123D Sculpt: Designing a Mobile 3D Modeling Application for Novice Users

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Abstract

In this case study, we describe the design approach taken in creating 123D Sculpt, a digital sculpting and painting application for the Apple iPad. This paper will focus on tailoring the user experience toward casual users, introducing 3D (three-dimensional) manipulation tools and concepts through the use of metaphors.

Keywords

User Experience Design, Gestural Interfaces, Design Research, 3D Modeling, Mobile.

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g. HCI): User Interfaces.
J.7. Computer Applications: Computers in Other Systems.

General Terms

Design, Human Factors

Introduction

Our objective in creating 123D Sculpt was to create an application that could make 3D modeling accessible to casual users, while still providing functionality powerful enough to appeal to more advanced users.

Many desktop 3D modeling tools are designed for precise control and versatility, and are generally aimed at professionals. Consequently, their user interfaces can be difficult for casual users to learn due to

complexity and reliance on the user to be familiar with the underlying mathematical and geometric concepts behind 3D object manipulation (see Figure 1) [3]. Furthermore, on a touch-based device, the majority of traditional desktop interaction paradigms do not work well. These factors provided the impetus for us to develop an interaction metaphor and associated tools that could introduce 3D modeling to a casual user in a more familiar domain.
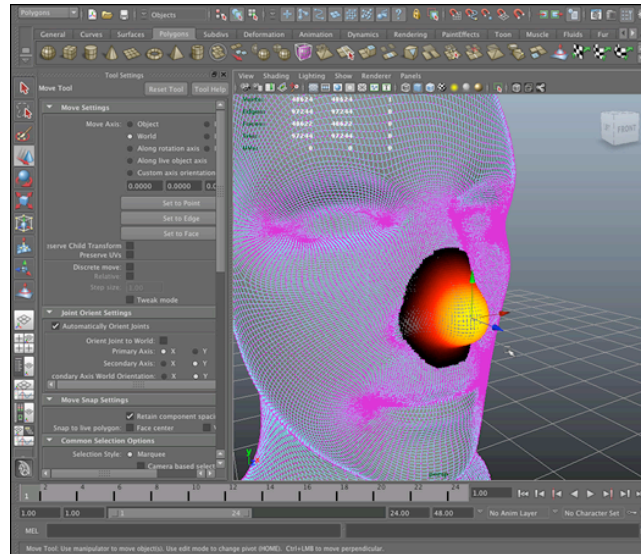

figure 1. The user interface for Autodesk Maya. Here, the soft select tool is used to select vertices of the nose mesh, to be translated later. Each tool offers many adjustable parameters. The user must grasp the concepts of vertex manipulation and selection as well axial transformation in 3D space.

The use of metaphor in interaction design is not a new concept, and can be a controversial topic [5], but metaphors are innately part of our cognitive processing [4] and (even if a designer does not provide them) users will bring their own "metaphorical baggage" to unfamiliar domains. We hope that by using metaphors appropriately, we can help users make the "cognitive leap" [5] to understanding the often alien concepts in 3D modeling applications.

Metaphor: From Sketching to Sculpting
There has been significant research into gestural sketch-based interfaces for freeform 3D modeling [1,2,6], which allow users to manipulate 3D objects directly, rather than abstractly through control vertices and curves. This method is seen as being more fluid and intuitive overall, largely due to the analogy implicit in pen-based interaction [3]. Taking this research into account, we conceptualized the application as "sketching in 3D", an idea which we later refined to derive the sculpting metaphor, on the basis of both concept and interaction design.

Conceptually, framing 3D modeling as "sculpting" abstracts some of the more complex geometric and mathematical principles by allowing users to relate to 3D spatial manipulation in a familiar, real-world context. To assess whether this conceptual framework would allow novices to more quickly grasp 3D manipulation tools, we conducted user testing with both novice and experienced users (see page 3).

In dealing with a touch-based device, the tactile analogy of sculpting fit better with common interaction paradigms than a sketching analogy. A fine-grained, pencil-type interaction would be difficult to accomplish with the coarse-grained modality of gestural interaction. However, gestures maintain the desired intuitiveness and fluidity; a drag gesture that can "push

figure 2. Mesh deformation in 123D Sculpt. A drag gesture is used to grab and pull the nose mesh. There are limited parameters for each tool. The geometry of the mesh is not visible to the user, nor is the axial system of the 3D environment.

and pull" clay around (see Figure 2) allows users to quickly rough out form and shape, as in real-world sculpting. By testing a prototype with both experienced and novice users, we were able to adjust the tool fidelity to balance interaction precision and fluidity, allowing experts to get the detailed results they want, while still appealing to novices.

123D Sculpt does not allow for blank screen creation of 3D forms, only for manipulation of existing geometry. This was suited perfectly to the metaphor of giving users a lump of clay to mould and shape, and, by providing various start forms, reduces the barrier of entry for less skilled novices.

Many people have the desire to sculpt well, but the knowledge of form and proportion required to create a convincing sculpture from a lump of clay can require years of study to master. To allow novice users to get a visually compelling result without requiring extensive practice and skill, we provided descriptive forms such as a simple human face and body (in addition to geometric base forms). We likened the provision of evocative forms to providing the base sculpture scaffold; allowing users to layer on mass and modify the form, just as they would apply clay to a scaffold. By providing successive layers of complexity (simple starting points versus more defined starting points), we hoped to not only ease novice users into the sculpting experience, but also provide more open-ended outcomes for advanced users (see Figure 3).
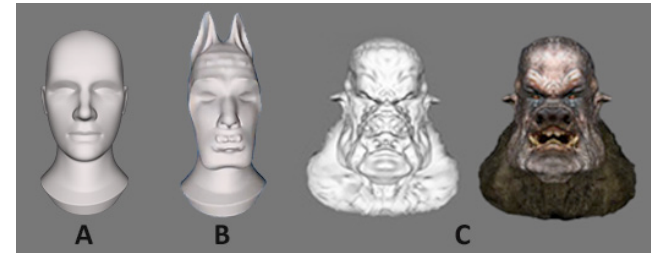

figure 3. Sculpting and painting done in 123D Sculpt. **A.** The human head starting form. **B.** Sculpture done by a user with no previous 3D experience. **C.** Sculpture done by Chris Kunzmann, a Character Art Director and advanced 3D user.

Usability Testing
To study whether 123D Sculpt could appeal to diverse populations, we conducted qualitative user testing with a prototype. We recruited a mix of children and adults, as well as novice and experienced modelers (see Figure 4). Participants were given a series of tasks that required the discovery and effective use of tools for object creation, object manipulation, and camera navigation. Afterwards, participants were asked to fill out a 7 point Likert scale questionnaire to query the intuitiveness, ease of use, and discoverability of the user interface.

Participants spent only about one hour discovering and effectively using the set of basic controls. Experienced users completed the tasks in an average of 54 minutes, and novices averaged 66 minutes (Figure 5). Most participants responded positively to the overall experience of using the application. For instance, both experienced users (scoring 5.6/7 on a Likert scale) and novices (scoring 5.3/7 on a Likert scale) found the camera navigation and object manipulation gestures intuitive.

Number of Participants	26
Experienced 3D Users	42%
Average Age	33 years
Users under 18 years	27%

figure 4. 123D Sculpt user testing demographics.

figure 5. Average completion time of user test tasks for experienced and novice participants.

In a similar first experience study of the professional 3D modeling application Maya, 3D novices were still learning to operate the camera after the first hour [7]. Comparably, functionality in 123D Sculpt was more discoverable.

The results of the usability testing largely supported our design decisions, however several improvements were identified which were integrated into the design. For example, as compared with experienced users (scoring 5.0/7), novices (scoring 4.1/7) were unable to intuit the function of some sculpting tools before trying them. The tool icons were redesigned, renamed, and their behavior tweaked, to make their effect more evident. The user tests also provided the basis for developing the application's help content and startup experience, introducing the tool and gesture sets to novices.
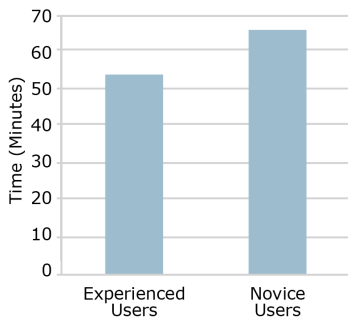
Outcome and Conclusion

123D Sculpt was launched in August 2011, and placed 3rd in the iTunes' free app category. It has over 1 million downloads, and has received positive reviews from both expert and novice 3D modelers.

This case study not only presents the design process undertaken in the creation of 123D Sculpt, but also showcases a method of approach to design problems in general. We hope to inspire other groups and provide insight into design methods and practice.

Acknowledgements

References

[1]   Bae, S., Balakrishnan, R., Singh, K. EverybodyLovesSketch: 3D Sketching for a Broader Audience. *UIST* (2009), 59-68.

[2]   Igarashi, T., Matsuoka, S., and Tanaka, H. Teddy: a sketching interface for 3d freeform design. In *Proc. SIGGRAPH 1999*, ACM Press (1999), 409 – 416.

[3]   Kara, L.B., D'Eramo, C.M., Shimada, K. Pen-based Styling Design of 3D Geometry Using Concept Sketches and Template Models. In *Proc. SPM 2006*, ACM Press (2006), 149-160.

[4]   Layoff, G. and Johnson, M. *Metaphors We Live By*. University of Chicago Press, 1980.

[5]   Saffer, D. *The Role of Metaphor in Interaction Design*. Thesis, Carnegie Mellon University, Pittsburgh, 2005.

[6]   Schmidt, R., Singh, K., Balakrishnan, R. Sketching and Composing Widgets for 3D Manipulation. *Eurographics*, 27:3 (2008), 301-310.

[7]   Sy, D. and Miller, L., Using Movies to Make Complex Software More Approachable, in *Proc. of Usability Professionals' Association (*2003).