves)	S-K	S-K	S-K
208	27:56.3 - 28:06.4	(rotate the curves)	S-K	S-K	S-K
209	28:06.4 - 28:11.0	"group" (group)	S-K	S-K	S-K
210	28:11.0 - 28:16.3	"just make a set of geometry, and i am going to apply these curves again"	S-K	Be-K	Be-K
211	28:16.3 - 28:22.9	"to the facade, just to see what the effect is"	Bs-K	Be-K	Be-K
212	28:22.9 - 28:29.5	(apply cur)	S-K	S-K	S-K
213	28:29.5 - 28:41.0	"now there's some interesting patterns happen, but still i am not convinced so i am not going to do that" (evaluate and then delete)	Bs-K	Bs-K	Bs-K
214		"rotate this, and apply again" (rotate, apply cur)	S-K	S-K	S-K
215	28:41.0 - 28:46.7	"maybe I will do a side curve, see what does it looks like"	Be-K	Be-K	Be-K
216	28:46.7 - 28:55.8	(apply cur)	S-K	S-K	S-K
217	28:55.8 - 29:11.7	(rotate)	Bs-K	Bs-K	Bs-K
218	29:11.7 - 29:25.2	"previewing from the street, from human height" (rotating)	Bs-K	Bs-K	Bs-K
219	29:25.2 - 29:33.9	(rotate the model)	Bs-K	Bs-K	Bs-K
220	29:33.9 - 29:37.0	"and every time i make change, I just undo and adjust it" (apply cur)	S-K	S-K	S-K
221	29:37.0 - 29:44.8	"doesn't suit the way I used to work" (rotating)	Bs-K	Bs-K	Bs-K
222	29:44.8 - 29:51.1	"so I've got a pattern" (rotating)	Bs-K	Bs-K	Bs-K

223	29:51.1 - 29:53.5	"now pretend to be windows or something"	F-K	F-K	F-K
224	29:53.5 - 29:57.0	"here, I am not too happy with that" (looking at the corner)	Bs-K	Bs-K	Bs-K
225	29:57.0 - 30:13.5	(delete)	S-K	S-K	S-K
226	30:13.5 - 30:27.6	"so what i prefer to do is to use parametric way of using these curves or pattern on this facade and testing it up quickly with many interactions, what I do use a lot of time"	Be-K	Be-K	Be-K
227	30:27.6 - 30:37.4	"just do... in this case, scale, and reapply the same steps" (scale)	S-K	S-K	S-K
228	30:37.4 - 30:43.1	"which is applying the curve to the surface" (apply curve to the surface)	S-K	S-K	S-K
229	30:43.1 - 30:51.9	"and once again, i am not so happy with it"	Bs-K	Bs-K	Bs-K
230	30:51.9 - 31:07.5	(rotate)	Bs-K	Bs-K	Bs-K
231	31:07.5 - 31:12.5	(twist)	S-K	S-K	S-K
232	31:12.5 - 31:22.7	(undo)	S-K	S-K	S-K
233	31:22.7 - 31:33.5	"try taper" (taper)	S-K	S-K	S-K
234	31:33.5 - 31:36.3	(apply cur)	S-K	S-K	S-K
235	31:36.3 - 31:39.6	"i am starting some interesting results" "we a kind of like that"	Bs-K	Bs-K	Bs-K
236	31:39.6 - 31:44.7	"test it again, on the other facade"	Be-K	Be-K	Be-K
237	31:44.7 - 31:54.8	(apply cur)	S-K	S-K	S-K
238	31:54.8 - 32:02.7	(rotate)	Bs-K	Bs-K	Bs-K
239	32:02.7 - 32:08.5	(undo) "I don't do that"	S-K	S-K	S-K
240	32:08.5 - 32:17.6	(rotate)	Bs-K	Bs-K	Bs-K
241	32:17.6 - 32:22.7	"ok, at this stage, I will probably do some rendering"	Bs-K	Be-K	Bs-K
242	32:22.7 - 32:26.5	"some shadow analysis"	Be-K	Be-K	Be-K
243	32:26.5 - 32:33.7 (+7:42.5)	"just to see what shadow does these massing has on this site"	Bs-K	Bs-K	Bs-K

Designer 5

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:03.6 - 0:10.0	So I am now doing the second exercise which is the shopping centre, I use grasshopper.	R-K	R-K	R-K
2	0:10.0 - 0:21.3	kind of play with it, not design with it, I haven't use grasshopper very much, I do understand what grasshopper's going to give me, to help with getting out of stuff, so not totally sure what I am going to do here, and create different sort of creation, when we have it model explicitly, which is good	N	Be-K	N
3	0:45.0 - 0:51.3	so what I am thinking of is a shopping centre, which is a concept for it.	R-K	R-K	R-K

4	0:51.3 - 0:59.8	will be a twisting, two floor form	R-K	S-K	S-K
5	0:59.0 - 1:06.9	with shopping and leisure	F-K	F-K	F-K
6	1:06.9 - 1:10.1	comparing across the form and moving over	Be-K	Be-K	Be-K
7	1:10.1 - 1:16.9	from shops, building and maybe some other part of the building	F-K	F-K	F-K
8	1:16.9 - 1:24.3	you have to have capacity for cars as well	F-K	Be-K	F-K
9	1:24.3 - 1:35.0	so not too much in design, I am interested in what it is in grasshopper, it is kind of .. not ideal, I know I would try this in grasshopper, so	Be-K	N	N
10	1:47.0 - 1:53.7	first, I will look at the site again	R-K	R-K	R-K
11	1:53.7 - 1:57.2	I can sketch out things that is important	Be-K	N	N
12	1:57.2 - 2:08.0	for shopping, it is feel like, you know, this is the main road again,	F-K	F-K	F-K
13	2:08.0 - 2:15.2	if you drive left, you have to drive in... you have to cross over,	Be-K	Be-K	Be-K
14	2:15.2 - 2:21.9	the best way for them to really get into the building is that junction	Be-K	Be-K	Be-K
15	2:21.9 - 2:26.2	so here or here, so last time I put it here	Be-K	S-K	S-K
16	2:26.2 - 2:29.9	and this time, I am going to put it here	S-K	S-K	S-K
17	2:29.9 - 2:32.3	it is going to make junction, so	F-K	Be-K	F-K
18	2:32.3 - 2:38.3	so I can sketch, this is where cars going to come in	Be-K	Be-K	Be-K
19		(make curve in rhino)	S-K	S-K	S-K
20	2:38.3 - 2:49.3	so cars is going to come in this way	Be-K	Be-K	Be-K
21	2:49.3 - 2:54.9	so this way	Be-K	Be-K	Be-K
22		(make curve in rhino)	S-K	S-K	S-K
23	2:54.9 - 3:14.2	this way	Be-K	Be-K	Be-K
24		(make curve in rhino)	S-K	S-K	S-K
25	3:14.2 - 3:22.3	so it can be cool if cast it spare up, and through this building	Be-K	Be-K	Be-K
26	3:28.9 - 3:35.9	so I want a relationship with the street	Be-K	Be-K	Be-K
27	3:35.9 - 3:40.5	so I want to create as much space as possible	F-K	F-K	F-K
28	3:40.5 - 3:49.2	I am thinking something like this	Be-K	Be-K	Be-K
29		(draw a curve in rhino)	S-K	S-K	S-K
30	3:49.2 - 3:54.8	which has an area of 4.976 (check the area of the circle)	Bs-K	Bs-K	Bs-K
31	3:54.8 - 4:03.4	and then I want it to move up	S-K	Be-K	S-K
32	4:03.4 - 4:29.2	so if I use grasshopper (open grasshopper)	N	N	N
33	4:29.2 - 4:47.2	I need a circle (put an circle component)	S-K	S-K	S-K
34	4:47.2 - 5:05.5	so I set the input, I set one point, and I want it to serve this centre of	Be-R	Be-R	Be-R
35	5:27.4 - 5:36.2	(set the point)	S-R	S-K	S-K

36	5:36.2 - 5:52.9	I am also read these instructions about how it works	N	N	N
37	5:52.9 - 6:06.6	so set the number, I am going to set this number to 10 (set parameter)	S-R	S-R	S-R
38	6:06.6 - 6:24.5	now I get a unit z vector (set z)	Be-R	Be-R	Be-R
39	6:24.5 - 6:41.2	I right click this input, set this number to 10 (set parameters)	S-R	S-R	S-R
40	6:41.2 - 6:51.2	So I am going to have a "move" component here (set "move")	S-K	S-K	S-K
41	6:51.2 - 7:08.7	so I will take this into here (connect z with move), so the output of the z vector goes to t	S-R	S-R	S-R
42	7:08.7 - 7:19.2	so put c into g to move (connect the circle with move)	S-R	S-R	S-R
43	7:19.2 - 7:39.8	so centre of the circle has a radius of 10	Bs-K	Bs-K	Bs-K
44	7:39.8 - 7:44.4	(change to rhino interface to check the circle),	Bs-K	Bs-K	Bs-K
45		So this circle needs to be bigger.	Be-K	Be-K	Be-K
46	7:44.4 - 7:50.7	pan on the rhino interface	Bs-K	Bs-R	Bs-K
47	7:50.7 - 8:03.8	(measure the radius of the circle) so that actually 7.8	Bs-K	Bs-K	Bs-K
48	8:03.8 - 8:10.9	(change parameters) so I will make this 40	S-R	S-R	S-R
49	8:10.9 - 8:19.7	cool, says my radius is 40	Bs-K	Bs-K	Bs-K
50	8:19.7 - 8:46.0	now in terms of height..	S-K	F-K	S-K
51		I want to take a unit	Be-R	Be-R	Be-R
52	8:46.0 - 9:00.6	so I want to move it...10, 10 metres	S-K	S-K	S-K
53	9:00.6 - 9:06.6	I want to make it three stories,	F-K	F-K	F-K
54		so 15 metres	S-K	S-K	S-K
55	9:06.6 - 9:12.5	to 20..	S-K	S-K	S-K
56	9:12.5 - 9:15.7	(change to perspective view in rhino)	Bs-K	Bs-K	Bs-K
57	9:15.7 - 9:20.0	so I got two circles in the space (rotate the model)	Bs-K	Bs-K	Bs-K
58	9:20.0 - 9:30.4	I've moved one circle, and then move along the distance	Bs-K	Be-K	Be-K
59		(check grasshopper definition)	Bs-R	Bs-R	Bs-R
60	9:30.4 - 9:41.5	so now I need to divide curve, component (set "divide" component)	Be-K	Be-R	Be-K
61	9:41.5 - 9:54.9	need two of these (copy component)	Be-K	S-R	S-R
62	9:54.9 - 10:07.7	I need to take the circle to the first divide (connect component)	S-R	S-R	S-R
63	10:07.7 - 10:22.8	I need to take g out put to c (connect component)	S-R	S-R	S-R
64	10:22.8 - 10:34.0	now I need a slider (set parameter)	S-R	S-R	S-R
65	10:34.0 - 11:25.2	to alter, min 1 , max 30 (set constraints)	Be-R	Be-R	Be-R
66	11:25.2 - 11:32.5	so we just divide that curve	Be-K	Be-K	Be-K
67		(connect slider)	S-R	S-R	S-R
68	11:32.5 -	so now I can alter that, a kind of cool (change	S-R	S-R	S-R

	11:40.3	parameter)			
69	11:40.3 - 11:54.5	and I am taking another version of that (copy slider)	Be-R	S-R	Be-R
70	11:54.5 - 11:59.2	so I can then change the numbers as well (change parameter)	S-R	S-R	S-R
71	11:59.2 - 12:19.2	so I need a shift list (set "shift list" component)	Be-R	Be-R	Be-R
72	12:19.2 - 12:48.5	so now the point is going to the "shift" to move it around the circle	Be-R	Bs-R	Bs-R
73		(connect)	S-R	S-R	S-R
74	12:48.5 - 13:05.8	and I take another slider, (set parameter)	S-R	S-R	S-R
75	13:05.8 - 13:21.3	and this time, min 10 (set constraints)	Be-R	Be-R	Be-R
76	13:21.3 - 13:34.7	(connect slider and change parameters)	S-R	S-R	S-R
77	13:34.7 - 13:56.7	shift list... true (examine the component)	Bs-R	Bs-R	Bs-R
78	13:56.7 - 14:00.7	(change parameters)	S-R	S-R	S-R
79	14:00.7 - 14:07.3	so shift the points of that circle by 10	Be-R	Be-R	Be-R
80	14:07.3 - 14:11.9	(change parameters)	S-R	S-R	S-R
81	14:11.9 - 14:20.6	ok, we are going to create rough entrance for data	Be-R	Be-R	Be-R
82	14:20.6 - 14:27.4	so now we are going to put a line component here (set "line")	S-K	S-K	S-K
83	14:27.4 - 14:44.2	so first, divide curve P (connect line)	S-K	Be-K	S-K
84	14:44.2 - 15:17.6	can I shift line to the point B component input	Be-R	S-R	S-R
85	15:17.6 - 15:32.8	Line A input, line B, so.. kind of first divide curve B	Bs-R	S-R	S-R
86	15:40.9 - 16:03.4	(set "line" component)	S-K	S-K	S-K
87	16:03.4 - 16:15.4	shift our output	Be-R	Be-R	Be-R
88	16:15.4 - 16:37.9	(set "panel", examine the panel)	Bs-R	Bs-R	Bs-R
89	16:37.9 - 16:44.2	ok, so give me values (connect component)	S-R	S-R	S-R
90	16:44.2 - 16:53.1	give me everything, just good (look at the model)	Bs-R	Bs-K	Bs-R
91	16:52.0 - 17:03.6	trying to get this curve permitted ...	Be-R	Be-R	Be-R
92	17:03.6 - 17:16.6	ok, cool, so take off the wrong one (delete and set another "line")	S-R	S-R	S-R
93	17:16.6 - 17:23.9	so A comes from P..(connect line A and B)	S-R	S-R	S-R
94	17:23.9 - 17:33.9	(change parameter)	S-R	S-R	S-R
95	17:33.9 - 17:39.9	(change parameter)	S-R	S-R	S-R
96	17:39.9 - 17:45.1	(change parameter)	S-R	S-R	S-R
97		(rotate the model)	Bs-K	Bs-K	Bs-K
98	17:53.7 - 17:56.7	I am generating the ... which potentially can take cars as well	Be-K	Be-K	Be-K
99		(rotate model)	Bs-K	Bs-K	Bs-K

100	17:56.7 - 17:59.9	I am up a level	N	S-K	S-K
101	17:59.9 - 18:03.5	outside slightly	Be-K	S-K	Be-K
102		(change parameters)	S-R	S-R	S-R
103	18:03.5 - 18:14.2	that's equal, you can actually pass from one to the other	Bs-K	Bs-K	Bs-K
104		(change parameter)	S-R	S-R	S-R
105	18:14.2 - 18:18.6	(rotate the model)	Bs-K	Bs-K	Bs-K
106	18:18.6 - 18:36.7	(change parameter) what is better is I actually change to 10.. maybe 30	S-R	S-R	S-R
107	18:36.7 - 18:41.8	(change constraints)	Be-R	Be-R	Be-R
108	18:41.8 - 19:07.2	to 30, ok (change parameter)	S-R	S-R	S-R
109	19:07.2 - 19:14.2	(rotate the model)	Bs-K	Bs-K	Bs-K
110	19:14.2 - 19:24.9	so minimize this (rotate the model)	Bs-K	Bs-K	Bs-K
111	19:24.9 - 19:39.0	cars can move around,	Be-R	Be-K	Be-R
112		and then leisure	F-K	F-K	F-K
113		on the top	S-K	S-K	S-K
114	19:39.0 - 19:48.7	(rotate the model)	Bs-K	Bs-K	Bs-K
115	19:47.2 - 19:56.5	So I want to bake it (bake) things will do.. change to rhino interface	N	N	N
116	20:14.4 - 20:18.8	(rotate the model) ok	Bs-K	Bs-K	Bs-K
117	20:18.8 - 20:31.3	So we should bake this.. (bake)	N	N	N
118	20:31.3 - 20:57.0	so I got this wireframe now (rotate the model)	Bs-K	Bs-K	Bs-K
119		seems interesting	Bs-K	Bs-K	Bs-K
120	20:57.0 - 21:10.0	Now I want to take these lines off and criticize from.. (delete component)	N	S-K	S-K
121	21:10.0 - 21:25.7	so I need to loft the lines (set "loft" component)	S-K	S-K	S-K
122	21:25.7 - 21:39.4	c curves as list (connect component)	Be-R	S-R	Be-R
123	21:39.4 - 21:45.0	(look at the model) cool, ok	Bs-K	Bs-K	Bs-K
124	21:45.0 - 21:56.1	(rotate the model) not quite working	Bs-K	Bs-K	Bs-K
125	21:56.1 - 22:06.2	loft options, ...(change property of loft)	Be-R	S-K	S-K
126	22:06.2 - 22:28.2	(rotate the model)	Bs-K	Bs-K	Bs-K
127	22:28.2 - 22:32.4	(change parameter)	S-R	S-R	S-R
128	22:32.4 - 22:40.8	(rotate the model)	Bs-K	Bs-K	Bs-K
129	22:40.8 - 22:50.5	(change parameter)	S-R	S-R	S-R
130	22:50.5 - 23:12.3	(rotate the model)	Bs-K	Bs-K	Bs-K
131	23:12.3 - 23:19.9	create a wise surface	S-K	S-K	S-K
132	23:19.9 -	(set "loft" component)	S-K	S-K	S-K

	23:26.4				
133	23:26.4 - 23:34.9	(change parameters) must be somewhere not working	S-R	S-R	S-R
134	23:34.9 - 23:39.9	ok, some mesh doesn't work	Bs-K	Bs-K	Bs-K
135		(change parameters)	S-R	S-R	S-R
136	23:39.9 - 23:46.9	so wired, (rotate the model)	Bs-K	Bs-K	Bs-K
137	23:46.9 - 24:00.8	(change parameters)	S-R	S-R	S-R
138	24:00.8 - 24:46.0	(rotate the model)	Bs-K	Bs-K	Bs-K
139		Why it is like that...	N	Bs-K	Bs-K
140	24:46.0 - 24:56.9	(pan on the grasshopper interface) ok, I am not really sure what it does (check loft)	Bs-R	Bs-R	Bs-R
141	24:56.9 - 25:09.3	I am going to close "loft" (turn of "loft" component)	S-R	S-K	S-R
142	25:09.3 - 25:13.7	(look at the model) ok, cool	Bs-K	Bs-K	Bs-K
143	25:13.7 - 25:26.8	ok, so if I bake (bake)	N	N	N
144	25:26.8 - 25:35.3	(rotate the model) it gives me an interesting form	Bs-K	Bs-K	Bs-K
145	25:35.3 - 25:53.8	as a surface, it's a bit... (rotate the model)	Bs-K	Bs-K	Bs-K
146	25:53.8 - 25:56.4	I patch this (patch the surface)	S-K	S-K	S-K
147	25:56.4 - 26:07.0	(rotate the model)	Bs-K	Bs-K	Bs-K
148	26:07.0 - 26:17.7	(rotate the model) I could say, it's quite a cool form	Bs-K	Bs-K	Bs-K
149	26:17.7 - 26:27.1	we need to work on where the cars could circle the outside	Be-K	Be-K	Be-K
150	26:27.1 - 26:37.1	I also want that there are some spaces inside to have other activities going on	F-K	F-K	F-K
151	26:37.1 - 26:43.3	cars on the outside and then protections inside	Be-K	F-K	F-K
152	26:43.3 - 26:58.5	I want a way of being able to take a point on the surface	Be-R	Be-K	Be-R
153	26:58.5 - 27:07.1	project a line to take the cars to the top	Be-K	Be-K	Be-K
154	27:07.1 - 27:14.2	(rotate the model)	Bs-K	Bs-K	Bs-K
155	27:14.2 - 27:25.4	so cars will move here, serve inside, here move over	Be-K	Be-K	Be-K
156	27:25.4 - 27:48.6	rotate the model	Bs-K	Bs-K	Bs-K
157	27:48.6 - 28:00.1	so if I can take ..(open grasshopper) I got a loft, so I have a surface	S-K	Bs-K	Bs-K
158	28:03.8 - 28:15.9	if I save..(save grasshopper document)	N	N	N
159	28:15.9 - 28:20.3	if I can do another one (set a new grasshopper file)	N	Be-R	Be-R
160	28:20.3 - 28:26.1	takes a surface (set "surface" component)	S-K	S-K	S-K
161	28:26.1 - 28:39.8	Cool, ok.	Bs-K	Bs-K	Bs-K
162		(take the surface generated)	S-K	S-K	S-K
163	28:39.8 - 28:54.3	now is a... where I get round the surface	Bs-K	Bs-K	Bs-K

164	28:54.3 - 29:01.9	I need something as a base	S-K	Be-K	S-K
165	29:01.9 - 29:14.1	points, and then y, up surface, the spiral	S-R	Be-R	Be-R
166	29:14.1 - 31:10.3	(checking information about the use of grasshopper) ok, seems complicated, spiral on the surface, ok, cool, so it project	Be-R	Bs-K	Be-R
167	31:10.3 - 31:13.4	so I can do a project onto.. (set component "project")	S-K	Be-R	S-K
168	31:13.4 - 31:17.0	I want to project a curve on to a brep	Be-R	Be-K	Be-R
169	31:17.0 - 31:28.9	project the curves	S-K	S-K	S-K
170	31:28.9 - 31:49.4	that one (set another "project" component)	S-K	S-R	S-K
171	31:49.4 - 31:52.9	geometry project (check the grasshopper definition)	Bs-R	Bs-K	Bs-R
172	31:52.9 - 31:58.3	(delete the component)	S-R	S-R	S-R
173	31:58.3 - 32:10.1	is there any spirals (looking for component)	S-R	S-R	S-R
174	32:10.1 - 32:43.1	(search grasshopper definition on website)	Be-R	Be-R	Be-R
175	32:43.1 - 32:51.0	(introduce external definition of grasshopper)	S-R	S-K	S-R
176	32:51.0 - 33:16.4	(check grasshopper definition)	Bs-R	Bs-R	Bs-R
177	33:16.4 - 34:48.7	(search grasshopper definition on website)	Be-R	Be-R	Be-R
178	34:48.7 - 34:52.2	so we could try to do a spiral	Be-R	Be-R	Be-R
179	34:52.2 - 35:10.5	we need a component (set "range")	Be-R	Be-R	Be-R
180	35:10.5 - 35:15.5	and then a slider (set parameters)(change name of the slider)	S-R	S-R	S-R
181	35:28.9 - 35:42.3	(set constraints)	Be-R	Be-R	Be-R
182	35:42.3 - 35:50.2	(change parameters)	S-R	S-R	S-R
183	35:50.2 - 36:02.2	(set another parameter)(change name of the slider)	S-R	S-R	S-R
184	36:16.1 - 36:25.9	(set constraints)	Be-R	Be-R	Be-R
185	36:25.9 - 36:29.3	(change parameter)	S-R	S-R	S-R
186	36:29.3 - 36:45.5	so I’m going to control that	Be-R	Be-R	Be-R
187		(connect sliders)	S-R	S-R	S-R
188	36:45.5 - 36:57.3	(check definition of the component)	Bs-R	Bs-R	Bs-R
189	36:57.3 - 37:08.6	so we need a function, single variable function	Be-R	Be-R	Be-R
190	37:08.6 - 38:31.8	(looking for component)	N	N	N
191	38:31.8 - 38:35.2	(set "expression" component) ok	Be-R	Be-R	Be-R
192	38:34.6 - 38:41.0	(delete the component)	S-R	S-R	S-R
193	38:41.0 - 39:06.7	(reset the "expression" component)	Be-R	Be-R	Be-R
194	39:06.7 - 39:31.1	(make mathematical expression in the function component)	Be-R	Be-R	Be-R

195	39:31.1 - 39:42.1	so this is the component, collect x, input something	S-R	S-R	S-R
196	39:42.1 - 39:50.3	(copy "expression" component)	Be-R	Be-R	Be-R
197	39:50.3 - 40:10.0	(make mathematical expression in the function component)	Be-R	Be-R	Be-R
198	40:10.0 - 40:17.8	the range output to the x input	S-R	S-R	S-R
199	40:17.9 - 40:25.6	(connect component)	S-R	S-R	S-R
200	40:43.0 - 40:47.5	ok, take a vector xyz, vector	Be-R	Be-R	Be-R
201	40:47.5 - 40:52.5	(set vector)	Be-R	Be-R	Be-R
202	40:52.5 - 41:01.4	the first should from "r" output	S-R	S-R	S-R
203	41:01.4 - 41:07.3	to "x" input (connect component)	S-R	S-R	S-R
204	41:07.3 - 41:16.0	to both function component	S-R	S-R	S-R
205	41:16.0 - 41:31.5	ok, the first function r output, the second I will put it in y (reconnect the component)	S-R	S-R	S-R
206	41:31.5 - 41:38.6	connect the range output	S-R	S-R	S-R
207	41:38.6 - 41:43.8	to the z input (connect component)	S-R	S-R	S-R
208	41:43.8 - 41:57.8	I feel it is right in v .. (rotate the model)	Bs-R	Bs-K	Bs-K
209	41:57.8 - 42:01.3	(pan on the grasshopper interface)	Bs-R	Bs-R	Bs-R
210	42:01.3 - 42:08.3	(change parameters)	S-R	S-R	S-R
211	42:08.3 - 42:14.4	10 (check grasshopper definition)	Bs-R	Bs-R	Bs-R
212	42:14.4 - 42:21.9	(rotate the model)	Bs-K	Bs-K	Bs-K
213	42:21.9 - 42:31.6	through the points to change the spiral, the beginning of the definition	Be-R	Be-R	Be-R
214	42:31.6 - 42:37.7	to change the number of points on the spiral	Be-R	Be-R	Be-R
215	42:37.7 - 42:48.7	a curve (set "curve" component)	S-K	S-K	S-K
216	42:48.7 - 43:31.5	connect p output to the curve input	S-R	S-R	S-R
217	43:31.5 - 43:36.3	point xyz, ok, right (set point xyz component)	S-R	S-K	S-R
218	43:36.3 - 44:25.7	(connect component)	S-R	S-R	S-R
219	44:25.7 - 44:30.8	where it is, ok (zoom in on the rhino interface)	Bs-K	Bs-K	Bs-K
220	44:30.8 - 44:34.7	so I need a position	S-K	Be-R	Be-R
221	44:34.7 - 44:40.6	(check grasshopper interface)	Bs-R	Bs-R	Bs-R
222	44:40.6 - 44:44.7	(set "move" component)	S-K	S-K	S-K
223	44:44.7 - 45:08.7	(delete component)	S-R	S-R	S-R
224	45:08.7 - 45:17.4	(change parameters)	S-R	S-R	S-R
225	45:17.4 - 45:23.3	(change parameters)	S-R	S-R	S-R

226	45:23.3 - 45:32.4	as tall as well (examine the left view on rhino interface)	Bs-K	Bs-K	Bs-K
227	45:32.4 - 45:43.7	(change parameters)	S-R	S-R	S-R
228	45:43.7 - 45:54.6	(check the building mass on rhino interface)	Bs-K	Bs-K	Bs-K
229	45:54.6 - 46:06.6	(rotate the model)	Bs-K	Bs-K	Bs-K
230	46:06.6 - 46:35.7	(move the points on the building mass in rhino)	S-K	S-K	S-K
231	46:35.7 - 46:40.8	Yeah, this is a wave!	Bs-K	Bs-K	Bs-K
232	46:40.8 - 46:54.9	(change parameters)	S-R	S-R	S-R
233	46:54.9 - 47:14.1	scale (set "scale" component)	S-K	S-K	S-K
234	47:14.1 - 47:19.4	(set parameters)	S-R	S-R	S-R
235	47:19.4 - 47:26.0	(change parameters)	S-R	S-R	S-R
236	47:26.0 - 47:41.9	(change constraints)	Be-R	Be-R	Be-R
237	47:41.9 - 47:51.7	(change parameters)	S-R	S-R	S-R
238	47:51.7 - 48:08.4	(rotate the model)	Bs-K	Bs-K	Bs-K
239	48:08.4 - 48:19.3	(change parameters)	S-R	S-R	S-R
240	48:19.3 - 48:29.8	(check grasshopper definition)	Bs-R	Bs-R	Bs-R
241	48:29.8 - 48:53.6	so here we go, as far as my design.	N	Bs-K	Bs-K
242	48:53.6 - 48:59.5	but for how cars would move around,	Be-K	Be-K	Be-K
243	48:59.5 - 49:06.5	(rotate the model)	Bs-K	Bs-K	Bs-K

GME session

ID	TIMESPAN	CONTENT	1st coding	2nd coding	Final coding
1	0:00.0 - 0:11.3	so I am doing firstly, community centre, within just in Rhino	R-K	R-K	R-K
2	0:11.3 - 0:18.4	so first, I am thinking what as community centre is important	F-K	F-K	F-K
3	0:18.4 - 0:27.5	for me, the two key thing is the main road and the park here	F-K	F-K	F-K
4	0:27.5 - 0:35.2	so just looking at the brief (read the design brief)	R-K	R-K	R-K
5	0:35.2 - 0:39.9	this is commercial, main road, residential, so	R-K	R-K	R-K
6	0:39.9 - 0:46.2	potentially two parts to the community centre	F-K	F-K	F-K
7	0:46.2 - 0:55.5	it could be an entrance or access to the commercial and then residential	F-K	F-K	F-K
8	0:55.5 - 1:05.6	so I am going to first look at possible car (switch back to top view)	Be-K	R-K	Be-K
9	1:04.1 - 1:17.7	placement, and traffic route, parking area (revisit the design brief)	R-K	R-K	R-K
10	1:17.7 - 1:31.4	so I think this park is quite important park which can cooperating with design, so I quite like	F-K	F-K	F-K
11	1:31.5 -	can show public areas	F-K	F-K	F-K

	2:08.8				
12	2:08.8 - 2:19.7	so things can come from here, feels like this kind of results	Be-K	Be-K	Be-K
13	2:19.7 - 2:21.8	(draw curves)	S-K	S-K	S-K
14	2:21.8 - 2:33.3	kind of do that (draw curves)	S-K	S-K	S-K
15	2:33.3 - 2:40.7	and same time kind of do that (draw curves)	S-K	S-K	S-K
16	2:40.7 - 2:52.7	(trim the curve)	S-K	S-K	S-K
17	2:52.7 - 3:25.4	maybe it will be nice if I can curve around	Be-K	Be-K	Be-K
18		(draw curve)	S-K	S-K	S-K
19	3:25.4 - 3:32.0	(delete curve)	S-K	S-K	S-K
20	3:32.0 - 3:46.2	while I will work on that angle, shear.. offset	Be-K	Be-K	Be-K
21	3:46.2 - 4:12.7	copy distance, two metres (offset)	S-K	S-K	S-K
22	4:12.6 - 4:30.8	(offset)	S-K	S-K	S-K
23	4:30.8 - 4:47.2	three ..just make it duplicate (offset)	S-K	S-K	S-K
24	4:47.2 - 4:52.7	so I am going to offset	S-K	Be-K	S-K
25	4:52.7 - 5:02.5	create some space, because I want the (offset)	Be-K	Be-K	Be-K
26	5:02.5 - 5:08.8	I want this to be able to inhabited by public	F-K	F-K	F-K
27	5:08.8 - 5:27.5	just change the unit (change unit in rhino setting)	N	Be-K	N
28	5:27.5 - 5:43.0	so that's ok (pan on the top view interface)	Bs-K	Bs-K	Bs-K
29	5:43.0 - 6:02.1	it's kind of I am start to form it	Be-K	N	N
30	6:02.1 - 6:36.1	it's a bit flat, so	Bs-K	Bs-K	Bs-K
31		(offset and trim the curve)	S-K	S-K	S-K
32	6:36.1 - 6:39.6	so I’m going to join these now (join the curves)	S-K	S-K	S-K
33	6:45.9 - 6:49.2	and have a bit, play around	N	Be-K	n
34	6:49.2 - 7:05.7	I might rebuild, 20 (rebuild the curve)	Be-K	Be-K	Be-K
35	7:05.7 - 7:32.7	(rebuild the curve again)	Be-K	Be-K	Be-K
36	7:32.7 - 7:45.4	so if I have more, (rebuild the curve again)	Be-K	Be-K	Be-K
37	7:45.4 - 7:51.0	ok, so turn the points on, (turn on the points)	Be-K	N	N
38	7:51.0 - 7:58.9	and start to stretch this a little bit in (dragging points)	S-K	S-K	S-K
39	7:58.9 - 8:03.7	just can bring this one in (dragging points)	S-K	S-K	S-K
40	8:03.7 - 8:05.8	this one as well (dragging points)	S-K	S-K	S-K
41	8:05.8 - 8:11.3	This one quite happy if... (dragging points)	S-K	S-K	S-K
42	8:11.3 - 8:16.8	so I am going to treat this to a ...block connect to	Be-K	Be-K	Be-K

43	8:16.8 - 8:24.2	through here,	Be-K	Be-K	Be-K
44		this is the entrance from the public	F-K	F-K	F-K
45	8:24.2 - 8:29.6	And this is the park, this has the relationship too.	F-K	F-K	F-K
46	8:29.6 - 8:48.0	so what I am thinking is that this is a flat surface is an inhabitable space	F-K	F-K	F-K
47	8:48.0 - 8:55.4	this end allow car goes in	Be-K	F-K	Be-K
48		as a car park	F-K	F-K	F-K
49	8:55.4 - 9:01.0	so the car park... and the activities happens within the body	F-K	F-K	F-K
50	9:01.0 - 9:10.1	and then the ground levels connect ,	Be-K	F-K	Be-K
51		and bring the park up on to the roof	F-K	F-K	F-K
52	9:10.1 - 9:13.8	so if I made this into a surface	S-K	Be-K	S-K
53	9:13.8 - 9:16.4	(patch the surface)	S-K	S-K	S-K
54	9:16.4 - 9:29.1	I can now start to play with a	Be-K	Be-K	Be-K
55	9:29.1 - 9:34.5	(change to perspective view)	Bs-K	Bs-K	Bs-K
56	9:34.5 - 9:47.9	(turn on the points) not review this, just set it simpler	N	Be-K	N
57	9:47.9 - 10:08.8	5,5 (rebuild the surface)	Be-K	Be-K	Be-K
58	10:08.8 - 10:22.9	(pan on the left view)	Bs-K	Bs-K	Bs-K
59	10:22.9 - 10:32.6	(move the points to form the surface)	S-K	S-K	S-K
60	10:32.6 - 10:43.0	say it is up 4 metres (move the points)	S-K	S-K	S-K
61	10:43.0 - 10:50.4	Has it do anything? No, it hasn't. it's good	Bs-K	Bs-K	Bs-K
62	10:50.4 - 10:54.5	(delete the surface) I will get back here	S-K	S-K	S-K
63	10:54.5 - 11:07.8	if I extrude it first	S-K	S-K	S-K
64	11:07.8 - 11:20.9	(extrude the curve)	S-K	S-K	S-K
65	11:20.9 - 11:32.2	3, ok	S-K	Bs-K	S-K
66	11:32.2 - 11:43.6	so, I join and cap (join and cap the surface)	S-K	S-K	S-K
67	11:43.6 - 11:52.7	if I turn on these points	Be-K	S-K	N
68	11:52.7 - 12:07.1	(rotate the model)	Bs-K	Bs-K	Bs-K
69	12:07.1 - 12:17.8	it seems I should get rid of this one	Be-K	Be-K	Be-K
70		(delete one surface)	S-K	S-K	S-K
71	12:17.8 - 12:23.5	what's the size of this (check the size of area)	Bs-K	Bs-K	Bs-K
72	12:23.5 - 12:30.2	ok, that's .. the surface	Bs-K	Bs-K	Bs-K
73	12:30.2 - 12:48.8	4 metres (move one corner point of the surface)	S-K	S-K	S-K
74	12:48.8 - 13:29.3	(rotate the model)	Bs-K	Bs-K	Bs-K

75	13:29.3 - 13:32.2	(change to right view)	Bs-K	Bs-K	Bs-K
76	13:32.2 - 13:38.6	I am considering hide the model, it's really annoying (hide site)	N	N	N
77	13:38.6 - 13:53.5	(rotate the model)	Bs-K	Bs-K	Bs-K
78	13:53.5 - 14:17.2	I can move this a little bit more, 3 metres (move point)	S-K	S-K	S-K
79	14:17.2 - 14:25.5	(change to top view)	Bs-K	Bs-K	Bs-K
80	14:25.5 - 14:41.6	(zoom in) it seems to wave more,	Bs-K	S-K	Bs-K
81		so yeah, take it up to 5 metres (move point)	S-K	S-K	S-K
82	14:41.6 - 14:47.2	so that's .. slightly allow something (rotate the model)	Bs-K	Bs-K	Bs-K
83	14:47.2 - 14:54.4	(rotate the model)	Bs-K	Bs-K	Bs-K
84	14:54.4 - 15:01.9	you can climb up from there	Bs-K	Be-K	Be-K
85	15:01.9 - 15:25.0	(Revisit the design brief) building area around 6000 m2.	R-K	R-K	R-K
86	15:25.0 - 15:29.2	(rotate the model)	Bs-K	Bs-K	Bs-K
87	15:29.2 - 16:09.6	so that I want this area here to be actual centre	F-K	F-K	F-K
88		(change layer colour, draw curve)	S-K	S-K	S-K
89	16:09.6 - 16:21.1	what's that on the ground (rotate the model)	Bs-K	Bs-K	Bs-K
90	16:21.1 - 16:51.4	Ok, so I want this ..so I rebuild, 10 and 10 (rebuild the surface)	Be-K	Be-K	Be-K
91	16:50.3 - 17:07.0	ok, so quite want this to move up (move up points)	S-K	S-K	S-K
92	17:07.0 - 17:17.9	and with these (rotate the model)	Bs-K	Bs-K	Bs-K
93	17:17.9 - 17:29.6	to move up (select the points and then move up)	S-K	S-K	S-K
94	17:29.6 - 17:34.2	to 10 metres (move up)	S-K	S-K	S-K
95	17:34.2 - 17:41.7	(rotate the model)	Bs-K	Bs-K	Bs-K
96	17:41.7 - 17:59.6	(move up points)	S-K	S-K	S-K
97	17:59.6 - 18:09.0	so there is a bowl, programme (rotate the model)	Bs-K	Bs-K	Bs-K
98	18:09.0 - 18:16.9	(rotate the model)	Bs-K	Bs-K	Bs-K
99	18:16.9 - 18:29.3	what's the area	Bs-K	Bs-K	Bs-K
100	18:29.3 - 18:44.1	to see the area, this whole area is 12867 (check the area of surface) 12867 m2	Bs-K	Bs-K	Bs-K
101	18:44.1 - 18:52.8	ask for building around 6000 (revisit design brief)	R-K	R-K	R-K
102	18:52.8 - 19:03.6	so half the space, so this is about area of the building	F-K	F-K	F-K
103		(move curve)	S-K	S-K	S-K
104	19:03.6 - 19:18.3	and these can cover as well, and these are gradient (turn on the points)	Bs-K	Be-K	N
105	19:18.3 - 19:27.9	take up to 4 (move up points)	S-K	S-K	S-K
106	19:27.9 - 19:45.2	cool (rotate the model)	S-K	Bs-K	Bs-K

107	19:45.2 - 20:00.5	ok (rotate the model)	S-K	Bs-K	Bs-K
108	20:00.5 - 20:02.9	so this is the entrance, main entrance	F-K	F-K	F-K
109	20:02.9 - 20:08.7	(rotate the model)	Bs-K	Bs-K	Bs-K
110	20:08.7 - 20:13.0	it's kind of cut down there (rotate the model)	Bs-K	Bs-K	Bs-K
111	20:13.0 - 20:14.7	it's going to straight down	Be-K	S-K	Be-K
112	20:14.7 - 20:24.2	(rotate the model)	Bs-K	Bs-K	Bs-K
113		going to have a wall, so	Be-K	Be-K	Be-K
114	20:24.2 - 20:29.3	that's flat to the street (rotate the model)	Be-K	Bs-K	Bs-K
115	20:29.3 - 20:36.1	(rotate the model)	Bs-K	Bs-K	Bs-K
116	20:36.1 - 20:47.1	that's cars, ok (rotate the model)	Be-K	Bs-K	Bs-K
117	20:47.1 - 20:51.1	(extend the curve)	S-K	S-K	S-K
118	20:51.1 - 20:57.4	(change to right view)	Bs-K	Bs-K	Bs-K
119	20:57.4 - 21:01.0	(zoom in)	Be-K	Bs-K	Bs-K
120	21:01.0 - 21:10.9	I'm going to extrude this (extrude)	S-K	S-K	S-K
121	21:10.9 - 21:23.1	so cap off where...this actually copy this (copy)	S-K	S-K	S-K
122	21:23.1 - 21:35.3	and bring it down (move down)	S-K	S-K	S-K
123	21:35.3 - 21:44.5	(rotate the model)	Bs-K	Bs-K	Bs-K
124	21:44.5 - 21:53.8	now I should copy that surface	S-K	S-K	S-K
125	21:53.8 - 22:04.2	(rotate the model)	Bs-K	Bs-K	Bs-K
126	22:04.2 - 22:11.2	I might take the default ground (unhide the site model)	N	Be-K	N
127	22:11.2 - 22:16.0	I will take a copy of this surface (zoom in)	S-K	S-K	S-K
128	22:16.0 - 22:30.1	so the ground.. so I'm going to copy this in place (copy the surface)	S-K	S-K	S-K
129	22:30.1 - 22:35.0	I'm going to split it	S-K	S-K	S-K
130	22:35.0 - 23:03.6	split using these curves, (select curves)	S-K	S-K	S-K
131	23:03.6 - 23:29.5	it's going to split ... (select curves, and patch the curve)	S-K	S-K	S-K
132	23:29.5 - 23:45.3	cool (select edges)	Bs-K	Bs-K	Bs-K
133	23:45.3 - 23:54.9	(change to top view)	Bs-K	Bs-K	Bs-K
134	23:54.9 - 24:04.2	(split) yeah, here it is	S-K	S-K	S-K
135	24:04.2 - 24:13.2	so I got this surface which is now the ground floor	F-K	F-K	F-K
136	24:13.2 - 24:22.5	change a layer (change layer)	N	N	N
137	24:22.5 - 24:29.6	kind of rebuild, 10*10 (rebuild the surface)	Be-K	Be-K	Be-K
138	24:29.6 -	(patch the surface)	S-K	S-K	S-K

	24:37.1				
139	24:37.1 - 24:59.3	what I want to do is to rebuild , 20*20 (rebuild the curve)	Be-K	Be-K	Be-K
140	24:59.3 - 25:09.9	if I now turn the points on (turn on points, zoom out)	Be-K	N	N
141	25:09.9 - 25:18.6	don't want that (undo)	Be-K	Be-K	Be-K
142	25:18.6 - 25:31.4	ok (rotate the model)	Bs-K	Bs-K	Bs-K
143	25:31.4 - 25:34.7	it's going to trim this	S-K	S-K	S-K
144	25:34.7 - 25:54.8	it's really annoying, (hide the surface)	N	N	N
145	25:54.8 - 26:05.5	rotate the model (unhide)	Bs-K	Bs-K	Bs-K
146	26:05.5 - 26:18.6	cool, as one	Bs-K	Bs-K	Bs-K
147		(join curves)	S-K	S-K	S-K
148	26:18.6 - 26:23.1	I find now it's on the ground	Bs-K	Bs-K	Bs-K
149	26:23.1 - 26:44.9	I'll cut this,	Be-K	S-K	S-K
150		if I patch 10,10 (patch the curves)	S-K	S-K	S-K
151	26:44.9 - 26:50.3	ok, cool	Bs-K	Bs-K	Bs-K
152	26:50.3 - 27:01.1	ground floor (change layer)	N	F-K	N
153	27:01.1 - 27:10.0	I'll turn the points on, then means I can keep this	Be-K	Be-K	Be-K
154	27:10.0 - 27:14.1	(zoom in)	Bs-K	Bs-K	Bs-K
155	27:14.1 - 27:28.0	and then these can gradually get down for cars	Be-K	F-K	F-K
156		(move down points)	S-K	S-K	S-K
157	27:28.0 - 27:30.8	cool, ok	Bs-K	Bs-K	Bs-K
158	27:30.8 - 27:34.1	it's something underground	Bs-K	F-K	Bs-K
159	27:34.1 - 27:38.9	(unhide the surface)	N	N	N
160	27:38.9 - 28:02.6	extrude up (extrude)	S-K	S-K	S-K
161	28:02.6 - 28:14.6	and then clipping here, so	Be-K	S-K	S-K
162		(rotate the model)	Bs-K	Bs-K	Bs-K
163	28:14.6 - 28:20.4	firstly, I'll trim this, no, split this	Be-K	S-K	S-K
164	28:20.4 - 28:29.6	by this (split)	S-K	S-K	S-K
165	28:29.6 - 28:31.4	so I will take away that	Be-K	Be-K	Be-K
166		(delete extra part)	S-K	S-K	S-K
167	28:31.4 - 28:36.2	can give me an interesting form	Be-K	Bs-K	Bs-K
168	28:36.2 - 28:45.7	(rotate the model)	Bs-K	Bs-K	Bs-K
169	28:45.7 - 29:03.2	I can do that in a minute, ok, so (rotate the model)	Bs-K	Bs-K	Bs-K
170	29:03.2 - 29:45.1	And then within this I can draw.. rebuild this (rebuild)	Be-K	Be-K	Be-K

171	29:45.1 - 29:54.6	let me rebuild (rebuild)	Be-K	Be-K	Be-K
172	29:54.6 - 30:11.7	if I explode this (explode)	Be-K	S-K	S-K
173	30:11.7 - 30:15.3	(rotate the model)	Bs-K	Bs-K	Bs-K
174	30:15.3 - 30:19.6	I don't really need this	Be-K	Bs-K	Be-K
175		(delete the curve wall)	S-K	S-K	S-K
176	30:19.6 - 30:24.7	(rotate the model)	Bs-K	Bs-K	Bs-K
177	30:24.7 - 30:26.8	this needs to be open	Be-K	Be-K	Be-K
178		(select the corner)	S-K	S-K	S-K
179	30:26.8 - 30:40.3	just I really need these points (select the points)	S-K	S-K	S-K
180	30:40.3 - 30:54.4	(move the points)	S-K	S-K	S-K
181	30:54.4 - 30:59.7	(rotate the model)	Bs-K	Bs-K	Bs-K
182	30:59.7 - 31:04.3	I might bring inside	Be-K	Be-K	Be-K
183		(move points inside)	S-K	S-K	S-K
184	31:04.3 - 31:07.2	(undo) just give a planar	S-K	S-K	S-K
185	31:07.2 - 31:25.5	so where I take it, I want it to be...pin short.	Be-K	Be-K	Be-K
186		(rotate the model	Bs-K	Bs-K	Bs-K
187		and move points)	S-K	S-K	S-K
188	31:25.5 - 31:34.2	let's take back where I take it	Be-K	S-K	Be-K
189		(move points)	S-K	S-K	S-K
190	31:34.2 - 31:45.6	ok, so (rotate the model)	Bs-K	Bs-K	Bs-K
191	31:45.6 - 31:52.0	so this, I want it inside	Be-K	Be-K	Be-K
192		(move points)	S-K	S-K	S-K
193	31:52.0 - 31:54.6	(undo)	S-K	S-K	S-K
194	31:54.6 - 31:59.6	rotate it from there, actually	S-K	Be-K	S-K
195		(rotate the model)	Bs-K	Bs-K	Bs-K
196	31:59.6 - 32:03.7	turn the points off (turn off points)	N	N	N
197	32:03.7 - 32:19.6	I want to stay there, so how do I start.	Be-K	N	N
198		(move the surface)	S-K	S-K	S-K
199	32:19.6 - 32:30.6	I'll join these (join surfaces)	S-K	S-K	S-K
200	32:30.6 - 33:24.9	(rotate the model)	Bs-K	Bs-K	Bs-K
201	33:24.9 - 33:29.6	so you can move up onto the top of this	Be-K	Be-K	Be-K
202	33:29.6 - 33:34.4	This needs to be more... slightly pronounced	Be-K	Be-K	Be-K
203		(rotate the model)	Bs-K	Bs-K	Bs-K
204	33:34.4 - 33:42.4	(rotate the model)	Bs-K	Bs-K	Bs-K

205	33:42.4 - 33:44.2	and this is the centre	F-K	F-K	F-K
206	33:44.2 - 33:50.8	(rotate the model)	Bs-K	Bs-K	Bs-K
207	33:50.8 - 33:54.7	and I should activities this side as well,	Be-K	Be-K	Be-K
208	33:54.7 - 34:21.8	so it's going to be .. cannot turn points on (turn on points)	N	N	N
209	34:21.8 - 34:23.4	(delete the curve)	S-K	S-K	S-K
210	34:23.4 - 34:34.1	(rotate the model)	Bs-K	Bs-K	Bs-K
211	34:34.1 - 34:41.4	so that can move from there, from there	Bs-K	Be-K	Be-K
212		(rotate the model)	Bs-K	Bs-K	Bs-K
213	34:41.4 - 34:47.0	(rotate the model)	Bs-K	Bs-K	Bs-K
214	34:47.0 - 34:54.9	now put the ground in	Be-K	Be-K	Be-K
215	34:54.9 - 35:16.0	(rotate the model)	Bs-K	Bs-K	Bs-K
216	35:16.2 - 35:22.9	where is the point (move a point)	S-K	S-K	S-K
217	35:22.9 - 35:36.7	(rotate the model)	Bs-K	Bs-K	Bs-K
218	35:36.7 - 35:44.3	I can see this corner... I test the whole thing	Be-K	Be-K	Be-K
219	35:44.3 - 35:46.9	join it (join surfaces)	S-K	S-K	S-K
220	35:46.9 - 35:51.7	I'm going to scale this	S-K	S-K	S-K
221	35:51.7 - 36:01.9	I'm going to scale it from this corner	Be-K	S-K	S-K
222		(scale)	S-K	S-K	S-K
223	36:01.9 - 36:05.5	(undo) I'm going to scale it from this corner	Be-K	S-K	S-K
224	36:05.5 - 36:22.0	this is where cars going, so it goes that way and that way, two ways	Be-K	Be-K	Be-K
225	36:22.0 - 36:25.3	(scale)	S-K	S-K	S-K
226	36:25.3 - 36:35.4	(rotate the model)	Bs-K	Bs-K	Bs-K
227	36:35.4 - 36:57.3	I have a polished surface now	Bs-K	Bs-K	Bs-K
228	36:57.3 - 37:03.7	(rebuild the surface) so I cannot rebuild it as well	Be-K	Be-K	Be-K
229	37:03.7 - 37:17.2	all right, so (rotate the model)	Bs-K	Bs-K	Bs-K
230	37:17.2 - 37:41.4	(polycurve)	S-K	S-K	S-K
231	37:41.4 - 38:18.5	so from the park, people go up here,	Be-K	Be-K	Be-K
232		(draw traffic route)	S-K	S-K	S-K
233	38:18.5 - 38:38.1	cars will come in from here	Be-K	Be-K	Be-K
234		(draw traffic route)	S-K	S-K	S-K
235	38:38.1 - 38:49.2	or coming here	Be-K	Be-K	Be-K
236		(draw traffic route)	S-K	S-K	S-K
237	38:49.2 -	(draw arrow)	N	S-K	S-K

	39:20.1				
238	39:20.1 - 39:44.9	so for this text, park, 5 metres, park is here (write text on the site)	R-K	F-K	F-K
239	39:44.9 - 40:18.7	car park is there (write text)	F-K	F-K	F-K
240	40:18.7 - 40:45.0	and then (draw curve)	S-K	S-K	S-K
241	40:45.0 - 41:25.4	public entrance (write text)	F-K	F-K	F-K
242	41:25.4 - 41:50.9	so really, the whole concept is that this runs up, over (draw curve)	S-K	S-K	S-K
243	41:50.9 - 42:07.4	this is the community centre (write text)	R-K	S-K	R-K
244	42:07.4 - 42:18.7	car park that way	Be-K	F-K	F-K
245	42:18.7 - 42:29.8	(change layers)	N	N	N
246	42:29.8 - 42:34.4	this should spay out over here (stretching curves)	S-K	S-K	S-K
247	42:34.4 - 42:50.0	(stretching curves)	S-K	S-K	s-K
248	42:50.0 - 43:11.2	ok, I will save that	N	N	N
249	43:11.2 - 43:24.9	that's really a quick design, you got the community centre on the edge completely down into the ground (rotate the model)	Bs-K	Bs-K	Bs-K
250	43:24.9 - 43:30.7	and then on the one side is the entrance through, come across (rotate the model)	Bs-K	Bs-K	Bs-K
251	43:30.7 - 43:35.6	and then use this go up onto this building (rotate the model)	Bs-K	Bs-K	Bs-K
252	43:35.6 - 43:42.1	(rotate the model)	Bs-K	Bs-K	Bs-K
253	43:42.1 - 44:11.1	And yes, I guess if you go it further, there will be a series of holes, or light wells, or points on the landscape to cut it down, but that would be another part of design.	S-K	F-K	S-K
254	44:11.1 - 44:22.3	(Rotate the model) I will render that...	Bs-K	Bs-K	Bs-K

Designer 6

PDE session

ID	Timespan	Content	1st Coding	2nd Coding	Final Coding
1	0:00.0 - 0:12.3	Well, I will start from rhino and grasshopper task, as you can see here, is the site.	R-K	R-K	R-K
2	0:12.3 - 0:28.3	the definition I usually used is the division of the sun	F-K	F-K	F-K
3	0:28.3 - 0:35.6	there are some definition by depth and height, normally I will use, a pack, but I don't know if I will be quickly with this.	Be-R	Be-K	Be-R
4	0:48.5 - 0:59.3	so, I start with parameters of time zone, latitude, longitude, and I have a season – a summer icon for the calculation on this.	Be-R	Be-K	Be-R
5	1:08.1 - 1:16.5	The site, I want to create a pyrography... something like this	Be-K	S-K	Be-K
6	1:16.5 - 1:26.4	so first, I will start from the rooms, class rooms, meeting rooms	F-K	F-K	F-K
7	1:26.4 - 1:34.1	if we think about a little bit about the street here, we have	F-K	F-K	F-K

8	1:34.1 - 1:38.4	this point, maybe the maxim connectivity points go	Be-K	Be-K	Be-K
9	1:38.4 - 1:44.2	we have 5 streets on this point, so	Bs-K	Bs-K	Bs-K
10	1:44.2 - 1:50.6	I think this is correctly for the entrance.	F-K	Be-K	F-K
11	1:50.6 - 1:59.1	since we have the park here,	Be-K	F-K	F-K
12		so I think it will be nice to put another entry here	Be-K	Be-K	Be-K
13	1:59.1 - 2:08.1	I think I will put parking in this zone,	F-K	Be-K	Be-K
14	2:08.1 - 2:10.3	because it is a secondary road	F-K	F-K	F-K
15	2:10.3 - 2:16.6	so I will put a parking here,	F-K	Be-K	Be-K
16		something like this (draw a rectangle)	S-K	S-K	S-K
17	2:16.6 - 2:26.1	so I will start with a meeting room.	F-K	F-K	F-K
18		for example (draw a circle)	S-K	S-K	S-K
19	2:26.1 - 2:33.4	something like that (re-draw the circle)	S-K	S-K	S-K
20	2:33.4 - 2:38.6	then I will put classroom over here	F-K	F-K	F-K
21		(draw a circle)	S-K	S-K	S-K
22	2:38.6 - 2:50.4	and then tutorial room	F-K	F-K	F-K
23		like this, in this point.	S-K	S-K	S-K
24	2:50.4 - 2:56.5	here I made an ellipse not a circle because I	S-K	S-K	S-K
25	2:56.5 - 3:04.4	think it is necessary to create a façade within the parking	F-K	Be-K	F-K
26	3:04.4 - 3:12.4	I will make this a bit little	Be-K	S-K	S-K
27		(delete and re-draw a circle)	S-K	S-K	S-K
28	3:12.4 - 3:21.1	so we have to connect those	Be-K	Be-K	Be-K
29		(draw curve to connect circles)	S-K	S-K	S-K
30	3:21.1 - 3:35.1	I will try to find the centre of this	Be-K	S-K	Be-K
31		(draw to find the centre of the triangle)	S-K	S-K	S-K
32	3:35.1 - 3:47.8	and we will connect those spaces	Be-K	Be-K	Be-K
33	3:47.8 - 3:56.2	(draw curves)	S-K	S-K	S-K
34	3:56.2 - 4:01.5	three elements (delete the triangle)	S-K	S-K	S-K
35	4:01.5 - 4:13.8	then we can offset, I think 1.5 m (offset)	S-K	S-K	S-K
36	4:13.8 - 4:17.4	(delete previous curve)	S-K	S-K	S-K
37	4:17.4 - 4:26.0	so I will split all of these	Be-K	Be-K	Be-K
38		(split)	S-K	S-K	S-K
39	4:26.8 - 4:36.0	to get an organic group to work, operate	Be-K	Be-K	Be-K
40	4:36.0 - 4:49.5	then we can make..., something like that	Bs-K	Be-K	Be-K
41		(fillet the curves)	S-K	S-K	S-K

42	4:49.5 - 4:57.0	We have this, is the first group. we joint it (join curves)	S-K	S-K	S-K
43	4:57.0 - 5:08.0	so I will make this contour group as place	Be-K	S-K	S-K
44	5:08.0 - 5:14.4	I will take this group into grasshopper (set "cur" component)	Be-R	S-R	S-R
45	5:14.4 - 5:26.1	I will explode this on site (set "explode" component)	Be-R	S-R	Be-R
46	5:26.1 - 5:31.7	(set "list item")	Be-R	Be-R	Be-R
47	5:31.7 - 5:50.0	(change properties of "list item")	S-R	S-R	S-R
48		I will copy it to create the contour lines	Be-R	F-K	F-K
49	5:50.0 - 5:57.6	I will create a loft, simple... to operate	Be-R	S-K	S-K
50	5:57.6 - 6:13.4	(set "move")	S-K	S-K	S-K
51	6:13.4 - 6:18.2	I think I need to reverse it (set "x" unit, and "reverse")	Be-R	Be-R	Be-R
52	6:18.2 - 6:33.7	I will use I series, start with 5 (set "series" component)	Be-R	Be-R	Be-R
53	6:33.7 - 6:43.3	each 5 metres, and how make steps I need	Be-K	Be-K	Be-K
54	6:43.3 - 6:46.0	I'll put here a slider (set parameters)	S-R	S-R	S-R
55	6:46.0 - 6:50.7	(set constraints)	Be-R	Be-R	Be-R
56	6:50.7 - 6:57.1	(change parameters)	S-R	S-R	S-R
57	6:57.1 - 7:04.9	then I will intersect those lines (set "cct" component)	Be-R	Be-R	Be-R
58	7:04.9 - 7:11.0	(connect component)	S-R	S-R	S-R
59	7:11.1 - 7:16.0	select the intersection points and create the final lines	S-K	S-K	S-K
60		(set "list item")	Be-R	Be-R	Be-R
61	7:16.0 - 7:25.7	this is starting points, and end points(set "list item")	Be-R	Be-R	Be-R
62		(and set parameters)	S-R	S-R	S-R
63	7:25.7 - 7:31.2	(set "line" component)	S-K	S-K	S-K
64	7:31.2 - 7:35.7	"blind preview"	Bs-K	Bs-R	N
65	7:35.7 - 7:41.8	intersect these new lines with create line, I will	Be-K	Be-R	Be-K
66	7:41.8 - 7:50.0	select this (set curve)	S-K	S-K	S-K
67	7:50.0 - 7:58.4	intersect one more time (set "ccx")	Be-R	Be-R	Be-R
68	7:58.4 - 8:00.0	ok, so we have intersection points, so...	Bs-R	Bs-R	Bs-R
69	8:00.0 - 8:05.4	what we need to create now is a vertical line that	Be-R	S-K	S-K
70	8:05.4 - 8:25.4	Give me force weight, I think it will be 2 or 3 metres in the first and it will increase in the mid points.	Be-R	Be-R	Be-R
71	8:25.4 - 8:31.7	(Set "line" component).	S-K	S-K	S-K
72	8:31.7 - 8:35.1	Set the direction (set "z" direction).	Be-R	Be-R	Be-R
73	8:35.1 - 8:41.6	so we try to meet the points we have	Be-R	Be-R	Be-R

74		(change parameters)	S-R	S-R	S-R
75	8:41.6 - 8:49.0	I want to create a point in the middle of each line.	Be-K	Be-R	Be-K
76	8:49.0 - 8:54.6	so first we need to create the lines	S-K	S-K	S-K
77	8:54.6 - 9:01.0	(set "list item")	Be-R	Be-R	Be-R
78	9:01.0 - 9:09.7	(change parameters)	S-R	S-R	S-R
79	9:09.7 - 9:16.4	(set "line" component)	S-K	S-K	S-K
80	9:16.4 - 9:20.2	yes, perfectly	Bs-K	Bs-K	Bs-K
81	9:20.2 - 9:23.4	I will try to get these inter-medium points and create a line,	Be-R	Be-K	Be-K
82	9:23.4 - 9:25.9	(set parameters)	S-R	S-R	S-R
83	9:25.9 - 9:33.1	I think it is perfect.	Bs-K	Bs-K	Bs-K
84		(change parameters)	S-R	S-R	S-R
85	9:33.1 - 9:50.5	(set "list item")	Be-R	Be-R	Be-R
86		check data	Bs-R	Bs-R	Bs-R
87	9:50.5 - 9:58.3	we will try different numbers (copy "list item" and	Be-R	Be-R	Be-R
88		"line" component)	S-K	S-K	S-K
89	9:58.3 - 10:05.4	(change parameters)	S-R	S-R	S-R
90	10:05.4 - 10:08.5	this is nice	Bs-K	Bs-K	Bs-K
91	10:08.5 - 10:17.0	but now those points are not in the same side (rotate the model)	Bs-K	Bs-K	Bs-K
92	10:17.0 - 10:29.0	so now what I want to do is to create lines between all those lines	Be-K	Be-K	Be-K
93	10:29.0 - 10:35.8	the contour line that finally will give me the surface	Be-K	F-K	Be-K
94	10:35.8 - 11:04.2	(rotate the model)	Bs-K	Bs-K	Bs-K
95		this is the problem grasshopper always have, and I prefer to solve it in rhino.	N	N	N
96	11:04.2 - 11:47.3	so now I will bake these lines, also points (bake).	N	Bs-K	N
97	11:47.3 - 12:02.9	so I want to bring it here to get the mid points to make all the plants	Be-K	F-K	Be-K
98	12:02.9 - 12:16.3	(draw line)	S-K	S-K	S-K
99	12:16.3 - 12:25.5	so I will make it a bit easier (draw line)	S-K	S-K	S-K
100	12:25.5 - 12:37.5	so I will create these guide lines	Be-K	Be-K	Be-K
101	12:37.5 - 12:44.8	when I have all the lines, I will create a loft	Be-K	S-K	S-K
102	12:44.8 - 12:48.4	so I will create a topography to work over	Be-K	F-K	Be-K
103	12:48.4 - 12:53.0	and this topography to create the façade of the building	F-K	F-K	F-K
104	12:52.9 - 14:45.8	(draw lines)	S-K	S-K	S-K
105	14:45.8 - 15:01.2	So let's start making this, I connect starting point, mid-point and end point. (connecting points)	S-K	Be-R	Be-R

106	15:01.2 - 18:46.0	the grasshopper may be easier, but for this one, it needs test, I prefer in rhino,	N	N	N
107		(connecting points)	S-K	S-K	S-K
108	18:46.0 - 18:51.4	now we have all lines, I will create a loft	Be-K	S-K	S-K
109		(rotate the model)	Bs-K	Bs-K	Bs-K
110	18:51.4 - 19:23.0	I will create a surface using loft to get my topography	Be-K	F-K	Be-K
111		(loft)	S-K	S-K	S-K
112	19:23.0 - 19:29.6	the façade is based on this	Be-K	Bs-K	Bs-K
113		(rotate the model)	Bs-K	Bs-K	Bs-K
114	19:29.6 - 19:39.4	(set "surface" component)	S-K	S-K	S-K
115	19:39.4 - 19:54.4	I will use "..box to triangulate this surface (set "tri--area" component)	Be-R	Be-R	Be-R
116	19:54.4 - 20:07.6	because, to design a building, it is the way to transmission.	N	Be-K	Be-K
117	20:07.6 - 20:13.1	(set parameters)	S-R	S-R	S-R
118		now I will divided it as 50,	Be-K	Be-K	Be-K
119		I think it will be too much		Bs-K	Bs-K
120	20:13.1 - 20:20.6	(change parameters)	S-R	S-R	S-R
121	20:20.6 - 20:24.1	(change parameters)	S-R	S-R	S-R
122	20:24.2 - 20:28.7	Surface, 25 (connect sliders).	S-R	S-R	S-R
123		Here we have flow.. (rotate the model)	Bs-K	Bs-K	Bs-K
124	20:37.6 - 20:55.6	(connect components)	S-R	S-R	S-R
125	20:54.2 - 21:09.2	(checking problem and re-connecting)	Bs-R	Bs-R	Bs-R
126	21:09.2 - 21:18.7	so we have here the sun radiation levels (rotate the model)	Bs-K	Bs-K	Bs-K
127	21:18.7 - 21:31.6	what we want to do is to search the minimal radiation and panels for windows	Be-K	F-K	Be-K
128	21:34.8 - 21:55.0	For the other part, I will put some green panels or something like this to cool what over it.	Be-K	Be-K	Be-K
129	21:55.0 - 22:00.1	(rotate the model)	Bs-K	Bs-K	Bs-K
130		those are the entrance	F-K	F-K	F-K
131	22:00.1 - 22:05.6	(rotate the model)	Bs-K	Bs-K	Bs-K
132	22:05.6 - 22:12.1	We'll see.. here this is the data (check data)	Bs-R	Bs-R	Bs-R
133	22:12.1 - 22:40.1	100, 1000 (check previous script data)	Bs-R	Bs-R	Bs-R
134	22:40.1 - 22:48.3	I want to divide this domain into three parts, I think.	Be-R	Be-R	Be-R
135	22:48.3 - 22:52.6	or just for one to the windows	F-K	Be-R	Be-R
136	22:52.6 - 22:56.5	and the other for the green panels	F-K	Be-R	Be-R
137	22:56.5 - 23:01.6	but I think it will be too much (rotate the model)	Bs-K	Bs-K	Bs-K
138	23:01.6 - 23:06.8	too much panels with window	Bs-K	Bs-K	Bs-K
139	23:06.8 -	so I don't like this (rotate the model)	Bs-K	Bs-K	Bs-K

	23:09.0				
140	23:13.0 - 23:29.1	If I make this. (hide the model)	N	N	N
141	23:29.1 - 23:37.6	here are the lines of the traffic	F-K	F-K	F-K
142	23:37.6 - 23:48.0	so I think it will be good to create another one	F-K	Be-K	Be-K
143	23:48.0 - 24:02.3	and I want to go to the park by this way (unhide a curve)	Be-K	Be-K	Be-K
144	24:02.3 - 24:33.1	let's say, from street, intersect (draw traffic line)	Be-K	Be-K	Be-K
145	24:33.1 - 24:46.2	another one is from parking (draw another traffic line)	Be-K	Be-K	Be-K
146		right now I think it is more complete	Bs-K	Bs-K	Bs-K
147	24:46.2 - 24:53.5	so now I want to select all the panels in the zone of these lines, and create different panel	S-K	S-K	S-K
148	25:03.2 - 25:09.8	So let's make an offset of an.. three metres (offset curves)	S-K	S-K	S-K
149	25:28.5 - 25:35.9	intersect, split (split curves)(split and trim)	S-K	S-K	S-K
150	26:16.3 - 26:19.7	so let's make a 5 metre street	F-K	F-K	F-K
151	26:19.7 - 26:41.2	(trim and fillet)	S-K	S-K	S-K
152		so we have really nice place	Bs-K	Bs-K	Bs-K
153	26:41.2 - 26:48.7	(trim and fillet)	F-K	S-K	S-K
154		ok, then we have the park		F-K	F-K
155	26:48.7 - 27:09.9	let me get joint to this, all these lines (join lines)	S-K	S-K	S-K
156	27:09.9 - 27:21.1	now I will close all these lines to create a region (close the lines)	Be-K	S-K	Be-K
157	27:21.1 - 27:33.5	I will select all the panels inside the region, depart form the others to create these panel with rules, as I said (close the lines)	Be-R	Be-R	Be-R
158	27:53.1 - 28:07.8	(set "curve" component)	S-K	S-K	S-K
159	28:07.8 - 28:17.9	I'll find a region (set "solid different" component)	S-K	S-K	S-K
160	28:17.9 - 28:33.8	So cool, I have one.. (set "curve" and connect component)	S-K	S-R	S-K
161	28:33.8 - 28:50.7	(set "xy" plane)	Be-R	Be-R	Be-R
162	28:50.7 - 29:03.0	the region created, perfect (set "planar" component)	S-K	S-K	S-K
163	29:03.0 - 29:09.0	so here is the region	F-K	Bs-K	Bs-K
164	29:09.0 - 29:22.6	I have all the panels here to make it looks well	Be-K	Bs-K	Bs-K
165	29:22.6 - 29:33.3	we have the centre, (set "area")	Be-R	Be-R	Be-R
166	29:33.3 - 29:41.7	(rotate the model)	Bs-K	Bs-K	Bs-K
167	29:41.7 - 30:05.2	Right now, I want to create surfaces, one surface is that from here to the end of the park, it's like to create a bigger park.	F-K	F-K	F-K
168	30:05.2 - 30:13.6	not delete this street, but make this street a transition street	F-K	F-K	F-K
169	30:13.6 - 30:20.2	I've finish this part with lots of surface	Bs-K	S-K	S-K

170	30:20.2 - 30:33.6	so this is one (make a surface in the corner)	S-K	S-K	S-K
171	30:33.6 - 31:03.4	and the other one would be (make surfaces)	S-K	S-K	S-K
172	31:03.4 - 31:10.5	this is big (measure the distance)	Bs-K	Be-K	Bs-K
173	31:10.5 - 31:20.9	(Make surfaces) ok. (set "surface")	S-K	S-K	S-K
174	31:32.2 - 31:48.2	so make the same triangulation to those surfaces	Be-K	S-K	Be-K
175	31:48.2 - 32:02.3	(unhide component preview)	N	N	N
176	32:02.3 - 32:26.9	This happens, you have to slip the surface and you have to wait for the grasshopper take the original surface, but rhino I don't know why (rotate the model).	N	N	N
177		(rotate the model)	Bs-K	Bs-K	Bs-K
178	32:26.9 - 32:48.2	I will make this surface (make surfaces)	S-K	S-K	S-K
179	32:48.2 - 33:04.6	(rotate the model)	Bs-K	Bs-K	Bs-K
180	33:04.6 - 33:35.9	(re-make the surface)	S-K	S-K	S-K
181	33:35.9 - 34:01.4	I will delete the other part (rotate the model)	S-K	Bs-K	S-K
182	34:01.4 - 34:12.4	(rotate the model)	Bs-K	Bs-K	Bs-K
183		You know, sometimes, rhino makes these kind of things.	N	N	N
184	34:12.5 - 34:17.0	we have our topography here	N	F-K	F-K
185	34:17.0 - 34:27.3	let's get the centres (set "area" component)	Be-R	Be-R	Be-R
186	34:27.3 - 34:35.4	let's put all the centre together (set "point" component)	S-R	Be-R	S-R
187	35:01.6 - 35:08.4	(un-preview)	N	N	N
188	35:08.4 - 35:18.3	so let's see which are the points inside these region (set "contain" component)	Be-R	Be-R	Be-R
189	35:30.4 - 35:36.4	(check the data)	Bs-R	Bs-R	Bs-R
190	35:36.4 - 35:50.3	so let's see which are equal to one (set "lager" component)	Be-R	Be-R	Be-R
191	35:50.3 - 36:00.0	(check the data)	Bs-R	Bs-R	Bs-R
192	36:00.0 - 36:11.9	(change parameters)	S-R	S-R	S-R
193	36:11.9 - 36:29.6	let's make the surface (set "srf" component)	S-K	S-K	S-K
194	36:29.6 - 36:36.2	(un-preview)	N	N	N
195	36:36.2 - 36:50.7	(check previous data)	Bs-R	Bs-R	Bs-R
196	36:50.7 - 36:57.4	I will create a cone of this region (set "cone" component)	S-K	S-K	S-K
197	37:07.5 - 37:13.7	(set "z" direction)	Be-R	Be-R	Be-R
198		(set parameters)	S-R	S-R	S-R
199	37:13.7 - 37:26.0	(set "planar srf" component)	S-K	S-K	S-K
200	37:26.0 - 37:45.7	(set "include" component)	Be-R	Be-R	Be-R

201	37:45.7 - 38:06.6	the grasshopper is "thinking", I think right now we have 10 minutes to finish	N		N
202	38:06.6 - 38:09.4	(check previous data)	Bs-R	Bs-R	Bs-R
203	38:09.4 - 38:15.5	(connected)	S-R	S-R	S-R
204	38:15.5 - 38:30.8	(un-preview)	N	N	N
205	38:30.8 - 38:42.7	(unhide)	N	N	N
206	38:42.7 - 38:48.0	(generate surface using selected points)	S-K	S-K	S-K
207	38:48.0 - 39:02.2	now there are some points under surface, they are not inside the region	Bs-R	Bs-K	Bs-K
208	39:02.2 - 39:07.7	so we need to make it be transformed	Be-R	Be-R	Be-R
209	39:07.7 - 39:11.9	move (set "move" component)	S-K	S-K	S-K
210	39:11.9 - 39:18.6	we need to reverse it (set "z" unit)	Be-R	Be-R	Be-R
211	39:18.6 - 39:25.7	2 metres (set parameter)	S-R	S-R	S-R
212	39:25.7 - 39:36.1	now it works well (connect components)	S-R	S-R	S-R
213	39:36.1 - 39:42.4	waiting	N	N	N
214	39:42.4 - 39:57.0	now we have all these panels (rotate the model)	Bs-K	Bs-K	Bs-K
215	39:57.0 - 40:05.9	now make the same to the others	Be-R	S-K	S-K
216	40:05.9 - 40:18.7	I think I will put all of these surface into this (set "srf" component)	Be-R	S-R	S-R
217	40:18.7 - 40:25.3	because those panel will create the path	F-K	F-K	F-K
218	40:25.3 - 40:34.5	so I will make for this variation	Be-R	Be-R	Be-R
219	40:34.5 - 40:39.0	(check previous data)	Bs-R	Bs-R	Bs-R
220	40:39.0 - 41:07.6	(connect components)	S-R	S-R	S-R
221	41:07.6 - 41:26.8	perfect (preview)	Bs-K	Bs-K	Bs-K
222	41:26.8 - 41:42.3	so let's average all of these source together, two list	Be-R	Be-R	Be-R
223	41:42.3 - 42:08.5	(set "average" component)	Be-R	Be-R	Be-R
224	42:08.5 - 42:13.5	larger, or smaller (set "larger" component)	Be-R	Be-R	Be-R
225	42:13.5 - 42:24.0	(connect components)	S-R	S-R	S-R
226	42:24.0 - 42:25.8	and then smaller (set "smaller" component)	Be-R	Be-R	Be-R
227	42:25.8 - 42:28.6	(connect components)	S-R	S-R	S-R
228	42:28.6 - 42:33.5	I dispatch one more time (set "dispatch" component)	Be-R	Be-R	Be-R
229	42:40.3 - 42:52.1	(connect components)	S-R	S-R	S-R
230	42:52.1 - 43:00.5	take true values (set "srf" component)	S-K	Be-R	S-K
231	43:00.5 - 43:05.5	(unhide)	N	N	N

232	43:05.5 - 43:13.5	(connect components)	S-R	S-R	S-R
233	43:13.5 - 43:27.7	Ok, perfectly done. we have all these that will be windows, the other will be grass or green fond	F-K	F-K	F-K
234	43:27.7 - 43:41.8	so I will take these lines (set "edges" component)	S-K	S-K	S-K
235	43:41.8 - 43:50.8	now I offset them to create the window	S-K	S-K	S-K
236	43:50.8 - 43:54.4	(set "joint" component)	S-R	S-K	S-R
237	43:54.4 - 44:00.3	(set "offset" component)	S-K	S-K	S-K
238	44:00.3 - 44:02.7	perfect	Bs-K	Bs-K	Bs-K
239	44:02.7 - 44:08.8	no, I need to flip	Be-R	Be-R	Be-R
240		(rotate the model)	Bs-K	Bs-K	Bs-K
241	44:08.8 - 44:11.1	the line is in the same direction	Bs-R	Bs-R	Bs-R
242	44:11.1 - 44:22.8	(set "flip")	Be-R	Be-R	Be-R
243	44:22.8 - 44:24.2	(set "list item")	Be-R	Be-R	Be-R
244	44:24.2 - 44:35.7	(flatten and connecting)	S-R	S-R	S-R
245	44:35.7 - 44:42.5	(examine the model)	Bs-K	Bs-R	Bs-K
246	44:42.5 - 44:46.0	ok, perfect	Bs-K	Bs-K	Bs-K
247	44:46.0 - 44:58.3	so I think I would fillet it just together with the wall	S-K	S-K	S-K
248	44:58.3 - 45:04.2	so 0.2 (set parameters)	S-R	S-R	S-R
249	45:04.2 - 45:09.1	ok, perfect	S-K	Bs-K	Bs-K
250	45:09.1 - 45:17.1	those lines are the glass of the window	F-K	F-K	F-K
251		(rotate the model)	Bs-K	Bs-K	Bs-K
252	45:17.1 - 45:26.4	surface (set "planar" component)	S-K	S-K	S-K
253	45:26.4 - 45:30.1	perfect (rotate the model)	Bs-K	Bs-K	Bs-K
254	45:30.1 - 45:44.3	we need to create one more time the region between external line and these lines. (set "region difference" component)	Be-R	Be-R	Be-R
255	45:53.7 - 46:07.7	(connect components)	S-R	S-R	S-R
256	46:07.7 - 46:11.3	surface (set "planar" component)	S-K	S-K	S-K
257	46:11.3 - 46:14.8	perfect	Bs-K	Bs-K	Bs-K
258	46:14.8 - 46:24.1	(check previous script)	Bs-R	Bs-R	Bs-R
259	46:24.1 - 46:29.8	ok, perfect	Bs-K	Bs-K	Bs-K
260	46:29.8 - 46:36.0	this is the window	F-K	F-K	F-K
261		(rotate the model)	Bs-K	Bs-K	Bs-K
262	46:36.0 - 46:51.5	and here we have path panels, and there are ribbons	F-K	F-K	F-K
263	46:51.5 -	so let's make a bake by layers (make layers)(bake)	N	N	N

	46:55.6				
264	47:38.6 - 47:42.6	(examine the model) the same	Bs-K	Bs-K	Bs-K
265	47:42.6 - 48:02.3	(bake)	N	N	N
266	48:02.3 - 48:14.6	so right now we have all of them	Bs-K	Bs-K	Bs-K
267	48:14.6 - 48:37.6	(hide layers) I am looking for lines, I see it	Be-K	N	N
268	48:37.6 - 48:48.9	(delete lines outside site boundary)	S-K	S-K	S-K
269	48:48.9 - 48:54.8	(examine model)	Bs-K	Bs-K	Bs-K
270	48:54.8 - 49:18.5	(delete lines outside site boundary)	S-K	S-K	S-K
271		anyway, I will leave this part right now, but I want to show you that this will be the building,	N	N	N
272	49:28.1 - 49:38.4	I will put this blue (change colour of the layer)	N	S-K	S-K
273	49:58.3 - 50:03.0	so it will be something like that right now (rotate the model)	Bs-K	Bs-K	Bs-K
274	50:03.0 - 50:05.8	I will delete that part I made, then I think it will be better	S-K	S-K	S-K
275	50:19.8 - 50:22.5	a little bit work	N	N	N
276	50:22.5 - 50:44.4	But I think this is an interesting test in 40 mins.	N	N	N

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:06.2	well, task 2. Rhino task	R-K	N	R-K
2	0:06.7 - 0:26.2	Let's start with planning. I will create something really classic, I think.	Be-K	Be-K	Be-K
3	0:26.2 - 0:34.0	(offset site boundary)	S-K	S-K	S-K
4	0:34.0 - 1:01.7	(draw curves) ok	S-K	S-K	S-K
5	1:01.7 - 1:10.6	let's start, these are my first line to make a plan.	N	N	N
6	1:10.6 - 1:14.9	let's connect these (trim curves)	S-K	S-K	S-K
7	1:14.9 - 1:21.7	so I think this part would be the entrance	F-K	F-K	F-K
8	1:21.7 - 1:31.1	and this part would become something like "built points" to get different view from this park	F-K	Be-K	Be-K
9	1:35.6 - 1:50.8	so the other part here, the sun will be from the north	Be-K	Be-K	Be-K
10	1:50.8 - 1:59.5	so I will create in this part, a blind façade	S-K	S-K	S-K
11	1:59.5 - 2:11.5	another.. I will get here a window façade here	S-K	S-K	S-K
12	2:11.5 - 2:13.2	to get all the sun this side	Be-K	Be-K	Be-K
13	2:13.2 - 2:24.3	so I think I will put a stairway here, to get	F-K	F-K	F-K
14	2:24.3 - 2:30.9	the classroom in the first floor	F-K	F-K	F-K
15	2:30.9 -	and the ground floor have the general space and open	F-K	F-K	F-K

	2:38.0	space here			
16	2:38.0 - 3:12.9	so this is something like this, in the middle, or.. (draw curves)	S-K	S-K	S-K
17	3:12.9 - 3:26.3	ok, I will split this, and I will rotate it to 90 degrees, -90 degrees (rotate the curve) I will make it from this point, -90 (rotate the curve) ok	S-K	S-K	S-K
18	3:53.3 - 4:00.6	so I will move to the intersection (move points to the intersection)	S-K	S-K	S-K
19	4:00.6 - 4:04.6	perfect	Be-K	Bs-K	Bs-K
20		(delete one curve)	S-K	S-K	S-K
21	4:04.6 - 4:14.5	and I will have this, here, this way	Bs-K	Bs-K	Bs-K
22		(draw curves)	S-K	S-K	S-K
23	4:21.4 - 4:23.4	so here we will have a stairway, and	F-K	F-K	F-K
24	4:23.4 - 4:28.2	to the first floor, here we will have a path to the general space in the ground floor	F-K	F-K	F-K
25	4:33.4 - 4:47.5	so let's see this, all half here (draw curves)	Bs-K	S-K	S-K
26	4:47.5 - 4:58.3	let's make it (draw curves)	S-K	S-K	S-K
27	4:58.3 - 5:17.0	offset this to create a classroom of 2 meters long	F-K	Be-K	F-K
28	5:17.0 - 5:19.1	(offset curves) no	S-K	S-K	S-K
29	5:19.1 - 5:34.1	let's copy, to create classroom, like these (copy curves)	S-K	S-K	S-K
30	5:34.1 - 5:37.2	all we have here are two classrooms	Bs-K	Bs-K	Bs-K
31	5:37.2 - 5:44.2	but the first one needs to create	Be-K	N	Be-K
32	5:44.2 - 5:51.1	now let's consider the pass,	F-K	F-K	F-K
33		and here is the stairway which leads to the classroom here	Be-K	Be-K	Be-K
34	5:51.1 - 5:53.5	and create here the points of view	Be-K	Be-K	Be-K
35	5:53.5 - 6:03.1	Here we have double..	Bs-K	Bs-K	Bs-K
36		you can look at this from ground floor	Be-K	Be-K	Be-K
37	6:03.3 - 6:17.2	so let's make something like this (draw curves)	S-K	S-K	S-K
38	6:17.2 - 6:19.8	too much	Bs-K	Bs-K	Bs-K
39	6:19.8 - 6:25.3	(redraw the curve)	S-K	S-K	S-K
40	6:25.3 - 6:30.9	here we will have a point of view and two classrooms	Bs-K	F-K	Bs-K
41	6:30.9 - 6:57.9	I am just trying to create a simple line to form this stairway, I think here (draw lines)	S-K	S-K	S-K
42	6:57.9 - 7:01.4	something like this (delete curves)	S-K	S-K	S-K
43	7:01.4 - 7:15.8	so let's move (move curves)	S-K	S-K	S-K
44	7:15.8 - 7:24.1	ok, and here is the final lines (draw curves)	S-K	S-K	S-K
45	7:24.1 - 7:33.9	but as the sun came by this way, from the north,	Be-K	Be-K	Be-K
46	7:33.9 - 7:57.1	let's create here something different, ok, something like this to get the sun entry	Be-K	Be-K	Be-K

47		(draw curves)		S-K	S-K
48	7:57.1 - 8:01.7	in this way and have a different façade to this park	S-K	Be-K	Bs-K
49	8:05.0 - 8:11.9	and have a different plan to different part	Be-K	Be-K	Be-K
50	8:11.9 - 8:18.5	(adjust curves)	S-K	S-K	S-K
51	8:18.5 - 8:26.7	see we have this, the stairway.	Bs-K	Bs-K	Bs-K
52	8:26.7 - 8:32.0	move this point (adjust the curve)	S-K	S-K	S-K
53	8:32.0 - 8:38.0	(delete the curve)	S-K	S-K	S-K
54	8:38.0 - 8:42.5	(draw curves)	S-K	S-K	S-K
55	8:42.5 - 9:03.2	I think this wall or this façade will be concrete, so	S-K	S-K	S-K
56	9:03.2 - 9:15.7	I will create two language on concrete and rest of the building	Be-K	Be-K	Be-K
57	9:15.7 - 9:22.1	so this will be wood and glass, and	S-K	S-K	S-K
58	9:22.1 - 9:28.2	here will be whole concrete and a little openings.	S-K	S-K	S-K
59	9:28.2 - 9:39.3	(adjust the curve)	S-K	S-K	S-K
60		so let's say this is the main wall	F-K	S-K	S-K
61	9:39.3 - 9:56.9	3.1 meters, say 1 meter (offset curves and close the wall boundary)	S-K	S-K	S-K
62	9:56.9 - 10:05.8	Yes, I want to have a wall with a great entity as a.. with some openings	Be-K	Be-K	Be-K
63	10:11.8 - 10:20.2	something like equal openings something like that, in this way	Be-K	Be-K	Be-K
64	10:20.2 - 10:26.7	let's go to this (change to perspective view, rotate the model)	Bs-K	Bs-K	Bs-K
65	10:26.7 - 10:32.6	this line may not here	Bs-K	Bs-K	Bs-K
66	10:32.6 - 10:33.7	(delete curves)	S-K	S-K	S-K
67	10:33.7 - 10:36.1	again, this will be the stairways	F-K	F-K	F-K
68	10:36.1 - 10:39.8	and the space here to look	F-K	F-K	F-K
69	10:39.9 - 10:45.4	(rotate the model)	Bs-K	Bs-K	Bs-K
70	10:45.4 - 10:57.6	this is something like 5 meters, or 4 meters, 5 meter (draw a line in 3d view)	S-K	S-K	S-K
71	10:57.6 - 11:12.4	5 meters, no, we need more than 5 meters, doubled, 10 meters (draw a line in 3d view)	S-K	S-K	S-K
72	11:12.4 - 11:17.1	for two floors, two stage	Be-K	Be-K	Be-K
73	11:17.1 - 11:29.1	let's copy this (copy curves)	S-K	S-K	S-K
74	11:28.4 - 11:34.8	so something like that (rotate the model)	Bs-K	Bs-K	Bs-K
75	11:34.8 - 11:53.1	I think it will be nice if we make some lines on façade	Be-K	S-K	S-K
76	11:53.1 - 12:01.2	(draw a line) something like that	S-K	S-K	S-K
77	12:01.2 - 12:07.4	(rotate the model)	Bs-K	Bs-K	Bs-K
78	12:07.4 - 12:17.8	and then here I have,, 12 meters, (draw curve on the right view)	S-K	S-K	S-K

79	12:17.8 - 12:24.0	(copy curves)	S-K	S-K	S-K
80	12:24.0 - 12:33.0	so I have these face	Bs-K	Bs-K	Bs-K
81		(make surface)	S-K	S-K	S-K
82	12:33.0 - 12:47.8	let's copy this (copy curves)	S-K	S-K	S-K
83	12:47.8 - 13:01.1	we can start, the stairway start here, and then (make surface)	Be-K	S-K	S-K
84	13:01.1 - 13:08.4	we have this face anyway (make surface)	S-K	S-K	S-K
85	13:08.4 - 13:15.0	(rotate the model) ok, that's fine, but	Bs-K	Bs-K	Bs-K
86	13:15.0 - 13:21.2	we'll move this (move curve)	S-K	S-K	S-K
87	13:21.2 - 13:23.2	(delete surface)	S-K	S-K	S-K
88	13:23.2 - 13:39.6	I am making this façade or surface looking how it combine together, simply form (making surface)	S-K	S-K	S-K
89	13:39.6 - 13:50.9	nothing difficult,	Bs-K	N	N
90		just have a nice form (rotate the model)		Bs-K	Bs-K
91	13:50.9 - 13:54.0	(making surface)	S-K	S-K	S-K
92	13:54.0 - 13:57.8	so, let's see (rotate the model)	Bs-K	Bs-K	Bs-K
93	13:57.8 - 14:10.0	no, I want,.. anyway this is not a simple plane, it's complicated, I don't want it to be	N	N	N
94	14:10.0 - 14:15.9	but what I want is something like this,	Be-K	Be-K	Be-K
95	14:15.9 - 14:22.0	so I will remake it(move the surface)	S-K	S-K	S-K
96	14:25.1 - 14:33.0	yes, something like.. (rotate the model)	Bs-K	Bs-K	Bs-K
97	14:33.0 - 14:35.5	(delete surface)	S-K	S-K	S-K
98	14:35.5 - 14:40.4	let's put here a minim..	Be-K	Be-K	Be-K
99	14:40.4 - 14:48.4	ok, let's say, this is 5 (change length of curve)	S-K	S-K	S-K
100	14:48.4 - 14:53.4	this is 5, too (change length of curve)	S-K	S-K	S-K
101	14:53.4 - 14:57.7	(rotate the model)	Bs-K	Bs-K	Bs-K
102	14:57.7 - 15:01.7	then we have here 10, 10 meters.	S-K	S-K	S-K
103	15:01.9 - 15:07.3	this would not be here (delete curves)	S-K	S-K	S-K
104	15:07.3 - 15:21.6	I think I will put things here, this and this (copy curves)	S-K	S-K	S-K
105	15:21.6 - 15:30.9	(rotate the model) let's see	Bs-K	Bs-K	Bs-K
106	15:30.9 - 15:42.2	no, could be.. (copy curves)	S-K	S-K	S-K
107	15:42.2 - 15:47.9	because I want some part of these to be point to be opened	Be-K	Be-K	Be-K
108	15:47.9 - 15:56.8	no, let's put it on tense.. (create and delete curves)	S-K	S-K	S-K
109	15:56.8 - 16:09.4	(copy curves)	S-K	S-K	S-K
110	16:09.4 - 16:17.8	so let's see, we have this (make surfaces)	S-K	S-K	S-K

111	16:17.8 - 16:19.8	(rotate the model)	Bs-K	Bs-K	Bs-K
112	16:19.8 - 16:25.4	and this (make surfaces)	S-K	S-K	S-K
113	16:33.6 - 16:55.1	(rotate the model) I am not convinced	Bs-K	Bs-K	Bs-K
114	16:55.1 - 16:59.4	so let's see, while I will get another panel (make surfaces)	S-K	S-K	S-K
115	16:59.4 - 17:02.2	so here is a wall	Bs-K	S-K	S-K
116	17:02.2 - 17:05.6	(make surfaces)	S-K	S-K	S-K
117	17:05.6 - 17:12.9	(rotate the model)	Bs-K	Bs-K	Bs-K
118	17:12.9 - 17:29.6	well, I don't know if offset this line will be easier than extend this edge, because if I extend, I have to morph this point	Be-K	Be-K	Be-K
119	17:37.1 - 17:45.1	anyway, I will try, surface, extend	S-K	S-K	S-K
120	17:45.1 - 17:51.5	5 meter, may not so much (extend edge)	S-K	S-K	S-K
121	17:51.5 - 18:04.5	I will decompose this surface (decompose surface)	S-K	S-K	S-K
122	18:04.5 - 18:15.5	ok, perfectly (rotate the model)	Bs-K	Bs-K	Bs-K
123	18:15.5 - 18:37.5	I will create lift.. (create ground surface edge)	S-K	S-K	S-K
124	18:37.5 - 18:40.9	lift 5 meters (copy edge)	S-K	S-K	S-K
125	18:40.9 - 18:46.8	make it (make surface)	S-K	S-K	S-K
126	18:46.8 - 18:50.2	this way, perfect (rotate the model)	Bs-K	Bs-K	Bs-K
127	18:50.2 - 18:57.4	so extrude, 3.3 (extrude the surface)	S-K	S-K	S-K
128	18:57.4 - 19:01.0	(rotate the model)	Bs-K	Bs-K	Bs-K
129	19:01.0 - 19:26.8	and then put here this, the stairway (draw curves and make surface)	S-K	S-K	S-K
130	19:26.8 - 19:30.2	here we have the stairway	Bs-K	Bs-K	Bs-K
131	19:30.2 - 19:37.9	so let's join this line (join curves)	Be-K	S-K	Be-K
132	19:37.9 - 19:46.4	divide, to create some points, like 100 (divide the curve)	S-K	S-K	S-K
133	19:46.4 - 19:59.2	I put here are little stick in the wall, to have this wall in wood and glass	Be-K	S-K	S-K
134		(rotate the model)	Bs-K	Bs-K	Bs-K
135	19:59.2 - 20:05.4	it will be really easy in grasshopper, but	N	N	N
136	20:05.4 - 20:17.0	3.3, ok, this is what I want	Bs-K	Bs-K	Bs-K
137		(make a rectangle)	S-K	S-K	S-K
138	20:17.0 - 20:21.2	move it (move the rectangle)	S-K	S-K	S-K
139	20:21.2 - 20:27.7	copy (copy the rectangle)	S-K	S-K	S-K
140	20:27.7 - 20:30.1	no (delete the rectangle)	S-K	S-K	S-K
141	20:30.1 - 21:33.3	copy, it's going to be a lot	N	Be-K	N

142		(copy the rectangle)	S-K	S-K	S-K
143	21:33.3 - 21:41.1	ok. I have this copy (copy)	S-K	S-K	S-K
144	21:41.1 - 21:48.4	need to rotate, this, and this (rotate the rectangle)	S-K	S-K	S-K
145	21:48.4 - 22:15.9	copy this (copy)	S-K	S-K	S-K
146	22:15.9 - 22:21.7	ok, so let's create a lay called "wood" (create new layer)	N	N	N
147	22:21.7 - 22:53.1	I forgot this (copy)	S-K	S-K	S-K
148	22:53.1 - 23:02.3	extrude, solid, stick (Extrude)	S-K	S-K	S-K
149	23:02.3 - 23:18.2	select all these sticks, let's split it with this plane (split)	S-K	S-K	S-K
150	23:18.2 - 23:56.8	perfect	Bs-K	Bs-K	Bs-K
151		(delete the sticks upper)	S-K	S-K	S-K
152	23:56.7 - 24:02.5	let's make another layer, that is concrete (make new layer)	N	N	N
153	24:02.5 - 24:13.9	(rotate the model)	Bs-K	Bs-K	Bs-K
154	24:13.9 - 24:21.9	(hide layers, change properties of layer)	N	N	N
155	24:21.9 - 24:27.0	(rotate the model)	Bs-K	Bs-K	Bs-K
156	24:27.0 - 24:38.1	select all these (select curves) May exactly the same	N	S-K	Be-K
157	24:49.9 - 25:00.6	solid perfectly (extrude)	S-K	S-K	S-K
158	25:00.6 - 25:16.9	(rotate the model)	Bs-K	Bs-K	Bs-K
159		split (split)	S-K	S-K	S-K
160	25:16.9 - 25:22.1	(turn off the layers)	N	N	N
161	25:22.1 - 25:55.3	delete (delete stick upper)	S-K	S-K	S-K
162	25:55.3 - 26:09.7	(move points to shorten the sticks)	S-K	S-K	S-K
163	26:09.7 - 26:15.5	perfect (rotate the model)	Bs-K	Bs-K	Bs-K
164	26:15.5 - 26:21.6	so I will need to make the same with this line	Be-K	Be-K	Be-K
165	26:21.6 - 26:40.5	I want to get 1 meter here, to get to the roof, so	Be-K	Be-K	Be-K
166	26:40.5 - 26:45.4	scissors (trim curve)	S-K	S-K	S-K
167	26:45.4 - 26:51.0	divide (divide curve)	S-K	S-K	S-K
168	26:51.0 - 27:14.7	analyse distance between points, 1.3 (check distance)	Bs-K	Bs-K	Bs-K
169	27:14.7 - 27:24.9	Divide, length, 1.3. perfect (divide curve)	S-K	S-K	S-K
170	27:24.9 - 28:59.0	(copy rectangle)	S-K	S-K	S-K
171	28:59.0 - 29:15.9	so I am copy this point to here, and move it, 1.2 at least(copy and move points)	S-K	S-K	S-K
172	29:15.9 - 29:22.9	something like this, I want all the things to get here (rotate the model) to get all these grid window	Bs-K	Bs-K	Be-K
173	29:26.8 - 30:00.1	so (select all the rectangle) perfect	Bs-K	Bs-K	Bs-K

174	30:00.1 - 30:06.5	extrude, yes here (extrude the rectangles)	S-K	S-K	S-K
175	30:06.5 - 30:29.6	and we have it, offset this, 1 meter? (offset)	S-K	S-K	S-K
176	30:29.6 - 30:57.7	connect those line, perfect (trim curves)	S-K	S-K	S-K
177	30:57.7 - 31:19.5	let's make a new layer of this, called window or glass (make new layer)	N	N	N
178	31:19.5 - 31:27.5	extrude the line, let's get to the high point (extrude)	S-K	S-K	S-K
179	31:27.5 - 31:32.2	split it	S-K	S-K	S-K
180	31:32.2 - 31:42.0	this is the problem (rotate the model) (delete the surface)	Bs-K	Bs-K	Bs-K
181	31:42.0 - 31:49.4	I want to extend this edge to this line	S-K	Be-K	Be-K
182	31:49.4 - 31:58.0	this would be opened, and this will be the view point, something happening here	Be-K	Be-K	Be-K
183		(rotate the model)		Bs-K	Bs-K
184	31:58.0 - 32:02.3	(copy sticks)	S-K	S-K	S-K
185	32:02.3 - 32:05.2	ok (rotate the model)	Bs-K	Bs-K	Bs-K
186	32:05.2 - 32:17.5	and then extend the surface (extend surface), let's say 30.	S-K	S-K	S-K
187	32:17.5 - 32:23.7	1 meter (extend the curve)	S-K	S-K	S-K
188	32:23.7 - 32:56.6	so let's take all together, split it (split the wall)	S-K	S-K	S-K
189	32:56.6 - 33:06.3	(delete extra curves)	S-K	S-K	S-K
190	33:06.3 - 33:15.5	let's extrude those surface, 3.3 (extrude surface)	S-K	S-K	S-K
191	33:15.5 - 33:22.9	(rotate the model) perfect	Bs-K	Bs-K	Bs-K
192	33:22.9 - 33:27.3	and this will be 1 meter (extrude)	S-K	S-K	S-K
193	33:27.3 - 33:55.5	ok, well, I need to split this (split surface)	S-K	S-K	S-K
194	33:55.5 - 33:59.6	(make surface)	S-K	S-K	S-K
195	33:59.6 - 34:04.7	ok, perfect (rotate the model)	Bs-K	Bs-K	Bs-K
196	34:04.7 - 34:12.2	and here, I will need to create a concrete some different openings	Be-K	S-K	S-K
197	34:17.3 - 34:28.0	let's see in front (hide some layers)	Bs-K	Bs-K	Bs-K
198	34:28.0 - 35:38.7	so, let's see, this is a kind of openings (draw windows in the front view)	S-K	S-K	S-K
199	35:38.7 - 35:43.3	(evaluate the façade)	Bs-K	S-K	Bs-K
200	35:43.3 - 35:57.0	later there will be more time of working on this kind of opening, but the concept is there	Be-K	N	N
201	35:57.0 - 36:28.0	(draw openings)	S-K	S-K	S-K
202	36:28.0 - 37:11.2	take all these lines, and I will extrude them, solid, and then split them, to create openings (select curves)	Be-K	Be-K	Be-K
203	37:11.2 - 37:18.7	ok, (rotate the model)	Bs-K	Bs-K	Bs-K
204	37:18.0 - 37:23.6	(extrude curves)	S-K	S-K	S-K
205	37:23.6 -	they are solid? yes, they are solid (check the model)	Bs-K	Bs-K	Bs-K

	37:30.3				
206	37:30.3 - 37:32.8	I don't want solid (delete the extrude curves)	S-K	S-K	S-K
207	37:32.9 - 37:38.0	(extrude again)	S-K	S-K	S-K
208	37:38.0 - 37:49.1	so (rotate the model)	Bs-K	Bs-K	Bs-K
209	37:49.1 - 38:16.7	(change properties of layer)	N	N	N
210	38:16.7 - 38:29.7	I need to extrude this (extrude)	S-K	S-K	S-K
211	38:29.7 - 38:33.5	perfect (rotate the model)	Bs-K	Bs-K	Bs-K
212	38:33.5 - 39:00.1	split these opening (split)	S-K	S-K	S-K
213	39:00.1 - 39:02.4	reject this (delete extruded curves)	S-K	S-K	S-K
214	39:02.4 - 39:22.9	so the first on the face will be the light and the second one will pass the the glass layer (check the openings on the wall)	Be-K	Bs-K	Bs-K
215	39:22.9 - 40:21.2	(delete the surface on the openings)	S-K	S-K	S-K
216	40:21.2 - 40:31.1	(check the location of the surface)	Bs-K	Bs-K	Bs-K
217	40:31.1 - 41:02.5	(delete the surface on the openings)	S-K	S-K	S-K
218	41:02.5 - 41:05.0	ok (rotate the model)	Bs-K	Bs-K	Bs-K
219	41:05.0 - 41:51.0	then pass those to the last layer, glass (select the surface and change to the layer)	Be-K	N	N
220	41:51.0 - 42:16.8	delete the glass (change to the other layer)	S-K	S-K	S-K
221	42:16.8 - 42:21.5	ok (unhide the layers)	N	N	N
222	42:21.5 - 42:29.5	so this will be the building (rotate the model)	Bs-K	Bs-K	Bs-K
223	42:29.5 - 42:35.1	big one(rotate the model)	Bs-K	Bs-K	Bs-K
224	42:35.1 - 42:40.7	this will be wood, concrete, and these would be view points	S-K	Bs-K	S-K
225	42:40.7 - 42:49.0	interesting,	Bs-K	Bs-K	Bs-K
226	42:49.0 - 42:55.4	and then they will have here two classroom and another space here (rotate the model)	F-K	F-K	F-K
227	42:55.4 - 42:58.6	I am just thinking where is the parking (rotate the model)	F-K	F-K	F-K
228	42:58.6 - 43:03.8	we have all on the entrance, here is the parking (draw rectangle)	F-K	F-K	F-K
229	43:03.8 - 43:08.2	(rotate the model) yes, perfect	Bs-K	Bs-K	Bs-K
230	43:08.2 - 43:25.9	this point, and we have really nice façade here (rotate the model)	Bs-K	Bs-K	Bs-K

Designer 7

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:14.1	session with the use of grasshopper, I will do	R-K	R-K	R-K

2	0:14.1 - 0:22.6	the task 2, which is design a community centre, the site is the same,	R-K	R-K	R-K
3	0:22.6 - 0:40.7	Yes, exactly the same, so I don't need to analyse.	Be-K	R-K	Be-K
4	0:40.7 - 1:01.2	The site is the same, I read the design brief, this community centre is designed for nearby residence.	R-K	R-K	R-K
5	1:01.2 - 1:07.2	so the residence were those small buildings	F-K	F-K	F-K
6	1:07.2 - 1:12.3	Yes, have activities together.	Be-K	F-K	Be-K
7	1:12.3 - 1:22.0	Functions inside buildings are activity room, class rooms, meeting rooms, things to consider. for site design, consider the traffic route, parking area, other activity space, for the building design, consider the entrance, façade,...	R-K	R-K	R-K
8	1:48.6 - 2:06.1	So what are the activities we are talking about? here is... maybe, I really don't know, maybe they will meet, will socialize.	Be-K	F-K	Be-K
9	2:06.1 - 2:24.2	space, they may have some community, course, like you know, the drawing courses, something like that	Be-K	Be-K	Be-K
10	2:24.2 - 2:27.1	So the classroom can be like such purpose.	F-K	F-K	F-K
11	2:27.1 - 2:39.8	And meeting rooms, what about have some a small library inside this, is there any.	F-K	F-K	F-K
12	2:39.8 - 2:47.2	ok, so the traffic route, parking, directly this place	Be-K	Be-K	Be-K
13	2:47.2 - 2:58.0	So we need two activity space, one is closed, one is outdoor. and we need to think about that	F-K	F-K	F-K
14	2:58.0 - 3:01.9	the building, entrance and façade	F-K	F-K	F-K
15	3:01.9 - 3:08.9	I think the entrance should be from the road, which is	Be-K	Be-K	Be-K
16		(change to the perspective view)	Bs-K	Bs-K	Bs-K
17	3:08.9 - 3:18.5	which is close to the residential area	F-K	Be-K	Be-K
18	3:18.5 - 3:33.1	this area seems if for day review,	S-K	Bs-K	Bs-K
19		I would make a building that opens up from this		Be-K	Be-K
20	3:33.1 - 3:47.6	So the pedestrian comes from this road,	Be-K	Be-K	Be-K
21	3:47.6 - 3:53.2	which is close to the residential area,	F-K	Be-K	Be-K
22		which is this one	Bs-K	Bs-K	Bs-K
23	3:53.2 - 4:13.0	and I think I'd better write it down, pedestrian access	N	N	N
24	4:13.4 - 4:31.0	and car parks and the entrance from the approaches to the park (put text on the site)	F-K	F-K	F-K
25	4:31.0 - 4:42.9	from here,	S-K	Be-K	Be-K
26		so we may have some sort of parking area on this spot (put text on the site)	F-K	Be-K	F-K
27	4:42.9 - 4:50.8	and the building would be opens up like this	S-K	Bs-K	Be-K
28	4:50.8 - 4:58.2	so since this is the community centre	R-K	R-K	R-K
29	4:58.2 - 5:08.0	the meeting space and outdoor activity space is important	Be-K	F-K	F-K
30	5:08.0 - 5:17.5	I may have such building that may have nice, close indoor area	F-K	F-K	F-K
31	5:17.5 - 5:25.1	I may have a building that have a hole in like this one	S-K	Be-K	S-K

32	5:25.1 - 5:29.4	similar to this one, I may have a square building	S-K	S-K	S-K
33	5:29.4 - 5:38.8	and a hole in it,	S-K	S-K	S-K
34		could be symmetry close space		S-K	Be-K
35	5:38.8 - 5:47.4	just core as a cover from the rain and strong sun	Be-K	Be-K	Be-K
36	5:47.4 - 6:08.9	but it will stand as a hat out of the building that sitting on it, but somehow, there will be some gap between the building and the roof	S-K	Be-K	Be-K
37	6:08.9 - 6:25.8	so what I am trying to say is I may have a building like this (draw a box)	S-K	S-K	S-K
38	6:25.8 - 6:32.5	make it smaller, from this corner	Be-K	Be-K	Be-K
39		(re-draw the box)	S-K	S-K	S-K
40	6:32.5 - 6:36.5	the height will be one floor height, and two floors height	Be-K	Be-K	Be-K
41	6:40.2 - 7:11.9	In the middle of this. I may have a .. maybe I may try this, anyway, doesn't really matter,	N	N	N
42	7:11.9 - 7:22.4	what I am trying to do, is to make a hole on this cube	S-K	S-K	S-K
43	7:22.4 - 7:35.5	I may use a second box, I may use some Boolean operation	Be-K	Be-K	Be-K
44		(make a box)	S-K	S-K	S-K
45	7:35.5 - 7:40.0	(move the box)	S-K	S-K	S-K
46	7:40.0 - 7:43.6	I'd better to look at the top view (change the views)	Bs-K	Bs-K	Bs-K
47	7:43.6 - 7:52.6	(move the box)	S-K	S-K	S-K
48	7:52.6 - 7:57.1	just check if it sits on the building	Bs-K	Bs-K	Bs-K
49	7:57.1 - 8:04.7	yes, it sits there (check), ok	Bs-K	Bs-K	Bs-K
50	8:04.7 - 8:20.1	so if I have the differences of these two, I have a hole	Bs-K	Be-K	Be-K
51	8:20.1 - 8:33.5	so the Boolean is here, not the union, but I need maybe this one (Boolean)	N	Be-K	N
52	8:33.5 - 8:50.2	I think difference might be better	Be-K	Be-K	Be-K
53	8:50.2 - 9:01.0	ok, the second, and then (Boolean)	S-K	S-K	S-K
54	9:01.0 - 9:36.5	Didn't work.	Bs-K	N	N
55		I will do it again.	Be-K	N	N
56	9:36.5 - 10:17.3	First set, second set, yes, didn't work (Boolean).	S-K	S-K	S-K
57		I have no idea why this didn't work, first one...		N	N
58	10:17.3 - 10:43.1	I try split, I select this, delete (Boolean)	S-K	S-K	S-K
59	10:43.1 - 10:45.4	ok, that's what I dream to get	Bs-K	Bs-K	Bs-K
60	10:45.4 - 10:54.3	so the pedestrian entrance should be from here	Be-K	F-K	Be-K
61	10:54.3 - 11:02.8	so I will lift it up,	S-K	Be-K	S-K
62		So there would be sort of opening here.	F-K	Be-K	Be-K
63	11:02.8 - 11:11.7	(make a box)	S-K	S-K	S-K
64	11:11.7 -	it's like this, I will split things again.	S-K	Be-K	Be-K

	11:16.7				
65		split operation	S-K	S-K	S-K
66	11:16.7 - 11:25.1	so that will indicate the entrance of my building	F-K	F-K	F-K
67	11:26.0 - 11:43.3	(Boolean)	S-K	S-K	S-K
68		couldn't work, I will do it again	Be-K	N	N
69	11:43.3 - 11:56.5	(make the box)	S-K	S-K	S-K
70	11:56.5 - 12:04.9	then I have this, I will check other side to see if it sits nicely (rotate the model)	Bs-K	Bs-K	Bs-K
71	12:04.9 - 12:08.9	yes, looks it fits (rotate the model)	Bs-K	Bs-K	Bs-K
72	12:08.9 - 12:17.2	then I try split, first, second (Boolean)	S-K	S-K	S-K
73	12:17.2 - 12:26.3	ok, it's got consist part	Bs-K	Bs-K	Bs-K
74	12:26.3 - 12:30.0	delete this and this (delete box)	S-K	S-K	S-K
75	12:30.0 - 12:38.1	so that part will be the entrance of the whole thing	F-K	F-K	F-K
76	12:38.1 - 12:48.6	and what I would need is a very light and nice roof over it then I	S-K	F-K	Be-K
77	12:48.6 - 12:58.7	use grasshopper to make this roof	Be-R	Be-R	Be-R
78	12:58.7 - 13:09.8	what I need is to have several curves to define the edges of my roof first, then I will use those curves to design that light roof	Be-R	Be-R	Be-R
79	13:09.8 - 13:24.5	(rotate the model)	Be-R	Bs-K	Bs-K
80	13:24.5 - 13:29.8	ok, so (change view)	Bs-K	Bs-K	Bs-K
81	13:29.8 - 13:44.7	so this is... I would need one of these use to position the curves	Be-R	Be-R	Be-R
82	13:44.7 - 13:51.4	and I will use this top view to see how this fit in	Bs-K	Bs-K	Bs-K
83	13:51.4 - 13:59.6	I think I'd better use control point curve	Be-K	Be-K	Be-K
84	13:59.6 - 14:27.8	so I will start from this corner, then I will ... how to pick the corner of that, unfortunately (draw curves)	S-K	S-K	S-K
85	14:27.8 - 14:34.1	it is very difficult to achieve what I am going to achieve	S-K	N	N
86		(draw curves)		S-K	S-K
87	14:34.1 - 14:46.9	I will ... I thought what I need is just some sort of nice curve here	S-K	S-K	S-K
88	14:46.9 - 14:50.4	but it goes to very weird	Bs-K	Bs-K	Bs-K
89	14:50.4 - 15:25.0	I close the snap, I will close all these mid-points (close snap)	Be-K	Be-K	Be-K
90	15:25.0 - 16:01.5	all right, I will start with this corner, and using the curve to draw my curve (draw curves)	S-K	S-K	S-K
91	16:01.5 - 16:13.9	from this point, that surface, ok (draw curves)	S-K	S-K	S-K
92	16:13.9 - 16:16.5	(rotate the model)	Bs-K	Bs-K	Bs-K
93	16:16.5 - 16:26.2	and that point and that corner (draw curves)	S-K	S-K	S-K
94	16:26.2 - 16:51.5	ok, it looks nice,	Bs-K	Bs-K	Bs-K
95		I will position it to the corner, almost (move curves)	S-K	S-K	S-K

96	16:51.5 - 17:10.2	rotate it (rotate) again, to the back so we keep the corner of the building	S-K	Be-K	Be-K
97		(rotate)		Bs-K	S-K
98	17:10.2 - 17:16.6	then I will make several copies of this (copy the curve)	S-K	S-K	S-K
99	17:16.6 - 17:25.0	Ok, so it's fine. then I will put that,	Bs-K	Be-K	Be-K
100	17:25.0 - 17:35.2	because I need the curve adjust in my site	Be-K	Be-K	Be-K
101		(rotate the curve)	S-K	Bs-K	S-K
102	17:35.2 - 17:39.9	I really do not need to cover the road	Be-K	Be-K	Be-K
103		(move the curve)	S-K	S-K	S-K
104	17:39.9 - 17:48.0	I rotate that a little bit, too (rotate the curve)	S-K	S-K	S-K
105	17:48.0 - 17:57.9	I know that point are 0,	Bs-K	Bs-K	Bs-K
106		then I need to elevate them	S-K	Be-K	Be-K
107	17:57.9 - 18:07.7	I can do this on one of the right or front view	Be-K	N	Be-K
108	18:07.7 - 18:17.0	it could be like this, it could be above the building	Be-K	Be-K	Be-K
109		(lift the curve)	S-K	S-K	S-K
110	18:17.0 - 18:21.7	will have very light connections	Be-K	Be-K	Be-K
111	18:21.7 - 18:36.8	Ok, what else I need? I also need the look of a curve	N	Be-K	Be-K
112	18:36.8 - 18:56.8	on the right view, so I will try to make it looked curvy	Be-K	Be-K	Be-K
113		(move the control points)	S-K	S-K	S-K
114	18:56.8 - 19:12.6	like this, and I will do the other two as well (move the control points)	S-K	S-K	S-K
115	19:12.6 - 19:25.2	So, ok, here you go.	N	N	N
116	19:25.2 - 19:33.0	I can shorten it (move control points)	Be-K	S-K	S-K
117	19:33.0 - 20:02.4	and I will also change this curve a little bit as well. (move the control points)	S-K	S-K	S-K
118	20:02.4 - 20:26.5	all right, in grasshopper, I will use the curve component, this one (set component)	S-R	S-R	S-R
119	20:26.5 - 20:40.8	I also set multiple curves, that one, that one and that one, all right, done (pick curves)	S-R	S-R	S-R
120	20:40.8 - 21:05.9	And later I will make a surface on that loft... will do it (set "loft" component)	Be-R	S-K	S-K
121	21:06.2 - 21:11.3	I connect this with that, so (connect component)	S-R	S-R	S-R
122	21:11.3 - 21:16.7	I got the surface here, I will check that	Bs-R	Bs-K	Bs-R
123	21:16.7 - 21:22.5	the perspective view, oh, this is too high	Bs-K	Bs-K	Bs-K
124	21:22.5 - 21:29.7	this is way towards my work (rotate the model)	Bs-K	Bs-K	Bs-K
125	21:29.7 - 21:33.5	elevated too much (rotate the model))	Bs-K	Bs-K	Bs-K
126	21:33.5 - 21:39.0	anyway, I can fix it later, doesn't matter	Be-R	N	Be-R
127	21:39.0 - 21:46.8	I can lower it anytime, doesn't matter, it can stay like this	Be-R	Be-R	Be-R
128	21:46.8 - 22:05.2	At the moment, then I will go to the utilities, put some elaborated...	Be-K	Be-R	Be-R

129		(set "subsrf" component)	S-R	Be-R	S-R
130	22:05.2 - 22:10.2	make a division	Be-R	S-K	Be-R
131	22:10.2 - 22:23.3	I will connect that with this (connect component)	S-R	S-R	S-R
132	22:23.3 - 22:35.7	I also need to go to domain (set "domain")	Be-R	Be-R	Be-R
133	22:35.7 - 23:18.1	Was this one, or other one? (looking for components)	Be-R	N	Bs-R
134		just keep it for the moment	Bs-R	Be-R	Bs-R
135	23:18.1 - 23:34.1	so I connect this, (connect component)	S-R	S-R	S-R
136	23:34.0 - 23:52.0	I am have somewhere in my computer, just to see if I could use existing grasshopper file (open a grasshopper file)	S-R	S-R	S-R
137	23:52.0 - 24:11.2	so what I need here, what it does, basically, I have the curve here, if I can select these three (pick the curve)	Be-R	Be-R	Be-R
138	24:11.2 - 24:25.9	I will find the control points off.	Be-R	Be-K	Be-K
139	24:25.9 - 24:34.0	and I can select them nicely, and I can set the curve multiple curves (change "curve" component properties)	S-R	S-R	S-R
140	24:34.0 - 24:37.4	All right, here we go, so what it does? it's makes a loft, loft will show us the preview (un-preview)	Bs-R	N	N
141	24:42.5 - 24:52.5	I may have, I can consider this as a transparent material	S-K	S-K	S-K
142	24:57.5 - 25:06.5	or I may have it like this, just have a net on top of the building (un-preview)	Be-K	Be-K	Be-K
143	25:06.5 - 25:15.9	just to provide some sheet	Be-K	Be-K	Be-K
144	25:15.9 - 25:34.5	just several things here, I can change the size of that material,	Be-R	Be-R	Be-R
145		if you consider this. (rotate the model)	Bs-K	Bs-K	Bs-K
146	25:34.5 - 25:44.0	a metal frame	S-K	S-K	S-K
147	25:44.0 - 25:55.2	I may change the size of it	Be-K	Be-K	Be-K
148		(change parameters), you can see how it looks	S-R	S-R	S-R
149	25:55.2 - 26:02.7	(rotate the model)	Bs-K	Bs-K	Bs-K
150	26:02.7 - 26:05.1	ok, interesting	Bs-K	Bs-K	Bs-K
151	26:05.1 - 26:12.6	I may adjust it to make it thicker	Be-K	Be-K	Be-K
152		(change parameters)	S-R	S-R	S-R
153	26:12.4 - 26:29.9	I am trying to show the division of various changes I may have, the big vertical and horizontals, like this	Be-R	Be-R	Be-R
154		(change parameters)	S-R	S-R	S-R
155	26:29.9 - 26:39.2	or I can have something like this (changing parameters)	S-R	S-R	S-R
156	26:39.2 - 26:43.6	too much, I made this too much	Bs-K	Bs-K	Bs-K
157	26:43.6 - 27:09.5	so I will check (rotate the model)	Bs-K	Bs-K	Bs-K
158	27:09.5 - 27:12.7	so I start to adjust the height	Be-K	Be-K	Be-K
159	27:12.7 - 27:18.2	because it's far too high	Bs-K	Bs-K	Bs-K
160	27:18.2 -	I need to select just curves, I might group them	Be-K	Be-K	Be-K

	27:27.8	(select curves)			
161	27:27.8 - 27:33.0	to make it easier to make the future selections (group curves)	Be-K	Be-K	Be-K
162	27:33.0 - 27:42.1	then I will move them down to see	Be-K	S-K	Be-K
163	27:42.1 - 27:49.8	(move curves) something like this	S-K	S-K	S-K
164	27:49.8 - 28:00.9	so that is my design, and roof on top of it.	Bs-K	Be-K	Bs-K
165	28:00.9 - 28:08.2	of course, it cannot be hanged like that,	Be-K	Bs-K	Bs-K
166		we need some nice connections	Be-K	Be-K	Be-K
167	28:08.2 - 28:21.5	here, I can draw small connections on each corner,	S-K	Be-K	Be-K
168	28:21.5 - 28:25.5	and that bit I can't leave out	Be-K	Be-K	Be-K
169	28:25.5 - 28:36.5	I really don't need anything, just stand along element.	Be-K	N	N
170	28:36.5 - 28:54.9	all right, so the first, the small core one would be on this corner	S-K	S-K	S-K
171	28:54.9 - 29:15.0	The sun will be very light, I would say. 5…	Be-K	Be-K	Be-K
172		I will move it to other way (draw curve)	S-K	S-K	S-K
173	29:15.0 - 29:17.9	this is too big	Bs-K	Bs-K	Bs-K
174	29:17.9 - 29:22.6	Half of it, maybe, two (draw curves).	S-K	S-K	S-K
175	29:22.6 - 29:34.3	Minors 2, and.. (extrude the box)	S-K	S-K	S-K
176	29:34.3 - 29:55.5	so those are the structure elements keeping the surface, the roof, I would say	Be-K	Be-K	Be-K
177	29:55.5 - 30:06.1	(checking the roof)	Bs-K	Bs-K	Bs-K
178	30:06.1 - 30:16.7	from that corner to that corner (move the columns)	S-K	S-K	S-K
179	30:16.7 - 30:21.5	I hope it is correct spot	Be-K	Be-K	Be-K
180	30:21.5 - 30:27.8	yes (checking the model)	Bs-K	Bs-K	Bs-K
181	30:27.8 - 30:58.3	and the other two would be ...I will copy them to the other corner (copy columns)	S-K	S-K	S-K
182	30:58.3 - 31:07.4	then I would adjust the roof	Be-K	S-K	S-K
183	31:07.4 - 31:15.6	that is fully cover the whole building	Be-K	Be-K	Be-K
184	31:15.6 - 31:21.4	this surface to the right	Be-K	Be-K	Be-K
185		(move the surface)	S-K	S-K	S-K
186	31:21.4 - 31:31.1	and I may rotate it, just a little bit (rotate the surface)	S-K	S-K	S-K
187	31:31.1 - 31:38.1	and move again, to this side of the building (move the surface)	S-K	S-K	S-K
188	31:38.1 - 31:43.2	looks better	Bs-K	Bs-K	Bs-K
189	31:43.2 - 31:48.5	but I miss to leave a space to a car park	F-K	F-K	F-K
190	31:48.5 - 31:57.7	I could resize it, I could make it a little bit smaller.	Be-K	Be-K	Be-K
191	31:57.7 - 32:03.8	we could provide the car parking underground	Bs-K	F-K	F-K

192	32:03.8 - 32:07.5	ok, let's consider the car parking underground	F-K	F-K	F-K
193	32:07.5 - 32:20.4	I will indicate several functions like the one we have	Be-K	N	Be-K
194	32:21.0 - 32:38.9	outdoor activities would be in the middle (put text)	F-K	F-K	F-K
195	32:38.9 - 32:47.8	this part would be the classrooms,	F-K	F-K	F-K
196		very close to the entrance	Be-K	Be-K	Be-K
197	32:47.8 - 32:57.0	class rooms (put text)	F-K	N	F-K
198	32:57.0 - 33:06.3	and the other part would be the meeting rooms (meeting rooms)	F-K	F-K	F-K
199	33:06.3 - 33:15.9	outdoor area, we are also have small lobby for the meeting room	F-K	F-K	F-K
200	33:15.9 - 33:22.6	for the breaks, they can go out for several activities	Be-K	Be-K	Be-K
201	33:22.6 - 33:37.6	also, have some other function like small coffee here	F-K	F-K	F-K
202		for people to use during the meetings or during the classroom time	Be-K	Be-K	Be-K
203	33:37.6 - 33:42.3	it could be located in the middle of the building	S-K	S-K	S-K
204	33:42.3 - 33:56.9	See, it from different views, just to check. (rotate the model)	Bs-K	Bs-K	Bs-K
205	33:56.9 - 34:08.5	I think it would be better if I have material just to cover the surface like that	Be-K	Be-K	Be-K
206	34:08.5 - 34:16.7	(rotate the model)	Bs-K	Bs-K	Bs-K
207	34:16.7 - 34:29.2	There is something similar, the concept is the same. there is a museum in Marin,	S-K	S-K	S-K
208	34:29.2 - 34:38.2	the concept is the same, it has the roof, the roof is so strong	S-K	S-K	S-K
209	34:38.2 - 34:43.3	but it's sort of hanging our buildings,	Bs-K	S-K	S-K
210	34:43.3 - 34:50.2	so I try to do such thing	Be-K	Be-K	Be-K
211		(change parameters)	S-R	S-R	S-R
212	34:50.2 - 35:03.5	the panels of the roof would be smaller like this	Be-K	Be-K	Be-K
213		(change parameters)	S-R	S-R	S-R
214	35:03.5 - 35:17.6	and the material would be lighter	Be-K	Be-K	Be-K
215		(change parameters)	S-R	S-R	S-R
216	35:17.6 - 35:25.1	(change parameters)	S-R	S-R	S-R
217	35:25.1 - 35:43.9	the profile of the material maybe steel, would be lighter, that looks better	Be-K	Be-K	Be-K
218	35:43.9 - 35:50.5	If I need a thickness, can I make a thickness here?	Be-K	Be-K	Be-K
219	35:50.5 - 36:00.2	On that I could... can I put a loft	S-R	S-K	S-K
220		(check grasshopper interface)	Bs-R	Bs-R	Bs-R
221	36:00.2 - 36:16.1	(copy loft) and sort of copy that (connect component)	S-R	S-R	S-R
222	36:16.1 - 36:33.8	what I will do, I will copy curves and make copy of those curves	Be-K	S-K	S-K
223	36:33.8 - 36:53.0	on top of that, then has two of them like this (move curves)	S-K	S-K	S-K
224	36:53.0 -	thickness of it (pick up the curve in grasshopper)	S-R	Be-R	Be-R

	37:01.9				
225	37:01.9 - 37:17.9	so this is the first set, I set again (pick up the curve in grasshopper)	S-R	S-R	S-R
226	37:17.9 - 37:28.0	the curves to here, then loft it, then I need to make those connections	Be-R	Be-R	Be-R
227	37:28.0 - 37:47.7	(connect components) I also need to connect this, here we go	S-R	S-R	S-R
228		I have two surfaces now,	Bs-K	Bs-K	Bs-K
229	37:47.7 - 37:56.4	looks better (rotate the model)	Bs-K	Bs-K	Bs-K
230	37:56.4 - 38:11.7	(rotate the model) I try to have some render of it to see how it looks	Bs-K	Bs-K	Bs-K
231	38:11.7 - 38:22.9	wait for render	N	N	N
232	38:22.9 - 38:31.4	ok, I forget something, I need to bake it to see	N	Bs-K	Bs-K
233	38:31.4 - 41:17.9	(bake) render preview, terrible render	N	N	N
234		I think this need to be fixed	Be-R	N	Be-R
235	41:17.9 - 41:47.6	(connect components)	S-R	S-R	S-R
236	41:47.6 - 42:26.0	so this is the end of my design (rotate the model)	Bs-K	Bs-K	Bs-K

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.6 - 0:08.5	ok, so we are recording the session	N	N	N
2	0:08.5 - 0:18.2	so this sequential site which is given to me, in Sydney	R-K	R-K	R-K
3	0:18.2 - 0:25.9	I also printed the site plan and design brief	N	N	N
4	0:25.9 - 0:32.8	I will start with task 2, shopping centre	N	N	N
5	0:32.8 - 1:47.3	Quickly, the design brief, the main function, is a shopping area. And leisure area, including coffee and restaurant, and 6000 square metres, the two main functions could be put into one whole building or separate, for site design, consider the traffic route, parking, for building design, consider the entrance, façade, don't think of detail. so the area should be around 6000 square metres, 1 or 2 storeys. the focus of the design is form generate of the building and simple site design, don't go to detail of the function layout, you are expected to finish the design in 40 mins, but you can continue... required outcome, a model and two rendered images	R-K	R-K	R-K
6	1:47.3 - 1:53.9	ok, so let's see what we have	N	Be-K	N
7	1:53.9 - 2:30.3	so this area is the park, this area is the residential area, this is main road, this is business and commercial, ok, site is in Sydney, .. normal temperature	R-K	R-K	R-K
8	2:30.3 - 2:43.1	where is the north, no indication of that (rotate the model)	Be-K	Be-K	Be-K
9	2:43.1 - 2:49.8	I will check how big is the site	Be-K	R-K	R-K
10	2:49.8 - 3:07.5	The plan has, but I can't read it, it's too small.	N	N	N

11	3:07.5 - 3:10.1	so I will write it down (check the area of given site)	R-K	Bs-K	R-K
12	3:10.1 - 4:08.5	283 metres, quite big 183, the other corner is 111, and the other one 98 (check the distance of site boundary)	R-K	R-K	R-K
13	4:08.5 - 4:43.0	I also want to check the height of neighbour building, 39, more than 10 floors. (check the height of building)	R-K	Be-K	R-K
14	4:43.0 - 4:47.9	what about this? 24 (check the height of building)	R-K	R-K	R-K
15	4:47.9 - 4:54.9	Could be 5, 6 storey building?	R-K	Bs-K	Bs-K
16	4:54.9 - 4:59.4	All right, what about the residential?	F-K	R-K	R-K
17	4:59.4 - 5:06.3	I also check the residential to see how tall they are.	R-K	Be-K	R-K
18	5:06.3 - 5:14.9	18 (check height of the residential building)	R-K	R-K	R-K
19	5:14.9 - 5:22.9	5, 6 floors building, if this is a residential building	R-K	Bs-K	Bs-K
20	5:22.9 - 5:27.3	so mine will be one or two storey building	R-K	R-K	R-K
21	5:27.3 - 5:31.5	we are doing the shopping centre, ok, so	R-K	F-K	R-K
22	5:31.5 - 5:47.1	let me see on top view, I prefer to see from the top view because it gives you the overall (change to the top view)	N	Be-K	N
23	5:47.1 - 5:53.5	I will look at the site, the urban fibre you have	Be-K	Be-K	Be-K
24	5:53.5 - 6:05.6	so what I can see is the very geometric form of the site, squares and rectangles	Be-K	Bs-K	Bs-K
25	6:05.6 - 6:13.8	and my site is sort of hemi-triangle	R-K	Bs-K	R-K
26	6:13.8 - 6:22.1	and I will keep this, because this is the main road	Be-K	Be-K	Be-K
27	6:22.1 - 6:30.8	we need to keep the same shape, I would say	S-K	Be-K	Be-K
28	6:30.8 - 6:43.6	and complete that, and fill this part with the façade, the windows of the shops	F-K	Be-K	Be-K
29	6:43.6 - 6:47.1	and here is the entrance for the pedestrian around	F-K	F-K	F-K
30	6:47.1 - 7:05.1	should be from this main road, and the rest would be connected with the park	Be-K	Be-K	Be-K
31	7:05.1 - 7:16.5	I will write a park here (input text on the site)	N	N	N
32	7:16.5 - 7:27.3	ok, so the leisure area which is the coffee and restaurant would be connected with the park	F-K	F-K	F-K
33	7:27.3 - 7:33.1	so it could have a open courtyard, sort of thing	S-K	Be-K	F-K
34	7:33.1 - 7:36.1	then would be connected with the park	Be-K	Be-K	Be-K
35	7:36.1 - 7:39.8	then will have a nice view of the park	Be-K	Be-K	Be-K
36	7:39.8 - 7:51.0	And the service area, this is the residential, right?	F-K	F-K	F-K
37	7:51.0 - 8:06.8	The service area of the shopping centre would be from this road, facing the residential area.	Be-K	F-K	Be-K
38	8:06.8 - 8:30.4	here is the service area, I will write "service" here (input text on the site)	N	N	N
39	8:30.4 - 8:46.6	main entrance of the building (input text on the site)	N	F-K	F-K
40	8:46.6 - 8:51.0	will be from here, so I will put it here somewhere	Be-K	Be-K	Be-K

41	8:51.0 - 9:23.2	and the back will be the leisure, this area (input text on the site)	F-K	F-K	F-K
42		so the leisure will be here connected with the park		Be-K	Be-K
43	9:23.2 - 9:34.8	What about the parking? I need to consider the parking, traffic route	F-K	F-K	F-K
44	9:34.8 - 9:48.5	Ok. so the parking would be come from, not here but here, because I don't want to break the traffic, because this is the residential area	Be-K	Be-K	Be-K
45	9:48.5 - 9:57.8	so I may change the service area down, this area (move "service" down)	F-K	S-K	S-K
46	9:57.8 - 10:06.2	parking would be from here as well (input text on the site)	Be-K	Be-K	Be-K
47	10:06.2 - 10:15.4	would be from here, some part of it would be parking	F-K	F-K	F-K
48	10:15.4 - 10:21.9	they may have some setback, the building may start here	Be-K	F-K	S-K
49	10:21.9 - 10:33.2	and then the service area from the site again	F-K	F-K	F-K
50	10:33.2 - 10:52.7	maybe a L shaped or U shaped building trying the triangle corner,	S-K	S-K	S-K
51		with an open courtyard connected with the park area	F-K	Be-K	Be-K
52	10:52.7 - 11:05.4	I will draw some construction lines, just to understand the dimensions	Be-K	Be-K	Be-K
53	11:05.4 - 11:17.4	50 metres from this point, which is here (draw lines)and maybe 20 metres here (draw lines) something like this, ok (draw lines)	S-K	S-K	S-K
54	11:41.0 - 11:51.0	so I've permission, of course, but this is, I think this is too much, maybe we should	Bs-K	Bs-K	Bs-K
55	11:51.0 - 11:59.1	tabulate as well, because if you look at the end of the block	N	Be-K	Be-K
56	11:59.1 - 12:03.7	this is residential, and commercial area,	R-K	R-K	R-K
57	12:03.7 - 12:14.4	we should get similar foot print	Be-K	Be-K	Be-K
58	12:14.4 - 12:17.6	so this is too big	Bs-K	Bs-K	Bs-K
59	12:17.6 - 12:19.8	I will delete that (delete curves)	S-K	S-K	S-K
60	12:19.8 - 12:25.8	and maybe something like this, right? (draw lines)	S-K	S-K	S-K
61	12:25.8 - 12:39.8	ok, so the parking, the leisure (inspect the site)	F-K	Bs-K	F-K
62	12:39.8 - 12:48.8	and I just want' a to leave the parking outside the whole thing	F-K	Be-K	Be-K
63	12:48.8 - 12:56.8	then the building like this (draw the line)	S-K	S-K	S-K
64	12:56.8 - 13:00.0	start from here, so this part is for parking	F-K	F-K	F-K
65	13:00.0 - 13:21.6	and the building will start from this point, something like this, maybe 20 metres (draw the boundary of the building)	S-K	S-K	S-K
66	13:21.6 - 13:40.4	So I don't want... How much is it?	Bs-K	N	N
67		something like this (draw the boundary of the building)	S-K	S-K	S-K
68	13:40.4 - 13:48.6	so we have a building that have open courtyard, and two wings like these two, the big one, and small one and also, the façade on the main road	F-K	Be-K	Be-K
69	14:05.2 - 14:19.4	so those buildings keep the same with the main road	S-K	Be-K	Be-K
70	14:19.4 - 14:24.5	like, look, for example, this one and this one (compared to the existing building on the site)	Be-K	Bs-K	Bs-K

71	14:24.5 - 14:31.3	so I will repeat the same concept on my building to repeat that and complete that triangle	Be-K	Be-K	Be-K
72	14:36.3 - 14:41.0	finish, complete here, leave it there and have the rest of the building	S-K	Be-K	Be-K
73	14:44.8 - 15:06.0	so I may starting with the drawing phase, the surface	Be-K	N	N
74	15:06.0 - 15:14.9	I will delete the construction lines (delete lines)	S-K	S-K	S-K
75	15:14.9 - 15:21.1	this is the first part of my building	Bs-K	Bs-K	Bs-K
76	15:21.1 - 15:33.5	and I may have the first wing, the first wing will be a little shorter	Be-K	Be-K	Be-K
77	15:33.5 - 15:39.5	may be sort of that big (draw a circle)	S-K	S-K	S-K
78	15:39.5 - 15:45.4	I am trying to have a nice proportion	S-K	Be-K	S-K
79	15:45.4 - 15:52.0	maybe something like that (make a surface)	S-K	S-K	S-K
80	15:52.0 - 16:01.5	what's that, something is wrong, I will delete that	Bs-K	Bs-K	Bs-K
81	16:01.5 - 16:05.3	Right point	N	N	N
82	16:05.3 - 16:12.7	I think I will delete this entrance first (delete "entrance" text)	N	N	N
83	16:12.7 - 16:22.5	it's hard to see what is going on there, just approximation	N	N	N
84		(make surfaces)	S-K	S-K	S-K
85	16:22.5 - 16:26.0	doesn't really need to be that (inspect the model)	Bs-K	Bs-K	Bs-K
86	16:26.0 - 16:32.0	then I will delete that as well (delete the circle)	S-K	S-K	S-K
87	16:32.0 - 16:37.8	delete the construction line (delete the construction line)	S-K	S-K	S-K
88	16:37.8 - 16:56.7	and the final wing of the building will be this, I mean, the longest, maybe we also use the same principle (draw a circle)	S-K	Be-K	Be-K
89	16:56.7 - 17:02.5	so approximate that big (draw the building boundary)	S-K	S-K	S-K
90	17:02.5 - 17:13.1	each should be.. (draw lines), again, I delete the construction lines (delete lines) to see what is going on	S-K	Be-K	S-K
91	17:13.1 - 17:17.6	ok, the building will be like this (rotate the model)	Bs-K	Bs-K	Bs-K
92	17:17.6 - 17:27.4	so this part will be the leisure area	F-K	F-K	F-K
93	17:27.4 - 17:32.7	for example, this bit will have a restaurant	F-K	F-K	F-K
94	17:32.7 - 17:37.5	including the coffee and restaurant	F-K	F-K	F-K
95	17:37.5 - 17:42.8	they will have open sitting area here with nice landscaping and have some trees, etc.	Be-K	Be-K	Be-K
96	17:50.1 - 17:55.3	so they will have a nice view when they sit here	Bs-K	Be-K	Be-K
97	17:56.6 - 17:59.1	and the rest will be the shops	F-K	F-K	F-K
98	17:59.1 - 18:13.2	what else do I need to put here?	N	N	N
99	18:13.2 - 18:23.9	ok, so this is the envelope of the building, if I try to (rotate the model)	Bs-K	Bs-K	Bs-K
100	18:23.9 - 18:33.1	elevate this envelope into 3d dimension	S-K	S-K	S-K
101	18:33.1 -	so I would say the highest part would be the front	Be-K	Be-K	Be-K

	18:38.3	part,			
102	18:38.3 - 18:44.5	and these two would be the lowest	Be-K	Be-K	Be-K
103	18:44.5 - 18:53.7	so I try to have a different shading option (change to shade view)	N	N	N
104	18:53.7 - 18:57.9	I will see what is going on by that	N	N	N
105	18:57.9 - 19:08.9	Ok, so what was the height of this? 12 or 9 something?	Bs-K	Bs-K	Bs-K
106	19:08.9 - 19:12.0	this is too big for such building	Bs-K	Bs-K	Bs-K
107	19:12.0 - 19:18.5	Could be ten metres high?	S-K	Be-K	Be-K
108	19:18.5 - 19:27.3	so, ok, surface, I need to extrude the surface	S-K	S-K	S-K
109	19:27.3 - 19:52.4	select the surface, all right, let me see (change to perspective view) so the yellow highlight shows my site selected (pan on the front view)	Bs-K	Bs-K	Bs-K
110	20:13.3 - 20:51.2	I am trying to figure out the height of that, would be that big? or that big?	Bs-K	Be-K	Be-K
111		Ok, almost the same height with the residential buildings (extrude) could be like, ok, that's fine. like this,	Bs-K	Bs-K	Bs-K
112	20:51.2 - 21:00.7	Ok, so we have, this is quite big, isn't it?	Bs-K	Bs-K	Bs-K
113	21:00.7 - 21:08.1	But if you look at those, these are bigger. ok, let's keep it. like that	Be-K	Be-K	Be-K
114	21:15.1 - 21:20.4	then we have these two, no, I will change the height, this would be taller than that	S-K	Be-K	Be-K
115	21:28.4 - 21:40.6	I will try to do it again, so same height with these, or these	Be-K	Be-K	Be-K
116		(extrude)	S-K	S-K	S-K
117	21:40.6 - 21:45.8	now it looks fine	Bs-K	Bs-K	Bs-K
118	21:45.8 - 22:06.2	then the rest – these two will be shorter, the same with this, I am trying to figure the height of this	Be-K	Be-K	Be-K
119	22:06.2 - 22:11.7	ok, I think this is one floor, so ... (extrude)	S-K	S-K	S-K
120	22:11.7 - 22:16.6	so this is two floor height, and this is one floor height	S-K	Be-K	S-K
121	22:16.6 - 22:23.5	and this would be one floor height as well (extrude)	S-K	S-K	S-K
122	22:23.5 - 22:31.8	then so this will be the height of the building	Bs-K	Bs-K	Bs-K
123	22:31.8 - 22:38.8	the restaurant will be on this side	F-K	F-K	F-K
124	22:38.8 - 22:43.6	the kitchen will be at the back, the service	F-K	F-K	F-K
125	22:43.6 - 22:54.2	the kitchen will be facing the secondary road, close the residential area	Be-K	Be-K	Be-K
126	22:54.2 - 22:57.7	We have the residential here, right? yes	R-K	R-K	R-K
127	22:57.7 - 23:08.5	then the entrance, of course from here, or from here, possibly	Be-K	Be-K	Be-K
128	23:08.5 - 23:12.9	because we have seating, outside seating	F-K	F-K	F-K
129	23:12.9 - 23:20.7	in general, the it proportional looks fine (rotate the model)	Bs-K	Bs-K	Bs-K
130	23:20.7 - 23:34.0	what is missing is to have a nice shade, because this is in Sydney, and will have strong sun	Be-K	Be-K	Be-K
131	23:34.0 - 23:45.1	so it might have the idea of cover, to close some area	S-K	Be-K	Be-K

132	23:45.1 - 23:52.9	Here, may be a nice awning. so, could be a nice awning, right?	S-K	S-K	S-K
133	23:59.5 - 24:02.5	something like, closing the triangle	S-K	S-K	S-K
134	24:02.5 - 24:12.6	I just lost my drawing, what happened	N	N	N
135	24:12.6 - 26:00.3	looking for problem, I am trying to figure out what happened to my view, ok, I was so worried that I lost it	N	N	N
136	26:00.3 - 26:22.1	Ok, this is not top, but it shows the top, what happened? anyway	N	N	N
137	26:22.1 - 26:28.9	doesn't matter, I know this is perspective view	N	N	N
138	26:28.9 - 26:34.2	so what I am thinking is to add here a nice opening	S-K	S-K	S-K
139	26:34.2 - 26:47.1	maybe something different, a curve, a nice curve, maybe	S-K	S-K	S-K
140	26:50.5 - 27:02.2	because everything is so nice, rectangular, that would be nice to have something different	Be-K	Be-K	Be-K
141	27:02.2 - 27:12.3	then, try to have two curves, and then make a loft	Be-K	Be-K	Be-K
142	27:12.3 - 27:42.7	could be something like this (draw curves)	S-K	S-K	S-K
143	27:42.7 - 27:52.1	no, I was thinking of doing it in other view, but somehow, I have just the top view, I can't figure out what happened. anyway, I will try my best to do this	N	N	N
144	28:03.3 - 28:13.5	What if I do it somewhere else then move it here? could be easier	Be-K	N	N
145	28:19.4 - 28:30.5	I will have, but in that case, I wouldn't understand the dimension of it, right?	Bs-K	N	N
146	28:30.5 - 28:54.3	(draw curve) what I am trying to do is to increase the control points of this	Be-K	S-K	S-K
147	28:54.3 - 28:58.8	and I may play with that	N	Be-K	N
148	28:58.8 - 29:06.3	but I can't use the f10, because it controls the video	N	N	N
149	29:06.3 - 29:16.4	so insert knot, I will have a knot here, that's good (insert knot)	S-K	S-K	S-K
150	29:16.4 - 29:43.8	try again, I will do another one here, and another one here (insert knot)	S-K	S-K	S-K
151	29:43.8 - 29:56.4	something happens here, I think I forgot to press enter	Bs-K	N	N
152	29:56.4 - 30:06.7	I will try, ok (insert knot)	S-K	S-K	S-K
153	30:06.7 - 30:18.3	click this and move it, this time too much knot	Bs-K	Bs-K	Bs-K
154		(move knot)	S-K	S-K	S-K
155	30:18.3 - 30:24.9	I think I lose the control of the viewport	N	N	N
156	30:24.9 - 30:36.6	I can't do it properly, because I can't see properly, I can't see the façade from the front or the right view	N	N	N
157	30:36.6 - 30:41.4	somehow I need to figure out, but I don't want to lose time of that	N	N	N
158	30:41.4 - 30:45.9	so ok, what I will do, I will delete this (delete knots)	S-K	S-K	S-K
159	30:45.9 - 30:54.4	some of these, I think it is too much	Bs-K	Bs-K	Bs-K
160	30:54.4 - 31:18.3	I am trying to give it a little form that is interesting (move knots)	S-K	S-K	S-K
161	31:18.3 - 31:23.8	then I may copy this to the other side	S-K	S-K	S-K
162	31:23.8 -	I can select the line, I can copy that and collect that	S-K	Be-K	S-K

	31:34.0	further control point off, copy, somewhere here (copy curves)			
163	31:50.0 - 32:01.8	then I will just have partial cover on this area	Bs-K	Be-K	Be-K
164	32:01.8 - 32:04.0	we don't need to cover the whole thing, will be so ugly to do it like that, so I prefer to partially cover it	Be-K	Be-K	Be-K
165	32:13.6 - 32:21.6	I may loft (loft)	S-K	S-K	S-K
166	32:21.6 - 32:29.3	yes, loft works, but didn't close the whole thing	Bs-K	Bs-K	Bs-K
167	32:29.3 - 32:42.6	simplify, loose, preview (adjust loft options) looks fine	N	S-K	S-K
168	32:42.6 - 32:54.6	so it is something like this (rotate the model)	Bs-K	Bs-K	Bs-K
169	32:54.6 - 33:08.8	the envelope, it fit nicely, I think, on that site,	Bs-K	Bs-K	Bs-K
170	33:08.8 - 33:21.0	I will check if the height is fine, I am not sure (inspect the model), yes, so one floor height, one floor height, and this is also one floor height (inspect the model)	Bs-K	Bs-K	Bs-K
171	33:26.9 - 33:33.1	if you think this will be a nice sitting area at the back	F-K	F-K	F-K
172	33:33.1 - 33:37.9	looks fine (rotate the model)	Bs-K	Bs-K	Bs-K
173	33:37.9 - 33:43.1	we will have some openings here, gates	S-K	S-K	S-K
174	33:43.1 - 33:49.0	just make the access available for the people here	Be-K	Be-K	Be-K
175	33:49.0 - 33:55.6	on this façade and also, from here and here	S-K	S-K	S-K
176	33:55.6 - 34:02.6	yeah, (rotate the model)	Bs-K	Bs-K	Bs-K
177	34:02.6 - 34:35.8	ok, in general, it's about that big, that shape and I think you will understand, it looks fits the general urban fabric (rotate the model)	Bs-K	Bs-K	Bs-K
178	34:35.8 - 34:55.7	if you think there will be some green, some trees, there will be a very nice area	Be-K	Be-K	Be-K
179	34:55.7 - 35:02.8	What if I close the whole thing, close the whole courtyard, from that point to that, shall I try?	Be-K	Be-K	Be-K
180	35:07.6 - 36:04.2	Delete this, and I will draw another nice curve, like this (draw curves) then I am trying to have... it should be open	S-K	S-K	S-K
181	36:04.2 - 36:11.5	so I will loft this one and the very first one, to see how it looks	Be-K	Be-K	Be-K
182	36:11.5 - 36:19.4	press enter, done (loft)	S-K	S-K	S-K
183	36:19.4 - 36:39.0	ok, so I will check a few things here, duplicable, I will make a change this time, ok (change loft options)	N	N	N
184	36:39.0 - 36:43.9	I was thinking it will be too big (rotate the model)	Bs-K	Bs-K	Bs-K
185	36:43.9 - 36:54.0	but if you can imagine if you have some glass parts, and those parts on this roof	S-K	Be-K	Be-K
186	37:01.7 - 37:11.2	that would be a nice roof (delete extra curves)	S-K	S-K	S-K
187	37:11.2 - 37:32.9	I will see how it looks from the top (rotate the model) so this is one end, another end, ok	Bs-K	Bs-K	Bs-K
188	37:32.9 - 37:47.2	so the façade information, what I can do, I will check	N	N	N
189	37:47.2 - 38:10.7	If I can add, can I see the rendering? I was so afraid that I would lose the view	N	N	N
190	38:10.7 - 38:15.9	I couldn't figure out what happens to my viewport	N	N	N

191	38:15.9 - 38:42.1	visibility, (rendering) so the first rendering will show the height of the leg and wings	Bs-K	Bs-K	Bs-K
192	38:42.1 - 38:58.4	the main part of the building and. is the default settings, my computer does not have that good memory	N	N	N
193	38:58.4 - 39:08.2	the video cut, so economic show very basic stuff (render)	N	N	N
194	39:08.2 - 39:17.8	I will change it a little bit	Be-K	N	Be-K
195	39:17.8 - 39:33.5	The view, if I can.	N	N	N
196	39:33.5 - 39:42.6	I am trying to figure out if the height of the building, the general concept will fit with the current neighbouring	Be-K	Be-K	Be-K
197	39:42.6 - 39:45.9	the residential and so on (rotate the model)	Bs-K	Bs-K	Bs-K
198	39:45.9 - 39:57.0	and (render) yes, of course, those are some problematic areas	Bs-K	Bs-K	Bs-K
199	40:06.2 - 40:13.4	looks like a pool, that may have some water on it	Be-K	Bs-K	Be-K
200	40:13.4 - 40:18.4	if have rain, that would have problem	Bs-K	Be-K	Bs-K
201	40:18.4 - 40:33.8	But anyway, in general, looks fine. another view may be from the main road (rotate the model)	Bs-K	Bs-K	Bs-K
202	40:33.8 - 40:53.3	so the view will be like this (adjust the view)	S-K	N	N
203	40:53.3 - 40:59.5	and render would be, so this is the building (render)	Bs-K	N	Bs-K
204	40:59.5 - 41:07.3	we may have of course, maybe doesn't need to be that flat	Be-K	Be-K	Be-K
205	41:07.3 - 41:15.5	Right? this is a flat surface, we might have some curves to make it stand along	S-K	S-K	S-K
206	41:15.5 - 41:21.5	make it different,	Be-K	Be-K	Be-K
207	41:21.5 - 41:28.8	I will try to make it	N	N	N
208	41:28.8 - 41:51.6	just demonstrate, may be a façade, that have such curve, something like this (draw curves)	S-K	S-K	S-K
209	41:51.6 - 42:05.0	What if I extrude this, can I extrude the curve? yes, like this (extrude)	S-K	S-K	S-K
210	42:05.0 - 42:15.7	(rotate the model) yes	Bs-K	Bs-K	Bs-K
211	42:15.7 - 42:31.7	(Render) it's dark. we can't see properly	N	N	N
212	42:31.7 - 42:37.6	(rotate the model)	Bs-K	Bs-K	Bs-K
213	42:37.6 - 42:41.8	we can do similar things here, on that façade as well	S-K	Be-K	Be-K
214	42:41.8 - 42:58.3	of course we have to get back to the board of the given site (rotate the model)	Bs-K	Bs-K	Bs-K
215	42:58.3 - 43:03.9	at the moment, it relatively looks big	Bs-K	Bs-K	Bs-K
216	43:03.9 - 43:06.4	but could be fixed	Be-K	Be-K	Be-K
217	43:06.4 - 43:15.5	ok, that's it. in general, it looks like that	Bs-K	Bs-K	Bs-K
218	43:15.5 - 44:16.8	the parking, we have the main shopping building, we have the leisure area at the back, service will comes this point, the parking will be here, and we will have some outside sitting area, connected with the coffee, and the restaurant will be on that courtyard, which will cover with nice curved glass or semi-glass, roof or awning, I would say which is	F-K	F-K	F-K

		connected with the park at the back of the building.			

Designer 8

PDE session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:11.5	this is the second task I am starting now (rotate the site model) it's a shopping centre using grasshopper and rhino (rotate the site model)	R-K	R-K	R-K
2	0:17.1 - 0:27.3	Actually, the ... are two main tasks on the site: leisure area and commercial area.	R-K	R-K	R-K
3	0:32.0 - 0:42.2	in the context of commercial building, I would like to keep the building in these areas the inner corner of the site,	Be-K	Be-K	Be-K
4	0:42.2 - 0:52.6	so I start drawing now	N	N	N
5	0:52.6 - 1:11.8	since it is a 6000 square metres and two storeys building	R-K	R-K	R-K
6	1:11.8 - 1:26.3	I will offset the site to make a boundary from the main road	Be-K	Be-K	Be-K
7	1:25.7 - 1:35.8	6 metres (offset the curve)	S-K	S-K	S-K
8	1:35.2 - 1:41.5	so this should be the area you walk in	Be-K	Be-K	Be-K
9		(rotate the model)	Bs-K	Bs-K	Bs-K
10	1:41.5 - 1:50.7	since I don't have to worry about the internal function,	R-K	R-K	R-K
11	1:50.7 - 1:58.3	the main function is the shopping centre, the shopping centre here should be huge quantity	F-K	Be-K	Be-K
12	1:58.3 - 2:04.2	so I am taking this corner to the commercial area.	F-K	F-K	F-K
13	2:04.2 - 2:09.3	and leave the rest of the part for parking	F-K	F-K	F-K
14	2:09.3 - 2:19.1	and here for pedestrian	F-K	F-K	F-K
15		so I will start here, in this corner	Be-K	Be-K	Be-K
16		(draw curves)	S-K	S-K	S-K
17	2:19.1 - 2:28.5	I offset it by 30 metres (offset the curve)	S-K	S-K	S-K
18	2:28.5 - 2:41.8	so at this moment, the complex context, it is easy for guard to access	Bs-K	Be-K	Be-K
19	2:41.8 - 2:51.2	they get nice, easy access into the site street	Be-K	Be-K	Be-K
20	2:51.2 - 2:56.4	this entire centre space will come back in these	F-K	Be-K	Be-K
21	2:56.4 - 3:06.1	so, see (draw curves)	S-K	S-K	S-K
22	3:06.1 - 3:09.6	(trim curves)	S-K	S-K	S-K
23	3:09.6 - 3:26.2	so maybe it is linking shopping to the street here	Be-K	Be-K	Be-K
24		(rotate the model)	Bs-K	Bs-K	Bs-K
25	3:26.2 - 3:42.8	since the requirement is using grasshopper, I don’t use grasshopper to make faces, I use it more to make façade creating patterns, so that is how I’m going to look at the shopping centre	Be-K	Be-R	Be-K
26	3:42.8 -	I will exhibit moving junk, I use grasshopper to	Be-K	Be-R	Be-R

	3:56.6	create some kind of balls			
27	3:55.2 - 4:12.4	things about shopping centre, I believe that entrance, courtyard, and such a building in here	F-K	F-K	F-K
28	4:12.4 - 4:20.8	I need to extrude it, 3 metres (extrude)	S-K	S-K	S-K
29	4:20.8 - 4:31.2	I want to use those internal faces	Be-K	Be-R	Be-K
30		(rotate the model)	Bs-K	Bs-K	Bs-K
31	4:31.2 - 4:38.5	I will put the building from the corner of the block	Be-K	S-K	S-K
32	4:38.9 - 4:45.1	not sure what to do, I don't really want to just make the surface of the building	N	Be-K	Be-K
33		(rotate the model)	Bs-K	Bs-K	Bs-K
34	4:45.1 - 4:51.4	and I really would like to use the intersect, to cut	Be-K	Be-K	Be-K
35		(rotate the model)	Bs-K	Bs-K	Bs-K
36	4:51.4 - 5:04.1	so I am going to define functions in this (rotate the model)	Be-K	Bs-K	Be-K
37	5:04.1 - 5:21.5	so I have it here and (change to wireframe view)	Bs-K	Bs-K	Bs-K
38	5:21.5 - 5:27.6	the curve here, I might extrude it (extrude)	S-K	S-K	S-K
39	5:27.6 - 5:33.6	just let it start taking façade for different storeys	Be-K	Be-K	Be-K
40	5:37.8 - 5:47.7	(rotate the model)	Bs-K	Bs-K	Bs-K
41	5:47.7 - 5:59.0	I guess this side would stay like this, only for people from here into the shopping centre (rotate the model)	Bs-K	Be-K	Be-K
42	5:59.0 - 6:07.5	Actually, I would like to add in some offices...	F-K	F-K	F-K
43	6:07.5 - 6:16.1	so I can go around to make some small shops ok,	Be-K	F-K	F-K
44		so I make this open	Be-K	Be-K	Be-K
45	6:16.1 - 6:22.3	I want to create a small internal courtyard	F-K	F-K	F-K
46		(rotate the model)	Bs-K	Bs-K	Bs-K
47	6:22.3 - 6:37.1	which has to be a regular (draw curves)	S-K	S-K	S-K
48	6:37.1 - 6:52.9	so extrude this courtyard (extrude)	S-K	S-K	S-K
49	6:52.9 - 7:01.2	(Boolean the box)	S-K	S-K	S-K
50	7:01.2 - 7:03.1	(rotate the model)	Bs-K	Bs-K	Bs-K
51	7:03.1 - 7:09.1	and I want to extrude it excluding the slab on the top (undo)	S-K	S-K	S-K
52	7:09.1 - 7:21.5	so try (extrude the courtyard)	S-K	S-K	S-K
53	7:21.5 - 7:38.2	(Boolean the box)	S-K	S-K	S-K
54	7:38.2 - 7:45.2	get a space inside	Bs-K	Be-K	Be-K
55	7:45.2 - 7:48.7	(rotate the model)	Bs-K	Bs-K	Bs-K
56	7:48.7 - 7:58.6	what I want to try in a shopping centre is that a long street with more small shops	F-K	F-K	F-K
57	7:58.6 - 8:01.0	I know as a shopping mall (rotate the model)	Bs-K	Bs-K	Bs-K
58	8:01.0 - 8:11.5	they could open gradually they don't have to be full cover, like there's slab on the empty space	Be-K	Be-K	Be-K

59	8:11.5 - 8:20.8	they could go to gradually into the building, and to create that, that is the idea that would be helpful	Be-K	Be-K	Be-K
60	8:20.8 - 8:39.6	I just add commercial core, because..	F-K	F-K	F-K
61		(rotate the model)	Bs-K	Bs-K	Bs-K
62	8:39.6 - 8:55.6	ok, I can make 2000 when we drew (draw curves)	S-K	S-K	S-K
63	9:06.0 - 9:20.7	(extrude)	S-K	S-K	S-K
64		(rotate the model)	Bs-K	Bs-K	Bs-K
65	9:20.7 - 9:25.2	I would like to leave the corner as the commercial centre of the building	F-K	F-K	F-K
66	9:25.2 - 9:30.3	(rotate the model)	Bs-K	Bs-K	Bs-K
67	9:30.3 - 9:45.5	as large as 1000 metres, and .. (draw a box)	S-K	S-K	S-K
68	9:45.5 - 9:55.6	(rotate the model)	Bs-K	Bs-K	Bs-K
69	9:55.6 - 10:04.1	this is the mass initially made in rhino, and I am going to switch to grasshopper (rotate the model)	Be-K	Be-R	Be-R
70	10:04.1 - 10:09.5	I have only old version	N	N	N
71		(rotate the model)	Bs-K	Bs-K	Bs-K
72	10:09.5 - 10:19.4	it does not have attraction points in that version, but I am not going to use that, I guess	N	N	N
73	10:19.4 - 10:33.5	(open grasshopper)	N	Be-R	N
74	10:33.5 - 11:00.6	(rotate the model)	Bs-K	Bs-K	Bs-K
75	11:00.6 - 11:17.3	so I want to gradually made up these faces.	Be-K	Be-K	Be-K
76	11:17.3 - 11:25.4	so let's see, first, brep (set "brep" component)	S-R	S-R	S-R
77	11:25.4 - 11:31.5	and set it (pick up the mass into brep component)	S-R	S-R	S-R
78	11:31.5 - 11:48.0	I can use "3d populate" (set "populate") so I create a box of points	Be-R	Be-R	Be-R
79	11:56.6 - 12:09.9	so I set the box (pick up box into "populate")	S-R	S-R	S-R
80	12:09.9 - 12:26.4	And now.. (check script properties)	Bs-R	Bs-R	Bs-R
81	12:26.4 - 12:35.6	(set "point" component)	S-R	S-R	S-R
82	12:35.6 - 12:43.8	(delete component)	S-R	S-R	S-R
83	12:43.8 - 12:59.3	(set surface in "population")	S-R	S-R	S-R
84	12:59.3 - 13:06.0	so I got a very simple definition, nothing at all complex	Bs-R	N	N
85	13:11.4 - 13:19.0	to see if some variation can be on the top surface of building	Be-R	Be-R	Be-R
86	13:19.0 - 13:24.7	so now I drag out the points, and I need "box"	Be-R	Be-R	Be-R
87	13:24.7 - 13:40.3	(set "box" component)	S-R	S-R	S-R
88	13:40.3 - 13:46.9	(set parameters)	S-R	S-R	S-R
89	13:46.9 - 13:53.9	(change parameters) the dimension	S-R	S-R	S-R
90	13:53.9 - 13:57.8	(set parameters)	S-R	S-R	S-R

91	13:57.8 - 14:06.4	need more (change parameters)	S-R	S-R	S-R
92	14:06.4 - 14:12.9	and I will scale it (set "scale" component)	S-K	S-K	S-K
93	14:12.9 - 14:18.6	based on the distance from the corner, so	Be-R	Be-R	Be-R
94	14:18.6 - 14:30.8	and so basically, I set these points (connect component)	S-R	S-R	S-R
95	14:30.8 - 14:43.9	and scale factor, I may use distance	Be-R	Be-R	Be-R
96		(checking component)		Bs-R	Bs-R
97	14:43.9 - 15:07.3	(check the property of the component)	Bs-R	Bs-R	Bs-R
98	15:07.3 - 15:52.4	(looking for components)	N	N	N
99	15:52.4 - 15:59.6	(set "distance" component) the distance between two points (set the points of distance) from point A to B	Be-R	Be-R	Be-R
100	16:15.3 - 16:24.7	so this is the scale factor	Bs-R	Be-R	Bs-R
101	16:24.7 - 16:28.7	(rotate the model)	Bs-K	Bs-K	Bs-K
102	16:28.7 - 16:39.5	divide (set "divide curve" component)	Be-R	Be-R	Be-R
103	16:39.5 - 16:44.5	(connect component)	S-R	S-R	S-R
104	16:44.5 - 16:49.8	slider button (set parameters)	S-R	S-R	S-R
105	16:49.8 - 17:01.7	that's A (connect components)	S-R	S-R	S-R
106	17:01.7 - 17:08.5	(un-preview)	N	N	N
107	17:08.0 - 17:15.5	(connect components)	S-R	S-R	S-R
108	17:15.5 - 17:23.1	(change parameters)	S-R	S-R	S-R
109	17:23.1 - 17:28.8	(change constraints)	Be-R	Be-R	Be-R
110	17:28.8 - 17:38.9	(change parameters)	S-R	S-R	S-R
111	17:38.9 - 17:54.0	I was thinking, if they are bigger when further from the building, and smaller when they near the building	Be-R	Be-R	Be-R
112		(reconnect components)	S-R	S-R	S-R
113	17:54.0 - 18:12.7	I can adjust the box size (change parameters)	S-R	S-R	S-R
114	18:12.7 - 18:21.9	randomize the points here	S-R	Be-R	Be-R
115		(set parameters)		S-R	S-R
116	18:21.9 - 18:33.0	(change constraints)	Be-R	Be-R	Be-R
117	18:33.0 - 18:46.1	(change parameters) so I can just play round points, to change the range size	S-R-Pc	S-R-Pc	S-R-Pc
118	18:46.1 - 18:49.4	we can see how it looks now	Bs-K	Bs-K	Bs-K
119	18:49.4 - 19:10.2	and we are going to create different solid now (set "sd different" components)	S-K	S-K	S-K
120	19:10.2 - 19:21.1	so this is the first set, and this is the second set	S-K	Be-R	Be-K
121		(checking previous script)	Bs-R	Bs-R	Bs-R
122		and set "brep" component)	S-R	S-R	S-R
123	19:21.1 -	so this is the first set, and this is the second set	S-K	Be-R	Be-K

	19:53.2				
124		(connect components)	S-R	S-R	S-R
125	19:53.2 - 20:00.2	so I can see something came out here (inspect the models)	Bs-K	Bs-K	Bs-K
126	20:00.2 - 20:11.4	try to see (un-preview)	N	N	N
127	20:11.4 - 20:16.0	so we have this, can see the clear form of this	Bs-K	Bs-K	Bs-K
128	20:16.0 - 20:24.4	and un-preview, the points also, (un-preview)	N	N	N
129	20:24.4 - 20:29.0	this is interesting (rotate the model) it's quite interesting	Bs-K	Bs-K	Bs-K
130	20:34.9 - 20:40.0	(un-preview)	N	N	N
131	20:40.0 - 20:44.6	so I can see the surface (rotate the model)	Bs-K	Bs-K	Bs-K
132	20:44.6 - 20:55.3	the points populate on the surface,	F-K	Be-R	Be-R
133		could become a quite interesting entrance (rotate the model)		Be-K	Be-K
134	20:55.3 - 21:09.0	the entrance form could be more genetic	Be-R	Be-R	Be-R
135		(rotate the model)	Bs-K	Bs-K	Bs-K
136	21:09.0 - 21:21.4	so certain part has to be cleaned up, because we can see them from base	Be-K	N	N
137	21:21.4 - 21:35.2	I can just increase the box size, and these corners, so it properly there	Be-K	Be-K	Be-K
138	21:35.2 - 21:48.5	the scale factor (change parameters)	S-R	S-R	S-R
139	21:48.5 - 22:13.3	waiting, the computer is a bit slow	N	N	N
140	22:13.3 - 22:19.0	Yeah! it seems unique (rotate the model)	Bs-K	Bs-K	Bs-K
141	22:29.5 - 22:45.5	it's a way of exploring definition, I’m sure it can be used to more complicated way, but	N	N	N
142	22:45.5 - 22:49.2	it is a kind of entry space	F-K	F-K	F-K
143		(rotate the model)	Bs-K	Bs-K	Bs-K
144	22:49.2 - 23:00.4	so I would like to do this with all of the slabs	Be-K	Be-K	Be-K
145		and may be floating in the supermarket	S-K	Be-K	S-K
146		(rotate the model)	Bs-K	Bs-K	Bs-K
147	23:00.4 - 23:05.6	actually I'd like to do an entire skin of the supermarket	Be-K	Be-K	Be-K
148	23:05.6 - 23:13.3	I think I am going to scale.. maybe this (rotate the model)	S-K	Bs-K	S-K
149	23:13.3 - 23:20.0	and then subtract it, to get a skin on which, properly this. see if I can do that (rotate the model)	Be-K	Be-K	Be-K
150	23:34.8 - 23:48.2	(rotate the model)	Bs-K	Bs-K	Bs-K
151	23:48.2 - 23:54.7	I am keep exploring other things in building	Be-K	Be-K	Be-K
152	23:54.7 - 24:05.9	so to scale the building, I need to find, centre point	Be-R	S-K	Be-R
153	24:05.9 - 24:43.0	(looking for component)	N	N	N
154	24:43.0 - 25:12.7	so I remember there is a finding of the centre of the surface	Be-R	N	N
155		(looking for component)	N	N	N

156	25:12.7 - 25:25.2	ok, so I can use "brep area" (set "brep" component)	S-R	S-R	S-R
157	25:25.2 - 25:36.1	(check previous script)	Bs-R	Bs-R	Bs-R
158	25:36.1 - 25:43.6	(connect component)	S-R	S-R	S-R
159	25:43.6 - 25:51.3	and we have the centre to scale (set "scale" component)	S-R	S-R	S-R
160	25:51.3 - 26:00.6	to get a skin (connect component)	S-R	S-R	S-R
161	26:00.6 - 26:05.1	(set parameters)	S-R	S-R	S-R
162	26:05.1 - 26:20.1	(change parameters)	S-R	S-R	S-R
163	26:20.1 - 26:33.9	(rotate the model)	Bs-K	Bs-K	Bs-K
164	26:33.9 - 26:41.9	(change parameters)	S-R	S-R	S-R
165	26:41.9 - 26:59.5	(rotate the model)	Bs-K	Bs-K	Bs-K
166	26:59.5 - 27:10.3	So I think, here.. a bit uneven (rotate the model)	Bs-K	Bs-K	Bs-K
167	27:10.3 - 27:26.8	(trim surface)	S-K	S-K	S-K
168	27:26.8 - 27:29.6	perfect,	Bs-K	Bs-K	Bs-K
169		I will loft	Be-K	S-K	S-K
170	27:29.6 - 27:44.3	(rotate the model)	Bs-K	Bs-K	Bs-K
171	27:44.3 - 27:49.9	increase scale factor (change parameters)	S-R	S-R	S-R-
172	27:49.9 - 27:55.6	(rotate the model)	Bs-K	Bs-K	Bs-K
173	27:55.6 - 28:01.9	(check script)	Bs-R	Bs-R	Bs-R
174	28:01.9 - 28:09.2	so let's continue the tile until mode	Be-K	Be-R	Be-K
175	28:09.2 - 28:17.6	I will disconnect brep (disconnect component)	S-R	S-R	S-R
176	28:17.6 - 28:28.7	and just the whole tiles (rotate the model)	Bs-K	Bs-K	Bs-K
177	28:28.7 - 29:08.1	(draw curves)	S-K	S-K	S-K
178	29:08.1 - 29:17.7	(extrude curve)	S-K	S-K	S-K
179	29:17.7 - 29:31.5	(set "brep" component)	S-R	S-R	S-R
180	29:31.5 - 29:39.0	(rotate the model)	Bs-K	Bs-K	Bs-K
181	29:39.0 - 29:48.4	(change parameters)	S-R	S-R	S-R
182	29:47.9 - 30:13.9	15 underneath watching form built from the centre, the building is still, the building shape is such a really (rotate the model)	Bs-K	Bs-K	Bs-K
183	30:13.9 - 30:21.3	(delete components)	S-R	S-R	S-R
184	30:21.3 - 30:32.5	now we continue this structure	S-R	Be-K	S-R
185		(rotate the model)	Bs-K	Bs-K	Bs-K
186	30:32.5 - 30:52.1	so I will copy this definition (copy components)	S-R	S-R	S-R

187	30:52.1 - 31:11.8	I will use disable to dis-function them (disable)	Be-R	Be-R	Be-R
188	31:11.8 - 31:22.7	and make a different box (set box for "population")	Be-R	Be-R	Be-R
189	31:22.7 - 31:31.2	so make this on shape, I can use this to set geometry (set "pop geo" component)	S-R	S-R	S-R
190	31:31.2 - 31:49.7	(connect components)	S-R	S-R	S-R
191	31:49.7 - 32:11.0	(draw ellipse)	S-K	S-K	S-K
192	32:11.0 - 32:44.7	(draw box)	S-K	S-K	S-K
193	32:44.7 - 33:24.7	(redraw box)	S-K	S-K	S-K
194	33:24.7 - 33:35.2	(connect components)	S-R	S-R	S-R
195	33:35.2 - 33:55.2	(enable component)	Be-R	Be-R	Be-R
196	33:55.2 - 34:07.7	(rotate the model)	Bs-K	Bs-K	Bs-K
197	34:07.7 - 34:14.4	so I need to get the points here, in order to do that	Be-R	Be-K	Be-R
198	34:14.4 - 34:30.3	waiting	N	N	N
199	34:30.3 - 34:34.5	(rotate the model)	Bs-K	Bs-K	Bs-K
200	34:34.5 - 34:49.2	to set the corner	S-K	S-K	S-K
201	34:49.2 - 35:12.4	(change parameters)	S-R	S-R	S-R
202	35:12.4 - 35:41.9	(Rotate the model) you can see different parts of the building, I am using separate brep...		Bs-K	Bs-K
203	35:41.9 - 36:04.4	(change parameters)	S-R	S-R	S-R
204	36:04.4 - 36:10.8	(rotate the model)	Bs-K	Bs-K	Bs-K
205	36:10.8 - 36:20.0	so here again, I would like to just switch off.	N	N	N
206	36:20.0 - 36:29.5	(rotate the model)	Bs-K	Bs-K	Bs-K
207	36:29.5 - 36:35.0	(un-preview)	N	N	N
208	36:35.0 - 36:39.8	(rotate the model)	Bs-K	Bs-K	Bs-K
209	36:39.8 - 36:49.2	The.. could be more measure (rotate the model)	Bs-K	Bs-K	Bs-K
210	36:49.2 - 37:07.1	This is just a planning instead of detail design.. sort of building	N	N	N
211	37:07.1 - 37:27.3	(change parameters)	S-R	S-R	S-R
212	37:27.3 - 37:35.6	actually I am going to change the points again	Be-R	S-K	Be-R
213	37:35.6 - 37:56.1	Set the distance corner of this point, make the.. more..	Bs-K	Be-R	Be-R
214	37:56.1 - 38:04.8	(set points)	Be-R	S-R	S-R
215	38:04.8 - 38:22.3	I have to start again	N	N	N
216	38:22.3 - 38:40.2	(change parameters)	S-R	S-R	S-R
217	38:40.2 - 38:49.6	(change parameters) since this area is not allow to keep density	S-R	S-R	S-R

218	38:49.6 - 39:05.5	(set parameters)	S-R	S-R	S-R
219	39:05.5 - 39:12.3	here I can make it 200 (set constraints)	Be-R	Be-R	Be-R
220	39:12.3 - 39:39.9	(change parameters)	S-R	S-R	S-R
221	39:39.9 - 39:47.9	so it gives us a stronger character	Bs-K	Bs-K	Bs-K
222	39:47.9 - 40:01.7	so the slab is a cluster of baby squares (rotate the model)	Bs-K	Bs-K	Bs-K
223	40:01.7 - 40:14.0	so anyway, this is a formulation (rotate the model)	Bs-K	Bs-K	Bs-K
224	40:14.0 - 40:28.2	I am not only use it to make the skin of the building, but to use it for creating the space character of the building	Be-K	Be-R	Be-K
225		(rotate the model)	Bs-K	Bs-K	Bs-K
226	40:28.2 - 40:36.9	of course, it can be form the building of certain skin	S-K	Be-K	Be-K
227		(rotate the model)	Bs-K	Bs-K	Bs-K
228	40:36.9 - 40:48.2	I guess it's the flat .. proportion outweigh the master storey	Be-K	Be-R	Be-R
229	40:48.2 - 40:50.5	could be interesting (rotate the model)	Bs-K	Bs-K	Bs-K
230	40:50.5 - 41:03.9	so I am just going to complete this stage, the last part here.	Be-K	N	N
231	41:03.9 - 41:16.7	here we have a connection unit	F-K	Bs-K	Bs-K
232	41:16.7 - 41:33.3	(rotate the model)	Bs-K	Bs-K	Bs-K
233	41:33.3 - 41:43.6	so I'll continue the same definition on to the curve part	Be-R	S-R	S-R
234	41:43.6 - 41:55.8	I'll adjust the centre, and of course,	Be-K	Be-K	Be-K
235		change certain scale factor	Be-R	Be-K	Be-K
236	41:55.8 - 42:17.6	(copy components) shift it	Be-R	S-R	Be-R
237	42:17.6 - 42:24.4	so here I have to plan geometry	Bs-K	N	N
238	42:24.4 - 42:39.6	(rotate the model)	Bs-K	Bs-K	Bs-K
239	42:39.6 - 42:46.1	(delete components)	S-R	S-R	S-R
240	42:46.1 - 42:53.4	(set "populate" components)	Be-R	Be-R	Be-R
241	42:53.4 - 43:01.5	(connect components)	S-R	S-R	S-R
242	43:01.5 - 43:03.2	(enable function)	Be-R	Be-R	Be-R
243	43:03.2 - 43:17.1	(set one box of "population") and one box	Be-R	Be-R	Be-R
244	43:17.1 - 43:21.8	(rotate the model)	Bs-K	Bs-K	Bs-K
245	43:21.8 - 43:34.3	set the corner	S-R	S-K	S-K
246	43:34.3 - 44:00.7	and enable (enable components)	Be-R	Be-R	Be-R
247	44:00.7 - 44:10.9	similar strategy for this one (rotate the model)	Be-R	Be-R	Be-R
248	44:10.9 - 44:18.6	(rotate the model)	Bs-K	Bs-K	Bs-K
249	44:18.6 -	so this is the last part of the shopping centre	F-K	Bs-K	Bs-K

	44:20.6				
250	44:20.6 - 44:26.2	very interesting (rotate the model)	Bs-K	Bs-K	Bs-K
251	44:26.2 - 44:38.9	so now I am doing the rest of the building (rotate the model)	Be-K	Be-K	Be-K
252	44:38.9 - 45:07.9	I used grasshopper for this part, for the rest part of the building, I guess it could be simpler (rotate the model)	Be-K	Be-R	Be-R
253	45:07.9 - 45:18.7	so these shops, coffees get under here	F-K	F-K	F-K
254	45:18.7 - 45:23.7	more opening and faces which need connection	Be-K	Be-K	Be-K
255		(rotate the model)	Bs-K	Bs-K	Bs-K
256	45:23.7 - 45:26.2	so nothing complicated there	N	N	N
257	45:26.2 - 45:44.2	I'm not going to go that aspect (rotate the model)	Bs-K	Be-K	Be-K
258	45:44.2 - 45:51.7	now I am going to look at the design brief	R-K	R-K	R-K
259	45:51.7 - 45:59.5	the shopping centre, cafe, and restaurant	R-K	R-K	R-K
260	45:59.5 - 46:21.9	(rotate the model) both would come into this larger central space, the corner could be two separate entrance of the building	F-K	Be-K	F-K
261	46:21.9 - 46:35.7	I guess, for the façade I would right now, just imagine that entire nature of the square, maybe in a little too mathematic (rotate the model)	Bs-K	Be-K	Bs-K
262	46:35.7 - 46:49.0	and I am running out of time	N	N	N
263	46:49.0 - 46:58.3	I am trying the box here	S-K	Be-K	S-K
264	46:58.3 - 47:08.4	maybe the triangle here could be a parking place	F-K	F-K	F-K
265		(draw curves).	S-K	S-K	S-K
266	47:08.4 - 47:42.9	(rotate the model)	Bs-K	Bs-K	Bs-K
267	47:42.9 - 48:09.9	(delete boxes in rhino)	S-K	S-K	S-K
268	48:09.9 - 49:59.3	let's bake it (bake)	N	N	N
269	49:59.3 - 52:05.0	so what I am going to do is Boolean (Boolean difference)	S-K	S-K	S-K
270	52:05.0 - 52:21.7	so it's the end of design	N	N	N
271	52:21.7 - 53:39.5	(rotate the model) not consider too complex building design, of the shopping centre, but I guess the corner would be pretty interesting, and the centre space would be interesting, yes, very quick exercise in grasshopper	Bs-K	Bs-K	Bs-K

GME session

ID	Timespan	Content	1st coding	2nd coding	Final coding
1	0:00.0 - 0:11.4	Hi, I am.. we start from task 1, the community centre	R-K	N	R-K
2	0:09.8 - 0:22.1	so I will continue with the brief, which is the community centre within the block (looking at the site)	R-K	R-K	R-K
3	0:21.8 - 0:35.8	so I guess for the community centre, we can focus on the main building	F-K	Be-K	Be-K

4		towards this area, the part near the park.	Be-K	Be-K	Be-K
5	0:33.8 - 0:44.6	and this area for the parking.	F-K	F-K	F-K
6	0:42.9 - 0:51.0	so, let's see (rotate the site model)	Bs-K	Bs-K	Bs-K
7	0:48.1 - 0:54.5	so as I said before, I am going to put the building besides the park	Be-K	Be-K	Be-K
8	0:51.2 - 1:08.2	so the building area should be 6000 m2,so .. 1600 m2	R-K	S-K	R-K
9	1:06.2 - 1:23.1	so could be a rectangle, so I tack the chunk in this area (draw a rectangle)	S-K	S-K	S-K
10	1:21.2 - 1:30.4	the length I keep it as 300 metres	S-K	S-K	S-K
11	1:27.2 - 1:33.2	(draw the rectangle)	S-K	S-K	S-K
12	1:30.2 - 1:43.7	(try the command) where did it go? (rotate the site model) ok. still odd	N	N	N
13	1:42.2 - 2:00.4	so let's stick to the previous..	Be-K	Be-K	Be-K
14		(draw a rectangle)	S-K	S-K	S-K
15	1:57.2 - 2:05.8	ok, so 90 degree,	S-K	S-K	S-K
16	2:03.2 - 2:08.8	the length is 1930, ok (check the length of the rectangle)	Bs-K	Bs-K	Bs-K
17	2:06.2 - 2:17.0	so basically, this is the corner where is the wall of the building (rotate the model)	Bs-K	Bs-K	Bs-K
18	2:15.2 - 2:25.4	and since this is the left hand side driving, and this is facing the main road	Be-K	Be-K	Be-K
19	2:24.2 - 2:31.2	and this is the entrance	F-K	F-K	F-K
20		and parking area,	F-K	F-K	F-K
21		and this is the outdoor activity area	F-K	F-K	F-K
22	2:30.2 - 2:34.2	(rotate the site model)	Bs-K	Bs-K	Bs-K
23	2:33.2 - 2:38.2	we can also shift the building at this corner.	Be-K	Be-K	Be-K
24	2:36.2 - 2:41.8	so the activity in this area is an extension	F-K	F-K	F-K
25		(rotate the site model)	Bs-K	Bs-K	Bs-K
26	2:39.2 - 2:44.6	and the back of the building is commercial	F-K	F-K	F-K
27	2:42.2 - 2:48.1	and the entrance is approximately towards the park	Be-K	Be-K	Be-K
28	2:45.2 - 2:50.5	(rotate the site model)	Bs-K	Bs-K	Bs-K
29	2:48.2 - 2:53.8	so this is my basic chunk for the building in this place	S-K	Bs-K	Bs-K
30	2:51.2 - 3:03.9	so since it is community centre, we do not have to worry about this area	F-K	F-K	F-K
31	3:00.1 - 3:13.7	I am thinking how about working on a kind of specific roof for building	S-K	S-K	S-K
32	3:12.2 - 3:15.7	so we have a large open lawn	Be-K	Be-K	Be-K
33	3:12.2 - 3:18.5	And this is specific. Roof	S-K	S-K	S-K
34	3:15.2 - 3:22.0	that kind of ...interior areas	F-K	F-K	F-K
35		(drawing lines)	S-K	S-K	S-K
36	3:21.2 - 3:29.9	so I will divide this rectangle (divide rectangle)	S-K	S-K	S-K

37	3:27.2 - 3:47.8	so we have a base for the facility in the roof	Be-K	Be-K	Be-K
38		(draw lines)	S-K	S-K	S-K
39	3:45.2 - 3:57.2	so this maybe unclear, because I am thinking that how the building will be built	Be-K	N	Be-K
40		(draw lines)	S-K	S-K	S-K
41	3:54.2 - 4:02.8	so it is much clearer right now (rotate the model)	Bs-K	Bs-K	Bs-K
42	4:02.8 - 4:12.5	creating new division (draw lines)	S-K	S-K	S-K
43	4:09.1 - 4:34.4	but each of the divisions are going from here (draw lines)	S-K	S-K	S-K
44	4:33.2 - 4:39.6	so I am picking certain points to .. (connecting points)	S-K	S-K	S-K
45	4:36.2 - 4:48.1	so bake to the roof	S-K	N	S-K
46	4:45.2 - 4:51.0	(rotate the model)	Bs-K	Bs-K	Bs-K
47	4:48.2 - 5:01.7	so I guess the building could be huge here from this area (rotate the model)	Bs-K	Bs-K	Bs-K
48	5:00.2 - 5:07.3	so maybe I just move it, to here (move the shape)	S-K	Be-K	S-K
49	5:06.2 - 5:16.2	so this could be the parking, driving, include the car parking	F-K	F-K	F-K
50	5:12.2 - 5:23.2	so, moving to this part, say community centre building	Be-K	Be-K	Be-K
51	5:21.2 - 5:26.5	(move the curve)	S-K	S-K	S-K
52	5:24.2 - 5:27.3	(delete, and redraw the curve)	S-K	S-K	S-K
53	5:24.2 - 5:37.5	so basically, what I want, to protect the building is to consider (rotate the model)	Be-K	Be-K	Be-K
54	5:36.2 - 5:40.8	(rotate the model)	Bs-K	Bs-K	Bs-K
55	5:39.2 - 5:46.8	you know, when the water flows, it will towards the edges, it should not step into the building (rotate the model)	Be-K	Be-K	Be-K
56	5:45.1 - 5:51.6	so from this point, we will lift the height	S-K	S-K	S-K
57	5:48.1 - 5:57.1	so that the internal points will be higher and external will be lower	Bs-K	Be-K	Be-K
58	5:54.2 - 6:02.4	so we just need to take care of the water flow out	Be-K	Be-K	Be-K
59		(rotate the model)	Bs-K	Bs-K	Bs-K
60	6:00.2 - 6:10.5	so I will do some more sub-divisions (draw curve), I am not sure about what's happening here, just try (draw curve)	Be-K	S-K	S-K
61	6:12.2 - 6:40.6	(draw curve)	S-K	S-K	S-K
62	6:39.2 - 6:43.9	(rotate the model)	Bs-K	Bs-K	Bs-K
63	6:42.2 - 6:47.0	so now, we will lift the points (rotate the model)	S-K	S-K	S-K
64	6:45.2 - 6:55.1	first we want to increase the height of this part (draw the curve)	Be-K	S-K	S-K
65	7:03.2 - 7:12.2	so as you, client ask me to use the rhino as geometrical modelling tool	R-K	N	N
66		(draw the curve),	S-K	S-K	S-K
67	7:09.2 - 7:20.5	so this will be the boundary right now (rotate the model)	N	Bs-K	Bs-K

68	7:18.2 - 7:31.6	But the idea is that to create a ..Interesting rule not...there because after expending building there.	Be-K	Be-K	Be-K
69	7:30.2 - 7:39.8	And I guess I am not going to permit to use grasshopper, it's not going to be parametrically. (rotate the model)	R-K	N	N
70	7:36.2 - 7:54.2	(rotate the model)	Be-K	Bs-K	Bs-K
71	7:51.2 - 8:01.3	Now I am giving height, I change the ..(set origin plan)	S-K	S-K	S-K
72	8:00.1 - 8:06.7	and I choose surface (set surface planar)	S-K	Be-K	S-K
73	8:06.2 - 8:14.2	so now what height (rotate the model)	Be-K	Bs-K	Bs-K
74	8:12.2 - 8:16.9	Since it could be 3 metres? (rotate the model)	S-K	Bs-K	Bs-K
75	8:15.2 - 8:22.8	Going back to the brief, ok. 2.3-2.6c, the maximum is 6000 m, (read the brief)	R-K	R-K	R-K
76	8:27.2 - 8:29.6	do not want the maximum size, so (rotate the model)	Be-K	Be-K	Be-K
77	8:27.2 - 8:45.2	so, actually I .. 4.6-4.9, so external.	S-K	Bs-K	Bs-K
78		(draw curve at z direction)	S-K	S-K	S-K
79	8:42.2 - 8:55.0	(rotate the model)	Bs-K	Bs-K	Bs-K
80	8:54.2 - 9:10.9	So I am going to take.. 6.. (draw another curve at z direction), 9, kind of what I have done in grasshopper (draw another curve at z direction)	S-K	S-K	S-K
81	9:18.2 - 9:22.4	(delete the curve)	S-K	S-K	S-K
82	9:21.2 - 9:26.4	(redraw the curve)	S-K	S-K	S-K
83	9:24.2 - 9:29.1	(rotate the model)	Bs-K	Bs-K	Bs-K
84	9:27.2 - 9:34.4	(delete the curve)	S-K	S-K	S-K
85	9:33.2 - 9:36.6	(rotate the model)	Bs-K	Bs-K	Bs-K
86	9:33.2 - 9:43.9	(draw another curve at z direction)	S-K	S-K	S-K
87	9:42.1 - 9:50.4	(delete the curve)	S-K	S-K	S-K
88	9:48.2 - 9:55.4	(redraw the curve)	S-K	S-K	S-K
89	9:54.2 - 9:59.4	(rotate the model)	Bs-K	Bs-K	Bs-K
90	9:57.2 - 10:19.1	(draw another curve at z direction)	S-K	S-K	S-K
91	10:18.2 - 10:29.1	(rotate the model)	Bs-K	Bs-K	Bs-K
92	10:27.2 - 10:30.7	so I have those profiles now (rotate the model)	N	Bs-K	Bs-K
93	10:27.2 - 10:34.4	let's just see, I have to connect them to a triangle	Be-K	Be-K	Be-K
94	10:33.2 - 10:37.9	(rotate the model)	Bs-K	Bs-K	Bs-K
95	10:36.2 - 10:53.8	(connect points) actually it is really .. in grasshopper, I would get the id....	S-K	S-K	S-K
96	10:51.2 - 10:59.5	(rotate the model)	Bs-K	Bs-K	Bs-K
97	10:57.2 - 11:05.8	but we start doing that in more... and let's continue (connecting points)	S-K	S-K	S-K
98	11:03.2 -	(connecting points)	S-K	S-K	S-K

	11:24.0				
99	11:21.1 - 11:29.7	here we points towards to the centre (rotate the model), kinds of particular points comes to the edge,…is kind of omit the points (rotate the model)	Be-K	Bs-K	Be-K
100	11:42.2 - 11:49.6	(rotate the model) yes, can see some of them here generated has problem	Bs-K	Bs-K	Bs-K
101	11:48.2 - 11:53.6	(make the surface form curves)	S-K	S-K	S-K
102	11:51.2 - 11:56.1	(rotate the model)	Bs-K	Bs-K	Bs-K
103	11:54.1 - 12:05.1	(make the surface form curves)	S-K	S-K	S-K
104	12:03.2 - 12:08.2	it's really founded I suppose.. (rotate the model)	Bs-K	Bs-K	Bs-K
105	12:06.2 - 12:12.5	I am not thinking too much about the brief	N	R-K	N
106	12:09.2 - 12:16.5	(rotate the model) but what I imagine is that	Bs-K	Bs-K	Bs-K
107	12:15.2 - 12:22.0	this could be a bit more informal area for the community centre	F-K	F-K	F-K
108	12:21.2 - 12:27.2	and obviously could face this block (rotate the model)	Be-K	Be-K	Be-K
109	12:24.2 - 12:31.6	and it could be into outdoor activity space	F-K	F-K	F-K
110	12:30.2 - 12:34.3	so the entrance of the building would be through here	F-K	Be-K	F-K
111	12:33.2 - 12:39.3	And this would open up into informal space, and up there	Be-K	Be-K	Be-K
112	12:42.2 - 12:49.7	it's really built into this outdoor activity area open here and we could force here with pop-up... (rotate the model) so we can obviously deal with this surface and how it build down	Be-K	Bs-K	Be-K
113	12:57.2 - 13:04.6	but until it covered (make surface from curves)	S-K	S-K	S-K
114	13:09.2 - 13:17.8	So since . Look again, not adequate (rotate the model).	Bs-K	Bs-K	Bs-K
115	13:15.2 - 13:19.1	but interesting	Bs-K	Bs-K	Bs-K
116	13:18.2 - 13:23.3	and once we continue, ... (rotate the model)	N	Bs-K	Bs-K
117	13:21.2 - 13:26.4	so I'll cover this corner	S-K	Be-K	Be-K
118	13:24.2 - 13:31.0	(rotate the model) looks interesting	Bs-K	Bs-K	Bs-K
119	13:33.1 - 13:41.5	so I do not know for sure if I should complete further	N	N	N
120		(rotate the model)	Bs-K	Bs-K	Bs-K
121	13:39.2 - 13:44.9	I feel like it will be nice to leave it here	Be-K	N	Be-K
122	13:42.2 - 13:48.9	with small temporary out-house here	F-K	Be-K	Be-K
123		(connect points)	S-K	S-K	S-K
124	13:45.2 - 13:52.9	(rotate the model)	Bs-K	Bs-K	Bs-K
125	13:51.2 - 13:54.6	so I am going to give a height here	Be-K	Be-K	Be-K
126	13:51.2 - 13:58.0	3 metres (draw curve at z direction)	S-K	S-K	S-K
127	13:57.2 - 14:12.0	or 2.6 (redraw the curve)(connect points)	S-K	S-K	S-K
128	14:18.2 -	I'm obviously making façade, but it will give us a lot	Bs-K	Be-K	Bs-K

	14:30.9	of structure members that would internal families, may be that will give me façade			
129	14:27.2 - 14:35.2	(Rotate the model) so this becomes internal courtyard.	F-K	F-K	F-K
130	14:33.2 - 14:37.9	(rotate the model)	Bs-K	Bs-K	Bs-K
131	14:36.2 - 14:41.9	and this is the basic form of community centre (rotate the model)	Bs-K	F-K	Bs-K
132	14:39.1 - 14:47.8	I mean the roof and space, something like this (rotate the model)	F-K	Bs-K	Bs-K
133	14:45.2 - 14:59.6	and for the formal area, you know, I am thinking if I should continue, keeping everything in triangle manner or I wonder if I should keep it like this	Be-K	Be-K	Be-K
134	15:06.2 - 15:10.5	(draw curve)	S-K	S-K	S-K
135	15:09.2 - 15:15.4	this area becomes more usable	Bs-K	Bs-K	Bs-K
136	15:12.1 - 15:19.2	(revise the curve)	S-K	S-K	S-K
137	15:18.2 - 15:34.9	so merely I made this as 4 metres,	S-K	S-K	S-K
138		and here is corridor	F-K	F-K	F-K
139	15:33.2 - 15:46.5	another thing I need to do is to make this (draw curve)	S-K	S-K	S-K
140	15:45.1 - 15:53.7	10 metres (draw curve)	S-K	S-K	S-K
141	15:51.2 - 15:57.5	(Rotate the model), this is ..But it's really like a room, a corridor..	Bs-K	Bs-K	Bs-K
142	15:54.2 - 16:07.7	so I think I will exhibit more, make the corridor,	F-K	F-K	F-K
143	16:06.2 - 16:18.4	so I will set it to 12 metres (offset curve)	S-K	S-K	S-K
144	16:15.2 - 16:22.3	so we have this long room (rotate the model). It's long building block here	Bs-K	Bs-K	Bs-K
145	16:24.2 - 16:34.4	(delete curves)	S-K	S-K	S-K
146	16:33.2 - 16:41.4	so I do like such a form interactive strategy, I really have no mind of skip...	N	N	N
147	16:39.2 - 16:47.3	and this kind of structural support of roof, and I'm just trying to keep the.. of the form, and keep the scheme I want	Be-K	Be-K	Be-K
148	16:48.2 - 16:55.4	(rotate the model)	Bs-K	Bs-K	Bs-K
149	16:54.1 - 17:05.4	but it could be miss target because I have to work quickly without much reference,	Bs-K	N	N
150	17:12.2 - 17:19.9	(rotate the model) so here we have a block and it needs to be further deep	Be-K	Be-K	Be-K
151	17:18.2 - 17:30.0	this block is from this side, but it is obvious becomes the entrance	Be-K	Be-K	Be-K
152	17:30.0 - 17:37.4	so I feel it is a nice walking space,	Be-K	F-K	F-K
153		so this triangle will become the lobby space	F-K	F-K	F-K
154	17:36.2 - 17:41.4	here you can come and do some relax thing, and formally area	Be-K	Be-K	Be-K
155	17:45.2 - 18:06.2	so here we can have a this mediate area.	Be-K	F-K	F-K
156		(extrude)	S-K	S-K	S-K
157	18:03.1 - 18:07.7	(rotate the model)	Bs-K	Bs-K	Bs-K
158	18:06.2 - 18:11.0	I just put it randomly, but when you see the plan, this is obviously an irregular building, irregular walk	Be-K	Bs-K	Bs-K

159	18:18.2 - 18:27.4	this is kind of really ... exhibition area, community activity area (rotate the model)	F-K	F-K	F-K
160	18:24.2 - 18:31.7	(rotate the model.)	Bs-K	Bs-K	Bs-K
161	18:30.2 - 18:38.3	so keep the scheme that it is the heart of the community centre	Be-K	R-K	Be-K
162	18:36.1 - 18:41.7	what makes the community centre work, so we can see that there is air coming in, kind of open space, here in part of the site	Be-K	Be-K	Be-K
163	18:51.2 - 18:56.7	(rotate the model)	Bs-K	Bs-K	Bs-K
164	18:54.2 - 19:04.7	and now I am going to complete the columns of the building (rotate the model)	S-K	S-K	S-K
165	19:03.2 - 19:18.3	I guess I will make really huge one, of course we will make the structure of dependencies, like 20 metres (draw curves)	Be-K	S-K	S-K
166	19:18.2 - 19:21.7	I am going to divide these edges (rotate the model), divides these lines, and kind of cross lattices (rotate the model)	S-K	S-K	S-K
167	19:27.2 - 19:40.7	that support these roofs here, these polygon forms (rotate the model)	Be-K	Be-K	Be-K
168	19:39.1 - 19:42.6	(rotate the models)	Bs-K	Bs-K	Bs-K
169	19:39.1 - 19:57.3	so I will start to divide them, see how it goes.	S-K	S-K	S-K
170	19:54.2 - 19:59.0	50 metres	S-K	S-K	S-K
171	19:57.2 - 20:07.6	so I divide, 10 metres, so I divided as six (divide line)	Be-K	S-K	S-K
172	20:06.2 - 20:13.3	and all we need is this point	N	N	N
173	20:12.1 - 20:24.7	(divide the surface)	S-K	S-K	S-K
174	20:21.2 - 20:28.9	I would like to divide this curve, now I want to have a triangular structure support	Be-K	Be-K	Be-K
175	20:36.2 - 20:49.2	and I am going to divide it by 6 (divide curve)	S-K	S-K	S-K
176	20:48.1 - 21:13.2	so here we have 1, 2, 3, 4, 5, 6 (connect curves)	S-K	S-K	S-K
177	21:12.2 - 21:24.9	(rotate the model)	Bs-K	Bs-K	Bs-K
178	21:21.1 - 21:29.6	so I just want to take this triangular as reference, so basically, the system structure, or the structure support, obviously, right now, is based on dimension.	Be-K	Be-K	Be-K
179	21:42.2 - 21:51.1	these internal points, opening support, so (rotate the model)	Bs-K	Bs-K	Bs-K
180	21:48.2 - 21:58.7	to give it more realistic effect, I will pipe it, (pipe) with radius .5	S-K	S-K	S-K
181	22:12.2 - 22:20.7	(rotate the model) so this is the support we have	Bs-K	Bs-K	Bs-K
182	22:18.2 - 22:29.9	and I also want to put these edges pins (rotate the model)	Be-K	Be-K	Be-K
183	22:27.1 - 22:47.0	because... I know I need it (rotate the model)	Bs-K	Bs-K	Bs-K
184	22:45.2 - 22:55.5	so here if dinner shade come into hole	Be-K	Be-K	Be-K
185	22:54.2 - 23:03.1	under the roof, and (rotate the model)	S-K	Bs-K	S-K
186	23:00.2 - 23:06.4	sun grade this now	Bs-K	Be-K	Be-K
187	23:03.1 - 23:16.1	Yes, I divide this, 6. (divide curve)	S-K	S-K	S-K

188	23:15.2 - 23:18.7	Now it needs adjusting, because here has to be continue.	Be-K	Be-K	Be-K
189	23:15.2 - 23:29.4	So I have to take this line to this support, I guess too much.. to have right now	Be-K	Be-K	Be-K
190	23:27.2 - 23:31.8	(connect curves) to this support	S-K	S-K	S-K
191	23:30.2 - 23:41.8	now we have approximately structure members with distance of 10 metres	Bs-K	Bs-K	Bs-K
192	23:45.2 - 23:49.6	so this will be 10 metres, so I will divide it, (divide curve) two	S-K	S-K	S-K
193	24:00.2 - 24:07.6	(connect curves)	S-K	S-K	S-K
194	24:06.1 - 24:09.8	(rotate the model) ok	Bs-K	Bs-K	Bs-K
195	24:06.1 - 24:15.3	so here, need to divide it to 16 (connect curves)	S-K	S-K	S-K
196	24:12.2 - 24:20.4	and that's fit, (measure the distance)	Bs-K	Bs-K	Bs-K
197	24:18.2 - 24:33.6	ok, so again here, I have the counterpart to divided same to 15. (connect curves)	S-K	S-K	S-K
198	24:42.1 - 24:49.8	(rotate the model)	Bs-K	Bs-K	Bs-K
199	24:48.2 - 24:52.8	(delete curves)	S-K	S-K	S-K
200	24:51.2 - 25:02.0	now pick the points, so this is really form building (connect curves)	Be-K	S-K	S-K
201	25:00.2 - 25:11.3	just the look at the view of the building, and the space that keep for community centre (rotate the model)	Bs-K	Bs-K	Bs-K
202	25:09.2 - 25:25.8	we already got the sense of the space and the structure members we really get the sense of the space here, and look into here (rotate the model)	Bs-K	Bs-K	Bs-K
203	25:36.2 - 25:47.9	let's see now, we have this in site, (rotate the model)	Be-K	Bs-K	Bs-K
204		but of course we can't' keep the building transparent	Be-K	Be-K	Be-K
205	25:45.1 - 25:55.0	so I have to close some of these	Be-K	S-K	Be-K
206	25:54.2 - 26:12.2	some of them can be glass (rotate the model)	S-K	S-K	S-K
207	26:09.2 - 26:18.2	so keep the thick rigger, I'll keep the wide area between the wall into glass, the rest would be walls	S-K	S-K	S-K
208	26:21.1 - 26:27.5	so I can just use "close" I think	N	N	N
209	26:24.2 - 26:41.2	do it manually (close the surface)	S-K	S-K	S-K
210	26:41.2 - 26:46.2	ok, so basically this is the solid and this should be transparent	Bs-K	Be-K	Be-K
211	26:48.2 - 26:55.1	(rotate the model) so this kind of façade, kind of elevation to get in	Bs-K	Bs-K	Bs-K
212	26:54.1 - 27:07.2	and of course, these piped to 0.5 (pipe)	S-K	S-K	S-K
213	27:06.2 - 27:13.1	so quickly complete this (rotate the model)	Bs-K	Bs-K	Bs-K
214	27:12.2 - 27:19.3	I will just give it a shade (change to the shade interface)	N	N	N
215	27:18.2 - 27:28.4	so we can see the construction line, the roof close (rotate the model)	Bs-K	Bs-K	Bs-K
216	27:27.1 - 27:42.6	ok, maybe I should close this, give it new layer called glass (set new layer)	N	N	N
217	27:39.2 - 27:58.4	and that is transparent, colour (set properties of the layer)	S-K	Be-K	Be-K
218	27:57.2 - 28:10.9	edge close (close edges as surface), so it's going to make surface, with edge close (close again)	S-K	S-K	S-K

219	28:45.2 - 28:54.6	and I will put this into glass (change layers)	S-K	S-K	S-K
220	28:51.2 - 29:01.7	so let's see if there is any wrong here (zoom in, rotate the model)	Bs-K	Bs-K	Bs-K
221	29:21.2 - 29:33.5	I will just repeat it	Be-K	Be-K	Be-K
222	29:30.2 - 29:46.5	(delete surface)	S-K	S-K	S-K
223	29:45.2 - 30:11.8	I should lock, which close, surface.. I choose glass (as said)	S-K	S-K	S-K
224	30:09.2 - 30:27.1	so this is the main façade (rotate the model)	Bs-K	Bs-K	Bs-K
225	30:24.2 - 30:29.8	quickly finish up the model	N	N	N
226	30:27.2 - 31:02.6	I am building the form that can achieving, ...(make curve)	S-K	S-K	S-K
227	31:00.2 - 31:13.3	so I am trying to divide, actually have to pay attention to division now (divide curves)	S-K	S-K	S-K
228	31:12.2 - 31:17.8	(connect curves)	S-K	S-K	S-K
229	31:15.2 - 31:33.9	(rotate the model)	Bs-K	Bs-K	Bs-K
230	31:30.2 - 31:57.5	ok, (make surface from edges)	S-K	S-K	S-K
231	31:54.1 - 32:04.3	this need to be glass (change layer)	S-K	S-K	S-K
232	32:03.2 - 32:10.7	(rotate the model)	Bs-K	Bs-K	Bs-K
233	32:15.2 - 32:35.7	we create an elevation, the elevation is good, we have to go over there (rotate the model)	Bs-K	Bs-K	Bs-K
234	32:33.2 - 32:38.2	(change view)	N	N	N
235	32:36.2 - 32:46.4	(rotate the model)	Bs-K	Bs-K	Bs-K
236	32:45.2 - 33:05.5	I'm going to divide this, and (divide the curve)	S-K	S-K	S-K
237	33:03.1 - 33:36.7	(connect curves)	S-K	S-K	S-K
238	33:33.1 - 33:42.3	I want to see how it fits into the system element we have in the building	Be-K	Be-K	Be-K
239	33:39.2 - 33:47.6	(connect curves)	S-K	S-K	S-K
240	33:45.2 - 33:53.8	because it may lead to auctions.	Be-K	Bs-K	Bs-K
241	33:51.2 - 34:20.3	I will pipe these (pipe curves)	S-K	S-K	S-K
242	34:18.2 - 34:25.7	(rotate the model)	Bs-K	Bs-K	Bs-K
243	34:24.2 - 34:32.2	so this is the kind of façade we are going to decide (rotate the model)	Bs-K	Bs-K	Bs-K
244	34:30.2 - 34:41.7	so this produce part of the constructions is gravid face, (rotate the model)	Bs-K	Bs-K	Bs-K
245	35:06.2 - 35:40.5	(connect curves)	S-K	S-K	S-K
246	35:39.2 - 35:42.0	this is the height of human, so this is very large face (rotate the model)	Bs-K	Bs-K	Bs-K
247	35:39.2 - 35:49.4	so structure may give it actually theatre effect (rotate the model)	Bs-K	Bs-K	Bs-K
248	35:48.1 - 35:57.2	(rotate the model) I actually don't like that because I know that if it looks too large, the building would break the feeling (delete and rebuild the façade)	Bs-K	Bs-K	Bs-K
249	36:09.2 -	the roof is too large, and the façade is too flat	Bs-K	Bs-K	Bs-K

	36:15.1				
250		(delete surface)	S-K	S-K	S-K
251	36:12.2 - 36:28.6	so I think that could be something else (rotate the model)	Be-K	Be-K	Be-K
252	36:27.2 - 36:54.3	for façade, right now, for example, for these points, I can use it as a structure node	Be-K	Be-K	Be-K
253	36:51.2 - 37:03.6	and (connect curves)	S-K	S-K	S-K
254	37:00.2 - 37:09.2	(rotate the model)	Bs-K	Bs-K	Bs-K
255	37:06.2 - 37:30.3	(connect curves)	S-K	S-K	S-K
256	37:27.1 - 37:43.6	so these are kind of node we can use in the building	Bs-K	Bs-K	Bs-K
257	37:42.2 - 38:03.5	we find problems, but this is something block the view (rotate the model)	Bs-K	Bs-K	Bs-K
258	38:00.1 - 38:08.3	(delete the pipes)	S-K	S-K	S-K
259	38:06.2 - 38:12.8	but just I think the façade is not working, so (rotate the model)	Bs-K	Bs-K	Bs-K
260	38:09.2 - 38:15.6	so I need to remove it (delete pipes)	S-K	S-K	S-K
261	38:12.2 - 38:29.2	(rotate the model) and the roof is really 2 dimensional and it can't be so large form (rotate the model)	Bs-K	Bs-K	Bs-K
262	38:42.2 - 38:49.3	can create a large triangular, and look at the model which I do (rotate the model)	Bs-K	Bs-K	Bs-K
263	39:12.2 - 39:19.2	and façade, should be, have a bit shell nature or it just not as flat as it is now	Be-K	Be-K	Be-K
264	39:27.2 - 39:40.4	so what if I built a new structure for the triangles	Be-K	Be-K	Be-K
265	39:39.1 - 40:02.7	(make curves)	S-K	S-K	S-K
266	40:00.2 - 40:05.5	(rotate the model)	Bs-K	Bs-K	Bs-K
267	40:05.4 - 40:30.0	going to draw. (draw curve and pipe)	S-K	S-K	S-K
268	40:27.2 - 40:34.0	(rotate the model)	Bs-K	Bs-K	Bs-K
269	40:33.2 - 40:44.4	(make surface)	S-K	S-K	S-K
270	40:42.2 - 40:48.2	(rotate the model)	Bs-K	Bs-K	Bs-K
271	40:45.1 - 41:16.8	so this is glass (make surface and change layers) so this is the connection centre and actually this is the core area of the project, log to the area of the roof to the form (rotate the model)	Bs-K	F-K	F-K
272	41:27.2 - 41:38.2	it doesn't divide these. (rotate the model)	Bs-K	S-K	Bs-K
273	41:36.2 - 41:45.5	it's really get messy, I think (rotate the model)	Bs-K	Bs-K	Bs-K
274	41:42.2 - 41:54.8	this will be the way I make all the walls or the elevation	Be-K	Be-K	Be-K
275	41:51.2 - 41:59.6	(rotate the model)	Bs-K	Bs-K	Bs-K
276	41:57.2 - 42:04.2	and I will finish as much as possible, I don't have much time now, so	N-K	N-K	N-K
277	42:09.2 - 42:20.6	(connect curves)	S-K	S-K	S-K
278	42:18.2 - 42:30.7	(make surface)	S-K	S-K	S-K
279	42:27.1 - 42:35.6	(extrude)	S-K	S-K	S-K

280	42:33.2 - 42:39.6	extrude this direction (rotate the model)	S-K	S-K	S-K
281	42:36.2 - 43:07.0	(make surface)	S-K	S-K	S-K
282	43:06.2 - 43:10.7	(rotate the model)	Bs-K	Bs-K	Bs-K
283	43:09.2 - 43:13.5	(change view)	N	N	N
284	43:12.2 - 43:17.4	so this is the façade, I choose this façade to further (rotate the model)	Bs-K	Bs-K	Bs-K
285	43:51.2 - 44:02.1	I have to finish up two more sides, so that I have a complete face	N	Bs-K	Bs-K
286	44:00.2 - 44:13.4	the division is fine	Bs-K	Bs-K	Bs-K
287		(connect curves)	S-K	S-K	S-K
288	44:12.2 - 44:28.0	(make a surface)	S-K	S-K	S-K
289	44:27.2 - 44:30.7	(delete the surface)	S-K	S-K	S-K
290	44:27.2 - 44:37.6	(rotate the model)	Bs-K	Bs-K	Bs-K
291	44:36.2 - 44:57.9	(redraw the curves) try to get the points here	S-K	S-K	S-K
292	44:54.2 - 45:06.6	(make surface)	S-K	S-K	S-K
293	45:03.2 - 45:09.2	(rotate the model)	Bs-K	Bs-K	Bs-K
294	45:06.2 - 45:21.2	so this makes façade surface (extrude surface)	S-K	S-K	S-K
295	45:18.2 - 45:30.7	which actually should be here	N	Be-K	Be-K
296	45:27.2 - 45:52.0	and (make surfaces)	S-K	S-K	S-K
297	45:51.2 - 46:05.2	(change layers)	N	N	N
298	46:03.2 - 46:14.7	(rotate the model)	Bs-K	Bs-K	Bs-K
299	46:12.2 - 46:36.4	The building isn't complete, but I hope that you do understand what I want, and time is limited (rotate the model)	N	N	N
300	46:33.2 - 46:45.9	but in the shaded view, we will get a better idea (rotate the model)	Bs-K	Bs-K	Bs-K
301	46:42.2 - 46:50.6	the triangular form, and the logic behind it, (rotate the model) and just a quick review everything	Bs-K	N	N
302	46:54.1 - 49:33.3	(put text) administration	F-K	F-K	F-K
303	49:30.2 - 49:44.0	I imagine that the community centre would be here, administration	F-K	F-K	F-K
304	49:42.1 - 49:59.8	this becomes activity, it's the heart of community centre (put text)	F-K	F-K	F-K
305	49:57.2 - 50:17.8	and here we have outdoor activities (put text)	F-K	F-K	F-K
306	50:15.1 - 50:35.5	good to park this side, here we got parking (put text)	F-K	F-K	F-K
307	50:42.2 - 51:09.6	(rotate the model)	Bs-K	Bs-K	Bs-K

Appendix 5: Publications arising from this research

Refereed journal articles:

1. Rongrong Yu, Ning Gu, Michael Ostwald, John Gero (2014), Empirical support for problem-solution co-evolution in a parametric design environment, *Artificial intelligence for engineering design, analysis, and manufacturing (AIEDAM),* doi: 10.1017/S0890060414000316, Published online by Cambridge University Press 14 July 2014

2. Rongrong Yu, Ning Gu, Ju Hyun Lee (2013), Comparing designers' behaviour in responding to unexpected discoveries in parametric design environments and geometry modelling environments, *International Journal of Architectural Computing (IJAC)*, Vol.11, Issue 4, 393–414.

3. Rongrong Yu, Ning Gu, Michael Ostwald (2013). Comparing designers' problem-solving behaviour in a parametric design environment and a geometric modelling environment. *Buildings*, Vol. 3, 621–638.

4. Rongrong Yu, Ning Gu, Michael Ostwald (2012). Using situated FBS ontology to explore designers' patterns of behaviour in parametric environments, *Journal of Information Technology in Construction (ITcon),* Vol. 17, 271–282.

Refereed conference papers:

1. Rongrong Yu, John Gero, Ning Gu, (2014). Cognitive effects of using parametric modelling by practicing architects: a preliminary study, *Proceedings of the 19th International Conference on Computer-Aided Architectural Design Research in Asia (CAADRIA 2014),* Kyoto, Japan, 677-686.

2. Rongrong Yu, John Gero, Ning Gu (2013). Impact of using rule algorithms on designers' behaviour in a parametric design environment: Preliminary results from a pilot study, *Proceedings of the* 15^{th} *International Conference on Computer Aided Architectural Design Futures (CAAD Futures 2013),* Shanghai, China, 13–22.

3. Rongrong Yu, Ning Gu, Michael Ostwald (2013). A method for comparing designers' behaviour in two environments: parametric and geometric modelling, *Proceedings of the* 18^{th} *International Conference on Computer-Aided Architectural Design Research in Asia (CAADRIA 2013),* Singapore, 479–488.

4. Rongrong Yu, Ning Gu, Michael Ostwald (2012). Situated creativity inspired in parametric design environments, *Proceedings of the* 2^{nd} *International Conference on Design Creativity (ICDC 2012)*, Glasgow, UK, 221–230.

5. Rongrong Yu, Ning Gu, Michael Ostwald (2012). Explore patterns of human-computer interactions in parametric design environments, *Proceedings of the* 12^{th} *International Conference On Construction Applications Of Virtual Reality (CONVR 2012)*, Taipei, China, 212–222.

6. Rongrong Yu, Ning Gu, Michael Ostwald (2012). Using situated FBS ontology to explore designers' patterns of behaviour in parametric environments, *Proceedings of* 6^{th} *International Conference Of The Arab Society for Computer Aided Architectural Design (ASCAAD 2012)*, Manama, Kingdom of Bahrain, 23–32.