A Designer's Approach to Scientific Visualization: Visual Strategies for Illustrating Motion Datasets

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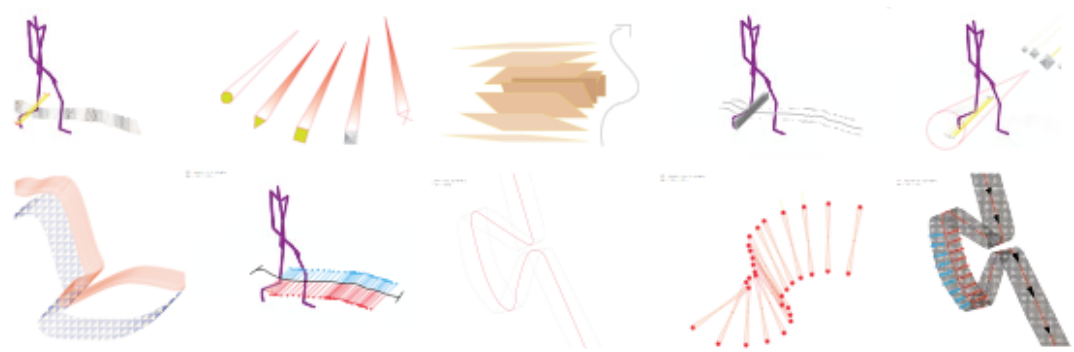

Figure 1. A small selection of images from a set of graphic designs for improving scientific visualizations of motion datasets. Unlike the typical programming-driven visualization development process, these images come from a set of more than 100 graphic designs generated in just over one week by a trained designer using traditional illustration tools, such as Adobe Illustrator. We are interested in how the graphic design insight evident in these sketches can be leveraged to improve scientific visualization techniques.

Abstract

We present a case study incorporating the process of ideation of an experienced graphic designer into the workflow of a team of programmers to improve scientific visualization methods. Our work highlights the current opportunities and reports on the process we have adopted for beneficial collaboration between designers, computer scientists, and other collaborators. The specific design problem we address is creating illustrative visualization rendering algorithms for describing complex motion data, such as those analyzed in studies of human biomechanics.

1 Introduction

Visualization has become an active area of development, research and teaching, not only in the computer science and engineering communities, but also in art and design. Within the visualization community, there is certainly a strong history of research into incorporating ideas from art and design into the illustrative rendering and other automated tools that we develop; however, to date, relatively little work has addressed the challenge of incorporating designers trained in the art and design tradition into visualization design processes.

The limited work that has been done in this area shows great promise. Early pioneers, such as Donna Cox, discuss the potential of "renaissance teams" serving science. More recently, Keefe et al. developed virtual reality design tools to enable collaboration with visual experts, such as illustrators, designers and artists [1]. Introducing designers into the scientific process via the mechanism of visual critique has also produced results that are "faster and more productive than quantitative user studies" [2]. For example, designers "improved the evaluation by providing insights into the reasons for the effectiveness of each visualization method and suggesting specific improvements" [2].

Our current research builds on these early examples of successful artist-scientist collaborations by presenting the process and results we have generated while investigating a particularly challenging current topic in visualization—effective depiction of complex 3D motions. Due to its importance in describing motion datasets generated in biomechanical studies, our work has focused initially on the problem of conveying changes in the axis of rotation for joints during a motion, such as walking. These data are complex in both space and time and are currently underutilized in analysis, in part because these space-time relationships are so challenging to depict and understand.

2 Background in Graphic Design Research

Graphic designers organize information so it can be communicated effectively. As the experience of the world has become more multifarious and nuanced, the demands of our visual perception have increased proportionally. So it is by no surprise that graphic designers, such as the first author, have become interested in learning and adapting ways to communicate within it. Using design to give shape to data and experiment with its abstraction not only challenges the viewer's visual recognition, it also provides access and insight to the hidden patterns of meaning that are revealed.

Within the graphic design field, an example of this type of visual investigation is Thorson's piece entitled, *First 24 Hours of Spring* (exhibited in the VisWeek 2001 Art Show). This piece is a visualization of data in which Spirographic images were produced using Processing from data of the first day of spring, showing how a complex data set can be presented, and communicating its key-aspects in an engaging way [3]. Although this piece is not intended to depict data in a way that helps a scientist investigate a current question, it does clearly show how designed thinking can produce abstracted and interesting results that inspire unique and more intuitive visualizations. This is the type of thinking that we hope can be applied more broadly in scientific applications. We are excited that doing so will likely lead to new discoveries both in science and in graphic design, such as the first author's MFA research, which explores ideas of visual representation and abstraction of communication.

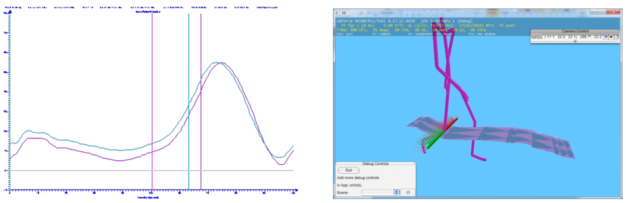

Figure 2. Left: A sample 2D kinematic plot. Right: A screenshot from the original 3D visualization, which was refined through the work reported here. These images served as starting points for the designer's ideation.

3 PROCESS: VISUALIZATION DESIGN CASE STUDY

Our team includes two undergraduate programmers and a Masters of Fine Arts candidate in Graphic Design, all delving into this type of research for the first time. Coming together in weekly meetings, the team developed a process of communication and production to create rapid results.

3.1 Process of Ideation

The designer's role in this process is to create an abundance of visual imagery, to spark conversation, inspire solutions, and identify positive and negative visual representations. This design process saves countless hours of programming, while still being able to produce conversations and achieve visual representations that can be critiqued for the specific dataset. After an introductory session to a specific problem, in this case the axis of rotation of the knee joint (fig. 2), a conversation including many questions and areas of interest are clarified for the designer. Current visualizations that have been created (fig. 2) are given to the designer to use as reference when creating alternate strategies. From the information collected, the designer uses her knowledge in graphic communication as a whole to create as many 2D graphic visualizations as she finds applicable to the problem. Our illustrations were developed using Adobe Illustrator, averaging about 63 illustrations a week to be critiqued. This is along with compiled visual imagery, to be shown as inspiration to the team, in solving similar visual problems. This quantity of visual inspiration excessively speeds up and gives variety to the process of visualizing the scientific dataset. Thus, we have found that the most radical change from our more traditional design processes is the speed at which the designer can create (so that we may all discuss and critique) many illustrations (e.g., fig 1), without having to wait for an idea to be programmed.

3.2 Process of Implementation

After being critiqued by the team, a sketch or two is selected to move forward into the programming phase. Fig. 3 shows one example sketch that we determined would be interesting to explore. With this very clear visual specification set out on paper in front of them, the programmers on the team were able to implement the idea within a few days, connecting it to the underlying dataset to create the animated visualization shown in Fig. 4. Reducing the timeframe of ideation to development to about a week, compared to the multiple months reported previously.

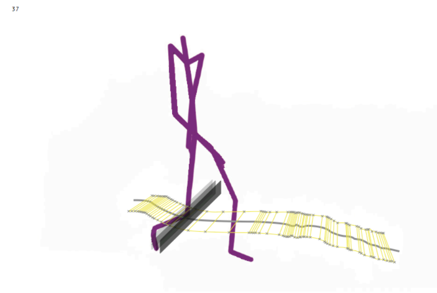

Figure 3. Initial sketch from the designer.

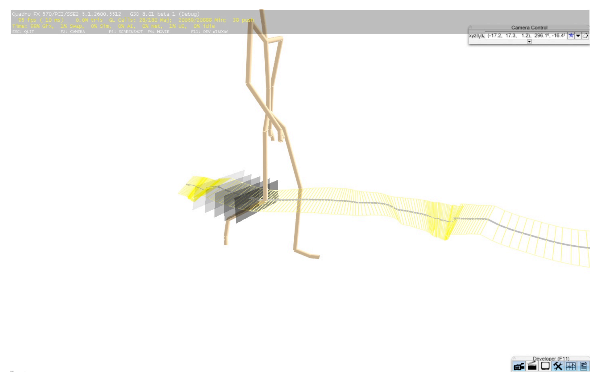

Figure 4. Data-driven, animated implementation.

4 SUMMARY AND FUTURE WORK

Design is a cross-disciplinary tool and way of thinking. In this research, design has proven beneficial as a method for rapid and expansive production of graphic design illustrations. There are ideas in art and design—creative intuitions—that relate directly to problems in scientific visualization, but that researchers in other disciplines would not necessarily connect. We report in this poster on the processes we have researched to harness these insights in the context of motion visualization. We are excited to expand this approach to address major current challenges in this area, such as understanding the impact of pain and disease on neck kinematics.

ACKNOWLEDGMENTS

This work was supported by the NSF (CAREER award and REU suppl. IIS-1054783). The database used in this project was obtained from mocap.cs.cmu.edu and created with funding from NSF EIA-0196217.

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