DATA ARCHITECTURE STUDIO: PREMISES, PEDAGOGY, AND RESULTS

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Abstract

Information Visualization (InfoVis) is the field devoted to the study of methods for displaying data in information-rich domains. Although most of the InfoVis solutions have been developed by scientists and engineers, artists and designers have began to bring in their expertise to advance the state of the art. The role that architects may play in this development could be substantial. Yet, participating in this new design frontier means to master skills and knowledge not necessarily covered by traditional architectural education. This paper presents a four-year effort devoted to develop such InfoVis curricula in an architectural context. The course encodes knowledge harvested over almost 10 year of InfoVis research bridging 5 disciplines and delivering many successful academic, technological, and commercial products. In particular, the class investigates the use of architecture as (1) a fundamental data organizational device and (2) a research method of examination, response, and communication for InfoVis problems.

1. Rationale

A data explosion of huge proportion has been underway for over quarter century. Every second, millions of data points are stored, processed and disseminated. Similarly, engineers, medical specialists, stock brokers, network administrators, power plant operators, government officials, and other professionals are using data to make important decisions in their fields. Paradoxically, the very information outburst characterizing and fueling contemporary civilization is also what threatens its continuity and evolution. The reason is simple: the complexity, rate of change, and size of data being produced have overwhelmed our old methods of displaying them to the point of creating potentially dangerous situations for individuals, organizations and society at large. We all know of famous break-downs in decision making due to poor data displays (e.g., the three mile island crisis, the Challenger disaster, Chernobyl, etc.). However, these are easily overshadowed in terms of cost, casualties and productivity loss by more systemic and pervasive errors occurring in daily information-driven activities.

Information Visualization (InfoVis) is the field devoted to the creation and evaluation of methods for displaying data in information-rich domains. Although most of the InfoVis solutions have been developed by scientists and engineers, artists and designers have began to bring in their expertise to advance the state of the art. As we have argued elsewhere (Bermudez et al 2004a-b), the role that architects may play in this development could be substantial. Yet, participating in this new design frontier means to master skills, knowledge and methods not necessarily covered by traditional architectural education. It is therefore imperative to create curricula that prepare future architects and designers to engage in this new and alternative practice of architecture.

2. The class

The course (arch 6261: Data Architecture) has been a four year effort devoted to develop such InfoVis curricula in architectural education. It has allowed us to encode knowledge, techniques, and skills harvested over almost 10 year of InfoVis research bridging 5 disciplines and delivering many successful academic, technological, and commercial products. The class is eight weeks long, meets twice a week, and taught at the graduate level. For a student perspective, refer to Parera (2003).

Teaching this class means to focus in four architectural competencies central to successful InfoVis. We slowly and often surprisingly came to learn about their power through our years of research efforts in data architecture. It is these core proficiencies that make architecture especially relevant to InfoVis.

Representation expertise

Architecture has a centuries-old expertise in the representation, simulation and communication of diverse and complex types of information. There is also a long tradition of using depictions to conceive the not yet built and speculate about impossible architectures and utopian environments. (Harbison 1991) Digital media gives architecture the potential to extend this expertise and visionary skills to other domains, notably in the creation of data environments wherein representation and imagination rule the day.

Formal semiotics

Architects ordinarily deal with the syntax, semantics, and pragmatics of form and space. As a result the discipline has collected a comprehensive knowledge base of the nature, methods, and value of basic 2D and 3D design and their relationship to human collective and individual psychology and behavior. (Bogdan 2002, Massironi 2002) Such expertise in formal semiotics and representation lays the ground for developing graphic conventions to successfully encode (and decode) data parameters into representations. It is thus natural for architecture to take a leadership role in advancing InfoVis.

The studio model & the master builder: training supporting interdisciplinary research

Developing new data representation architectures demands responding to many intertwined issues. Not only must we have some cognitive model of the user's decision making process, but also determine the nature and behavior of the data (structure, process), the type of problem, needs and requirements, and the technology to deliver such depiction. Clearly, architects alone cannot do this. Bringing together the expertise of different disciplines provides the necessary tools to address this challenge. (Benowitz 1995, Khan and Prager 1994) However, carrying out interdisciplinary collaboration is not easy. Here the tolerant yet critical and productive ***architectural design studio*** becomes remarkably useful. The ***studio model*** offers a real intellectual and physical environment for conducting inquiries engaging multiple viewpoints in productive cross fertilization.

The design process as interdisciplinary research methodology

Our expertise in using the ***design process*** as a methodology for discovering, developing, and testing hypotheses is yet another reason behind the relevance of architecture in InfoVis. The *design process* allows for a spontaneous and natural way of socially engaging a wide range of disciplines and individuals working in difficult problems. This is in line with existing knowledge that the *design studio model* in general and the *design process* in particular are a successful working laboratory and methodology for addressing open-ended, fuzzy, and multivariable problems. (Cross 1982, Schön 1983)

These four architectural competencies and their natural application to interdisciplinary work are particularly relevant to architectural programs because they speak of the potential capabilities of our discipline beyond the tradition bound conceptions of research and practice.

3. Pedagogy

We use these four competencies as the pedagogic skeleton to approach and teach content specific InfoVis curricula. Yet, the learning objective is not just delivering InfoVis content to the students but instead using such knowledge to create new knowledge. In effect, as a graduate level course in a Research I university environment, an important goal of this class is to advance the state of the art in architecture and InfoVis. Graduate students are thus invited to contribute in the construction of knowledge at the very cutting edge of research. A pedagogy encouraging experimentation based on a "no wrong or right answers, only investigations" maxim is set in place to make best use of students' enthusiasm, risk-taking attitude, and self-criticism.

Although students spend considerable amount of time learning new software, the intensity, creativity and interest of the inquiry makes such effort endurable. Learning these technical skills is another important pedagogic goal in addition to communicating intentions, deepening a self-critical attitude, and developing research abilities.

Logistically, the class functions as a ***studio*** directed towards the solution of a design problem. In addition we conduct numerous lectures and assign relevant readings. Students work in small teams to create a productive and intellectual critical mass that makes best use of the short time available. More specifically, the class investigates the use of architecture as (1) a fundamental data organizational device and (2) a research method of examination, response, and communication. This is done utilizing a bi-directional strategy of study: the exploration of data through architecture and the exploration of architecture through data. Data is considered to be a construction material and cyberspace the natural yet unique environment for building information architectures. Although the focus is architectural, the class requires interdisciplinary conversations and research to approach, grasp and eventually solve InfoVis problems. Individuals from other disciplines (notably computer science, psychology, and medicine) participate in the class as students, guest lecturers, or critics.

3.1. First Assignment: "Power of 8" (2.5 week long)

The class starts by introducing students to the topic of InfoVis design while addressing a conceptual and mind-expanding assignment, called "Power of 8". The exercise aims at moving students into an intellectual/emotional space suited for a new understanding of architecture. The problem statement is only one sentence: *"In the midst of boundless virtuality, cyberspace architecture is expressed as* X^8*. Visualize it!"*

Such open-ended and provocative statement literally pushes students beyond their edge of architectural knowledge. All sorts of questions arise: Is there an 8-dimensional space ? Can you imagine n-dimensional form? What makes up architecture in dataspace? What is uniquely cyber? What does it mean to have an exponential increase versus an additive one? Students are asked to move beyond obvious solutions and think philosophically and metaphorically. They are told that although they may not know what this architecture could be, it surely does exist (virtually). In this assignment, the presentation quality is secondary to the idea pursued and the breadth and depth of the exploration.

After the initial intellectual puzzlement, students react by doing the obvious first, only to grow increasingly sophisticated in terms of ideas, design, and argumentation. Despite its short length, this project invariably disarticulates students' preconceptions and propels them into new understanding of the nature of design as a process of inquiry whose value clearly transcends the formal output.

3.2. Second Assignment: Data Architecture (5.5 week long)

Once we have gained students' attitudinal openness, we present an actual InfoVis problem. At this time,

Figure 1: "Power of 8" investigation by student Thomas Morahan.

we request students to utilize architectural methods, skills, and knowledge to solve it in the context of an interdisciplinary perspective. We have given students one of two basic types of InfoVis problems: (1) data representation or (2) data exploration. For instance, we have assigned students structured data (without their knowledge) and asked them to figure out the hidden order by designing information visualization instruments that enhance pattern recognition. On the other hand, we have also provided data that did not have known structure and the job was to try to find meaning in it. This latter is a much tougher problem but most rewarding if solved. Finally, last year we did an abstract, time dependent, and multiple relationships visualization problem because, as we have come learn, it is often the architecture of relationships which is the key to solve many InfoVis challenges.

Unlike the first assignment in which there is total freedom of exploration, the second exercise is based on hard data that serve as the bricks for building the architectural construct. This exercise teaches students that it is absolutely necessary to bring some bias into the reading/organization of information. No bias means no way of approaching the problem. It is essential that this bias be acknowledged from the very beginning. In this way, the design/research process becomes a way to test the designer's own biases towards the data. Poor designs demonstrate wrong or weak assumptions. Good results show potentially successful hypotheses that deserve further study. The design process follows this logic that is also at the core of the scientific method.

Naturally, students have had a much harder time with this assignment than with the first. Students demonstrate initial but at times sustained problems in logic. More so than in usual studio projects, perhaps because architectural students don't have enough training in focused and systematic reasoning as students in other disciplines do (e.g., philosophy, computer science). Another student weakness discovered is the difficulty in presenting and justifying ideas, especially when they are very abstract. Therefore, teaching students how to coordinate and articulate thoughts and design and then to

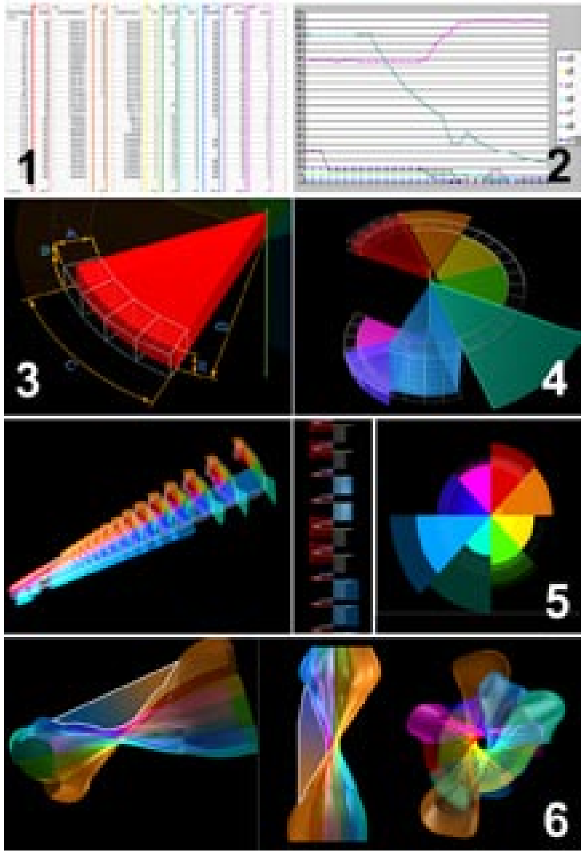

Figure 2: "Data Architecture". Visual summary of design process by student Curtis Livington.

communicate them to an interdisciplinary jury, has been an important component of this class. It is remarkable that, comparatively, such teaching has consumed as much time as the one required to deliver and guide the subject matter of the class. For this reason, we believe that this exercise is also very useful for assisting architectural students in developing high level logic and communication skills that often get forgotten in ordinary curricula and may surface only too late at the end of the program (such as in thesis).

The InfoVis work resulting from this assignment has been innovative and successful at solving the data problems assigned. In fact, despite the weakness in reasoning and communication described, architectural students have been incredibly creative, forthcoming, and productive at devising convincing solutions. This is particularly true when compared with the performance of non-architectural students both within the class and in our research experience with research assistants. Architectural students have at their disposal powerful problem solving strategies that facilitate the framing, proposition, critique, development, and visualization of solutions to difficult challenges. The four architectural competencies are at the very core of these remarkable skills not easily found in students from other disciplines.

4. Conclusion

Visualization has de-facto become an essential way to address not only architectural issues but also a wide variety of problems, disciplines, users and technologies. As argued, there are four core architectural competencies that place our discipline in a natural leadership role among many disciplines for advancing the state-of-the-art of visualization research and applications. The class presented is a first attempt at moving in this direction by teaching students alternative ways of exercising architectural competencies and practice. It is also a unique experiment on campus as it brings faculty and students from different departments to collaborate. In so doing, it demonstrates the value of architectural education and inquiry beyond the limited confines of our field. It also shows the potential leadership role that architectural schools and faculty may play in interdisciplinary education and research on campus and beyond.

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