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Use of Grammar for Shape Exploration with Novice Students

Experiment 1: against the first impressions

Mohamed S. Ibrahim[1], Alan Bridges[2], Scott C. Chase[3], Samir Bayoumi[4], Dina S. Taha[5]
[1, 4, 5]Alexandria University, Egypt, [2]Strathclyde University, UK, [3]Aalborg University, Denmark
[1]Mohsobhy77@gmail.com, [2]a.h.bridges@strath.ac.uk, [3]scha@create.aau.dk, [4]samir_hosni@hotmail.com, [5]dina.taha@eng.alex.edu.eg

Abstract. *This paper describes a teaching experience conducted and carried out as part of the architectural coursework of the first year students. The workshop is the first of three planned to take place during the course of the first year studio. It aims at introducing new ways of thinking as well as introducing students to the new pattern of architectural education; It also helps communicating and-if required- unlearning accumulative conceptions that were unconsciously gained by the lack of practice, ignorance of actuality or simply by the accumulation of images and ideas in their minds over the years.*
A grammatical approach was chosen to develop the described methodology, based on the shape grammars system in general, and on one of its basic skills of seeing/understanding shapes & extracting elements of the visual composition in particular.
Keywords. *Beginning/Novice students; shape grammar; pedagogical grammar; design education.*

Novice students and Preconceptions

Architectural design studio remained the emotional core and the most prominent subject of the architecture education in term of both time spent and curriculum emphasis (Thakur, 2007). The first year design studio is seen as the students' entry level to architecture, sometimes described as the architectural kindergarten, where students form their first ideas about design and architecture that will distinguish their future career.

From the beginning of the first year, instructors are confounded with the prospect of introducing novice students to an extremely different pattern of education. In which, they are asked to target complex design problems differently and not in the very direct way they have learned prior to entering design schools .The most obvious barrier that stands between tutors and their goals is the plain truth that novice students already come to architectural schools with preconceptions that are both disturbing and in many cases not true. These were caused either by the lack of practice (Temple, 2009), ignorance of actuality or simply by the accumulation of

images and ideas in their minds over the years (Al-Asad, 2002). These preconceptions provoke the students' understanding of design, their intention, the way they design and even their ability to aesthetically taste and judge designs.

Crossing that barrier and overcoming these misperceptions is the most salient issue for students to successfully transit into design problem. It is also the most difficult task to consider while planning the beginning design studio course.

The in-depth search within the written literature concerning the same subject revealed that a project–based methodology that confronts students to the act of "*making*" from the first day is more capable of targeting their preconceptions within a playful exploration and self developing environment.

The main concept was applied in health science curricula since 1969 (Smith, 2005). It presumes that constructing things in the real world builds connections between thinking and making, between the abstractness of ideas and the concreteness of lived experience (Temple, 2009). This offers an optimal pedagogy for initiating students to design education, as well as targeting the difficulties caused by the first year students conceptions about the essence/concept of design and what designer do?

Bearing in mind that this pattern of education is normally at odd with their pre-university education, students frequently meet freedom to explore with confusion, as they are not yet accustomed to solving problems without a set methodology to follow. It was therefore necessary to search for a methodology to carry out this role and deliver a strategy in a more explorative format that excites the act of making.

Implementing Shape Grammars (SG)

During the last four decades, formulating design science efforts came up with ideas that challenged the traditional design practise. The research community tried to reach for rigorious models of design reasoning that are based on a hard analytic science of design rather than soft traditional strategies like intuition and the use of formal knowledge (Goldschmidt, 2001).The methodologies that emerged from these CAAD studies had been adopted computationally in developing algorithmic models and pedagogically for teaching more experienced students, while the core of each remained pedagogically unexplored though it is still considered understandable and suitable to introduce fresh minds (like the beginners) to design in a well defined manner.

The research here implements a rule based reasoning approach in the beginning design education. The teaching methodology is loosely based on the concept of grammatical design, an idea that was first developed by Stiny and Gips (1972) as "*Shape Grammars Formalism*".

Grammar's concept draws on analogies between visual and natural language, capturing a sense of order in matter and form. It is therefore familiar beside other terms like "style" and "theme" that highlight the awareness of form repetitive patterns, constituent parts, compositional rules and families of designs that share common features. Using "grammar" and "language" as metaphor in design is an attempt to make seemingly tacit practice explicit through defined criteria. The methodology breaks down in four key components (Burton and Radford, 2003):

1. Vocabulary: a collection of elements of an object similar to words in a language.
2. Rules: which guide the way the vocabulary is combined and modified.
3. Derivation: a process by which a product derives from its earlier versions of the same product to its final state.
4. Languages: families or corpus of products, which share common formal features, and can be seen as derived from common set of rules.

Although there is no comprehensive literature about using grammar systems for the beginning design studio education, the methodology is thought to be well-suited for the early teaching of composition and visual correlations such as proportion and symmetry (Knight, 1999). It is also very significant to be used under the proposed pedagogical approach

as synthetic shape grammars involve a playful "making" process. This could be clearly seen in examples like Stiny's kindergarten grammar, Knight's UCLA work (Knight, 1999), Eizenberg's Wright grammars (Eizenberg, 1981) and Flemming's Wall grammar (Flemming, 1989). These examples show how a simple making mechanism enabled students to producing large and complex designs in their studio experimentations.

Structuring the first year studio

During the course of the beginning year, design studio exercises used to be set for the *early, mid* and *final* stages according to a gradual complexity plan. Students usually begin with abstract actions (Kiessel and Abbasoglu, 2008), starting at the early *Abstract experimentation* stage with simple design assignments that are mostly about abstract or artistic explorations of shape composition, form generation, color and texture, etc. *Goal driven composition* at the Mid-Stage introduces some limitations to the design exercises in order to teach students to design in response to a defined purpose. More complex design requirements are introduced during the final stage of *Experiencing architecture* in a complete (yet simple) architectural project.

But the closer look at the novice students 'thinking behavior and the expected learning outcomes reveals that the complexity plan in itself is not enough, there are other factors that should be altogether responsible for defining themes to control the selection of each stages' exercises. For example, the target thinking type at each stage should be defined, knowing that the architectural education aims to develop a bipolar thinking skill for students (Lawson, 2005), teaching them to control, combine and alternate between rational and imaginative thinking types in order to produce logical yet artistic designs.

For the proposed structure of the first year studio the induction to imaginative thinking at first is favored. This is thought to excite the sense of curiosity and creative skills and reflect the inner personal needs. Rational thinking will be gradually merged throughout the whole year course at the expense of imaginative one by the emergence of more complex design problems. Students will then need to make more logical (beside artistic) connections, reaching at the end to a point where they gain the ability to control the alternation between both thinking types .

Targeting the student's thinking skills, one must also understand the main productive thinking factors subdivided by Guildford (1956) into cognition, production and evaluation. These are not entirely separate activities (Lawson, 2005), nor are they linked in a static way during the process of thinking. A productive design thinking most likely begins with "cognition" appreciating the relationship between the given elements of the problem rather than beginning with "production" directly in a self reflective way.

This is why the first year strategies are structured to nurture first, the skill of seeing to recognize (analysis) and appreciate (evaluate) in the early stage themed *Recognition*, stepping forward to emphasize more on reflective design in the *Production* stage, and finally to test the application of the three skills in the final project during the final *Evaluation* stage.

This studio structure is believed to build accumulative skills for students and develop their critical thinking in a more creative way, enabling them to target any further design problem successfully regardless of its complexity.

During the course of the first year studio, three main experiments were planned, each under one of the pedagogical themes and the remainder of this paper will focus on the first early stage experiment of "Recognition".

The early stage: recognition

At the early stage, design exercises are planned to endorse a sense of visual reasoning, inspired by Leonardo Da Vinci's "*Saper Vedere*" which is meant to deal with a capacity more than observation (Kucker

and Perkins, 2005)

Why? - Saper Vedere (Knowing how to see)
It is important that students in the very beginning of their design education develop a critical eye that knows: how to see. Nurturing the skill of seeing in beginners is not only about the observation of figural appearance, it is more about acquiring the ability of questioning what is being seen, as well as imparting a manner for deducing and proposing what can be seen. Training the student's eye for such skill requires a training of simultaneously thinking and making together. This also motivates a sense of visual curiosity that will soon become the core of the analytical process of reasoning that fuels creative work.

The recognition (and respect) of the relationship between the given elements of the problem provides students with some start points to begin their design and a logic to build their design decision on. It also encourages them to take control over their decision making process from the first beginning

How? - Divergent or convergent task?
Before students get involved with real world problem, they should be allowed a free and open ended regime in which free expression is encouraged. This is what was previously meant by promoting the induction to imaginative thinking at first. It also means that the early stages exercises are more about divergent, intuitive and imaginative tasks rather than convergent, rational and logical ones.

Introducing students to design from the wide gate of imaginative thinking is believed to unleash their hidden abilities, unblock alternatives and encourage the emergence of original and creative ideas. Later, it will provide them with the proper foundation to gradually implement logic and rational thinking without scarifying Creativity. This may aid achieving the delicate balance between formal/deductive/convergent on a hand and adventurous/divergent thinking on the other.

The early stage grammatical model

The implemented grammar should mainly respond to the previous "How? and Why?" answers on a hand, and the nature of the beginning design students on the other.

To develop the novice students' analytical ability the implemented grammar process was in the simplest form of the basic analytical grammar process. This simple formula of analysis/design has been used mainly as a comprehensive shape grammars exercise in shape grammars/ design computation courses. It has also been an effective teaching tool for studying compositional attributes of a style or a language of design (Knight, 1999).

According to Chase (2002), generating designs with basic grammar process involves two main stages (Fig. 1). First, the development stage where vocabularies, rules and initial state are initiated. Second, the application stage where rules are applied and designs are generated.

In Analytic grammars, development starts by the analysis of a specific corpus of designs in term of similarity of some spatial descriptions, those

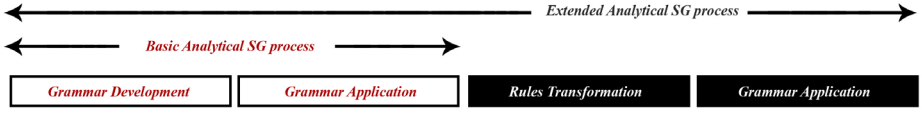


Figure 1
Basic and Extended Analytical grammar process

descriptions are then extracted in the form of vocabularies, rules and initial state.

In the proposed model, a less ambitious analytical grammar will depend only on the students' extraction of the basic compositional elements (vocabulary, rules or both) and their exploration of different ways of rules application.

The early Stage Experiment: Seeing Shapes (Ambiguity)

One fact of the beginning studio is that novice students are more absorbent for new knowledge and experiences in their early design experimentations than other advanced students. Once they have seen something done in a certain way, or done it themselves, this experience tends to reinforce the idea in their fresh minds and may block other alternatives.

Therefore, instead of teaching students to see things in a definite way, the proposed exercise intends to train their eyes on flexibility where there is no correct answer and all possibilities are open.

The experiment's theme is inspired by the same concept from Stiny's book "Shape: Talking about seeing and Doing "(2006). The idea is based on "Ambiguity", one of the most interesting qualities of shape where they can be surprisingly seen different every time, our perception can fuses, divides or connects them freely, and one can always see something new. This opens the minds to surprises and new understandings helping students to recognize possibilities when they present.

Unlike preconceptions and ignorance that close potentials and limit the possibilities, ambiguity brings novelty that makes creative design possible (Stiny, 2006). In fact, Creativity happens in response to ambiguity, when students try to build relations with a whole that seems to be unrelated.

Temple (2009) argued also that challenging students to make this kind of creative exploration undermine preconceptions deeply enough so as to render these preconceptions ineffective for the project-at-hand.

The Workshop

The conducted experiment is devised on the basis of the "recognition" theme and the proposed teaching methodology. The application's framework is loosely based on the basic analytical grammar's process that consists of the two stages of development and application. The development stage involves the extraction of the basic design elements (vocabulary) while the rules of composition are chosen from the basic transformation rules of transition, rotation, scale, etc.

The grammars' formalism was not introduced separately in the introductory lecture nor was any historical background of the theory, the emphasis was on the processes of visual reasoning, extraction and application while the conceptual grammar framework was tacitly presented through illustrated examples.

The students' work was carried out in the traditional studio environment and presented with sketches or built-up models. The same work could be carried out by CAD software using computational models, thus increasing the number and varieties of alternatives and stimulating the use of CAD at an early stage, but in fact this requires more experienced students with a sufficient CAD background which is not the case of the beginning students at this early stage.

The workshop took place after a couple of months from the beginning of the early stage and was conducted on two groups of Students:

- *Group A, the Strathclyde University Students (UK):* Within a Project based Studio curriculum, students have some familiarity with "design" as they were confronted with designing and making from the beginning of the year. They probably have not yet developed a sufficient understanding to drawing techniques, design theories or any other related materials
- *Group B, the Alexandria University Students (EGY):* Studio education here is mainly about funda-

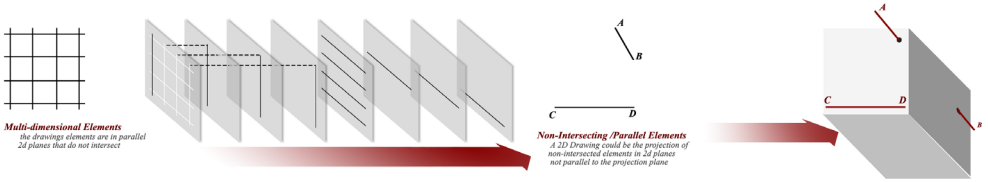


Figure 2
An example on the presentation of a shape as possible projections of multi-dimensional elements

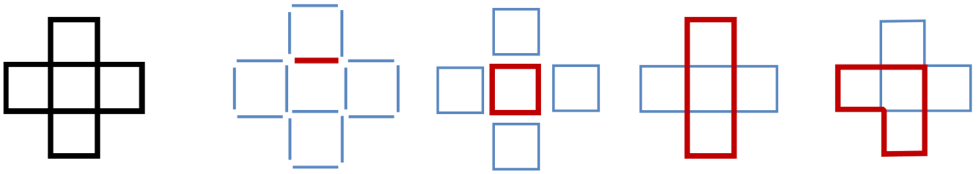


Figure 3
An example on Ambiguity that shows how to perceive the basic elements of one shape in different way

mentals and basic design. Students have not been subjected to any kind of designing or modelling activities ,yet they have fair amount of knowledge about drawing techniques, design principles, etc

The experiment began with a quick lecture about shapes and *how do we see* it from a 1D to 3D perception, accompanied with examples from architectural masterpieces with basic geometric forms. The next part *how to perceive the components of a more complex composition in 2D or 3D?* started by identifying the composition's basic elements (vocabulary) then the way they all connect (addition or subtraction).Examples like "the ice-ray grammar" were shown to demonstrate the simplicity of the vocabulary behind complex patterns like the Chinese Ice Lattice designs.

Afterward students were challenged with indirect and more complex ways of conceiving shapes as possible projections of *multi-dimensional elements* . Figure 2 shows that drawings on paper does not always present elements on the same plane, it could simply be a 2D projection of shapes on different levels (parallel or not).

They were confronted with another fact of ambiguity that lines in a single shape can fuse or divide in endless ways, meaning that shapes could be regarded as consisting of elements in different relations and limitless length (Fig. 3). This certainly opened their imagination for more possibilities and different understandings of the same shape and its basic elements.

To insure a proper understanding and better application for the workshop's experiment, a

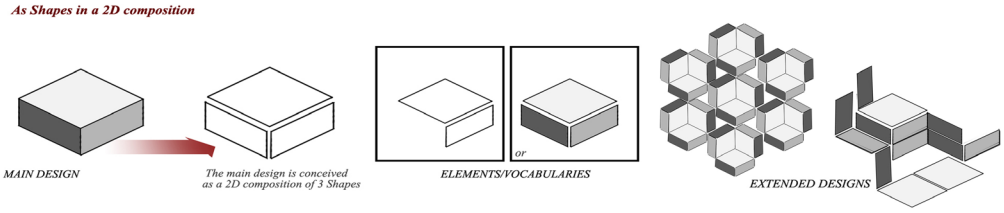
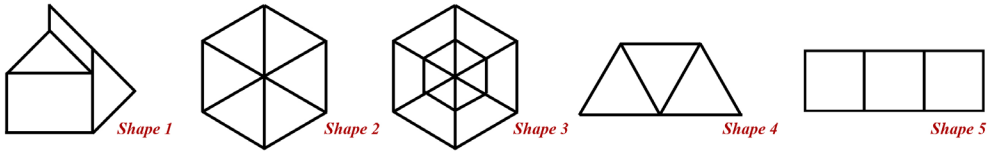


Figure 4
Part of the tutorial's example that shows the process of vocabulary extraction and design modification and extension

Figure 5
The five given shapes of the workshop



comprehensive example was illustrated in which a 2D shape/design was seen in different 2D and 3D ways. Taking into account the previous discussed facts about shapes, the main design's elements were extracted and then used to extend or modify the original design (Fig. 4).

At this point, students began to be more attentive about what they are seeing; they became aware that something different lies behind every simple layout of a shape. They were ready for surprises and some were eager to see. Students were then given the experiment which is more like a creativity test of "give some different usage to this ..." instead it is about "give different explanation for the drawn 2d shape". They were grouped in groups of fives; each group was given one of the 2D shapes in figure 5.

They were then asked to draw at least 4 different readings for the shape and its basic elements with at least one 3D interpretation of which. To extend and modify the existing design they have to extract its basic elements and work with basic geometric operations to create their new designs.

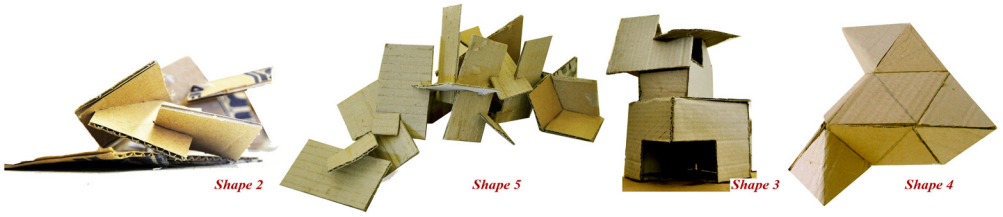
Observations and remarks

One of the main observations of the workshop is that most of the group B's students desired to solve the exercise in a very direct way from the moment it was given; they had the tendency to move directly to finished solutions giving less time for considering different patterns of seeing the shape. They chose the clear and shortest way thus spent more time experiencing design and composition with these elements. This unplanned opportunity of model making and practicing design was what they were waiting for since their first day; they tried therefore to impress their tutors with their-yet limited - design abilities (Fig. 6).

On the other hand, students of Group A were more stress-free dealing with shapes as this was not their first design experience. They spent more time seeing than doing, trying to find answers for what they see, giving the imaginative process much more time. There final designs were much more interesting (Fig. 7) yet less in numbers than the other group's ones.

Even though Group B concentrated on Making, their perception of the design elements and visual reasoning process was not to be overlooked. They

Figure 6
Some of the Group B's designs that were built on the basis of simple and direct interpretation of the basic elements



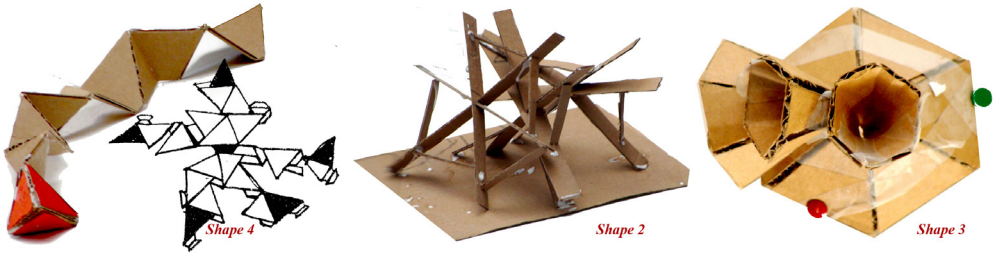


Figure 7
Some of the Group A's designs that shows innovation in both stages of basic elements recognition and Design

followed even the fine detailed of the given tutorial example, considering its shape interpretations options as models to mimic, thus extracting the design elements following the same typology (Fig. 8a). This behaviour is surely affected by their pre-university educational background where knowledge was often compartmentalized and memorization and recall were the primary aim.

Fortunately, students were required to develop alternatives more than the given types in tutorial's example; they ran out of clues after about three ones, began to search for more ideas and as a result, they were forced to be freer in their explorations. It is therefore thought that students could be more independent if they had the chance for more exercises under the same theme or maybe more time for developing the exercise's alternatives.

Unlike Group B, Group A Students were far more creative in their own explorations, though some of them also depended on the tutorial's example they rarely developed alternatives or propose elements that responds to it (Fig. 8b). They worked with lesser alternatives but also modified, changed perception several times and enjoyed proposing different ways of seeing. It is within a project based studio where they can develop analytical skill of understanding the composition anda generative one of composing, and this could not be achieved unless an early experience of seeing and making is gained.

After the workshop, each group was asked to present their final ideas. Although lots of them were not aware about their own designs' quality or even understood the composition at the beginning, they were able at the final presentation to sum up and describe their concepts in the matter of personal perception, the design process or according to their knowledge of design principles. Their attention was also drawn to the interesting fact that there were no two identical designs presented, even though they all began from the same shape.

These points were later stressed in the feedback session, highlighting the process in which the final design was generated; a process of analysis, questioning, exploration and evaluation that occurred during phases of design developments not just in an inspirational moment of creativity as they thought.

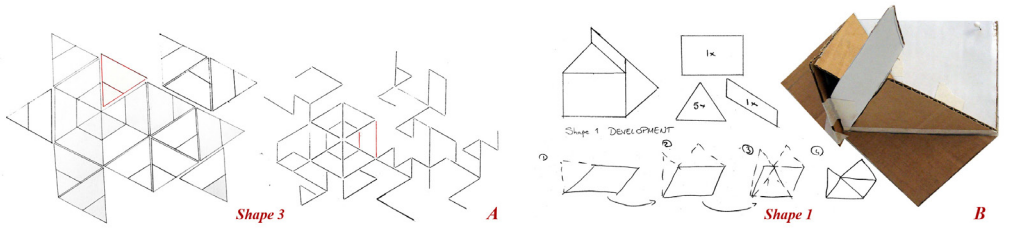
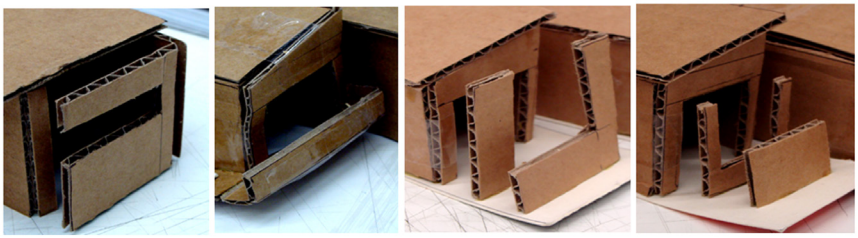


Figure 8
(A) Group B example that shows more commitment to the tutorial's steps and typology (B) Group A example that shows respect to the tutorial steps and less commitment to the elements' typology& application context

Figure 9
a Student's concept development for the "Room with A View" project influenced by the "seeing shape" experiment



Concluding remarks

Such process not only motivated the students' ability to see and make respectively, it also developed flexibility in design, an analytical awareness as well as a confident to take design decisions. The analytical skill allows them to build their proposals on a creative assimilation of the existing information and the circumstances of the current situation. Furthermore, this became a good start point for the next level workshop where students will be learn to design in response to some limitations like function, human scale, surrounding environment, etc.

One of the conclusions that came out of this exercise was that even students from both groups who initially seemed to express weak design abilities came up with very satisfactory results. This may be attributed to the indirect design process that allowed students to blindly follow a path of though without knowing where it would lead to.

The abstractness of the exercise forced them to think only about designing and following the process. Specially for the inexperienced group B students, they starts with spontaneous actions and they tried later to connect and reflect their knowledge about design principles concerning their project , reaching to a proper awareness – at this stage - of design. Such behavior guided them to interesting designs that were not expected and were also praised by their instructors.

One question that arises out from these observations is whether the accomplishment of students is momentary- only for the time of the experiment- or will it last and affect their design behavior in future projects. The plain truth is that no one hour workshop is enough to make the big change; it has to be carried out as a concept through the project(s) of the early stage or to be followed by other design activities under the same theme.

But considering the available circumstances, another feedback was given for the Group A students reflecting the workshop's outcomes and skills on their ongoing project "*A room with a View*". Their progress was later tested and monitored throughout the project phases and again at the final presentation. The evaluation of their progress came up with satisfactory results, showing that students were more flexible in developing further alternatives for every stage and most of all they tend to analytically consider the problem in different ways, in most of which, the ambiguity of the "View frame" in the previously mentioned project was the motivator for the design layout (Fig. 9).

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