23. Prototyping

17 November 2008

Bob Glushko

Plan for ISSD Lecture #23

The Practice and Problems of Prototyping

Prototyping Techniques

Dimensions of Prototype Design

"An Anatomy of Prototypes" - Filtering and Manifestation

Prototypes and Prototyping

A design space can be large and complex, and we can't explore it all at once

PROTOTYPES are representative and manifested forms of design ideas to "view a design's future impact" before it gets built

"PROTOTYPING is the activity of making and utilizing prototypes in design"

Prototypes in the Design Process

"A logical entailment of iterative design is that prototypes are constructed and evaluated to guide redesign and refinement" (Rosson & Carroll, "Usability Engineering")

Is prototyping appropriate for my design problem and context?

Where in the design lifecycle is it appropriate?

What is the purpose of the prototype? What design questions is it supposed to answer?

What is the project scope to which prototyping methods will be applied?

Traditional Purposes of Prototyping

To discover or refine requirements

To inspire design ideas, especially in collaboration or "co-production" with users

To test usability; to get feedback on "design failure or success"

Challenges Posed by "Low-Commitment" Stakeholders

The goals of prototyping assume the involvement of customers and users to "co-produce" the insights obtained with the prototype

But Schrage ("Never go to a client meeting without a prototype") argues that this is an unwarranted assumption in most design and development methodologies

In "requirements-driven" methods, it is easy for stakeholders to suggest requirements without real commitment to them

Schrage's Law: "The first client demo renders 40% of the listed requirements either irrelevant or obsolete - the problem is, we don't know which 40%"

Prototyping {and,or,vs} Requirements Gathering

"We take requirements far too seriously"

"Stop gathering requirements after the first 20 to 25 and then do a quick and dirty prototype to lure the client into codevelopment"

"The goal should always be to get the client to realize, react, and respond to an implemented prototype's possible implications"

Problems with Current Prototyping Practice

(Lim et al. in "The Anatomy of Prototypes")

Current prototyping practice and research is not based on "rigorous analysis of what prototypes are"

"Techniques are used without a reflective understanding of how they differ from each other in terms of their roles and characteristics"

"Generally applicable prototyping methods are not viable in face of the complex variety of interactive artifacts in HCI design"

Prototyping Techniques [1]

(p. 199 of Rosson & Carroll, "Usability Engineering")

STORYBOARD - Sketches or screen shots illustrating key points in a usage narrative

PAPER OR CARDBOARD "MOCK-UP" - Fabricated devices with simulated controls or display elements

WIZARD OF OZ - Invisible human assistant who simulates input, output, or processing functionality not yet available

VIDEO PROTOTYPE - Video recording of persons enacting one or more envisioned tasks

Prototyping Techniques [2]

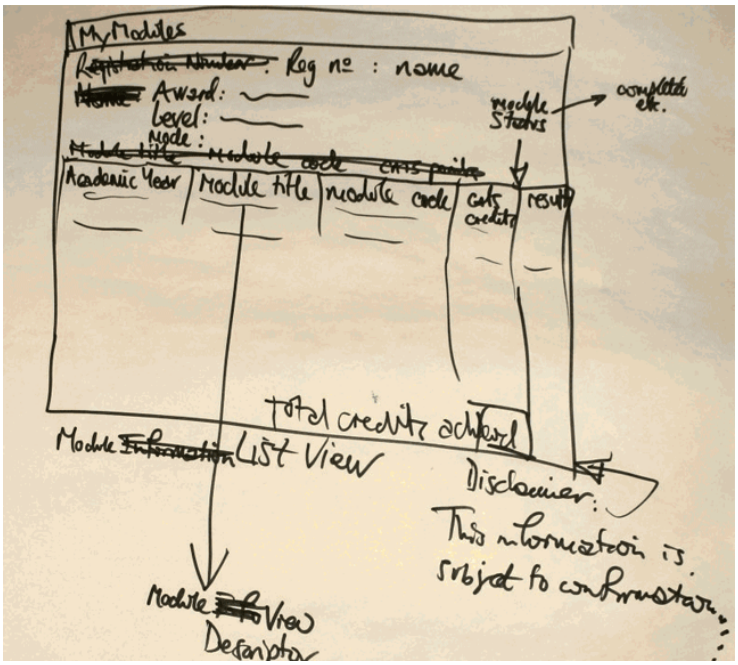
COMPUTER ANIMATION - Screen transitions that illustrate a series of input and output events

SCENARIO MACHINE - Interactive system implementing a specific scenario's event stream

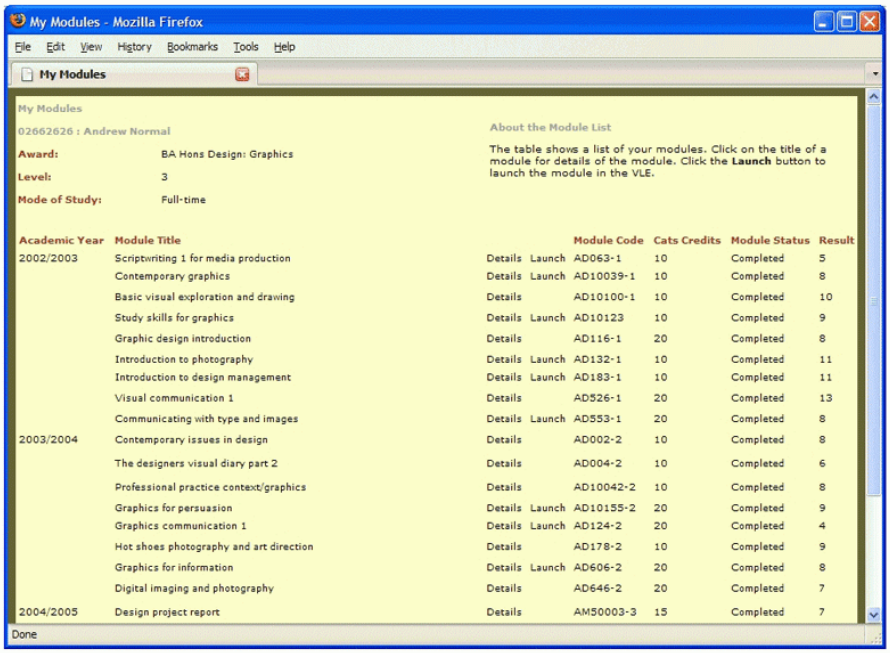
RAPID PROTOTYPE - Interactive system created with special-purpose prototyping tools

WORKING PARTIAL SYSTEM - Executable version of a system with a subset of intended functionality

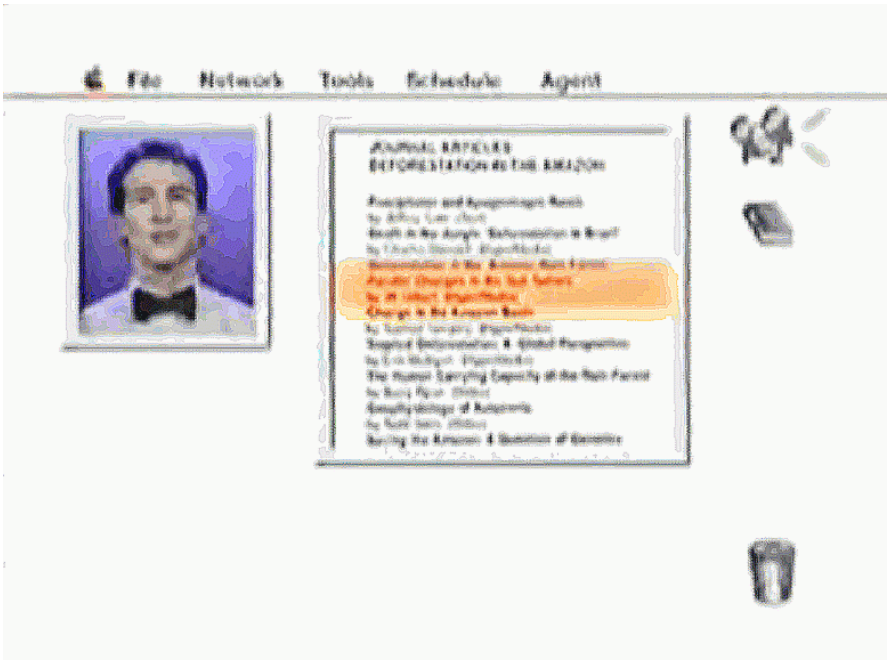
Sketching a Storyboard



Mock Screen for Storyboard



(In)Famous Video Prototype - The Knowledge Navigator



The Knowledge Navigator

In contrast to simple sketches, storyboards, or screen mock-ups, sometimes it is desirable to create high-quality video prototypes to illustrate potential functions and features

Video prototypes can include non-technical and social issues that might affect the desirability or feasibility of the design

The Knowledge Navigator video, made in 1987, illustrated the potential of speech recognition, smart agents, hypertext navigation, data and interface mashups, and more...

It was widely misunderstood to be product marketing!

Traditional Dimensions of Prototype Design

Prototyping techniques vary greatly on two dimensions:

COST AND EFFORT - as constrained by a design project's budget, schedule, and designer capabilities

FIDELITY - how realistic or similar is the prototype artifact to a final product or service?

These two dimensions are obviously correlated, so they are sometimes simplistically merged into a single LO-FI vs HI-FI one

Lo-Fi Prototypes for Usability Testing - Advantages

Faster to create and iterate

Lower cost

Lower perceived commitment encourages broader feedback

Lower skills needed to produce (e.g., non-programmers)

Flexible formats that can be adapted to context

Can be used at any stage in design process

Lo-Fi Prototypes - Disadvantages

Can't test performance (and other "hard" "ilities")

Can't address aesthetic or "flow" issues

Won't engage support by marketing or convince clients that "due diligence has been given to design"

Not useful to guide documentation team

SW developers can be dismissive

Won't scale

Challenges Posed by "Algorithmically-Based" Artifacts

(Holmquist, "Prototyping: Generating Ideas or Cargo Cult Designs?"

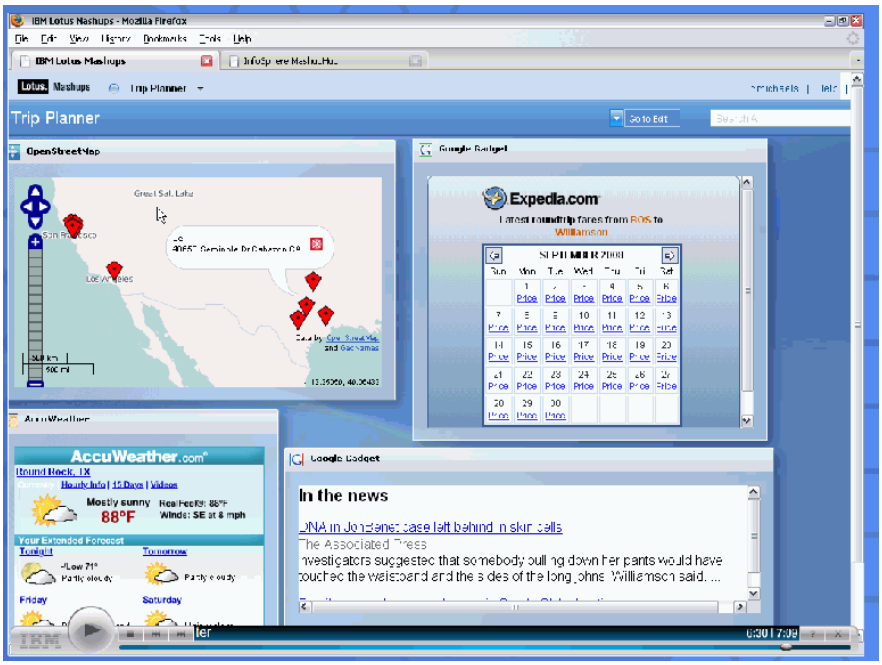
"When an object relies on purely mechanical operation, the function is closely related to the form and it will be fairly easy to determine if it has a chance of working as a real product"

"Artifacts in interaction design... rely ultimately on the execution of computer programs"

"There are many seemingly simple problems that are hard or even impossible to solve with algorithms"

"Prototypes and mock-ups are only pointers to what may be... and an unitiated audience or customer may easily be fooled to believe it is the real thing"

Remember the Mashup "Trip Planner"...



"Mixed-Fidelity" Prototypes

(McCurdy et al., "Breaking the Fidelity Barrier," CHI 2006)

The contrast between low and high-fidelity prototyping is too simplistic to describe the range of prototype techniques being used today

FIDELITY conflates five orthogonal dimensions of prototypes

- LEVEL OF VISUAL REFINEMENT - hand-drawn sketches or box-and-line wireframes vs. pixel-accurate display mockups
- FUNCTIONAL BREADTH - how many of the use cases?
- FUNCTIONAL DEPTH - only the success cases, or exhaustive coverage and error cases?
- RICHNESS OF INTERACTIVITY - paper page turning vs fully interactive, clickable links, etc.
- RICHNESS OF DATA MODEL - simple test cases vs complexity of real data?

Applying the "Mixed Fidelity" Framework

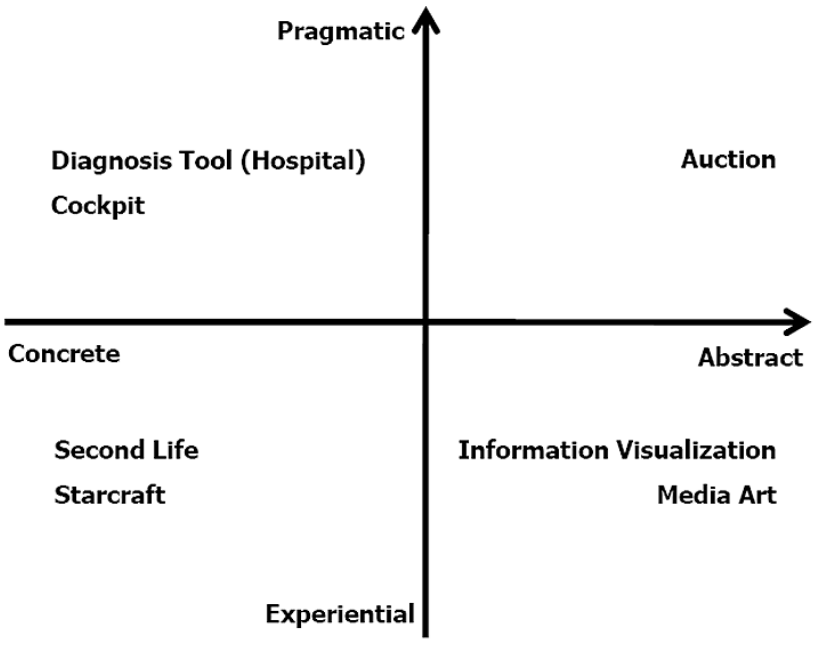
Recent advances in "front stage" prototyping tools and in programming more generally is making it possible to create prototypes that are high fidelity on VISUAL REFINEMENT and INTERACTIVITY and low on others...

... but at the cost of more traditional low-fi prototypes

Likewise, advances in "back stage" technology makes it possible to create prototypes that are high on DATA MODEL RICHNESS and FUNCTIONAL DEPTH/BREADTH while remaining low-fi on other dimensions

So how do we apply "mixed fidelity" in different design contexts

REMINDER: Pragmatic - Experiential, Abstract - Concrete Continua



Toward an "Anatomy of Prototypes"

(Lim et al., "The Anatomy of Prototypes")

Extends some of the ideas about "mixed-fidelity" to contrast two views of prototypes:

- To test ways of satisfying requirements
- To systematically "traverse a design space"

Proposes that prototypes should differ on the design dimensions in order to FILTER the (actual or hypothetical) design space to focus on particular regions

Furthermore, the MANIFESTATION of a prototype should be as simple or efficient as possible as long as long as it performs acceptably in its filtering role

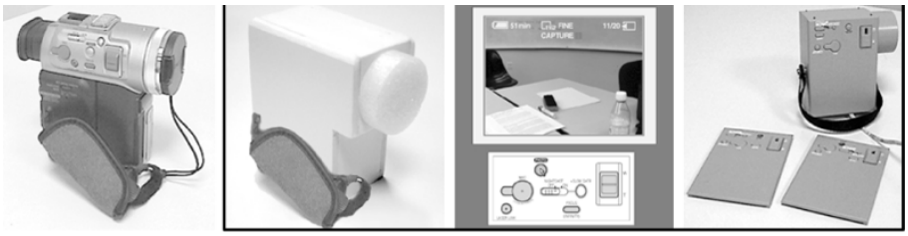
The "Fundamental Prototyping Principle"

Prototyping is an activity with the purpose of creating a manifestation...

that in its simplest form filters the qualities in which designers are interested...

without distorting the understanding of the whole

"Filtering" Design Aspects with Prototypes



Fully working product

3D form with a hand strap

Screen-based viewfinder and interface panel

3D form with partially working breadboard

Examining the ergonomic quality

Examining the input-feedback relationship quality

Examining the input layout quality

The Filtering Dimensions

Filtering Dimension	Example Variables
Appearance	size; color; shape; margin; form; weight; texture; proportion; hardness; transparency; gradation; haptic; sound
Data	data size; data type (e.g., number; string; media); data use; privacy type; hierarchy; organization
Functionality	system function; users' functionality need
Interactivity	input behavior; output behavior; feedback behavior; information behavior
Spatial structure	arrangement of interface or information elements; relationship among interface or information elements—which can be either two- or three-dimensional, intangible or tangible, or mixed

Using "Filtering Dimensions"

The filtering dimensions aren't completely separable; for example, the storage capacity (data dimension) of the iPod affects design alternatives for interactivity (like the use of thumbwheel browsing and selection)

But thinking in terms of dimensional filtering:

- can generate prototyping ideas
- can identify the relationships and constraints between design dimensions
- and result in a more thorough analysis of the design space

The Manifestation Dimensions

Manifestation Dimension	Definition	Example Variables
Material	Medium (either visible or invisible) used to form a prototype	Physical media, e.g., paper, wood, and plastic; tools for manipulating physical matters, e.g., knife, scissors, pen, and sandpaper; computational prototyping tools, e.g., Macromedia Flash and Visual Basic; physical computing tools, e.g., Phidgets and Basic Stamps; available existing artifacts, e.g., a beeper to simulate an heart attack
Resolution	Level of detail or sophistication of what is manifested (corresponding to fidelity)	Accuracy of performance, e.g., feedback time responding to an input by a user—giving user feedback in a paper prototype is slower than in a computer-based one); appearance details; interactivity details; realistic versus faked data
Scope	Range of what is covered to be manifested	Level of contextualization, e.g., website color scheme testing with only color scheme charts or color schemes placed in a website layout structure; book search navigation usability testing with only the book search related interface or the whole navigation interface

The "Economic Principle of Prototyping"

The best prototype is one that in the simplest and most efficient way makes the possibilities and limitations of a design idea visible and measurable

This principle should guide the nature of the manifestation in a prototype

(Compare this to OiSD's question: What is the minimal amount of information/artifact you need to show your stakeholders to get useful feedback?)

Using "Manifestation Dimensions"

Manifestation dimensions:

- influence how well a prototype performs as an "informing" tool in the design process
- so manifestation values should be chosen according to the economic principle

But this critically depends on having an explicit and clear set of design questions to be answered by the prototype

Planning for different types of prototypes is an essential part of a design project

How Filtering and Manifestation {shapes, is shaped by} Design Questions

Example in the Lim et al. article about house design

Two prototypes were built:

- Two dimensional paper-based blueprint
- Three dimensional virtual model

What dimensions are best filtered by the 2D manifestation?

What dimensions are best filtered by the 3D manifestation?

How do the different manifestations shape how users experience the design?

Filtering and Manifestation in House Design

Dimensions	2-Dimensional Blueprint	3-Dimensional Virtual Model
Filtering dimensions	**Addressed filtering dimensions:** *Spatial structure*—precise manifestation of relationships and proportions among spaces **Not addressed filtering dimensions:** appearance, data, functionality, interactivity	**Addressed filtering dimensions:** *Appearance*—colors and textures of walls; heights and widths of spaces *Interactivity*—the possibility to move around and interact with the 3-dimensional space *Spatial structure*—precise manifestation of relationships and proportions among spaces **Not addressed filtering dimensions:** data, functionality

Paper Manifestation of Mobile Phone

Computer Manifestation of Mobile Phone

Final Manifestation of Mobile Phone

Filtering and Manifestation in Phone Design

Dimensions	Paper Prototype	Computer Screen-Based Prototype	Final Product
Manifestation dimensions	*Materials*—paper; foam core board; knife; pen; wooden sticks; glue; yellow cellophane paper; two-dimensional phone appearance color-printout *Resolution*—rough and simplified sketches of screens;  	*Materials*—mobile phone simulation toolkit; laptop computer; mouse *Resolution*— simplified screens using given interface formats from the simulation toolkit;  	*Materials*—same as the final product *Resolution*—the same as the final product  (picture from [Lim et al. 2006]) *Scope*—exactly same as the final product

Readings for 19 November

[READ] Carl Kessler & John Sweitzer, “Chapter 4 – making products consumable”, Outside-in Software Development, IBM Press, 2008.

[SKIM] Andreas Holzinger, “Usability engineering methods for software developers” Communications of the ACM, January 2005.

[READ] Eelke Folmer & Jan Bosch, “Architecting for usability: A survey” Journal of Systems and Software, February 2004

[SKIP SECTION3, SKIM SECTION4] Natalia Juristo, Ana M. Moreno, & Maria-Isabel Sanchez-Segura, “Analysing the impact of usability on software design” Journal of Systems and Software, September 2007

Readings for 24 November

[SKIM] Joseph Valacich, D. Veena Parboteeah, & John D. Wells, “The online consumer’s hierarchy of needs” Communications of the ACM, September 2007.

[READ INTRODUCTION, "CONCEPTUAL FOUNDATIONS," "DISCUSSION AND IMPLICATIONS," AND SKIM THE REST] Matthew L. Meuter, Amy L. Ostrom, Robert I. Roundtree, & Mary Jo Bitner, “Self-Service Technologies: Understanding Customer Satisfaction with Technology-Based Service Encounters” Journal of Marketing, July 2000.

[SKIM] Carl Kessler & John Sweitzer, “Chapter 6 – Designing success in your stakeholder’s terms”, Outside-in Software Development, IBM Press, 2008.

[READ] Andrew N. Hiles, “Service level agreements: Panacea or pain?”