

A Practical Evaluation of the Prototype Fidelity Debate

JENNIFER M. HOCKO¹, Bentley College, Waltham, Massachusetts

An organization's ability or willingness to incorporate prototyping into its development process may depend on prototype fidelity. With release cycles as short as 3-4 months, organizations often do not have the liberty of working with many design iterations and must immediately recognize the benefits of prototyping techniques. While considering these constraints, this paper examines some empirical and anecdotal evidence for using low- and high-fidelity prototypes and offers possible counter-arguments. Based on the inconclusive nature of the debate, this paper advocates performing individual evaluations to determine the appropriate level of prototype fidelity for a given organization and/or software development project.

¹Requests for reprints should be sent to Jennifer M. Hocko, 1800 Commonwealth Avenue #7, Brighton, MA 02135.

Running Title: Evaluation of Prototype Fidelity Debate

Key words: prototype, low fidelity, high fidelity, definition, debate, issues, software development process, usability test, heuristic evaluation

INTRODUCTION

Where low-fidelity and high-fidelity prototypes fit into the software development process and whether one is superior to the other has been the subject of many publications. To examine these questions, this paper first defines fidelity and describes a method that may be used to classify prototypes into fidelity categories. Once this foundation for discussion is established, some of the primary issues surrounding the low-fidelity versus high-fidelity prototype debate are described. Each issue's perceived importance within a fast-paced software development environment is considered, and the current research critically evaluated.

DEFINITION OF FIDELITY

To fully engage in the prototype fidelity debate, one must first establish a definition of the term fidelity. The fidelity of a prototype is explicitly defined by Virzi (1989, pp. 224) as "a measure of how authentic or realistic a prototype appears to the user when it is compared to the actual service." He further qualifies this definition by espousing the Turing test, a measure used in the artificial intelligence community to assess the intelligence of a system based on whether or not users can distinguish between human and computer interactions (Russell and Norvig, 1995, pp. 5). Similarly, in a high-fidelity prototype situation, users should detect no differences between the prototype and the final system.

METHOD FOR CATEGORIZING PROTOTYPES

Virzi proposes that the fidelity of a prototype be based on four primary dimensions: breadth of features, degree of functionality, similarity of interaction, and aesthetic refinement (Virzi, 1989; Virzi et al., 1986). Upholding the Turing test analogy, he also states, "a prototype that compromises on one or more of these four dimensions in a way that is obvious to the user is a low-fidelity prototype" (Virzi et al., 1986, pp. 224).

Virzi's method for characterizing prototypes may be problematic in two ways: it expects users to be knowledgeable about that which they may not know, and leaves room for subjectivity. If a user believes that a prototype is the

final system but designers know it only demonstrates a subset of features (thus compromising on the first dimension), should it be categorized as high fidelity as Virzi suggests? Does a designer always know what is obvious to a user? Depending on the dimension compromised, the distinction between unfinished representation and system version in the mind of the user (or across multiple users) may not always be apparent or consistent. Thus, a useful modification to this method might be to shift the point of view from the user to the designer, enabling a more accurate sorting of prototypes into low-fidelity and high-fidelity categories.

ISSUES SURROUNDING PROTOTYPE FIDELITY

Feasibility

The feasibility of constructing low- or high-fidelity prototypes is an issue that fast-paced software organizations will confront. This issue will typically require an evaluation of prototype fidelity from three angles.

Skill and tool requirements. Low-fidelity prototypes are typically sketched or otherwise represented on paper using common office supplies, therefore eliminating the need for designers to learn the specific software tools or programming techniques that high-fidelity prototyping may require (Rudd, Stern, and Isensee, 1996). Moreover, since the creative skills needed to construct paper prototypes can often be found among existing project team members, low-fidelity prototyping tasks can be delegated rather than assigned to a single tool expert (Rettig, 1994). Alternatively, busy product managers and developers may not take tiny paper representations of an interface seriously, reducing organizational support for the low-fidelity prototype (Snyder, 2001). If specific designers become proficient with a prototyping tool -- especially if that tool generates usable code -- delegation may no longer be viewed as the most efficient option. Some authors even advise against delegation because it "breaks the feedback loop" (Rudd and Isensee, pp. 39). And contrary to popular belief (Cooper, 1994; Rudd, et al., 1996), alternatives to a design might be more easily explored using software, much like writing a paper using a word processor is more amendable than writing it long-hand.

Risk. Any change to a development process involves risk. However, releasing products that are difficult for customers to use is an even greater risk that organizations take every day (User Interface Engineering, para. 2, 3). Low-fidelity prototyping can be used to manage risk by helping development teams systematically focus on problematic areas of an interface before back-end implementation begins (User Interface Engineering, Day 6 section, para. 2; Synder, 2001). While high-fidelity prototypes can also help identify issues, they typically require more diligence on the part of the team to address underlying usability problems. When much has already been invested in a prototype's development, there may be an increased tendency to produce technology-based solutions (Rettig, 1994; Synder, 2001). In this way, the high fidelity of a prototype may negatively impact its real (though maybe not perceived) usefulness.

Time (Effort) and Cost. Uceta, Dixon and Resnick (as well as other authors) acknowledge that the "speed at which a prototype can be produced" is an important "factor for organizations looking to select a prototyping method" (1998, pp. 507). A decision about prototype fidelity ultimately affects an organization's bottom line, and organizations want to know which type of prototype will yield the best return on investment (Catani and Biers, 1998). Although low-fidelity prototypes have won praise because they "do not require a large investment in time and development dollars" (Rudd, et al., 1996, pp. 379), it can also be argued that a high-fidelity prototype with an operational focus may be more cost efficient because it can evolve into a finished product (Maner, 1997).

The issue of feasibility is marked by generalizations and unconfirmed statistics. For example, Rettig states that when using low-fidelity prototypes, "interface designers spend 95% of their time thinking about the design and only 5% thinking about the mechanics of the tool" (1994, pp. 22). However, there does not appear to be any concrete evidence for these figures. Similarly, it is unknown whether any detailed risk or cost analyses have been performed in real organizations that might better support feasibility arguments.

Objective

The objectives for building prototypes, along with the development stages in which the prototypes might be used, also impact decisions of fidelity.

Prototypes are most commonly used as design aids, or tools for conducting heuristic evaluations and usability tests.

Design aids. Based on field experience, authors unanimously recommend using low-fidelity prototypes during early stages of the software development cycle. Some cited benefits include: an increased focus on the more "relevant" aspects of a design, such as overall structure (Rudd, et al., 1996); a starting point for recording and developing innovative design ideas (Hackos and Redish, 1998; Rettig, 1994); and a method for determining necessary product features (Hong, 2000). Furthermore, low-fidelity prototypes created during design stages can help identify and refine product requirements, which can later be used by developers to code the product (Rudd and Isensee, 1994; Virzi, 1989). High-fidelity prototypes are generally avoided during design stages because the tools needed to construct them are believed to interfere with the designer's creativity (Uceta, et al., 1998). However, one wonders whether designers proficient in the use of a prototyping tool would always agree, and whether a level of creativity can ever be objectively assessed.

Heuristic evaluations and usability tests. Several experiments have shown that low- and high-fidelity prototypes unearth the same problems (both by type and perceived severity) during usability tests (Catani and Biers, 1998; Virzi et al., 1996). Additionally, the validity of studies performed using heuristic evaluations does not necessarily prove that they are more dependent on prototype fidelity for problem identification (Nielsen, 1990; Virzi, et al., 1996). To determine the superior fidelity in the midst of an apparent tie, some authors like Uceta, et al. propose that the artificial interaction between user and facilitator necessitated by low-fidelity prototypes may make it "difficult to identify design inconsistencies and shortcomings in the interface," thereby limiting a low-fidelity prototype's usefulness during usability testing (1998, pp. 507).

Perceptions of value

Whether users of the prototype are participants in a usability test or other members of a project team, two aspects of fidelity may influence perceptions of value: authenticity and openness to revision. Further, the importance of both appears to be dependent upon the objective of the prototype.

Authenticity. In this context, authenticity can be measured by how closely a prototype mimics the system's use in a real-world environment (think Virzi's "similarity of interaction" dimension). When used as a design aid, authenticity may or may not be a primary concern. A project team that is comfortable with the objective of a low-fidelity paper prototype may not view its inherent artificiality as an obstacle to valuable discovery. For organizations just starting out with prototypes, however, this lack of authenticity (equated with usefulness) may result in a hasty dismissal of the low-fidelity prototype. When used for a heuristic evaluation or a usability test, the authenticity of a prototype has also not been proven to affect problem identification. However, the obvious difference in interacting with a paper prototype/human facilitator instead of a functioning computer system may temporarily throw users off guard, possibly resulting in inconclusive results (Snyder, 2001; Uceta, et al., 1998).

Openness to revision. In Tognazzini's column on rough sketches, a managing engineer expresses his belief that the "unfinished" appearance of low-fidelity prototypes allows users to feel "less inhibited about giving useful critiques and constructive feedback than they would be if samples looked more polished" (1998, para. 2). Authors have also asserted that users testing high-fidelity prototypes appear more likely to focus on aesthetic issues rather than to address more significant usability questions such as information organization. This has been attributed to users' perceptions of the high-fidelity prototype's completeness (Hong, 2000; Newman and Landay, 2000; Rettig, 1994). Given this anecdotal evidence, it may seem that low-fidelity prototypes are more effective for gathering information and generating ideas. Nielsen's study, however, introduces doubt about whether these benefits also apply to prototypes used for heuristic evaluations (1990).

Depending on the heuristics used, it is possible that such an evaluation cannot be effectively performed with a low-fidelity prototype because not all dimensions of the system are available or complete. Unfortunately, creating a low-fidelity prototype may also be perceived by some as "unprofessional and unimpressive" if they do not understand its objectives (Newman and Landay, 2000, pp. 270). Prototypes constructed with objectives other than those described here, such as persuading management of product feasibility or demonstrating new features to potential customers, should probably be high in fidelity as well, because they serve an entirely different purpose (Rudd and Isensee, 1994).

CONCLUSIONS

The low- versus high-fidelity prototype debate is defined by both personal testimony and research. In some cases, attempts at controlled experimentation cause arguments to shift from differences in opinion or experience to the validity of test results. Although there seems to be no clear path for success, we do know that identifying and reducing the number of usability problems early in the development process with any fidelity prototype can significantly cut costs (Hackos and Redish, 1998). Therefore, incorporating prototyping is an idea worth investigating. This discussion has shown that the prototype fidelity organizations choose to implement depends on many factors, including:

- A critical evaluation of existing research and testimony
- The organization's culture and political structure
- Current software development stages and practices
- The objectives the prototype is expected to meet
- The skill sets and adaptability of project team members

Since each organization is unique, it must perform its own assessment to determine the return on investment for creating either low- or high-fidelity prototypes.

ACKNOWLEDGMENTS

I would like to thank Matthew Brandabur for his helpful editorial comments on several drafts of this paper.

REFERENCES

- Catani, M. B. and Biers, D.W. (1994). Usability evaluation and prototype fidelity: users and usability professionals. In Proceedings of the Human Factors Society 42nd Annual Meeting (pp. 1331-1335). Santa Monica, CA: Human Factors Society.
- Cooper, A. (1994). The perils of prototyping.
http://www.cooper.com/articles/art_perils_of_prototyping.htm. Accessed 15 September 2001.
- Newman, M.W., and Landay, J.A. (2000). Sitemaps, storyboards, and specifications: a sketch of web site design practice. In Conference proceedings on designing interactive systems: processes, practices, methods, and techniques (pp. 263-274). Brooklyn, NY.
- Hackos, J.T., and Redish, J.C. (1998). User and task analysis for interface design. New York: John Wiley & Sons, Inc.
- Hong, J.I., Li, F.C., and Lin, J. (2000). End-user perceptions of formal and informal representations of web sites. SIMS 247 Quantitative Usability Methods, University of California, Berkeley.
- Maner, W. (1997). Prototyping.
<http://csweb.cs.bgsu.edu/maner/domains/Proto.htm>.
Accessed 26 September 2001.
- Nielsen, J. (1990). Paper versus computer implementations as mockup scenarios for heuristic evaluation. In Proceedings of IFIP INTERACT '90: Human Computer Interaction (pp. 315-320): IFIP.
- Rettig, M. (1994). Prototyping for tiny fingers. Communications of the ACM, 37(4), pp. 21-27.
- Rudd, J. and Isensee, S. (1994). Twenty-two tips for a happier, healthier prototype. Interactions, pp. 35-40.
- Rudd, J., Stern, K., and Isensee, S. (1996). Low vs. high-fidelity prototyping debate. Interactions, pp. 76-85.

- Russell, S. and Norvig, P. (1995). Artificial intelligence: a modern approach. Englewood Cliffs, NJ: Prentice Hall, Inc.
- Snyder, C. (2001). Paper prototyping the user interface. Class slides.
- Tognazzini, B. (1998). Justifying rough sketches.
<http://www.asktog.com/columns/005roughsketches.html>. Accessed 15 September 2001.
- User Interface Engineering. (2001). Using paper prototypes to manage risk.
<http://world.std.com/~uieweb/paper.htm>. Accessed 26 September 2001.
- Uceta, F.A., Dixon, M.A., and Resnick, M.L. (1998). Adding interactivity to paper prototypes. In Proceedings of the Human Factors Society 42nd Annual Meeting (pp. 506-510). Santa Monica, CA: Human Factors Society.
- Virzi, R. A. (1989). What can you learn from a low-fidelity prototype? In Proceedings of the Human Factors Society 33rd Annual Meeting (pp. 224-228). Santa Monica, CA: Human Factors Society.
- Virzi, R. A., Sokolov, J. L., and Karis, D. (1996). Usability problem identification using both low- and high-fidelity prototypes. In Conference Proceedings on Human Factors in Computing Systems (pp. 236-243). Vancouver, Canada.

JENNIFER M. HOCKO (A Practical Evaluation of the Prototype Fidelity Debate)

JENNIFER M. HOCKO received a B.S. in Computer Science and Professional and Technical Writing from the University of Hartford in West Hartford, CT and works as a Senior Technical Writer for BEA Systems, Inc. In addition to working in the technical communications profession, she has also worked as a Web site designer, programmer, and project manager. She is currently pursuing an M.S. degree in Human Factors and Information Design at Bentley College in Waltham, MA.