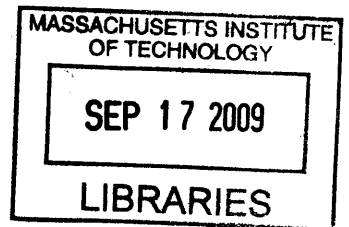


Knowledge Organization: Beichuan Middle School Architecture Design

by
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Knowledge Organization: Beichuan Middle School Architecture Design

Kanda Song

Abstract:

The thesis is comprised of two interrelated parts: the first part attempts to incorporate Design and Methodology into the framework of Knowledge Organization, tries to refine/redefine the workflow, and establishes a working model which represents/guides the process from the formation of ideas to the solutions of fabrication/construction using BIM. The second part further explore the meaning/connotation of Knowledge Organization, reconfigure the model and accordingly adjust the methods being used, considering the specific context and conditions at the earthquake area of Beichuan County in China.

Thesis Supervisor:

Tunney Lee, Professor Emeritus, Department of Urban Studies and Planning.

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Thank you my parents. You guide me all the time and give me confidence; share with me your happiness and everything.

Thank you Susan. You were with me all the time except the last minute; I owe you a lot and I hope you will be happy forever and ever.

Thanks to Tunney, you accepted my last minute request and all the time understands me; I am lucky to have such an advisor who gives me numerous advice not merely about the profession; they are from a senior who cordially shares his life experience.

Thanks to Xintong, although I am not very sure if it is you; I feel great these days with you. Thanks to all my friends. It is beyond my words to describe how I treasure all of you. But all the time my inspiration are from you. Thanks, again.

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[Chronology]

Timeline/Groups

2008.5.12

2008.7

2008.9.1

2008.9.6

2008.10.24

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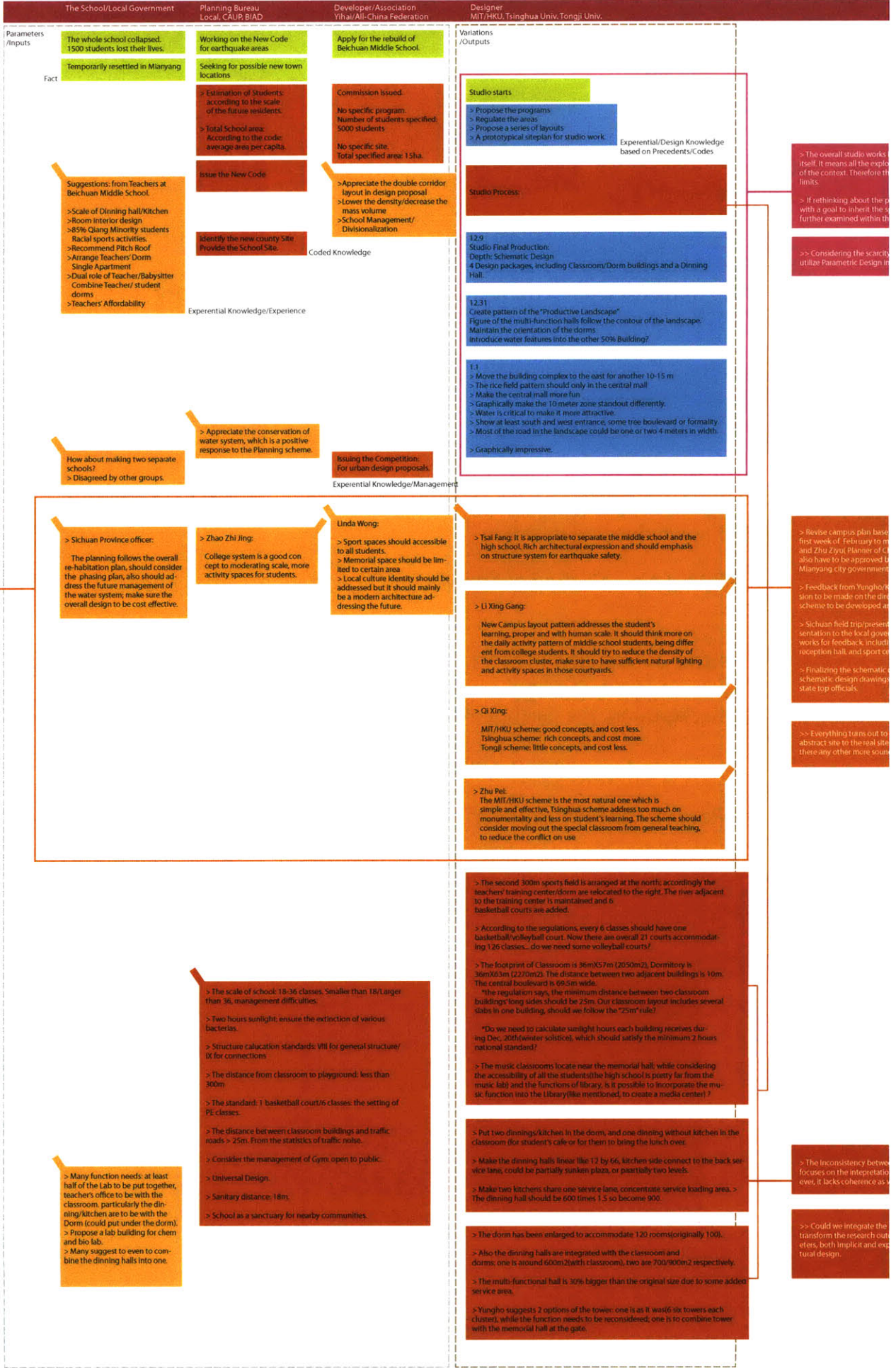
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2009.3.17



Field Trip to Beichuan: The First Review in Mianyang.

Yihai Group.
ACF (All China Federation)
MIT/HKU, Tsinghua Univ., Tongji Univ.
Beichuan Middle School.

The second Review in Shenzhen.

Yihai Group.
ACF
MIT/HKU, Tsinghua Univ., Tongji Univ.
Beichuan Middle School.

The third Review in Shenzhen.

Yihai Group.
ACF
China Academy of Urban Planning and Design
Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

China Architecture Design Institute
Qixin Design Office
THYF Design Group
Zhupei Design Studio.

The fourth Review in Beijing.

Yihai Group.
ACF.
Beijing Institute of Architecture/Design
Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

The Fifth Review in Beijing.

Yihai Group.
ACF.
Beijing Institute of Architecture/Design
Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

Foreword

Origin of the Thesis

The whole story started from last autumn, when I participated in the studio as a teaching assistant, helping Weijen Wang, who was in charge of the Beichuan studio. It was to build a middle school in Beichuan, one of the most ruined areas in Sichuan province during the earthquake. We received some funding from the developer and initiated the studio.

The studio ended at December and the project continued, I was working with Yungho Chang and Weijen on the further refinement of the scheme. It was a long and painful process and many institutions participated in this project. The whole process reflected the various interests of all sides, and more importantly, the issue of efficiency became a crucial factor when design process went on.

The Chronology on the right tells the overall process from the earthquake started in May last year until the time that the project was commissioned to BIAD finally in this April. I try to identify some problems that happen between stages; more importantly, the notion of Knowledge Organization is introduced to clarify the intellectual structure, and BIM/parametric tool is introduced trying to weave the gaps between stages.

Although either of the issues(Knowledge Organization and BIM/parametric tool) deserves a separate thesis to expatiate, this thesis focuses on the interrelationships between this two thoughts. . Literally the thesis is comprised of two chapters, one talks about theory and the other one talks about practice; one could always find a sub-issue in one chapter, and its counterpart in the other.

Established based on a virtual site, which is sound by variations and research are effective only with the premise these parameters and variations have a certain kind of prototypical study of the site, which has a clear structure and a part of a classical Virginia College pattern. It needs to be in a real context.

With the information of site and program, is it possible to discuss the prototypes?

Based on the scheme proposed and produce a report by the joint with ACF (All-China Federation of YH (Yihai Property), Tsinghua Academy of Urban Planning and Design). This may be related to the department of Sichuan Provincial and Land in their Beijing meeting on the master plan, decision of MIT classroom/dorms, among the four, which did how to handle the total 6 clusters?

Designation scheduled in mid-February: site visit, and preparation for the master plan and some schematic design of classroom and dormitory, library, administration, center.

Design of all buildings by the first week of March, submit to ACF/YH, ready for preparing the presentation to the developer.

It might be good. However, the direct interpretation from the might be fine considering the tense schedule. While is it a solution with the assistance of associative design?

In Studio works and real design: The phase after Feb 5th of the Codes and calculation of program areas. How well as efficiency when neglecting the previous research.

Research and practice with BIM tool? It will be used to come into Features, and therefore become the Parametric, which could be applied to the following architecture.

Intro: Knowledge Organization, Redundancy and Scarcity

What does it mean for Architecture Design when introducing Knowledge Organization as a tool, a method, or probably a possible solution? What will Knowledge Organization possibly bring to this design field, which seems to be the oldest and seemingly the slowest developed subject, when compared with the newest and seemingly the fastest developing category, Digital Technology?

One intriguing issue is, when the enterprises in Digital field positively seek a possible solution to accumulate their intellectual outcomes from numerous methods, finally they identify the Knowledge Organization/Management to strengthen both of their vertical and horizontal intellectual connections. However, in design fields there are few explorations related with the use of Knowledge Organization; the designers are still trying to solve their issues through some kinds of classical problem-solving sets. Until recently, when the BIM method was literally put into practice, the importance of Knowledge Organization is gradually acknowledged by architecture designers.

Therefore, the first topic the thesis addresses is how to apply the Knowledge Organization to design field. There will be a series of methods proposed to achieve this goal. And the design outcome that we achieve is presented, as I previously indicated in the title, in the form of "Redundancy."

Redundancy.

It is widely used in Information Theory, meaning that the number of bits used to transmit a message minus the number of bits of actual information in the message¹.

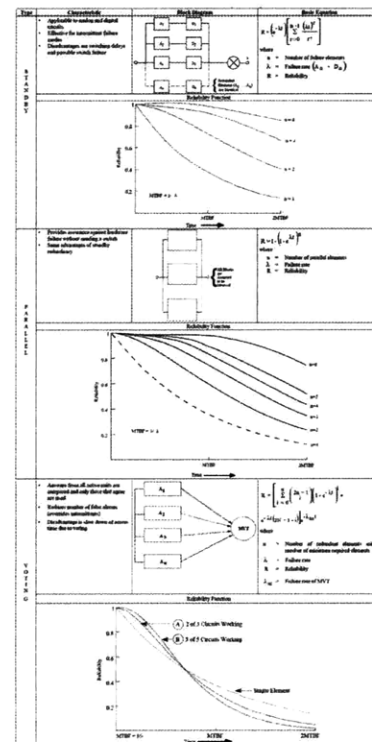


Fig 1.1 Three types of Redundancy creation in circuit design. [Source: Giarratano, J.C., & Riley, G. (2005).]

1. Giarratano, J.C., & Riley, G. (2005). Expert systems: principles and programming. Boston, Mass.: Thomson Course Technology.

Generally speaking, it is the amount of wasted “space” used to deliver certain amount of data. Data compression is a way to reduce the unnecessary redundancy. Redundancy provides a certain degree of tolerance, so that all or part of the data stored in the disks can be possibly recovered in case of disk failure.

In design field, it could signify different semantic meanings. And in different scenarios it refers to either positive or negative (neutral, sometimes) aspects. In the thesis “Redundancy” has a positive meaning, which refers to Experience Accumulation, Variations/Parameters, and Codes/Rules behind this whole data cloud.

Building Information Modeling (BIM)² might be one of the most appropriate ways to organize, and to illustrate this “Redundancy”. As from basic definition, it indicates “the process of generating and managing building data during its life cycle”. Typically it uses three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction. The process produces a rich-information model, which includes building geometry, spatial relationships, geographic information, and quantities and properties of building components.

Scarcity.

If without the real conditions in Beichuan County back to China, which is the ultimate focus of this thesis, BIM would be the most efficient and rational method to form the knowledge pool and manage the whole design/build process. However, the specific situation in the earthquake area produces some extremes, which become the huge obstacles to design and to the following building procedures: the scarcity of information.

Therefore, the second part of the thesis explores from two directions: one is trying to self aggregate the information/knowledge pool to achieve an appropriate de-



Fig 1.2 Present condition in beichuan County, China.
[Source: by author.]

2. Eastman, Charles M. (2008). BIM handbook :a guide to building information modeling for owners, managers, designers, engineers, and contractors. Hoboken, N.J. : Wiley.

gree of "Redundancy"; the other one is, as project goes on, information gradually fills the pool: the site information, possible budget, programs and suggestions from clients. Therefore it is crucial to test and accordingly to adjust the model so as to make it work in this extreme situation in Beichuan.

A practical limitation of the knowledge system nowadays is the trade-off of causal knowledge, which means the understanding of the underlying causes and effects in a specific field³. As comparing with organizing the system based on the structure, function and behavioral pattern of objects, it might be much easier to build that based on empirical knowledge. For example, it is much easier to program a knowledge system to prescribe an aspirin for a person's headache than to program that dealing with the underlying biochemical, physiological and anatomical knowledge about the human body. The programming of a causal model of the human body will be an enormous task and even if successful, the response time of the system would be probably extremely slow because of all the information that the system would have to process.

Similar to architectural design, it is literally as difficult as the prescription of aspirin to propose a solution based on the specific causal knowledge, meaning the underlying conditions that construct the context. However, it will be this thesis' aim to explore the possibility of creating such a model based on both the empirical and causal knowledge.

3. Giarratano, J.C., & Riley, G. (2005). Expert systems: principles and programming. Boston, Mass.: Thomson Course Technology.

Chapter 1

Redundancy: Knowledge Organization

1.1 Definition of Knowledge

The definition of knowledge is a literally an issue discussed among philosophers in the field of epistemology for a considerably long time. One of the classical definitions about the knowledge judgment is by Plato, indicating that if a subject matter needs to be considered as knowledge; at least three criteria must be achieved; this statement must be justified, true, and believed⁴. Though Plato's concept is challenged by many other scholars after him; many definitions of knowledge actually maintain the above three characteristics.

On the other hand in a very pragmatic view, knowledge is defined in the Oxford English Dictionary as:

1. Awareness or familiarity gained by experience of a fact or situation.
2. What is known in a particular field or in total; facts and information.
3. Expertise, and skills acquired by a person through experience or education;
4. The theoretical or practical understanding of a subject.

From the definition by Oxford English Dictionary, it is perceived that knowledge could be represented in a structural way in terms of its hierarchy⁵. As the diagram on the right shows, the Noise locates at the bottom level, meaning that this kind of information has no specific value for a given subject. Then above the Noise is data, which represents a series of facts more or less re-

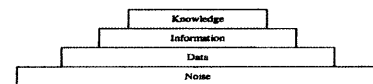


Fig 1.3 A structural illustration of knowledge hierarchy
[Source: Geisler, E. (2008).]

4. Geisler, E. (2008). Knowledge and knowledge systems: learning from the wonders of the mind. Hershey, PA : IGI Pub. Retrieved from MIT Libraries.

5. Definition retrieved from <http://www.oed.com/> on May 27th, 2009.

lated with the subject matter. It means that the degree of relevance determines the importance of data. On the next level of this pyramid is information, which means the data that has been filtered through a certain kind of mechanism. Then the specialized information, referred to as knowledge is the layer above information.

1.2 Knowledge Type.

The various connotations/extensions of knowledge make it really difficult to clearly define the categories of knowledge. To avoid debates, I start from a structural perspective, as we did in defining the knowledge hierarchy. Based on the information concepts defined by Boisot⁶, I am here trying to establish a semantic model including three kinds of knowledge types:

1. Experiential Knowledge.
2. Programmed Knowledge.
3. Theoretical Knowledge.

The first type, Experiential Knowledge originates from the status of differentiation. It starts from recognizing the situation based on the situation you have already been familiar with. This kind of knowledge could be explained that to some degree some of us have an acute sense of differences; they are sensitive observers, while others tend to overlook some of the details or neglect most differences while concentrating on the general characters. This kind of one-dimensional representation well emphasizes a kind of personal knowledge.

Experiential Knowledge is a kind of knowledge that is based on fact and physical existence: it means this knowledge cannot be normalized nor could it be coded, it is about people's experiences, and it can be shared only with those who had some same/similar experience before. Experiential Knowledge can be very generally defined, but also could be very detailed. Knowledge of

6. Boisot, M. (1995). *Information Space. A framework of learning in organizations, institutions and culture.* London: Routledge.

details is of course relative to what kind of academic/practical field it refers to, and to the knowledge about the domain of others types in the same category. Therefore a professional will be able to perceive more when looking at a certain phenomenon than an amateur will.

Based on the Experiential Knowledge, another type of knowledge emerges, which is a two-dimensional framework generated out of the relationship of differentiation and perception. This new dimension is the coded program, which requires semantic communication and reciprocally makes communication easier through the establishment of a common grammatical ground. The two-dimensional sign is related to a context, but it does not only refer to the context of a concrete state of affairs. The diffusion of the semantic web now takes place along the lines of a social community⁷. It is important to realize that two dimensions presuppose one dimension. Therefore, there must be the differentiation in perception that triggers this generative process, which makes the codes form. This means that one can discuss the codes without relating them to concrete facts. However, effective communication depends on a combination of facts and codes. It will be comparatively difficult to expatiate relying on either experience or codes.

Moreover, codes can be categorized by taking into account the number of Rules and Parameters that a code consists of, as well as the degree of Ambiguity allowed. Therefore, for instance, computational notation systems are more rigidly defined code than language systems. At the lower level of codification, codes have the tendency to turn into concrete experience. Therefore, in the use of images and metaphors, Programmed Knowledge comes closest to the non-coded concrete knowledge of the first type.

The third kind of knowledge, Theoretical Knowledge, emerges when a third dimension is introduced to the perceptual differentiations, which is that of the logical

7. Boisot, M. (1995). *Information Space. A framework of learning in organizations, institutions and culture*. London: Routledge.

or formal relations. Knowledge becomes theoretical when coded signs relate to the facts represented on the basis of structurally defined qualities/quantities. In the third type, knowledge becomes more abstract. Perception and Programmed Knowledge are extended with the aspect of structure. And also, Theoretical Knowledge makes intellectual diffusion much easier than Programmed Knowledge does as Theoretical Knowledge is not conventionally presented, but generally exists. Although codification is needed to communicate using Theoretical Knowledge, like a basic grammar; the Theoretical Knowledge goes beyond that: it never relies on historical facts and contexts; it is autonomous.

Similarly, there are numerous attempts trying to categorize Theoretical Knowledge. One such a differentiation is in terms of the levels of abstraction, which describes as followed: the more facts/instances/codes could be ascribed to a type of knowledge, the more abstract this knowledge is, such as the category of "Architecture", and that of "Building". Another proposal is the more complex the knowledge, the more abstract it is. In Jorna's thesis they developed a so called Knowledge Space for the different categories of knowledge⁷. All forms of Experiential Knowledge are on the horizontal axis. This knowledge is not yet coded, nor abstract, and ranges from the very global to the highly detailed. On a plane that contains this horizontal axis, we find Programmed Knowledge, which is not yet abstract. And in the three-dimensional volume, we find all kinds of Theoretical Knowledge, ranging from the concrete to the highly abstract. Again, as Theoretical Knowledge supports coding and Experiential Knowledge, the plane and axis are also involved in the theoretical dimension, which is the pervasive Volume.

7. Jorna, R.J. (1998). Knowledge management really is about representations. *The Semiotic Review of Books* 9.2 : 5-8.

1.3 Knowledge Organization

1.3.1 Style as the Formal Structure

Style started to be acknowledged since Renaissance. At that time it was gradually developed into a conscious system of design, and a visual code of knowledge based on tectonic preferences and structural choices. However, before that the style progression, or say, the evolution pattern of knowledge code was basically linear: one style followed another over the centuries then was taken the place by another. However, with the awareness of the romantic attitudes (the appreciation of picturesque values), and the accumulation of architectural archaeology that enriches the available choices, the notion of “styles” gradually take the place of “the style.”

However, the organization of knowledge during that time is not always systematically organized. An extreme instance is the Sir John Soane’s Commissioners’ Churches, which is entirely about the styles: It is a pure model of classical knowledge without consideration of function: the choice of styles tended to settle down on typological grounds: Gothic for churches, Greek for art galleries, Renaissance for banks and insurance offices, Romanesque for Jails, Tudor for schools and almshouses – and any styles of these for villas. As Thomas Hopper put it in 1830, “it is the business of an architect to understand all styles, and to be prejudiced in favor of none.”⁸

Moreover, the producer of the drawing of Commissioners’ Churches, who is also an advocator of Sir John Soane, J.M. Gandy, adopted a similarly eclectic viewpoint. Imitation as he announced as “unworthy of modern genius.” He explains, “A comprehensive mind will select from all styles”; “we moderns must prepare a system selected from all tastes ... from the beauties of every climate and



Fig 1.4 Sir John Soane’s commissioners’ churches by Gandy. [Source: Crook, J. M. (1987)]

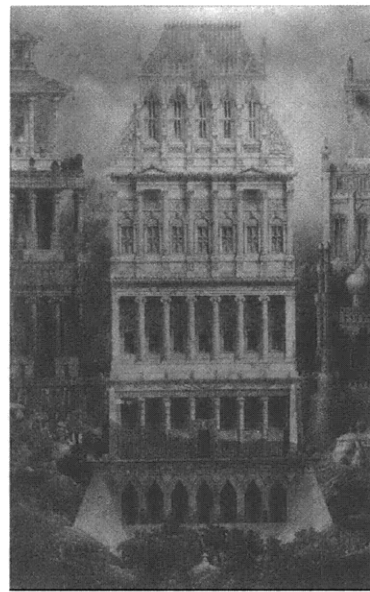


Fig 1.5 Gandy’s work, “Comparative Architecture”. [Source: Crook, J. M. (1987)]

8. Crook, J. M. (1987). The dilemma of style: architectural ideas from the picturesque to the post-modern. London: Murray.

every age." This kind of assertion led him to an atmosphere of fantasy. Moreover, as Gandy believed, there must be some explanation of the connection between the styles and culture. Without it there could be no clue to find a so-called "architectural philosopher's stone": a new style for a new age. In his work, "Comparative Architecture", he tried to decode the styles by juxtaposition of all the previous prominent styles: it is more like a diagrammatic analysis than a illustration about the styles. In fact, Gandy was attempting to find a future in the past, to trace the symbolism effect of architectural form back to its origin, which could be illustrated by "Architecture: its natural model" in 1838. He called the basic elements from the primeval time as "the protocol of architecture", from which "a symbolic system will emerge... perfect, durable and universal." However, some of Gandy's villa designs did exhibit a kind of unusual modernity, which more of less responds to the styles of the modernists around 1930s. But as many of his peers, Gandy was confined by the romantic sense and the "protocols", by means of which his production at most was a mimic, rather than a real creation stemmed from the classic styles.

When the industrial revolution significantly changed people's life styles, and also the ways the architecture being built and presented, there was once an interesting question posed: can skyscrapers or railway stations be made beautiful? It was raised in 1925, around when the modernity of architecture became gradually accepted and popular. The question itself actually contains a negative assumption of debasing the aesthetic value of the modern architecture. There are two answers to the question. One is to build the industrial structures in such a way that they fit into the received categories of beauty; the other one is to reconfigure the criteria so as to make them fit the skyscrapers and railway stations. And literally the latter solution is pursued by the modernists. When Nikolaus Pevsner's *Pioneers of the Modern Movement*, from William Morris to Gropius published in 1936,

it concluded that the modern movement as an evolving aesthetic process from Arts and Crafts to Bauhaus – from the ethics of Gothic Revival to the awareness of the International Style¹⁰. Then, the “Styles” merged into “A Style”, but the connotation of international style conveys much more meaning than its predecessors.

1.3.2 Collaboration as Architecture of Knowledge Organization

One important issue about organizational forms/ collaboration indicates entities’ coordination, cooperation and the architecture of Knowledge Organizations. It is not mainly about the primary process within the organization. Primary processes are about what an organization manufactures. Examples are hospitals that in treating and curing patients produce health or manufacturing industries that produce, for example, automobiles or other industrial assemblies. Specialized knowledge, most of the time including a combination of Experiential, Programmed and Theoretical Knowledge of the respective domains is needed for the operation of the primary processes. The way these primary processes are structured and interrelated focuses on the organizational formulation, as the secondary process, which is also called intellectual cooperation.

Organizational processes in collaboration can be categorized by their differentiated goals and tasks. All the tasks are executed by groups in terms of knowledge contents and types. The reason to combine various organizational forms is not to explore the content of the tasks; but in the types of knowledge that can be identified. Although in practice all types of knowledge exist in every group, it is very probable that one type is the dominant type comparing with the other knowledge types on a given task.

The core question is how organizational forms fit to the

10. Pevsner, Nikolaus. (2005). *Pioneers of modern design: from William Morris to Walter Gropius*. New Haven, Conn.; London: Yale University Press.

distributions and dominance of types of knowledge. In following paragraphs the combinations of dominant knowledge type and organizational form are presented. The combinations are not the result of empirical research. They are the result of analytical reasoning and could be reformulated according to various situations. From Family Bond to Market.

A Family Bond consists of a limited group of members that cooperate on the basis of trust, bonded by family or very close friendship relations. Boisot¹¹ says that the mechanism of Family Bond is built on limited-size transactions on the basis of shared experiential knowledge and values. These values are implicit and well-known by these members, but most of the time they are very difficult to be synthesized. Family Bonds often are small and local, which means that different Family Bonds have different interpretations of what a certain core values mean. If a Family Bond is large in terms of its size, it normally consists of sub-clans, because of the nature of its physical presence and definition. The organizational process, rooted in trust and relationships, does not work in general relations. This does not mean that Family Bonds do not use Programmed Knowledge, but the interpretation of the code is somehow determined by knowledge of the experiential type. Theoretical Knowledge is seldom used here.

The Division Bond is only structure where experiential and programmed knowledge are dominant and Theoretical Knowledge is on the secondary level. Often within the larger organization divisions are formed that operate mainly independently, but also have to communicate with the other divisions. The organizational process to coordinate, cooperate and communicate is by means of rules and procedures that often are available and used in coded form. As the divisions belong to a larger organization and because the coordination within the division requires personal knowledge, Experiential Knowledge will be frequently adopted if individual divisions are

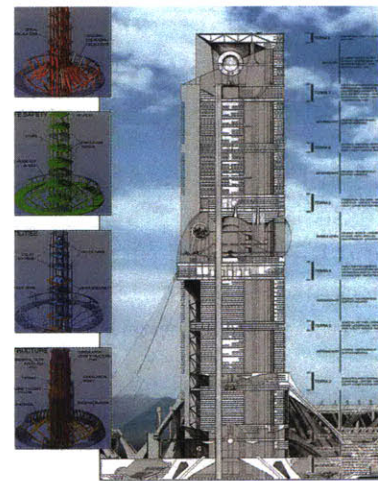


Fig 1.6 Theoretical research on BIM: 100k residents hyperbuilding [Source: Eastman, Charles M. (2008).]

11. Boisot, M. (1995). Information Space. A framework of learning in organizations, institutions and culture. London: Routledge.

more independent with each other.

Machinery Bond is a very good example of using Programmed Knowledge as a dominant type. Machinery Bonds are characterized by their self-motivated search for procedures, guidelines and scripts. Everything within the organizational process has to be coded. Experiential Knowledge is most of the time avoided in the operations. Theoretical Knowledge is also rare, because the rules are always self-evident. From the manufacturing industry we could easily identify the instances of the Machinery Bond.

In a Professional Bond, the fundamentals consist of highly trained and well-specialized expertise. It means that the organizational processes of coordination, control and planning are executed in close relation to the internal structure of the professions. Coded and Theoretical Knowledge are dominant here. The knowledge they use is coded in the way that it is represented and documented in rules, procedures and scripts. Examples of these organizations are hospitals and university labs in certain fields. Moreover, in design realm most of the offices follow the pattern of Professional Bond.

A Market Bond is characterized by many types of organizations. The kind of relation as an organizational process is achieved by means of an “invisible hand”, defined by Adam Smith in Book IV of *The Wealth of Nations*. The interaction is based on the competition among each other. In theory the organizations are said to be equally treated and considered, but literally they are very different in terms of their knowledge background. Therefore the differentiation register the different treatments from other organizations. Because these organizations are so diversified in reality, it implies that an organization with much Experiential Knowledge will probably competes with an organization with much coded and Theoretical Knowledge; and that two organizations with both dominant Programmed Knowledge may compete with one another. It also explains the complexity of market situations. One could also define a Market in this way: a dy-

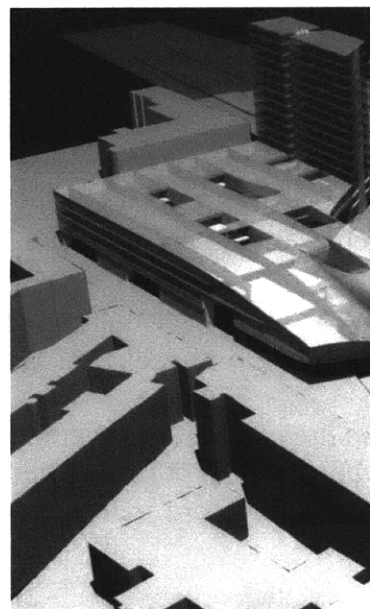


Fig 1.7 Arnhem Central. UN Studio. 1996-2010.

[Source: Berkel, B. V, & Bos, C. (2002)]

dynamic structure without the dominance of any kind of knowledge. It is a practical model that no certain knowledge type could perform independently;

1.4 BIM: A New Method of Knowledge Organization

“Traditionally” speaking, Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle. A basic premise of BIM is collaboration by different knowledge groups at different phases of the life cycle of a facility to insert, extract, update or modify information/knowledge in BIM to support and reflect the roles of the groups. BIM is a shared digital representation founded on open standards for interoperability¹².

In this context, BIM is a kind of tool trying to manipulate both formal structure, meaning the Style of the architecture; and the Collaborations between different knowledge groups. It characterizes with the coverage of an entire life cycle of a project. So how BIM successfully achieve the management of different knowledge systems, and finally integrate them together?

1.4.1 A Experiential Knowledge Accumulation: Formation of A Virtual Model

An architectural competition entry in design-build is more about a set of principles than it is about saying, “this is the building you are going to get.”

---- *Richard Keating*

1.4.1.1 Panel Discussions

BIM is not only dealing with high-end technology; one valuable technique being used frequently is panel discussion – a brainstorming among the members of the designers, builders, facility managers, users and owner representatives – all are from the participating knowledge organizations. These meetings will help to define what their preferences are about the current situation as well as their desire for the future scheme. After these face-to-face meetings, the project team organizes and prioritizes what they have learned into a comprehensive, while draft, visioning document¹³.

1.4.1.2 Project statements/Questionnaires

Outcomes produced in panel discussions can help the project team develop objective statements, which may include performance requirements of the building, completion date, decision making criteria, and the relative priority of cost, schedule and quality. It can be used to generate a project definition that leads to a specific set of design criteria. Moreover, some practitioners use project questionnaires to help to shape the project's vision. It is especially useful when the situation is complicated and the owner/users do not have a clear definition, and the practitioners will help to build a shared vision of the project. In Beichuan project we also adopted this method to retrieve useful information from teachers and students.

1.4.1.3 Stories

Another tool frequently used to capture the inner value of the project is to use stories describing the very idea. It is also well known as use cases or scenarios. Stories are about what the future users will probably do in the building. They could help establish a clear vision that can guide decision making as the design process proceeds. "We often use means like storytelling for projecting how the building might be used." Ben Van Berkel says, "They



Fig 1.8 Arnhem Central. Underground Car Park. UN Studio. 1996-2010. [Source: Berkel, B. V., & Bos, C. (2002)]

13. Elvin, G. (2007). Integrated practice in architecture: mastering design-build, fast-track, and building information modeling. Hoboken, N.J. : John Wiley & Sons.

are not fictions, but describe somewhat you will experience if you are in the building. It is a kind of test, almost as if you were to virtually go through the project and see what you might discover.”¹⁴

“When she reached the bottom of the garage the red car was not there. Slowly Diouma circled the vast, columnless floor, but the three aisles, separated by long, gradient walls, were largely vacant. She left her own car in an empty space in Section 45 and went out. She dashed to the nearest exit and found herself in a huge shaft, vibrant with daylight. There was no one there. She took the lift up to the next floor. Her heart was pounding as she scanned the floor. Once more the space was deserted. She ran to the other side of the building, passing the rough, rocky walls she had seen in her sleep. The crumbly and stony walls seemed incongruous in this land of clay and sand.”¹⁵

Panel discussions, objective statements/questionnaires and stories are used to form a virtual knowledge model before the design part actually starts, help to identify a clear and shared vision for the project. As for BIM, these methods are extremely important as ways to initiate the whole design process.

1.4.2 Create Coded Method of Knowledge Organization

1.4.2.1 Variations.

Le Corbusier once said, “There is no work of art without a system.” Any design process relies on multiple sets of rules but generally no single sets is in a governing position until the designer makes the final judgment decide which one is dominant. Therefore, an architect is always confronting the situation requires him develop sets of

14. Berkel, B. V, & Bos, C. (2002). UN Studio UN fold. Rotterdam: NAI Publishers.

15. Ibid.

rules. These rules could be subjective or objective, may take advantage of a certain kinds of spatial configurations, obey some performance criteria, or purely follow their own aesthetic tastes. Moreover, the use of rules and the way these rules are built, together with the implementations of constraints define the Variations of design. Variations play a crucial role in providing Redundancy to a design.

It is important to examine different types of variations, on which we could identify four methods when dealing with the notions of variations. The first method starts by examining the case of blind variations that are independent from each other. The incompatibility of the strategy is obvious as it lacks the essential coherence. In the trial and error strategy the variations are responsive to the errors but these are not essentially consciously made. This would result in a kind of changeable results to narrow the solution set. The insight strategy provides more consciousness exploring the goal and trying to understand the depth of the problem. By exploring variations more systematically it could be anticipated to find a way of understanding. The last strategy, while the most efficient one is the gradual Analysis, which equips the designer with a clear understanding. It assists to identify how to tune the variations so as to achieve a goal and to be consistent in the exploration.

Another case illustrates the method used to examine the variations, which is, the eleven lithographic drawings of bulls by Pablo Picasso from 1945-1946¹⁶. The sequential drawings illustrate a series of transformations from realistic figure of a bull to abstract outcome in the end. Actually, the variations in early stages of an architectural design can be most of the time, ascribed to the Insight strategy is because architects do not exactly know where they are, what the outcome will be, although the search is completed systematically by addressing various problems more or less related to the

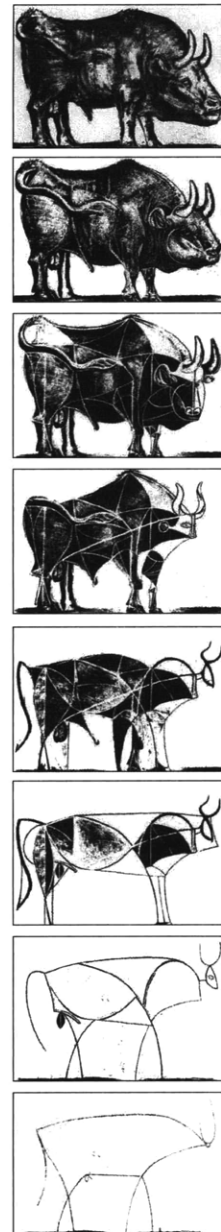


Fig 1.9 Bulls. by Pablo Picasso.1945-1946
[Source: Rubin, W. (ed). (1980)]

16. Rubin, W. (ed). (1980). Pablo Picasso, a retrospective. New York : Museum of Modern Art ; Boston : distributed by New York Graphic Society.

core issue. Similarly, Picasso's method kind of balances between the insight and gradual analysis, though closer to the latter, as he intentionally simplify the figure into an abstract representation. Furthermore, his process indicates an apparent understanding and consistency of the necessary modifications to achieve his goal.

Variations are crucial for the retrieval of complexity; however, variations alone are not enough to support complexity, as Variations at the same time create Ambiguity. It also indicates that the work of a designer towards a goal is not entirely under control, which actually is a process that can generate irregularity, especially in nowadays digital period, as in contrast, in a traditional sense the use of tools should be fully controlled by designers. But more recent developments point to a new direction, in which the designer depends on his own tool, generally digital that acts as codesigner, assisting in extending the solution set. In such "collaboration" the human designer will simply synthesize the outcomes generated by the digital system with his own thought that will give initial direction to the system to generate design Variations. Therefore, an obviously important question is, how to define the degree of the ambiguity in order to make it produce "Redundancy" or "Variations", rather than obstructing the design process?

The meaning of ambiguity is actually very vague is this situation. In the definitions related to ambiguity, one that is provided by Oxford English Dictionary says, "unclearness by virtue of having more than one meaning". Moreover, Jastrow's Duck-Rabbit perception model proves that the human brain tends to pursue new understandings after becoming familiar with an initial image. In the same way, the ambiguity in design supports complexity through allowing the reading of multiple meanings. Robert Venturi identified various examples in his *Complexity and Contradiction in Architecture*, as he questioned the Luigi Moretti's Casa il Girasole in Rome that if this is a building that is cut into two pieces, or the

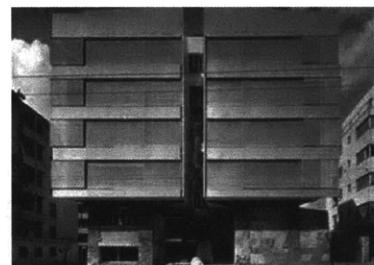


Fig 1.10 Luigi Moretti's Casa il Girasole. Rome. 1947-1950.
[Source: Venturi, R.(1977)]

one that is comprised of two parts joined together. And the sharp contrast between the simplicity of the façade and the complexity of the interior – they both signify the “richness of meaning.”

Parameters are critical for the rules to operate and accordingly for the Variations to be possibly achieved. They are the building blocks of any design, physical or virtual. So parameters can be formulated as any factors that define a system and determine its performance. These can vary from a set of measurable factors, such as temperature, pressure, distance and etc. to a set of non figurative measures like an individual’s state of emotion (i.e. Happiness and sadness) or the aesthetics of an object. But my investigation of parameters will be limited to the context of design.

1.4.2.2 Implicit parameters

Uses of implicit parameters can result in ambiguity of meaning as later they will be opened to discussions and interpretations. When designing with these parameters one can obtain most freedom simply because the design process is less constrained when using the same parameters to obtain various emerging results. “Mies, for instance, makes wonderful buildings only because he ignores many aspects of a building. If he solved more problems, his buildings would be far less potent.” Or continuing building from the idea in this Paul Rudolph’s comment, if using parameters with explicit meaning the resulting designs will be of a totally different nature because of the way parameters affect the execution of rules.

Piet Mondrian’s color composition offers a parameterizational image through an abstract visual pattern, characterized as the shape/color grammar. Mondrian’s paintings, generated by a set of rules, embody a cluster of meanings. This concept was applied to various forms of art like painting, sculpture, architecture, furniture and interiors. The designer was the one to set the rules and regulations for parameters employed to portray an inner working of color, form and meaning. The application of

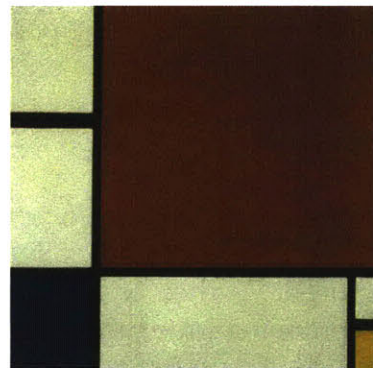


Fig 1.11 Piet Mondrian, Composition II in Red, Blue, and Yellow, 1930.

[Source: Wikipedia. Retrieve on May 17th, 2009]

implicit parameters gives the definition of a scenario at a macro level. The execution on details has been left to the designer's own desire, making the interpretation of the abstract parameters ambiguous.

1.4.2.3 Explicit parameters

Explicit parameters are normally used in design. These factors are favored by designers because of the clarity and predictability of the resulting variations in the developed outcome. Although artificial manipulations are limited; the result is clearer and easier to understand."Unless a certain kinds of fluid relationships are established among them, the explicit parameters that the designer utilizes will not have full control over the evolution of a parametrically defined design.

The concept of parameters in design is quite traditional in terms of the notion being appreciated. In ancient times the idea about proportions and exactly, the parameters of scale was established by Egyptians, using grids to introduce the basic module to achieve satisfying human scales. Also, a common grid helps to collaborate different people together working on one piece of work. And it is because of this grid that the proportion of people maintain the same since the grid was first adopted in drawings. Therefore, the discipline of design is somehow established by introducing the grid. And the parametrization is gradually developed based on that. More importantly, it helps to define a rigorous use of orders and rules of scale and proportions, which became the foundation of the Western architecture, until present time.

The parameters above actually all about dimensional factors, meaning they all refer to length, width, height, and etc. As they are the fundamentals for a grid. However, many other dimensions are introduced to make the design and evaluation more rich. However, the basic principle that all the explicit parameters follow is, no matter how simple one factor is, it must possess a certain degree of precision. Hence the manipulation of parameters whether for analysis or design suggests a meaning-

ful process of inquiry into the solution space. However, an architectural design process is very much non-unidirectional, which permits a loosely-defined knowledge cluster of parameters to create and conceive architecture. The ability to bring reasoned rigor in an architectural design process through the means of processes or methods of manipulating parameters harmoniously will significantly impact the contemporary architectural practice.

1.4.3 Establish Design Redundancy: Creating Parametric Model

Parametric models could have roughly two categories: Implicit model and Explicit model¹⁸. An implicit model refer to the kind of modeling process that uses geometries with fixed values, or collapsed attributes, which result that the re-model process has to erase some of all the construction components. Most of the models under the Rhino and 3Dmax environment belong to this category. On the opposite, the Explicit model tells the interrelationships of the components in the model. The components have pre-defined parameters and could be changed later. Because of the defined relations and constraints, one change on any one of the components may result possible parametric changes of the others. Therefore, through the basic parametric definitions and set rules/constraints, the integrity of the whole model is maintained. Many industrial enterprises have adopted this kind of tool to develop their products, such as Audi and Boeing.

Parametric Design is the process of designing with Parametric Models in a setting and/or environment where variations are produced, therefore replacing the singularity with multiplicity in the design process. A Parametric Model is a three-dimensional computer representation of a design, constructed with geometrical sets of shapes

18. Eastman, Charles M. (2008). BIM handbook :a guide to building information modeling for owners, managers, designers, engineers, and contractors. Hoboken, N.J. : Wiley.

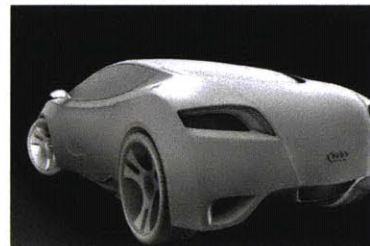


Fig 1.12 Audi Locus Concept. Shaded 3D model.

[Source: <http://www.carbodydesign.com/>. Retrieve on May 18th, 2009]

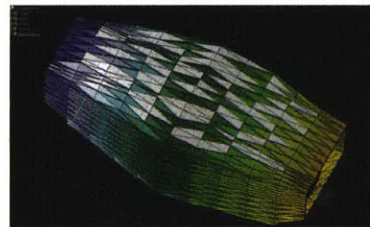


Fig 1.13/14 MOS. Puppet Theatre.

[Source: <http://www.mos-office.net/> Retrieve on May 18th, 2009]

that have the parameters that are explicit. The designer changes the parameters in the parametric model to search for different alternative solutions to the problem at hand, and the model responds to the changes by reshaping itself to the new values of the parameters.

Each of the design variations obtained from this kind of design manipulations is explicit and unique, since it represents a definite value or sets of values of the parameters at a specific point in the design. The following illustration shows different variations of design based on the given parameters from the original parametric model. The variations are laid out in a progressive pattern showing the evolution of the idea and the design itself. As the illustration on the right by Mos shows.

More importantly, the idea behind a parametric variation model is that the geometrical components are controlled by means of changing the values of the parameters or constraints without changing the amount of the components and the basic structural organization of the model. However, sometimes it is essential to add/subtract one or more components from the original model to adapt to the changing requirements.

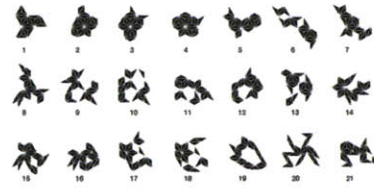


Fig 1.15 MOS. Design variations.
Soft Cell.

[Source: <http://www.mos-office.net/> Retrieve on May 18th, 2009]

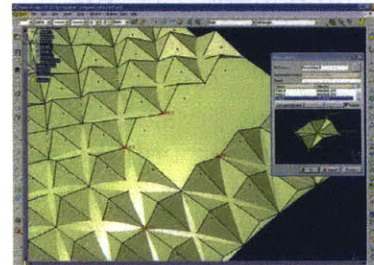


Fig 1.16 Variations study of Yokohama International Port Terminal. FOA.

[Source: <http://www.f-o-a.net> Retrieve on May 21th, 2009]

Chapter 2 Scarcity: In Beichuan

2.1 Background: the Earthquake

On May 12nd, 2008, a devastating earthquake measured 8.0 Ms scale, with an epicenter ninety kilometers north-west of the city of Chengdu, hit the central and northern portion of the Sichuan province, China¹⁹. It took away ninety thousand people's lives, causing over forty millions of populations homeless, and damaging cities and villages covering area over one hundred thousand square kilo-meters. Among the magnitude of disasters, seven thousand school buildings had collapsed and nearly five thousand school children lost their lives.

Beichuan is among the most severely hit of all disaster regions following the earthquake, including the Beichuan School campus, where more than 1,000 students lost their lives after two main buildings collapsed. Approximately 80% of the county's buildings have collapsed²⁰.

The earthquake also caused a landslide on Mount Tangjia which dammed the Jian River and created the Tangjiashan Quake Lake. The lake was once in danger of causing the Tangjiashan Dam to collapse and catastrophically flood downstream communities, totalling over a million persons. On June 10, 2008, the lake spilled through an artificially constructed sluice channel and flooded the evacuated town. No casualties were caused.

The original Beichuan County, which prior to the earthquake had a population of 20,000, is to be made into a memorial park, as the site has been considered to be too vulnerable. The survivors of the quake have been relocated.

19. Weijen, W. (2008). Beichuan Studio Report. Department of Architecture, MIT.

20. Ibid.



Fig 2.1 The ruins of Beichuan Middle School after earthquake on May 12nd.

[Source: <http://hi.baidu.com> Retrieve on Sep 5th, 2008]

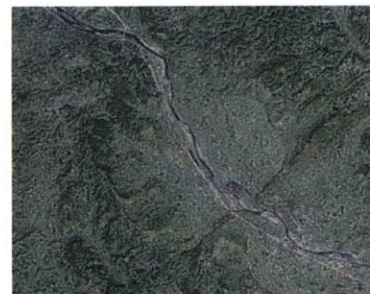


Fig 2.2 Above: site visit in November. Looking at the aerial view provided by local planning bureau.

Below: the aerial view of the area specified for the new county.

[Source: photo and aerial map by local planning bureau]

Beichuan was at the center of one of two zones, where seismic intensity was the highest at XI during this earthquake and its aftershocks. Since the earthquake, the central government has increased fortification intensity for seismic design for the old county town from VI to VIII.

2.2 Revision: From 2008.9 to 2008.12

2.2.1 Undetermined Context

If a site for a specific building or a cluster of buildings is fixed, there is always an assumption underlying this given condition: the context surrounding the site is, to some degree fixed. In most of the situations, there are three contextual scenarios to describe this kind of Determined Context: the one delineates a complex urban setting, depicting a site located somewhere among the differentiated architectural uses/infrastructures/facilities. The other one describes the site without any adjacent built environment, sometimes merely a certain types of infrastructures such as railways and roads. The third one describes the situation between the urbanized context and the second one, which is the context without any context. One of the examples is a piece of land in the suburbia.

Unfortunately, the site for the future Beichuan Middle school does not belong to any aforementioned category. The county was completely destroyed and the general planning is working under progress; until January next year the final scheme will be completely developed. It means the whole work will be initiated without a specific context. We are facing the situation of an Undetermined Context.

2.2.2 Unfinished Program

The new Beichuan County will be resettled and enlarged, which means the original scale of the school could not satisfy the future needs, in terms of the amount of chil-

dren qualified to go to schools. Therefore, the local planning bureau calculated the number based on a estimated amount of future residents living in this area, and the result is two times of it present scale, which is 5000 students.

It will be crucial to compare some precedents with the school that we are proposing. As a 5000-student campus will be considerably huge and the management will become extremely difficult as, for example, some specific areas will be periodically densely occupied that will cause the traffic issues.

2.2.3 Meaningless Budget

The total budget for the building construction is RMB 250,000,000, which is estimated by ACF(All-China Federation). The budget mostly comes from the donation of the oversea Chinese collected after the earthquake.

If the budget will be fully applied to the construction expenses(including design fees and labor expenses, of course), it will be definitely enough to support the whole design/construction process. However, there are several factors that make the budget become meaningless: the first reason is the unclear indication of the budget, which until now has not been given an official reply about where the budget should be used. Therefore, if the budget also covers the portion of purchasing the mechanics and furniture, the disbursements of the budget must be well balanced and considered.

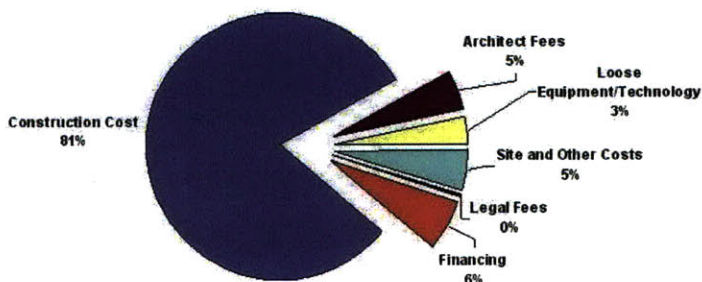


Fig 2.3 Schools spent nearly 20 percent of construction funds on architect fees, financing costs, advisor fees, and other “soft costs” in 2004 and 2005.

[Source: U.S. General Services Administration. Public Buildings Service.

(2007)]

The unit construction cost of Beichuan Middle School is RMB 3560/m². In order to identify the configurations of the buildings, it will be important to examine the domestic precedents in the perspective of the budgets and unit expenses(X RMB/m²)²¹.

1. College Teaching Building in Minhang District, Shanghai.

Total Floor Area: 9795m²
Structure Type: Reinforced concrete frame
Number of Floors: 4
Building Height: 19.35m
Unit price: 3152 RMB/m²

2. College Teaching Building, Beijing

Total Floor Area: 7400m²
Structure Type: Reinforced concrete frame/Shear wall
Number of Floors: 4
Building Height: 13.5m
Unit price: 2300 RMB/m²

3. High School Teaching Building, Beijing

Total Floor Area: 5186m²
Structure Type: Reinforced concrete frame
Number of Floors: 4/5
Building Height: 23m
Unit price: 1600 RMB/m²

4. High School Teaching Building, Ningbo Province

Total Floor Area: 6282m²
Structure Type: Reinforced concrete frame
Number of Floors: 5



Fig 2.4 College Teaching Building in Minhang District, Shanghai.



Fig 2.5 College Teaching Building, Beijing



Fig 2.6 High School Teaching Building, Beijing



Fig 2.7 High School Teaching Building, Ningbo Province

[Fig 2.4-2.7 Source: <http://www.zaojia8.com>. Retrieved on May 10th, 2009.]

Building Height: 14.7m
Unit price: 1350 RMB/m²

From this comparative study we may notice that the construction standard of Beichuan Middle School is literally higher than the college projects listed above. Moreover, the unit price of Beichuan Middle School, 3560/m² is an average value rather than exclusively the teaching buildings, considering the unit price of dorms will be considerably lower than teaching building while at the same time, the built area is about 1/3 of the total built area, therefore the unit price of the teaching buildings will be definitely more than the average unit cost.

The following case is also from the earthquake area in Sichuan province, where one of the largest real estate developers in China, Vanke, which recently donated this new teaching building²². From the data below we could see the unit price reaches even more than 4000 RMB/m². Most of the construction cost came from the fortification of the structure: the diameter of reinforced steel bar is 25mm, which is much thicker than the required 16mm from building code. The structure is calculated to resist a minimum of Ms scale 8.0 earthquake, while could main the structural integrity even in the earthquake measuring Ms scale 9.0. Moreover, light-weight steel is used instead of brick walls, avoiding possible collapses during the earthquake.

Equipment expense also constitute a considerable portion about 15% of the overall budget. In Zundao Middle School project the total cost on equipment is about RMB 6,560,000. However, many of the purchases go beyond the normal school requirement and demand: the communication/network system is from the Cisco; the overall solution provides a wide-band access to Intranet/Internet. However, as the schoolmaster said, only the electric fee itself will cost 30% of the total budget issued from county government every month. And the expenses on the maintenance and operation will significantly increase.



Fig 2.8 Zundao Middle School, Zundao County, Sichuan
[Source: <http://www.100ye.com>. Retrieved on May 10th, 2009.]

22. Construction information and statistics of building costs from <http://www.100ye.com>. Retrieved on May 10th, 2009.

5. Zundao Middle School, Zundao County, Sichuan

Total Floor Area: 4486 m²

Structure Type: Reinforced concrete frame+Shear wall

Number of Floors: 3

Building Height: 15m

Unit price: 4200 RMB/m²

Total Construction cost: RMB 12,281,200

Equipment expenses: 6,560,000

An interesting question is, if the Zundao project represents the high-end school standard, what is the minimum requirement of middle school design? The building code regulates that the construction cost of a teaching building should not be less than RMB 400/m², plus the equipment costs, which will be around 450/m² totally if following Zundao's cost percentages.

There are numerous teaching buildings with the unit expenses of 450/m² survived in the earthquake, among which the one in Beichuan county, called Hanlong Hope Junior School, kept intact and required merely minor reparation.

Therefore, the reason to propose such a tremendous amount of budget is literally questionable. First, is it necessary/practical to build a middle school with, or even exceeding the standard of college teaching buildings? If a lower standard could ensure the structural integrity as well as maintaining the daily functional uses, what is the reason to pursue a much higher standard? The budget should be established upon a justified while economic structural solution, and at the same time ensure the performance of the facilities and equipment. Therefore, the budget, rather than the 250,000,000, should reflect the actual needs from all aspects of the construction process.

2.2.4 Knowledge Groups

As previously discussed in chapter 1.3.2, it is always crucial to examine how different organizational forms coordinate with each other. First and foremost, we need to think about how many “knowledge groups” existed in the overall process.

The Beichuan Middle School/Local Government: Division Bond

Either of them represents a divisionalized cluster, within which the information/knowledge are distributed through experiential/coded language. Little theoretical knowledge is required as there is less informational exchanges based on the more abstract level.

Moreover, an intriguing issue is the school acts as an information provider during the whole design process, meaning that it at one hand represents itself to advise the designers using their experiential knowledge accumulated; on the other hand it performs as an agent that conveys the ideas from the Local Government. Therefore, these two divisionalized clusters act as a uniformed entity, within which the Local Government administered the School with some coded knowledge/methods.

Planning Bureau: Professional Bond

Immediately after the earthquake, the Planning Bureau in cooperation with other institutional ministries, started the revision of the planning/building codes of earthquake areas. The process is quite interesting, their research process is based on their research/records for years, which are experiential knowledge, and the outputs are, literally, the coded conclusions of these data.

Developer/Association: Family Bond

There are many types of developers in terms of its scale in China, while most of them start at a comparatively small size around 1980s. Yihai Group also started as a family enterprise in Beijing, and gradually evolved into a larger real estate entity. However, the organization of the company still maintains the original structure, most of the family members play important roles in the com-

pany.

As for the Association, which here represents the All-China Federation, though officially performs as government institution, and actually it should be a kind of Divisionalized form, it features with frequent uses of experiential knowledge rather than the coded knowledge. Especially on the Beichuan Project, it functions as the representative of the oversea Chinese who donate for the school. Therefore the inner organizational relation is more based on trust.

Designers: Professional Bond

Undoubtedly, designers here play as an executor of the outputs, meaning that they receive the inputs -- data, codes, and feedbacks, then produce the scheme in forms of drawings/models using their experiential knowledge, coded procedures and theoretical accumulations. Although what the previous knowledge groups have provided might result in some confusion, even contradiction with each other, designers need to extract the most useful information out of the data cloud, establish an efficient workflow and eventually produce a set of applicable design solutions.

2.3 Record: The Formation of “Virtual Model”

2.3.1 Questionnaires

The start of the virtual model formation is, as previously mentioned, to proceed interviews/questionnaires so as to acquire the first-hand information from the end users. Therefore, when we went to Mianyang on the visit of the middle school, questionnaires were distributed to the students to retrieve their thoughts about their future school²⁴.

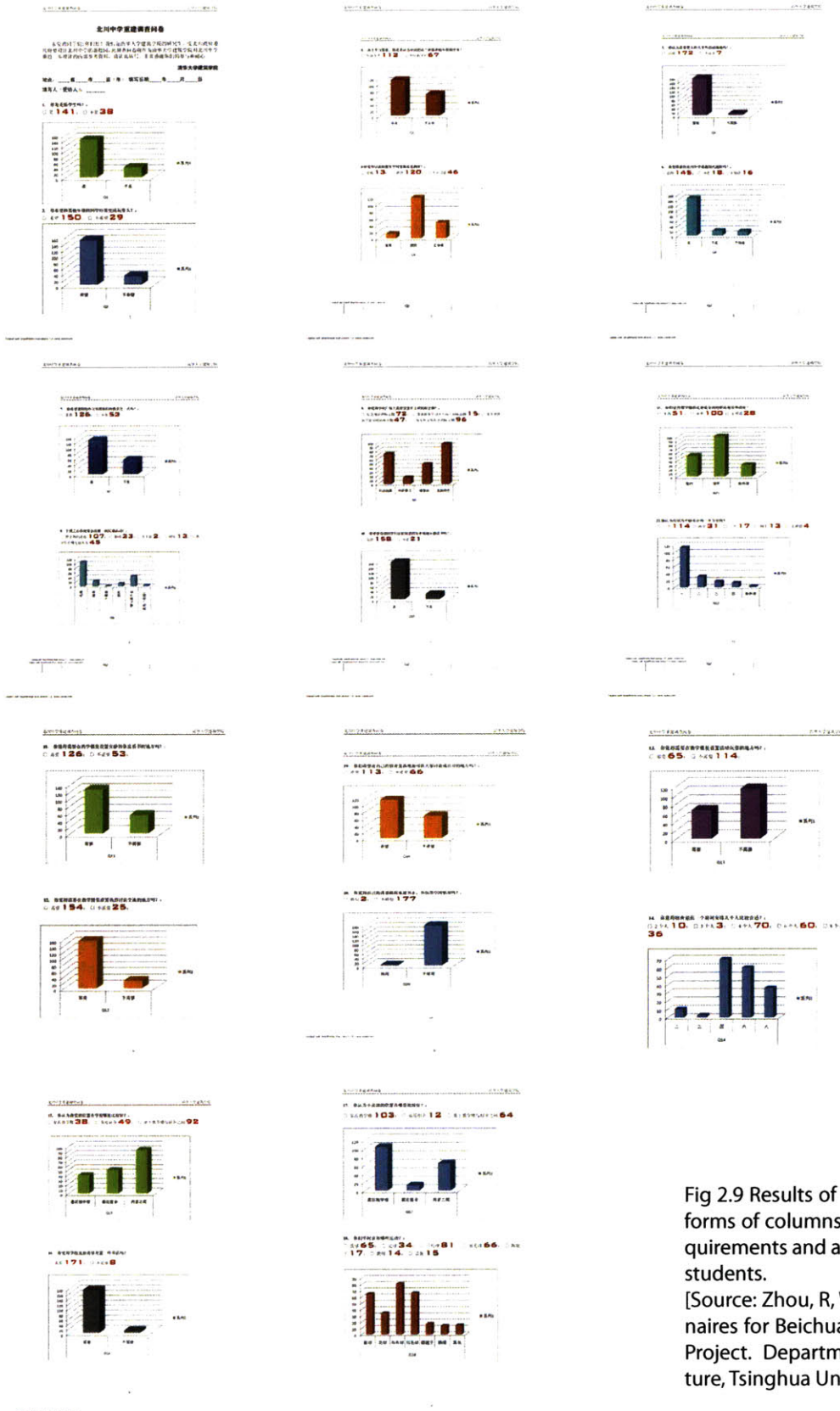


Fig 2.9 Results of the survey in the forms of columns, showing the requirements and anticipations from students.
 [Source: Zhou, R, Wu, H . Questionnaires for Beichuan Middle School Project. Department of Architecture, Tsinghua University.]

The feedbacks from the questionnaires are crucial: what the students expect are the facilities that most of the schools in rural area are short of: larger sports field, public spaces along corridor, space for group discussions and even, larger desk capacity. Therefore, some of the feedback will be carefully considered and be transformed into parameters that could be manipulated.

2.3.2 Reviews

From the November last year until this March, there were five reviews held by the Developer/Association to ensure the undergoing of the design process. And from the very beginning the formation of a draft proposal to the production of detailed architecture plans, those reviews helped to shape the designers' ideas and direction.

>First review, 11/7/2008, Beijing.

Attendant:

Yihai Group.

ACF (All China Federation)

MIT/HKU, Tsinghua Univ., Tongji Univ.

Beichuan Middle School

Suggestions from Teachers at Beichuan Middle School/ Developer/Association reflected some of their held basic values. They established a portion of the fundamental rules of the design.

>Second review, 1/4/2009, Shenzhen.

Attendant:

Yihai Group.

ACF.

China Academy of Urban Planning and Design

MIT/HKU, Tsinghua Univ., Tongji Univ.

Beichuan Middle School

There were some emphasis on the previous points declared; while the School proposed an idea to divide the

- >Scale of Dinning hall/Kitchen
- >Room interior design
- >85% Qiang Minority students Racial sports activities.
- >Recommend Pitch Roof
- >Arrange Teachers' Dorm Single Apartment
- >Dual role of Teacher/Baby sitter Combine Teacher/ student dorms
- >Teachers' Affordability

- >Appreciate the double corridor layout in design proposal
- >Lower the density/decrease the mass volume
- >School Management/ Divisionalization

How about making two separate schools?

- > Disagreed by other groups.
- > Appreciate the conservation of water system, which is a positive response to the Planning scheme.

> Sichuan Province officer:

The planning follows the overall rehabilitation plan, should consider the phasing plan, also should address the future management of the water system; make sure the overall design to be cost effective.

> Zhao Zhi Jing:

College system is a good concept to moderating scale, more activity spaces for students.

Fig 2.10 Comments made by faculty, planning bureau, school master, government officer and designers.

[Source: excerpted from Chronology. Drawn by author.]

campus into 2 parts: because the education system reformation resulted that the financial management of high school faculties becomes independent from that of the junior/middle school. Therefore it is reasonable for them to propose “two campuses”. However, the tight land use could not afford to provide another piece of land for an extra school.

As for the preliminary design of the campus, the Planning Bureau really appreciate the conservation of the water system and the original texture of the field, which should be, as they suggested, a common feature of the proposals.

>Third review, 1/17/2009, Beijing.

Attendant:

Yihai Group.

ACF.

China Academy of Urban Planning and Design

Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

China Architecture Design Institute

Qixin Design Office

THYF Design Group

Zhupei Design Studio.

It is more than a review but a judgement process by the jury to choose among 3 schemes, as previously (refer to the Chronology Diagram) the Developer/Association announced the competition among three design groups, which made the process become complicated, though help to identify the designers’ status in terms of their design priority.

Therefore, during the meeting the experiential knowledge combined with a certain kinds of coded knowledge exchanged reflected a considerable amount of evaluations than previous reviews. However the comments from the Developer still give some concrete clues about the programs. And also the other ideas from the designer side(part of the jury) provided useful sugges-

> Tsai Fang: It is appropriate to separate the middle school and the high school. Rich architectural expression and should emphasis on structure system for earthquake safety.

> Li Xing Gang:

New Campus layout pattern addresses the student’s learning, proper and with human scale. It should think more on the daily activity pattern of middle school students, being different from college students. It should try to reduce the density of the classroom cluster, make sure to have sufficient natural lighting and activity spaces in those courtyards.

> Qi Xing:

MIT/HKU scheme: good concepts, and cost less.

Tsinghua scheme: rich concepts, and cost more.

Tongji scheme: little concepts, and cost less.

> Zhu Pei:

The MIT/HKU scheme is the most natural one which is simple and effective, Tsinghua scheme address too much on monumentality and less on student’s learning. The scheme should consider moving out the special classroom from general teaching, to reduce the conflict on use

Fig 2.11 Comments made designers from the third review.

[Source: excerpted from Chronology. Drawn by author.]

tions sprung from the submitted proposal.

>Fourth review, 2/5/2009, Beijing.

Attendant:

Yihai Group.

ACF.

Beijing Institute of Architecture Design

Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

Following the last review's comments, many aspects of the design have been revised; the Developer/Association invited one of the specialists who institute the building codes in earthquake area. Therefore the comments given are crucial to the overall proposal.

>Fifth review, 2/5/2009, Beijing.

Attendant:

Yihai Group.

ACF.

Beijing Institute of Architecture Design

Beichuan Middle School

MIT/HKU, Tsinghua Univ., Tongji Univ.

The feedbacks came back to the practical uses of the buildings: there were a lot of discussion about the use of the labs/teachers' offices and especially the dining halls. The School/Local Government became again, the main voice; many of the following revisions followed these functional/management issues.

2.3.3 A Story: the quantified narration of the School

The interview, the reviews, the design methodology that the designers adopted and revised, weave two interrelated webs: one is the semantic web that tells the story, which is structured by experiential knowledge from various knowledge groups. The other one is comprised of data, coded by a series of rules/principles that actually supported by the semantic web.

- > The scale of school: 18-36 classes. Smaller than 18/Larger than 36, management difficulties.
- > Two hours sunlight; ensure the extinction of various bacteria.
- > Structure calculation standards: VIII for general structure/iX for connections
- > The distance from classroom to playground: less than 300m
- > The standard: 1 basketball court/6 classes: the setting of PE classes.
- > The distance between classroom buildings and traffic roads > 25m. From the statistics of traffic noise.
- > Consider the management of Gym: open to public.
- > Universal Design.
- > Sanitary distance: 18m.
- > School as a sanctuary for nearby communities.

- > Many function needs: at least half of the Lab to be put together, teacher's office to be with the classroom. particularly the dining/kitchen are to be with the Dorm (could put under the dorm).
- > Propose a lab building for chem and bio lab.
- > Many suggest to even to combine the dining halls into one.

Fig 2.12 Comments given by the specialist from BIAD and school/local government

[Source: excerpted from Chronology. Drawn by author.]

2.4 A “Regression” Parametric Model: About Associative Design

2.4.1 Antithesis: Zaha Hadid’s Parametric Urbanism.

Form Informing Urbanism - Parametric Urbanism is another computational issue raised by Zaha Hadid Architects for the Global Cities exhibition at Tate Modern in 2007²⁵. They choose Thames Gateway as a testing ground, and examine four main building types: individual villas, high-rise towers, slab-shaped buildings and city-blocks. These can be thought of as points, lines, planes, and volumes. A series of rapid prototype models give examples of how each type might be dispersed in the landscape.

In Zaha’s proposal, a range of new forms and an animated sequence which shows the evolution of an intensely urban pattern across the area are presented. The effect is striking; however, it might be important to raise the following questions:

1. What are the parameters of the model?
2. Could these parameters successfully manipulate the overall layout of Thames Gateway? Or say, what is the appropriate scale of layout that these parameters could operate on?
3. What are the rules that manage the parameters/features?

It might become another paper if trying to give a detail analysis of Zaha’s scheme. However, the answers to the questions could be quite concise: parameters are always not adequate by themselves to build a urban parametric

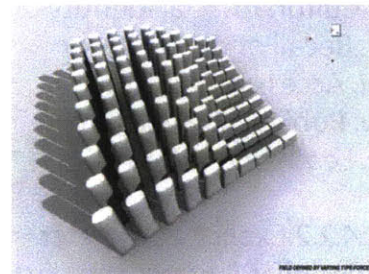
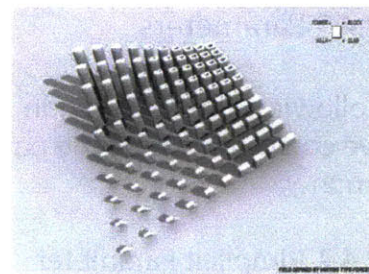


Fig 2.13/14/15
Zaha Hadid’s Parametric Urbanism. The dynamic model shows the variations of scheme with the changes of parameters.
[Source:<http://zahahadidblog.com/movies/2007/06/22/121>. Retrieved on May 15th, 2009.]

25. Zaha Hadid Architects. (2007). Thames Gateway. <http://zahahadidblog.com/movies/2007/06/22/121>. Retrieved on May 15th, 2009.

model without the guidance of rules.

However, if merely depending on a certain generative methods (Rhino Script, Maya MEL, etc.) will result that the model looks more like a pattern including various transitions from one type to the other. Therefore, instead of purely using scripting tools to generate the urban texture, here I am trying to establish a so-called "regression model" to explore the variations of the school layout, using the structure of Knowledge Organization.

2.4.2 Parameters

Following the expatiation on parameters in chapter 1, we could categorize the parameters using the same taxonomy:

2.4.2.1 Implicit Parameter

- i. Cultural/Racial Identity
- ii. Recall of the Memory
- iii. Accessibility
- iv. Public/private Domain
- v. Legibility

2.4.2.2 Explicit Parameter.

Immediately after the earthquake, the related national research ministries (Ministry of Education, Ministry of Housing and Urban-Rural Development, and National Development and Reform Commission) drafted the standards of school design in these areas. These parameters are therefore examined and calculated according to this building code.

i. Programs/Areas

The types of functions with areas specified are illustrated in the following diagram. It is literally an approximation of the real school program, reflecting most of the main functions in the school design.

ii. Sunlight Coefficient

It is regulated that the design should guarantee a minimum of 2 hours sunlight for the classrooms during the

winter solstice. An approximate substitution is to use the coefficient, which is the ratio of the height of building at the front and the distance between two buildings. In Sichuan area, the coefficient is 1.5.

iii. Green Ratio: higher than 30%

Also required by the building code. It indicates that the Building coverage will be around 60%.

iv. Building Height: Equal to or less than 4 floors.

v. FAR: less than 0.5.

2.4.3 Rules

i. Six “Institutions”

Early from the beginning of the studio, we tried to subdivide a school with 5000 students into schools with smaller amounts. It is an idea that refers to the college institution in Oxford University. However, it is not like the Oxford University that forms the three-tier management: all resident students, and most academic staff, must be members both of a college or hall, and of the university.

The subdivision being applied to Beichuan Middle School is more like a formal tool. It helps to regulate the school in terms of the management and functional operations, which include traffic organization, uses of dining halls and other service facilities.

Therefore, according to the building codes, one of the appropriate class number is 18 for one school. Then the school is organized as/subdivided into six Institutions.

ii. Cultivate a Human-scale behavioral space.

Besides the consideration of adopting appropriate scales for students, a human-scale behavioral space includes a well defined system that ranges from the sizes of basic utilities, the use of components, spatial layout and the sense of spaces. It is a combination of implicit and explicit knowledge: some of the criteria could be evalu-

ated by a certain set of standards; while some of them could only be perceived subjectively.

iii. Reflection of traditional style/value.

It will initiate another thesis related with tradition, which is a long-last issue and still continues to aggregate as time goes by. A very straight-forward answer in terms of architectural design to this reflection is to use symbolic representations. However, it is not at all a satisfying answer to the audience, to the mass as the use of symbols is literally a cliché.

Many of our precedents strived for appropriate ways to express the values; many of them failed. However, the successful ones and failures in all construct another layer of the tradition. As the tradition itself is never a one-dimension entity.

If looking at the definition of “tradition” in Wikipedia, which tells that “a tradition is a practice, custom, or story that is memorized and passed down from generation to generation, originally without the need for a writing system.” So what about providing a blank canvas, rather than setting up pre-defined contents and forms reflecting the values? The traditions will accumulate themselves on the canvas, which only provides, but great flexibility and adaptability.

2.4.4 Style I: Axis Pattern

The first style follows a similar pattern that the studio scheme adopted: an axis pattern. It tries to produce a prominent feature of the campus by means of creating two axis: one runs along the campus forming the boulevard surrounded by teaching buildings and dorms; one runs across to identify the public buildings.

1. Model of one cluster/institution.

From the illustration below, we could see the relationship between the components of one cluster: a teaching building, a dorm and a dining hall. They form a second-

ary axis that perpendicular to the main longitudinal axis. And actually the dining hall has a comparatively loose relation with the others in terms of its spatial location.

i.Assumption

Orientation: all the long elevations of teaching buildings/dorms are stipulated to face south to maximize the use of sunlight.

Sunlight Coefficient: though the coefficient is closely related with building height, we simplify the relationship by using a constant value 1.5 instead of calculating the sunlight in 3-dimension condition. Therefore all the teaching buildings/dorms are attached by "shadow realms" to indicate the insufficient sunlight areas.

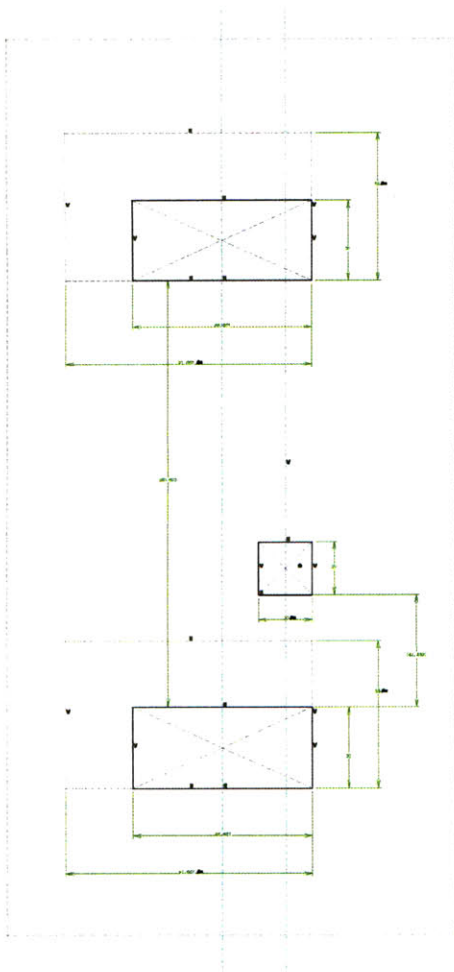


Fig 2.16 One of the clusters showing the spatial layout of teaching building, dorm and dining hall. The dotline boundaries indicate the shadow areas of the buildings.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

Boulevard: the central boulevard is maintained to strengthen the axial pattern, with the width of 60m on both longitudinal and transverse directions.

2. The whole Parametric Model

A parametric model with six clusters and one public clus-

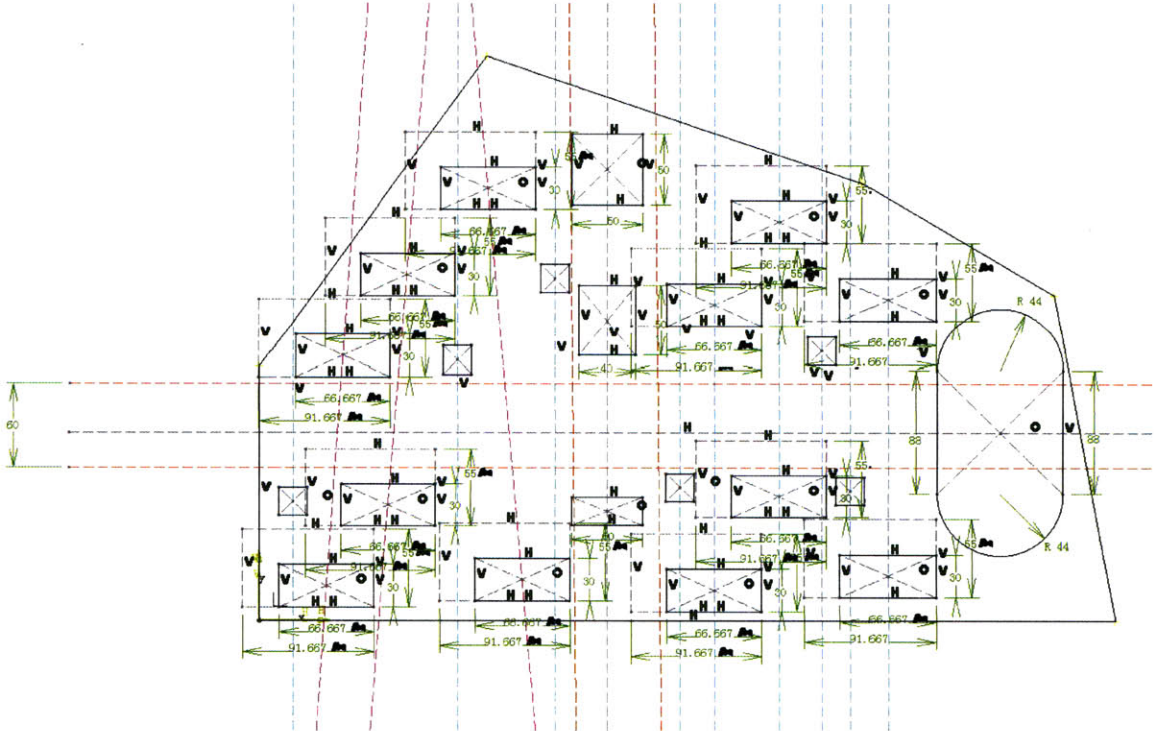


Fig 2.17 The illustration above shows the whole layout the parametric model. The axis could be rotated to produce more flexibility in order to maximize the land use.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

ter is illustrated below, with parameters, rules applied to the building masses in forms of constraints. Note that this is only one variation of the numerous situations that fulfill the basic rules and parameters.

3. The representation model

The two-dimension model then produces its reflection in three-dimension environment. Though in many situation the 3D model could also be a parametric one; here we accomplish most of the parametric steps in the sketcher(in Digital Project), rather than manipulating the variations with the introduction of the height parameter. Therefore the model is simplified by a certain transformations of the 2D parameters.

However, one could clearly observe more or less the constraints and rules that applied to the sketch model;

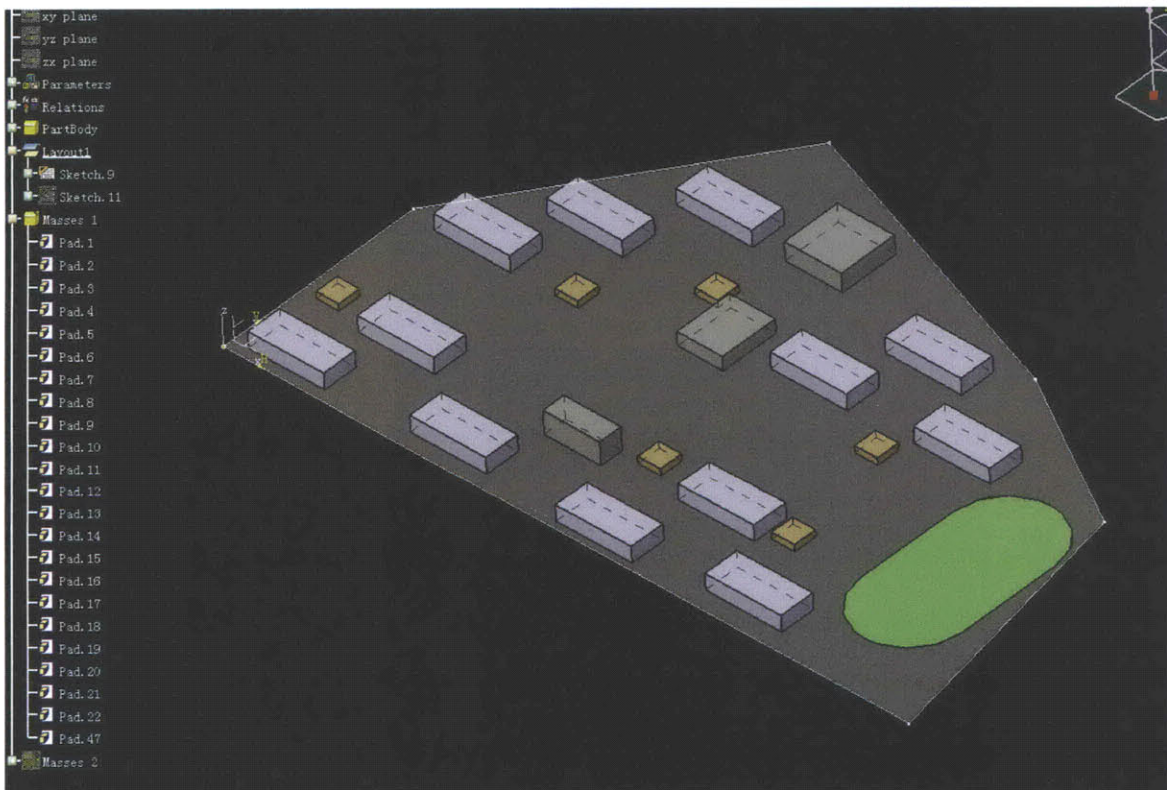


Fig 2.18 The solid model represents the physical outcome of the parameters and rules.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

and the axial feature is also indicated accurately through the representation model.

2.4.5 Style II: Courtyard Pattern

It is like a counter part of the Axial style; rather than creating a dominant feature of the campus, the courtyard pattern aims to cultivate an environment with appropriate behavioral scale, especially on planning level it refers to walking distances and the sizes of public spaces.

1. Model of one cluster/institution.

Three building masses are surrounding a central public spaces, the area of which is stipulated according to a normative size of squares, as well as considering the height of the buildings. The distance between any two of the buildings is less than 100 meters, so as to guarantee acceptable walking distance. Therefore, a series of variations are produced by rotating these volumes

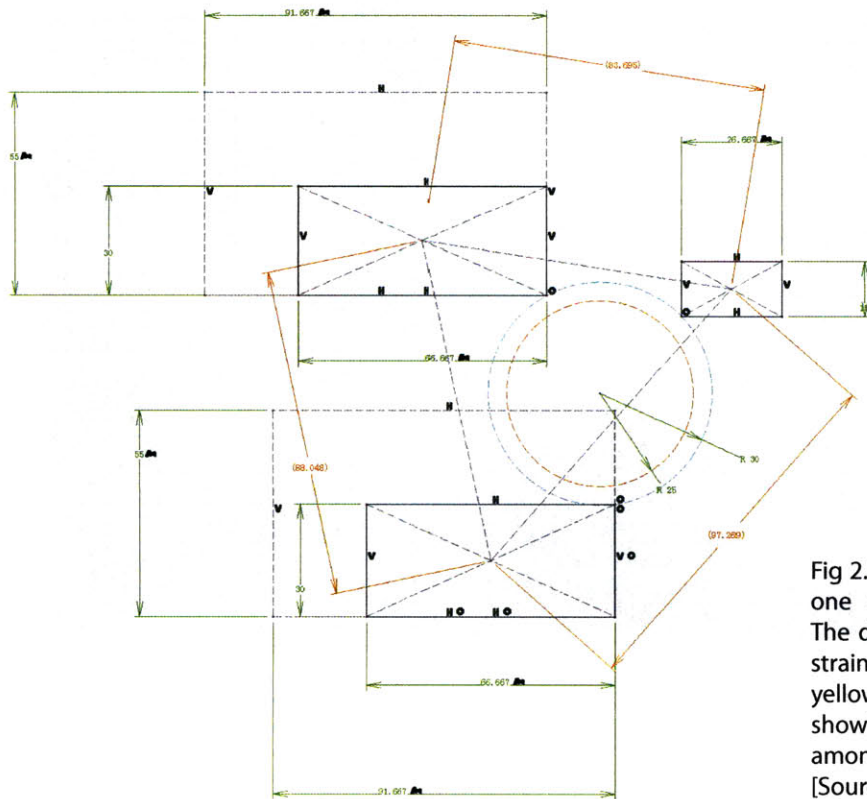


Fig 2.19 The illustration shows the one cluster in courtyard pattern. The dimensions in green are constraints applied to the model; the yellow dimensions are reference showing the distance changes among masses. [Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

3. The representation model

The three dimensional model gives the impression of the rules and parameters applied to the site. Although the courtyard pattern is not that obvious compared with axial pattern, it does provide the fundamental texture for further development. Also, in further design the importance of the public space will be emphasized, therefore

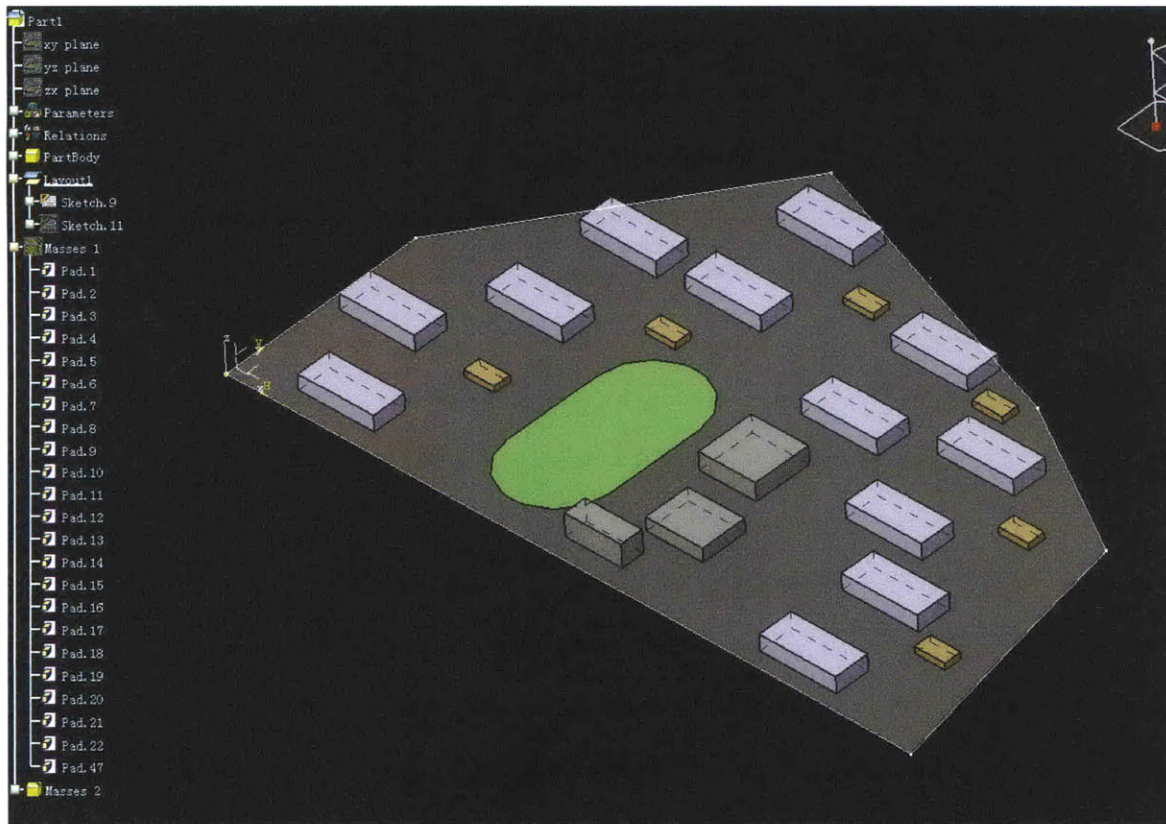


Fig 2.21 The solid model represents the physical outcome of the parameters and rules of the courtyard layout.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

the basic structure of the scheme will become prominent.

2.5 A Regression Architectural Model of BIM

Following the discussion on the campus layout, the building structure and performance need to be further considered. From the chronology that I formerly presented, it will be important to integrate some studio research with our design proposal in terms of the process' efficiency and integrity. I would like to expatiate the idea from the study of the teaching building to see how the process is integrated by means of parametric/BIM design.

2.5.1 Rules

1. Structural System

A light-weight steel frame structure with masonry blocks/glass frames forming the partition walls. It provides a certain degree of structural flexibility compared with a rigid concrete system.

2. Building Layout

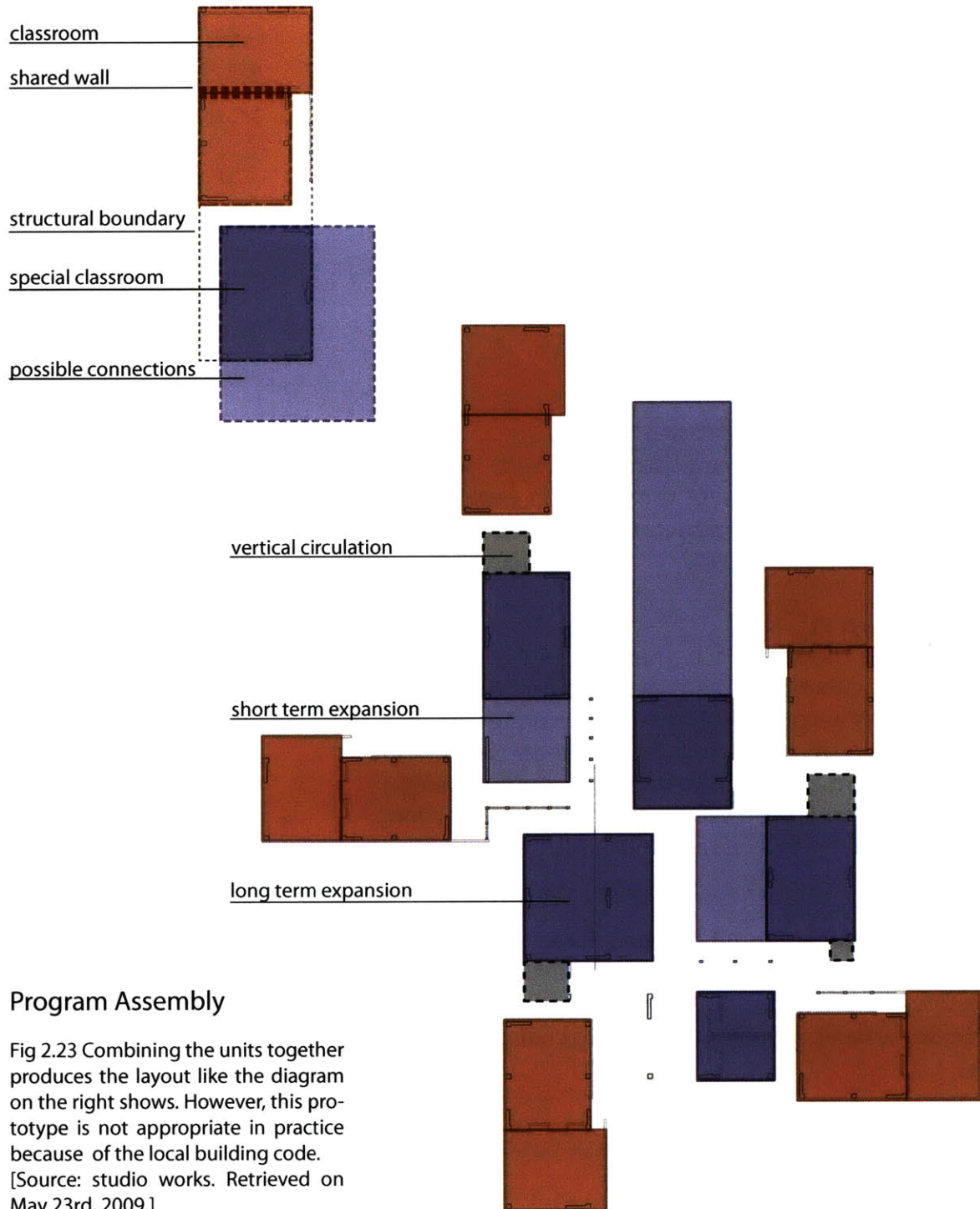
Follow one of the studio schemes, we try to define several clusters with different emphasis on functions. However, the previous pinwheel layout could not be possibly achieved because of the building code about sunlight hours (minimum of 2 hours sunlight for each classroom during winter solstice). Where as the idea of forming classroom clusters will be retained in further design.

3. Floor Plan Pattern

Each of the clusters could be considered as a function box "floating" on the slab, while with a certain constraint according to the definition of the columns. Also, there will be some flexibility for the masses to change in shape/size.

Program Module

Fig 2.22 The program module shows how a standard classroom and a special room interrelate with each other by means of corridors and other types of public spaces.
[Source: studio works. Retrieved on May 23rd, 2009.]



Program Assembly

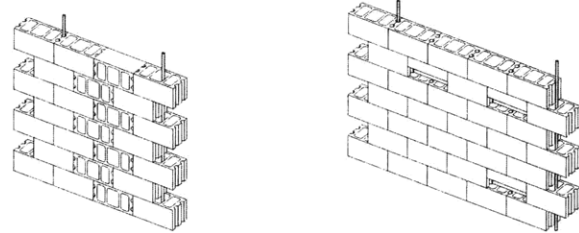
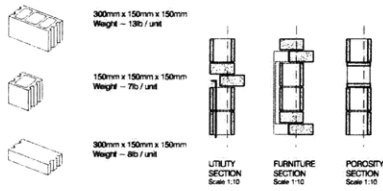
Fig 2.23 Combining the units together produces the layout like the diagram on the right shows. However, this prototype is not appropriate in practice because of the local building code.
[Source: studio works. Retrieved on May 23rd, 2009.]

4. Facade Expression

We would like to apply the “Assembly” idea to the overall fa-

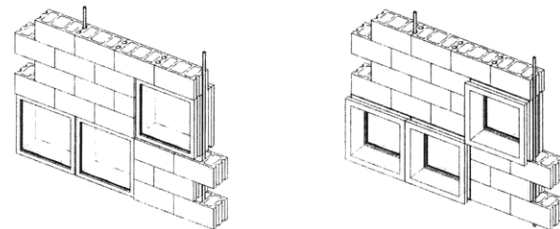
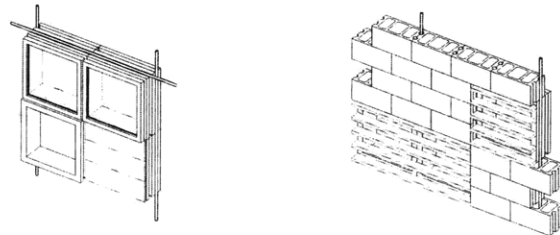
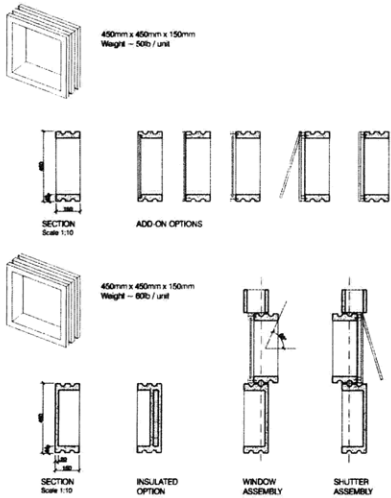
Units Fabricated On Site

N. T. S.



Prefabricated Units

N. T. S.



Corner Assembly Options

N. T. S.

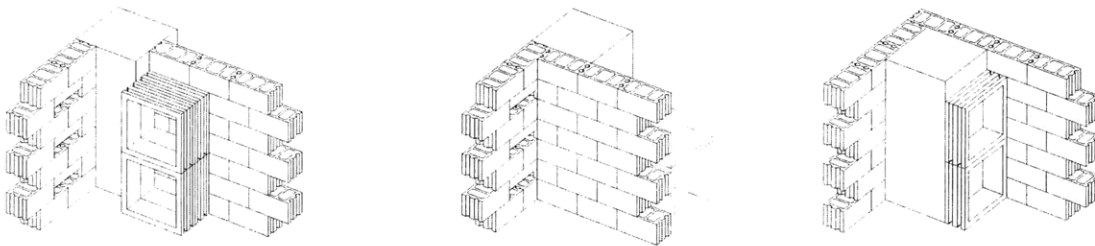


Fig 2.24 The above construction diagrams from studio works show various expressions of facade using different combinations of building components.

[Source: studio works. Retrieved on May 23rd, 2009.]

cade, while the ratio of the transparency is controlled through the percentage of the glass blocks/windows. The ratio of transparency/solid of the facades will be examined later.

2.5.2 Parameters

1. Site boundary

The buildable area is allocated within the given site, 66.67mX30m. A certain amount of open space should be kept for public uses. It will be difficult to regulate a certain ratio of the green area within one boundary; however, an economic use of land will be favored. The maximum floor number is 4, the foot print will be $4500\text{m}^2/4 = 1125\text{m}^2$, therefore the maximum green ratio will be $875/2000 = 0.45$. The limit of FAR will be 2.25.

2. Programs/Areas

The types of functions with areas specified are illustrated as followed. Note that this is also an approximation of the real building program, reflecting the basic functions required in the school design:

Normal Classrooms: 15. Unit size: $10\text{m} \times 7\text{m} = 70\text{m}^2$.

Special Classrooms: 4. Unit size: $5\text{m} \times 7\text{m} = 35\text{m}^2$.

Faculty Office: 4. Unit size: $5\text{m} \times 7\text{m} = 35\text{m}^2$.

Restroom: 4. Unit size: $9\text{m} \times 7\text{m} = 63\text{m}^2$.

Staircase: 2. Unit size: $3\text{m} \times 7\text{m} = 21\text{m}^2$.

3. Sunlight coefficient

It is regulated that the design should guarantee a minimum of 2 hours sunlight for the classrooms during the winter solstice. Considering the boundary limitation, it will be ideal if arranging most of the classrooms to the front while pushing the other service facilities to the back.

4. Budget estimation

It will be a evaluation process after the schematic design finishes; and from the parametric model we could give an approximate calculation of the budget spent on the teaching building.

2.5.3 A Model of Parametric Variations

1. Approximation of Building mass

Based on the given area and site boundary, we try to identify the basic layout of the mass: classrooms are arranged in the south with fire exits at both ends; the special classrooms are arranged to the north side as the secondary branches of the mass. The special classrooms at the same time form several clusters with the normal classrooms, as the previous diagram illustrates.

The model literally shows one of the variations that match the required rule. It demands experiential knowledge inter-

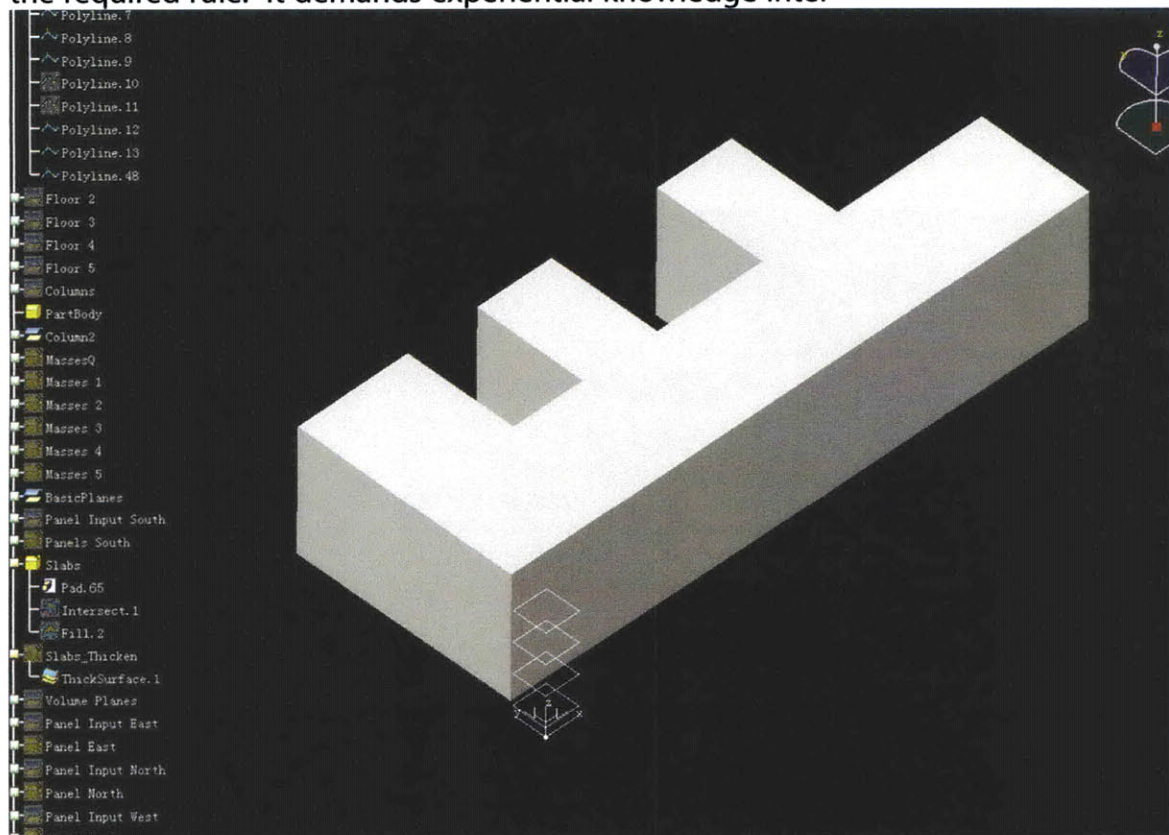


Fig 2.25 The building masses illustrated shows one of the variations that fulfills the rules and parameters.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

vened to list possible types of the mass. Also, further consideration of the column grid will help to reshape the volume.

2. Light steel structure layout

A structural grid of 4mX4m on the periphery of the building is adopted; while inside the building the span will be 8mX8m at most of the time. The unified module provides structural integrity to the building while offers convenience to the panelization of the exterior walls.

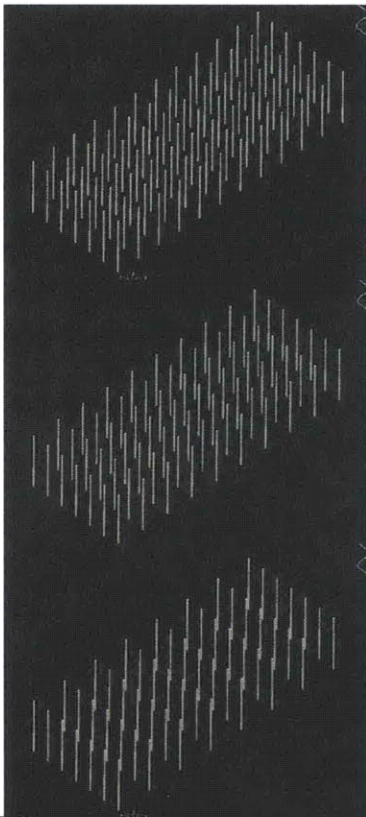
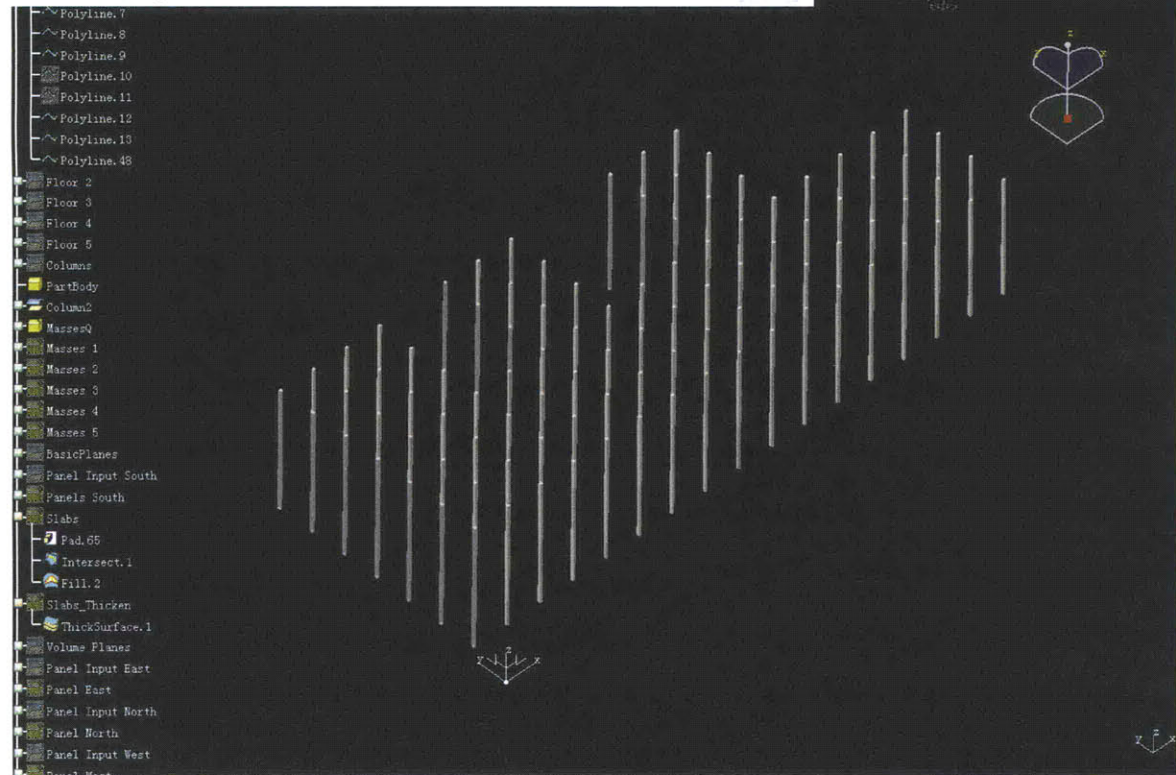


Fig 2.26 A parametric process showing different layout of the columns in terms of the structural span.
[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]



More importantly, the parametric column grid provides a certain flexibility in terms of the span variations. Although here the decisive element will be the building mass, which will determine the amount of the columns.

3. Plan layout

Based on the given building mass and column specification, A parametric set of the plan layout is proposed. As the former rules describes, "each of the clusters could be

Fig 2.27 One of the plan variations shows the cluster idea by means of setting a series of constraints.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]



considered as a function box 'floating' on the slab". Moreover, it is easy to identify that each of the cluster is composed of two or more of the elements: normal classroom, special classroom, faculty office. Sufficient public space is provided in the forms of corridors and platforms.

3. Panelization

Following the module provided by the column grid, a system of panelization of the exterior wall is developed. While excluded the width of the column, the actual unit panel would be 3.7m(width)X3.5m(height). According to the studio research, a combination of glass panel and

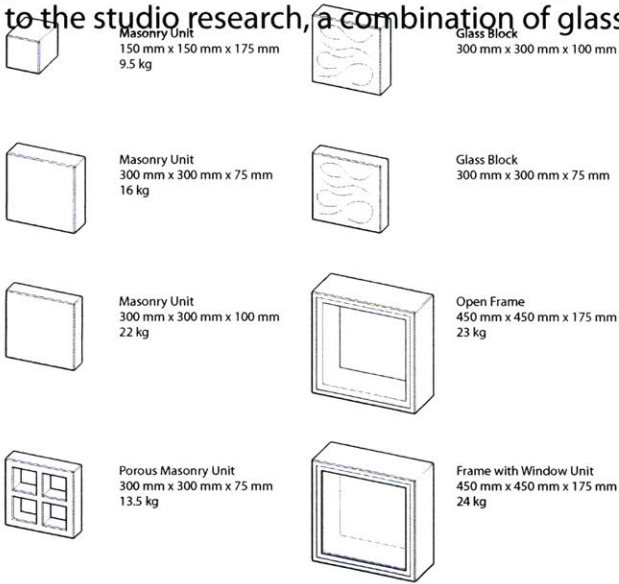
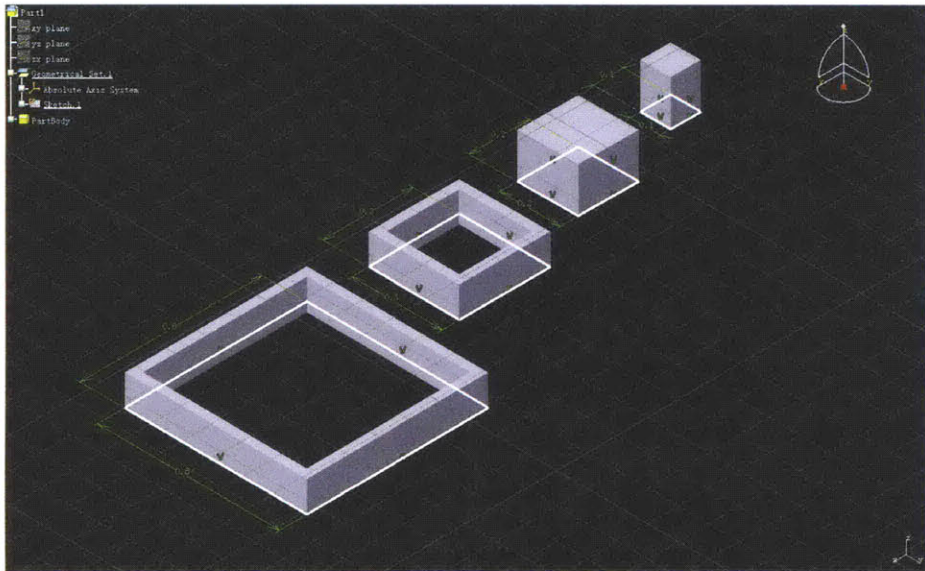


Fig 2.28/29 The diagrams on the left and below show the reconfiguration from a specified category of building components to a comparatively loosely-defined category of CMU and window frames with glass.

[Source: Left, excerpted from Studio works. Retrieved on May 22nd, 2009. Below, drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]



concrete masonry unit are adopted to form a kind of mosaic pattern. The smallest CMU that we could use is 0.1m(width)X0.1m(height)X0.15m(thickness), which is the basic module of the unit panel.

Rather than using many types of CMU and window frames in studio work, we try to reduce the types of the products in order to minimize the costs and improve design efficiency. Four basic types of CMUs/windows are used in the model (Width X Height X Thickness):

CMU type 1: 0.1mX0.1mX0.15m

CMU type 2: 0.2mX0.2mX0.15m

Window type 1: 0.3mX0.3mX0.1m

Window type 2: 0.6mX0.6mX0.1m

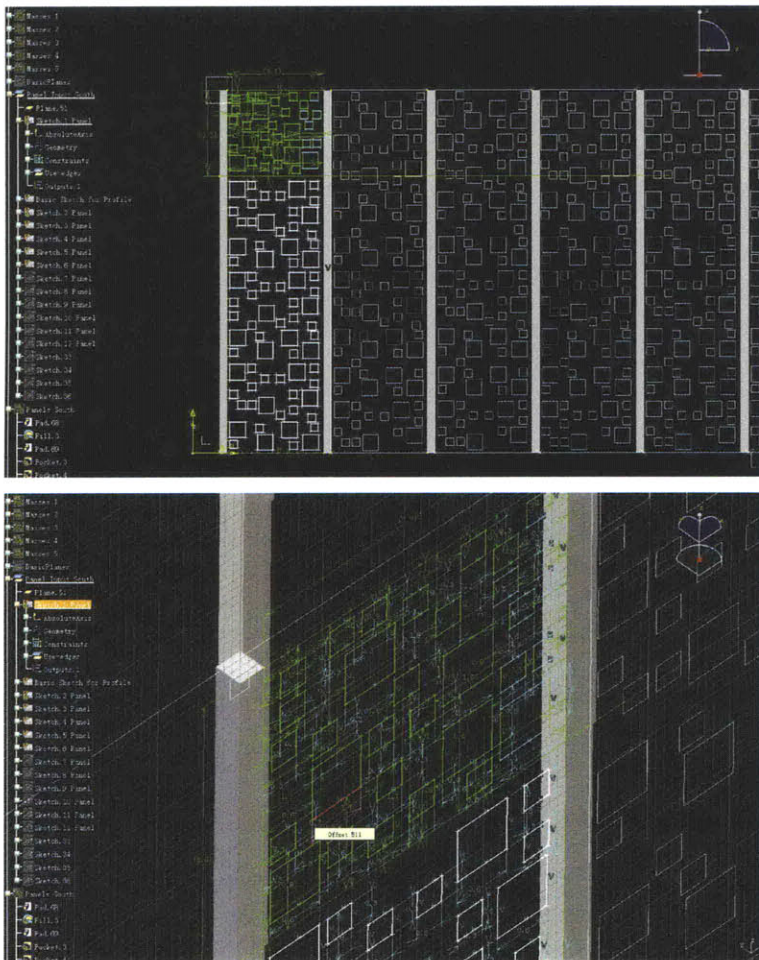


Fig 2.30 The illustrative panel layout above and the isometric view of the details below show the combination of different components within one of the panels.

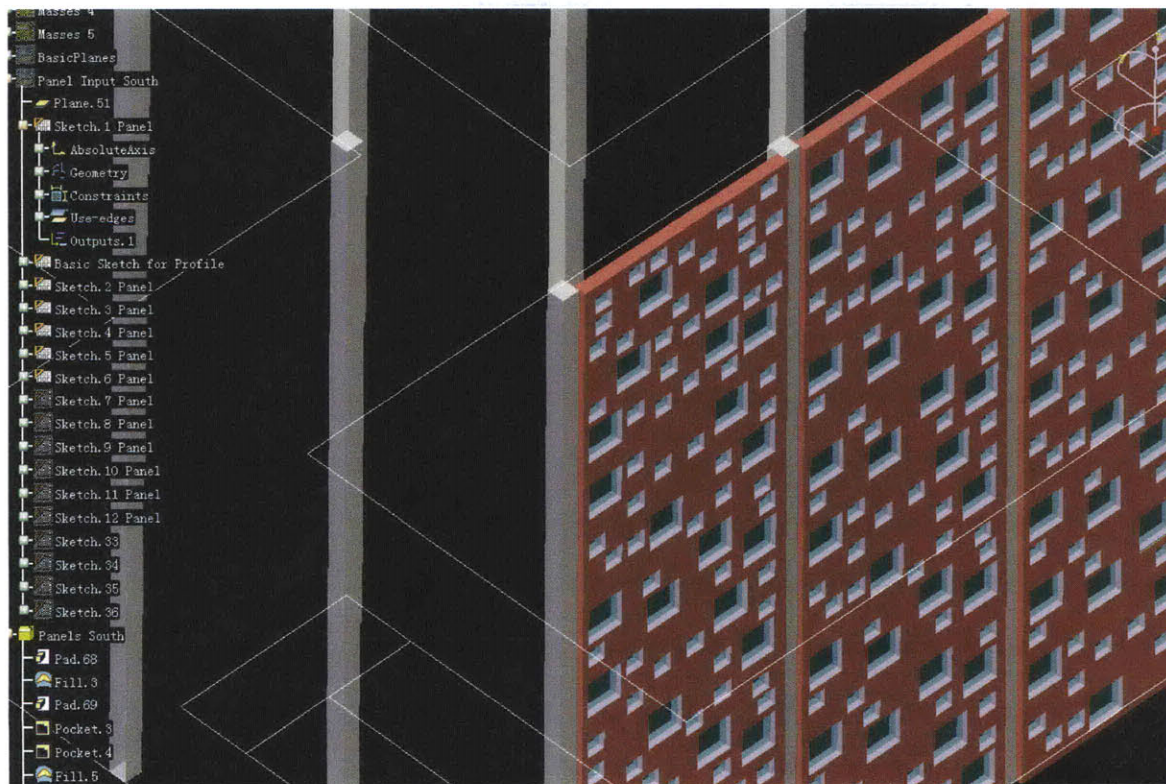
[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

Considering the variations of the column span, the panels will change accordingly. Therefore constraints are applied to the CMU and frames with window units to ensure their transformations with span changes.

Moreover, different ratios of transparency/solid are applied to different facades. To avoid excessive sunlight to the west, the ratio of the west elevation is 0.15; that of the rest of the facades is 0.30 to ensure necessary lighting.

Fig 2.31 The ratio of transparency/solid could be altered through the amounts of window frames. The parameter indicating the ratio will change accordingly.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]

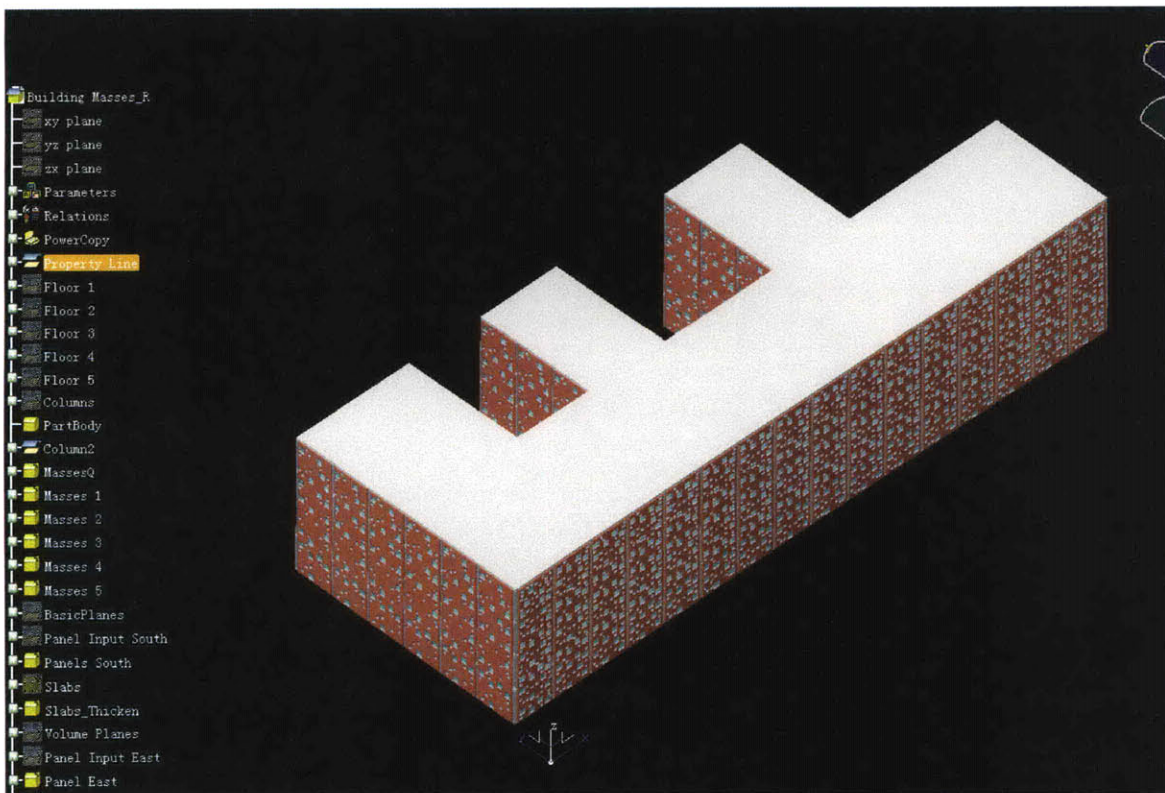


A prototypical massing model with panelization is illustrated below. Note that the differentiation between the west and south facade, and the relationship between the column grid and exterior panels. Besides, there are several issues need to be addressed here:

1. It is not a fully-parametric model, meaning that it does not possess the logical integrity as a completely developed one. However, the lack of integrity gives a certain flexibility to the further alterations of the proposal.

Fig 2.32 The final parametric building model shows the overall figure as well as the exterior panelization.

[Source: drawn by author in Digital Project environment. Retrieved on May 26th, 2009.]



2. The model itself still have some limitations in terms of the flexibility.

As the model is literally the combination of implicit/explicit parameters and experiential/theoretical knowledge. The explicit factors will give the model a certain constraints in some way, which will accordingly shape the model towards a final form. However, it is also these explicit factors that the scheme lost somehow the fluidity; and over emphasis on implicit parameters/experiential knowledge will only result that the model in the situation of uncertainty. Therefore, it is crucial to examine the coordination between the implicit and explicit factors, and also to identify the adaptability of the parametric methods themselves.

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