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The New Handout: Interactive Animations and Foundation Pedagogy

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Introduction

Foundation design studio (first year) in the School of Architecture introduces essential representational skills and design concepts through a rigorous sequence of hand-drawing and physical modeling exercises. In particular, first year emphasizes the use of 2D and 3D diagramming as an aid to understanding and generating designs. Unfortunately, teaching this to students can be a challenge. Our program's diagramming style involves complex geometric procedures that require a high degree of precision. Although we provide clear descriptions using serial images, we have found that many students still have trouble making connections between what they are trying to draw and how to produce the correct drawing. This paper describes a pilot study we conducted to determine the impact of interactive digital materials upon a preexisting curriculum with traditional handouts and documentation. In a year-long project, we developed and assessed a set of user-controlled animations as a supplement to our current teaching methods. Although our research is still preliminary and there are many technical improvements to be made in the animations themselves, we found evidence that animations can help beginning design students learn architectural diagramming methods.

Project Rationale

Much of today's architectural pedagogy is based on a master / apprentice system with its origins in the École des Beaux Arts[1]. As a result, teaching and learning in contemporary design studios is highly interpersonal and hands-on, with considerable contact hours compared to other types of university courses. While this type of instruction is essential to training representational skills and design thinking, we have found that beginning design students also need access to supplemental resources that can assist them with review and self-remediation outside of the studio. In our first year courses, these resources entail a considerable amount of visual and written information. The materials for the first semester alone comprise over 2,000 original high-resolution images and one hundred-fifty digital models (Fig. 1). Much of this material is related to the production and interpretation of diagrams.

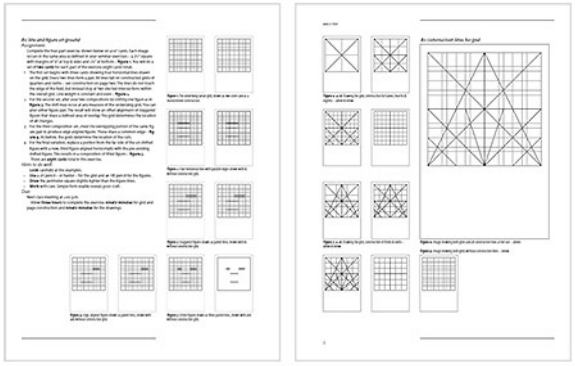

Fig. 1. Sample handouts from foundation design studio

A large quantity of supplemental material is necessary because the majority of lessons involve step-by-step descriptions of design exercises. While these appear to be helpful to our students, our experience has made us question whether these resources alone are sufficient. Research suggests that breaking down techniques and

conceptual explanations into discrete steps can impair comprehension of the task as a whole[2]. As exercises of design and craft, there are nuances and steps-between-steps in diagramming which are not quite captured by sequential stills or even video. Moreover, in these formats, students experience the material as a passive experience when active learning may be more appropriate[3]. Given the complexity of diagramming as a design activity, we wondered whether other media could communicate our lessons better than sequential images.

In response to our questions, we conducted a pilot study to convert some of our teaching materials from static sequential media (Fig. 2.) into animations and assess their impact upon the students. Our goal was to produce interactive online content that functions less like passive instruction manuals and more like what our students experience in studio: a hands-on master / apprentice approach that makes them active participants in their professional, creative, and intellectual development.

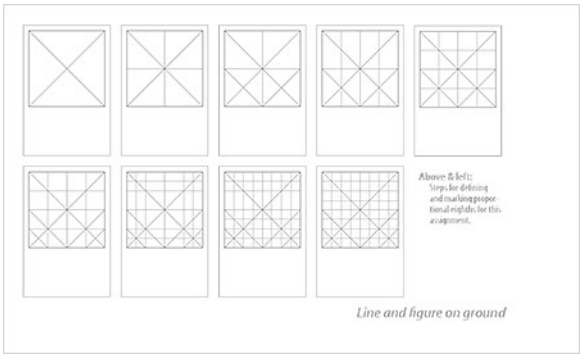

Fig. 2. An example of a serial diagramming sequence

Animations in Education

A review of existing educational research helped us understand how animations can be used to supplement other teaching methods and materials. In architecture, the use of instructional animations has been mostly limited to teaching building technology topics such as structures and environmental systems. Anecdotally, animations have improved student engagement with this material and helped many students master difficult concepts[4]. However, we could find no examples of their use for teaching diagramming in foundation design studio. While there are a few books that demonstrate how to construct and interpret diagrams, such as Architectural Diagramming[5], Precedents in Architecture[6], and our own textbook[7], none of these has animated supplemental materials.

Despite the lack of architectural precedents, there is a considerable body of research concerning teaching and learning with animations in other educational subjects. For instance, in math[8], the sciences[9], medicine[10], and computer science[11]. In general, it has been shown experimentally that animations can improve student learning in specific circumstances[12]. More relevant to our own research, we found evidence that animations are superior to static graphic sequences when applied to teaching motor-skill tasks such as folding paper, geometric construction, and handwriting[13]. This seems to support the idea that animations can help architecture students learn to construct diagrams.

It is important to note, however, that merely introducing animations is not sufficient to improve learning. In fact, studies have found that animations can be harmful to a student's performance[14]. The differences in outcomes are thought to stem from how the animations are designed and how they are used in class. For example, factors such as the speed of the animation, the tone of the narration, and the positioning of labels can affect how well students make use of animations[15]. In addition to design factors, pedagogical factors are also important. One problem with the way students learn animations on their own is that they tend to focus on the wrong details and fail to create coherent generalizations. To prevent this, learning has to be structured and guided to support animations, so students can process information needed to make use of them[16]. Towards this end, part of our research explores how to format and teach with

the animations in the context of architectural studio.

Methodology

In the summer before our fall 2013 studio, we worked with student research assistants to design and implement the new animations. The first task was to choose which lessons would benefit from the introduction of the updated materials. Because we did not want prior student knowledge or habits to bias our study, we purposefully selected one of the first groups of assignments in the studio. The diagrams we chose to animate focused on crafting a relational grid. This is a grid whose generation is geometric / relational in process rather than from numerical measurement. These assignments provide a good test case for animations because they exhibit many of the problems with teaching diagramming mentioned earlier: the need for precise construction, complexity of sequencing, and the need to connect intent with execution. Learning to correctly generate grids is important because they provide a foundation for later analytical and compositional exercises. The specific sequence we captured with animations entails three cumulative lessons: 1.) subdividing (finding) a square; 2.) using the square to divide a 2x3 field; 3.) and composing simple geometric figures within the field, utilizing principles of formal extension[17] (Fig. 3).

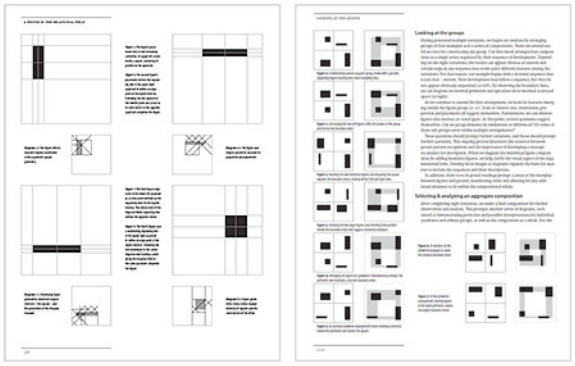

Fig. 3. Lesson for animation #3: Figures in a relational field

Once we selected the lessons, we conducted a design charette to determine the appearance and function of the animations. Returning to our earlier research, we made sure to draw from the best principles for instructional animations. The final version of each animation was carefully designed, not only to match the structure of the lectures and textbook descriptions, but also to capture the nuances of actually drawing the diagrams. For example, our sequences show students how to locate the starting position of their pencil and which direction to draw their lines. This detail may seem trivial, but is, in fact, critical for making well-crafted and precise drawings. While it is one of the most difficult techniques to communicate with static media, it is well suited to the medium of animation.

Besides matching the content of our face-to-face presentations, another goal of our animation design was to improve upon them where possible. One way we attempt to do this is by leveraging the capabilities of digital media to ensure that students can always follow how one step leads to the next step and can understand where each step falls within the full construction. Towards this end, we use color, symbols, and animated state changes to focus students' attention and create a visual hierarchy that clarifies the order of the process (Fig. 4). Red highlights, for instance, denote the object currently under scrutiny in the composition. Open circles indicate where a line under construction begins and ends. We also animate finished lines to fade them from red to gray (guide lines) and black (final lines). This makes it easier to determine how one step leads to the next. In addition, the animations have a two-column format, where the left column shows the current state of the diagram and the right demonstrates the procedures. This helps reduce the complexity of the process and helps students navigate when they repeat or skip steps within the drawing.

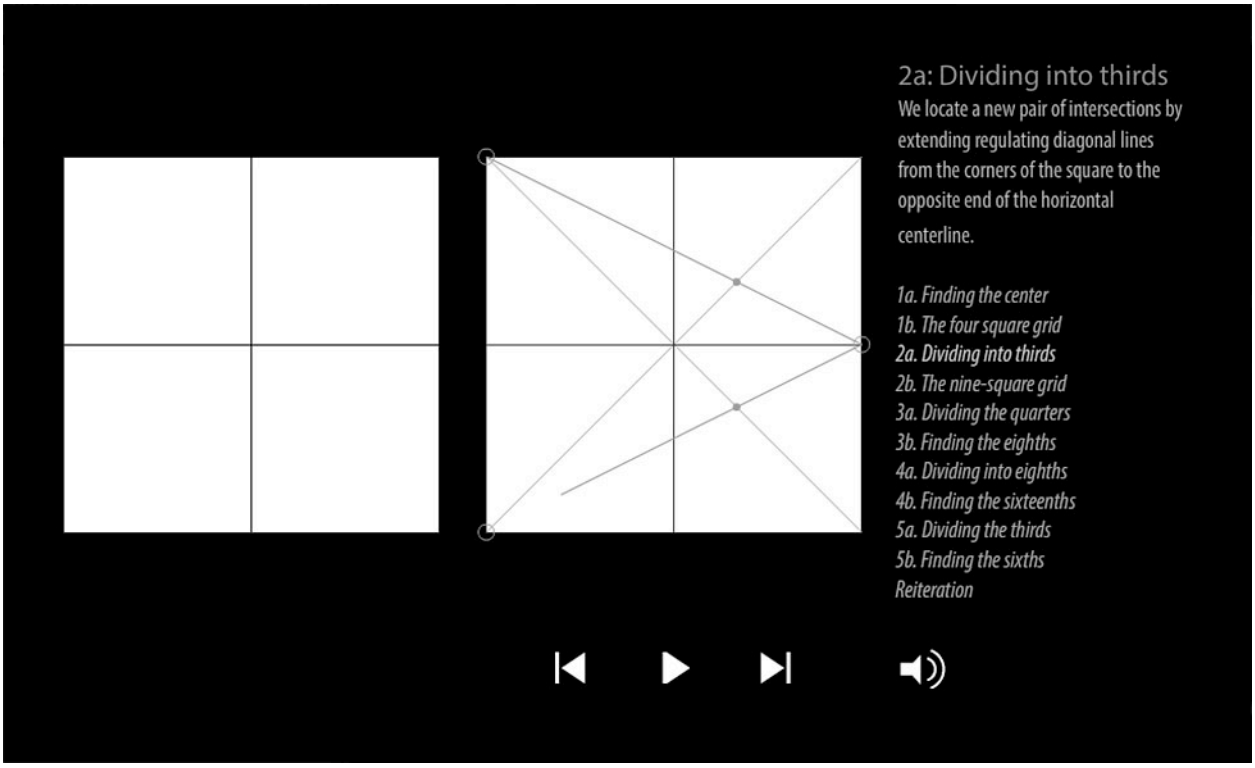

Fig. 4. An animation, stopped in mid-sequence. The figure on the left is the current state of the diagram. The other figure shows a line being drawn through points intersecting guidelines. On the far right, diagram steps allow students to skip to different parts of the exercise. Controls at the bottom of the interface allow students to pause / play animations and mute/unmute audio narration.

The last step in the design process was to implement the animations. Originally, we considered making video animations, but these did not provide us with the visual quality or user control that we felt the lessons needed. Instead, we produced the animations in Adobe Flash software. The deciding factor was that our teaching materials were originally drawn in Illustrator and this made it simple to import and animate them while preserving the clarity and quality of the native vector drawings. In addition, because Flash was first developed for animation, it also had many features that helped us organize and code the interface. The platform has limits – in particular that Flash files will not play on iOS (Apple) platforms – but since this was intended as a pilot study, we favored it for expediency.

The final product is a webpage where students can select a lesson to follow. The interface for each lesson is familiar to students because it is based upon the layout from their course materials, with a column on the left for animations / images and a column on the right for descriptive text and lesson steps. On the bottom of the animations are controls similar to those of media players: pause / play, rewind, etc.

Each lesson is broken down into steps (or chapters), which students can skip to and replay as needed within the interface. Most lessons are 5-10 steps long, as we felt this was a good balance between length and depth of content. When the student first presses "play", the lesson begins from the first chapter. A text description appears with each step and is read aloud with audio narration. The steps in the animation are synchronized to the narration, so there is coordination between what students hear and what is being demonstrated on the screen. The

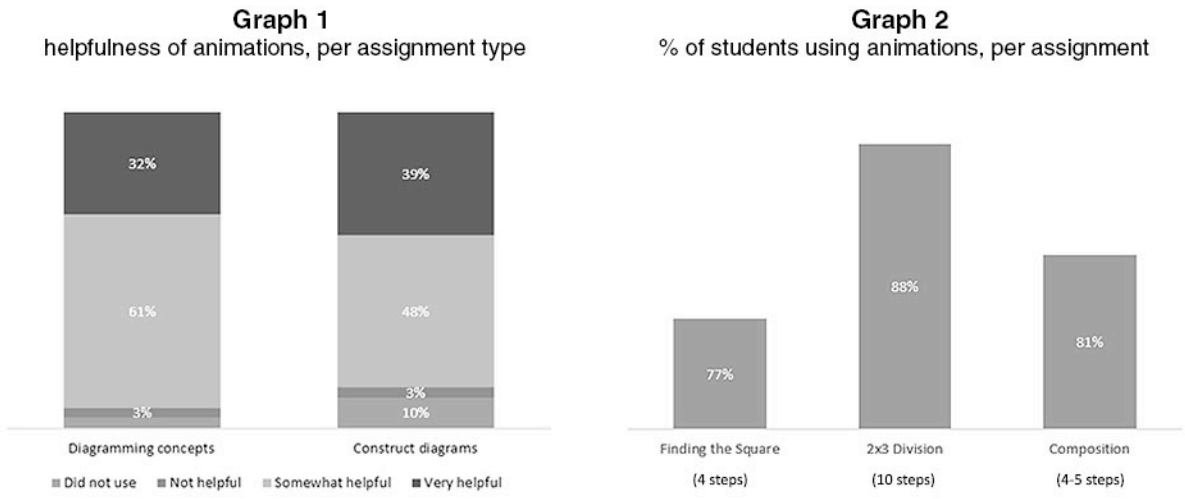

Fig. 5. Right: a majority of students told us the animations were helpful, but 10% fewer used them to learn diagram construction vs. diagramming concepts, an unexpected result; Left: students used the animations more for the assignment with the most steps (2x3 division), but not the most complicated one (composition), as hypothesized.

student can pause the lesson at any time and resume again with the play button. Audio can be muted and unmuted by the student.

We presented the animations to our students in the fall semester. First, they were demonstrated as part of the lecture on diagramming. Then, students were given descriptive handouts and access to a webpage containing the Flash files. Afterwards, we collected instructor observations of students and conducted two surveys: an online survey of Likert-style questions and short answers and a follow-up survey with essay questions. 53% of students (31 out of 59) completed the online survey and all of the students completed the follow-up. A research assistant collated, coded, and anonymized the survey data for analysis.

Methodology

In general, our students had a positive experience with the animations and used them often as a learning resource. All of the students surveyed reported that they appreciated having access to more materials online, although about one in five said they could not always access the animations when needed, due to problems with their browser or our server. Of the students surveyed, only one reported that he or she did not like using the animations for learning.

By wide margins, our students told us the animations helped them learn (see Fig. 5 – Graph 1). When we asked students how helpful the animations were for understanding diagramming concepts, 61% said they were "somewhat helpful" and another 33% said they were "very helpful". Repeating the question for diagram construction, we found that 49% of students thought the animations were "somewhat helpful" and 39% "very helpful." One student (3%) did not use the animations for diagram comprehension and three students (10%) did not use the animations for diagram construction. For both questions, only one student (3%) did not find the animations helpful.

In the essay questions, students described how they used the animations in their work. There seemed to be three main patterns of usage, which were about evenly split among the class. Some only watched the animations just before they worked, to refresh their memory and remind them of what they were supposed to do. Others watched the animations before work and kept

them open to follow along step-by-step. A third group referred to the animations only when they had questions about an assignment.

In terms of quantity of use, it appears that students tended to use the animations more when the method shown had more steps (see Fig. 5 – Graph 2): 77% referred to the animations "somewhat" or "very" often for the Finding the Square exercise (4 steps), 88% for the 2x3 division (10 steps), and 81% for the compositional exercises (average of 4-5 steps). This seems to indicate that students turned to the animations more when they had to coordinate a lengthier process, where digital media has particular advantages over the handouts.

We expected that students would find the animations more useful for diagram construction, which is more straightforward and procedural that the conceptual lessons, but students did not report a significant difference and found them about equally useful. In fact, students used the animations the least for diagram construction, perhaps because it was such a straightforward assignment. We did see differences elsewhere, however. In our observations with students, the students seemed to benefit more from the drawing and conceptual animations than the compositional ones in the third lesson. Because of its complexity, we thought students would use the animations more for the conceptual exercise, but they used it slightly less than the other types of exercises, on average. It may be the case that the compositional animations needed to be broken down into further steps. Our treatment may have been too subtle for such a complex assignment and therefore not as helpful.

The scope of our study is limited, so one should not draw too many conclusions from the available information. We only have data from slightly more than 50% of the class, which may not be enough for a representative sample. This data is also self-reported and therefore vulnerable to subject bias. Most importantly, this pilot study could not prove whether students actually performed better or had better process with their diagrams as a result of the animation. The effects of an educational intervention are difficult to measure under the best of circumstances, but particularly in studio because controlling for outside variables is challenging and the content of the work is subjective. Now that we have determined that animations are a viable addition to beginning design, developing a new study that addresses this criticism will be a priority.

Overall, the results of the survey suggest that the majority of students who used the animation felt they benefited from their inclusion in the course. All but one student said that the animations should remain part of our first year pedagogy. By any measure, this is a promising result for a newly introduced instructional method and grounds for further investigation.

Conclusion

Are animations "the new handout" for teaching diagramming in beginning design? This question is difficult to answer. Our experiment with animations demonstrated that most of our students found the materials useful as they learned how to construct and understand basic diagrams. Animations appear to have value, but do they have *enough* value? At the moment, we cannot prove that students who use animations learn any better than with traditional methods. This is critical, because in terms of student labor and our own time, creating the animations for the study was expensive. We were surprised to find that designing and implementing the animations took almost as long as creating the serial images in the first place – and this is after we already had the learning materials in hand! From a cost-benefit analysis, based upon assignment scores or final grades, animations are presently difficult to justify.

However, seen from another perspective, animations could provide a different kind of value in the classroom. If we replaced face-to-

face lectures and/or handouts with animations, for instance, this might allow instructors the class time and resources to cover more topics or existing topics with greater depth than before – essentially a flipped classroom model[18]. A different benefit of animations may be that they provide students with options for how they learn, resulting in a more enjoyable experience that is more receptive to different learning styles. If a student can choose how they learn and control this at their own pace, they might learn more in less time. With the growth of online courses and course materials, students today expect more flexibility in how they study. Someday, this expectation may even apply to lessons in their design studios. If this happens, developing more types of interactive learning materials may become a priority. Ultimately, when it comes to measuring and understanding the outcomes of using animations, they may need to be introduced apart from more traditional methods, in a primary role rather than a supplemental one (as in our study). We may also need to ask a different set of questions in our assessment.

This project was only a pilot study of animations in beginning design, but our first results are positive and suggest many opportunities for future studies. We have seen that animations can be used to teach diagramming. It will take more research to answer the questions of whether they ought to be used and how.

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