PATINA:

layering a history-of-use on digital objects

by
Ansel Arjan Schütte

B. A. Philosophy and Communication
Lewis & Clark College
Portland, Oregon, 1993

Submitted to the Program in Media Arts and Sciences,
School of Architecture and Planning,
in partial fulfillment of the requirements for the degree of

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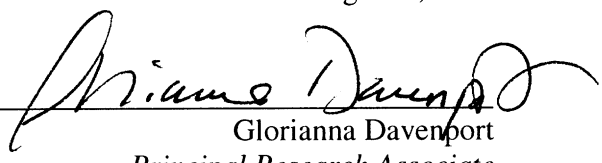
Certified by 

Glorianna Davenport
Principal Research Associate
Media Laboratory
Thesis Supervisor

Accepted by _____

Stephen A. Benton
Chair, Departmental Committee on Graduate Students
Program in Media Arts and Sciences

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Abstract

This thesis contains a set of experiments that explore the creation and impact of social traces on digital objects. I hypothesize that layering a "history-of-use" on digital objects will positively enhance their use and build an awareness of distributed audiences. In an attempt to construct a symbolic language of audience participation, this project consists of several initial and one primary experiments which explore the parameters of communicating use-based meta-data in the background and on the object itself.

PatinaMap is an enhanced image-map for the World Wide Web. Through this experiment, I explore several multivariate techniques for representing use-based meta-data. PatinaMap employs active visual filters, audio filters, remote usage-tracking, intra-session paths, synchronous use representation and PatinaText in its attempt to provide users with the feeling of being part of a distributed audience and allow them to benefit from social use.

Thesis Supervisor: Glorianna Davenport
Principal Research Associate

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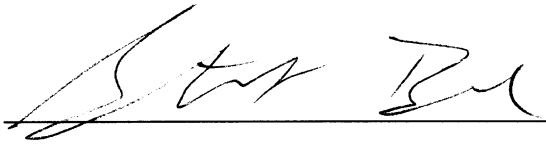
Thesis Reader 

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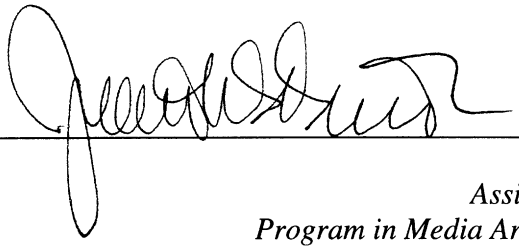
Thesis Reader 

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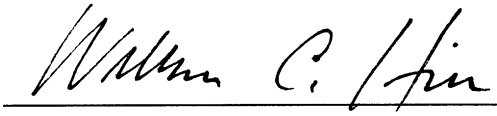
Thesis Reader 

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To my family: mom, dad, Amu, Joann – my spine. Mary, thank you for your care.

Thank you, extended Interactive Cinema group (beb, ppk, ricardo, sumita, jenny, michelle, pulsone), for being my home the last two years, physically and intellectually. Alon, thank you for programming and thinking. George Champlin, the name's yours. Ronmac, Tara, Jonathan, Ricki, Stefan, Mhadj and all too many others for supporting my work in things worn. David Cavallo for taking me to Thailand blindly.

Glorianna, I just have a glimpse of what you've given me.

Dedicated to mom. This thesis is one response in a lifelong discussion started by your belief in people and your faith in my intuition.

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"He says what the Americans lack is patina." -- (1933) H. Nicolson Diary 24 Feb. (1966) 140

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1. Introduction: Designing an Audience

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Personal motivation
Patina definition
Thesis overview
Definition of terms

}

I have been around digital media, education, narrative and communities quite intensively, both as a creator and a consumer. The designer in me is fascinated by the myriad possibilities of digital media, particularly in connecting people through constructionist learning communities, in appreciating stories and in defining new organizational structures. As a consumer, however, I'm rarely captivated by what is available in the digital "content" and "community" domains. Something's missing. Broadly, I explain my dissatisfaction with Jaron Lanier's observation that "information is alienated experience" (Lanier 1995). As digerati we try to simulate experience, fall short, and end up with something hollow, alien.

This is not a completely satisfying answer. I come closer with the lesson from LucasArt's *Habitat* that the depth and complexity we derive from any virtual environment, no matter how sophisticated the technology, comes from other *people* (Morningstar 1991). Amy Bruckman argues for virtual "constructionist communities:" social places that let people learn-by-doing *together* (Bruckman 1997). In addition, I discovered that what was missing from an excellent online story engine developed here at the Media Lab, is any sign of a social history of use. The technology is forever too alien to show the richness of human presence.

In January 1997, I visited Interval Research Corporation. This email represents the first thoughts that guide my inquiry into the social history of information and narrative.

```
Subject: some stuff I've been thinking about
Date: Fri, 10 Jan 1997 11:20:59 -0800
From: "Arjan (at Interval)" <arjan@interval.com>
Organization: MIT Media Lab/Interval
To: icgrads@media.mit.edu

[snip]

As far as research goes, I'm getting more and more into the
"social history" of information idea. there are so many ways that
can manifest itself and I think it's fascinating that as we
```

> (humans) have started to reconstruct so much ourselves - so as to make it ours (as opposed to God's, or something) - we have lost the sense that it is "ours." Our information (or stories, objects, etc) is pure and pristine. It shows no trace (or only an awkward one: eg hit counters) of previous use. It's funny, places with character (read: social history), like the [MIT dorm] senior haus, become popular. then they become refinished and in the process they lose their character. often, they're sterilized. [Interactive Cinema's] interactive stories are trying so hard to discover new narrative possibilities, but in the process they lose track of what they offer - different experiences to different people. it's not about repeat use, it's about unique experience. right? texture maps try to emulate our real surfaces, but with no imperfections. it seems that the only consistent way digital representation reveals rich social traces is in code. to the enduser this only appears in the form of bugs, as the rest is the representation of the computer.
>
> [snip] perhaps the endgoal would be to create a language of audience participation, a vocabulary that designers can use to allow their audience to be aware of eachother, a means by which we can remember why we're reconstructing everything - because we're human.

This email triggered what became an obsession that changed the way I look at the world. Now, I marvel over scratches and dents, the green stains on sidewalk below an old copper awning, the smooth texture of a hand railing, the shine on those telling number keys on the security lock to the Media Lab, the way a book has worn out, the sounds of an old car. I see beauty in decay. My senses are opened to the infinite subtle ways in which social traces add value, add comfort and inform our lives. I am aware of how forms of wear keep things clean, maintained, easy to use, comfortable, precious, up to date, etc. This, in contrast to popular knowledge in which stains, scratches, dents, rips, graffiti and corrosion are viewed with derision. Although both are true, we rarely acknowledge the benefits of social or environmental wear and we hardly ever build them into our design, whether digital or physical. Digital objects are especially without signs of wear, primarily because physics does not dictate their integrity over time.

Human use *can* have an impact on the integrity of digital objects. Drawing upon previous work in "history enriched digital objects" (HEDO) (Hill 1993), Patina will layer a "history-of-use" on a variety of digital objects. The primary purpose of this layer of meta-information is to inform, involve and subtly unite distributed audiences. Like an old Victorian house, people can experience Patina-enhanced digital information: benefiting from and appreciating how others have used it, feeling a social presence in its textured history, and assigning value as it is worn-in.

> **pa.ti.na** n, pl **pa.ti.nas** or **pa.ti.nae** [It, fr. L, shallow dish--more at paten] (1748) **1 a**: a usu. green film formed naturally on copper and bronze by long exposure or artificially (as by acids) and often valued aesthetically for its color b: a surface appearance of something grown beautiful esp. with age or use (Merriam-Webster online, 1994)

This research, Patina, combines characteristics of wear found in physical objects with unique digital attributes. I emphasize different ways to represent wear, varying degrees of historical persistence, and the impact of digitally enhanced "history" on different types of objects: physical traces based on computer use, a World Wide Web image-map and online interactive narratives. Each Patina experiment explores how an *audience* perceives and interacts with an *object* to create *social traces*. The *infrastructure* that collects, stores, retrieves and interprets these traces in turn affects the appearance and behavior of the object.

As the world becomes a more global community, we are challenged to design digital objects – files, applications, documents, games, environments, stories, interfaces – that reflect such broadening social awareness. There is a range of "ends," or applications for such social awareness, identified in chapter 2. In chapter 3, I have compiled a taxonomy of "wear," which sets the stage for broader research in this area and identifies critical axes to consider when addressing a social history of use. Next, in chapter 4, I discuss several "means," or methods for addressing the problem. Fortunately, others before me have tackled these problems. Chapter 5 contains the work on which I build by an analysis of prior work. Finally, I will discuss the implementation which I designed to address mapping a history of use on digital objects in chapter 6. Conclusions follow (chapter 7).

Are we speaking the same language?

I use several terms with some frequency in this thesis. Below are definitions of those terms, so that the reader has a better understanding of my basic assumptions.

Patina in this thesis refers to much more than the green tint of weathered copper. Patina, here, represents my methodology for mapping a history-of-use on digital objects (described in detail below). Thus, a "patina-enhanced" web page means a web page that tracks and displays usage meta-data consistent with the technical and design methodologies described here.

User, ***audience***, ***society*** each refers to a different capacity in which human beings use and relate to digital objects. *User* refers to a person who is using or interacting with the computer. It points to the direct relationship between person and computer. *Audience*, or *distributed audience* refers to a "group of listeners or spectators" (Merriam-Webster online, 1994) of a common, network accessible (online) digital object. These terms point to the direct or indirect human relationships of users as mediated by their use of a digital object. *Society* (or *society of audience*) refers to an audience with a set of shared attitudes, values, goals and practices. It emphasizes the common interests and activities – the culture – of users.

Object, ***digital object*** both refer to discreet unit of digital information that can be executed, edited or browsed. Examples of *digital objects* are an application, a computer game, a spreadsheet, and a web page.

History-of-use refers to that aspect of history, which is imprinted on objects. In the digital realm, a history-of-use refers to digital objects' ability to persistently reflect how people use this object over time. As a table's history-of-use might appear as coffee rings, dents where the baby-chair hung, grooves from cutting vegetables, etc., a web site can provide color patterns that speak to how and when it was used. The history-of-use provides information on how the object has been used (thus informing us how it *can* be used), and what kind of user or audience has used it.

Social Trace refers to the manifestations of an object's history-of-use. The signs that represent social traces reflect different types of users and are unique to the object to which they belong.

2. Social Presence: To What Ends?

> "This tendency prompts people to have their wall-brackets and picture-frames artificially dirtied to lend them the patina of age; so let us call it the 'patina-snobbery.'" -- (1955) Koestler Trail of Dinosaur 79

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Objectives and hypothesis
Feeling part of an audience
Benefiting from a social history-of-use

}

Telepresence, networking, chat, collaborative filtering, learning, audience, collaborating, management, research, and connectedness are oft pursued applications for digitally augmented social presence. Such ends may serve to let a person express him/herself, connect with others, remember the past, achieve better results, evaluate information, compete, cooperate, or interpret information differently.

Two broad ends direct this inquiry: the emotional experience of being part of an audience and the functional information gained from displaying a history-of-use; both of these employ social traces to improve a user's experience while navigating the web. In this thesis, I hypothesize that someone's experience on the web will be enhanced by feeling part of an audience and by benefiting from a social history-of-use.

Feeling part of an audience

We experience a certain pleasure in being a part of an audience, without explicitly interacting with others, like in a movie theatre. The presence of an audience makes our experience an occasion, a spectacle. It validates our presence. Feeling part of an audience may also impact our perception of the story being told, whether that is a movie, a rock concert or juggler on a street corner. In this thesis I explore how it is possible to evoke an emotional involvement as part of a physically and temporally distributed audience, which relates to our memories and our identity and which can be acquired passively (e.g. without trying to interact with the audience, per sé).

Benefiting from a social history-of-use

Dynamically collecting and representing a history-of-use can functionally benefit web users, by helping them discover better or more relevant stories or information. These Patina experiments collect use-based meta-data about users' frequency, recency, extent and sequence. Presented well, this information can serve both end-users and interface designers. The former will be able to navigate better and the latter can instantly learn from usage-data about the quality and effectiveness of their work. I also implement several active graphical filters that are designed to simulate and reflect wear. These serve as tools with which information designers can learn from how their interfaces are used and incorporate a social history into their design.

3. A TAXONOMY FOR DESIGNING WEAR

"The patination of metals is a highly specialized art." -- (1947) J. C. Rich Materials & Methods Sculpture vii. 199

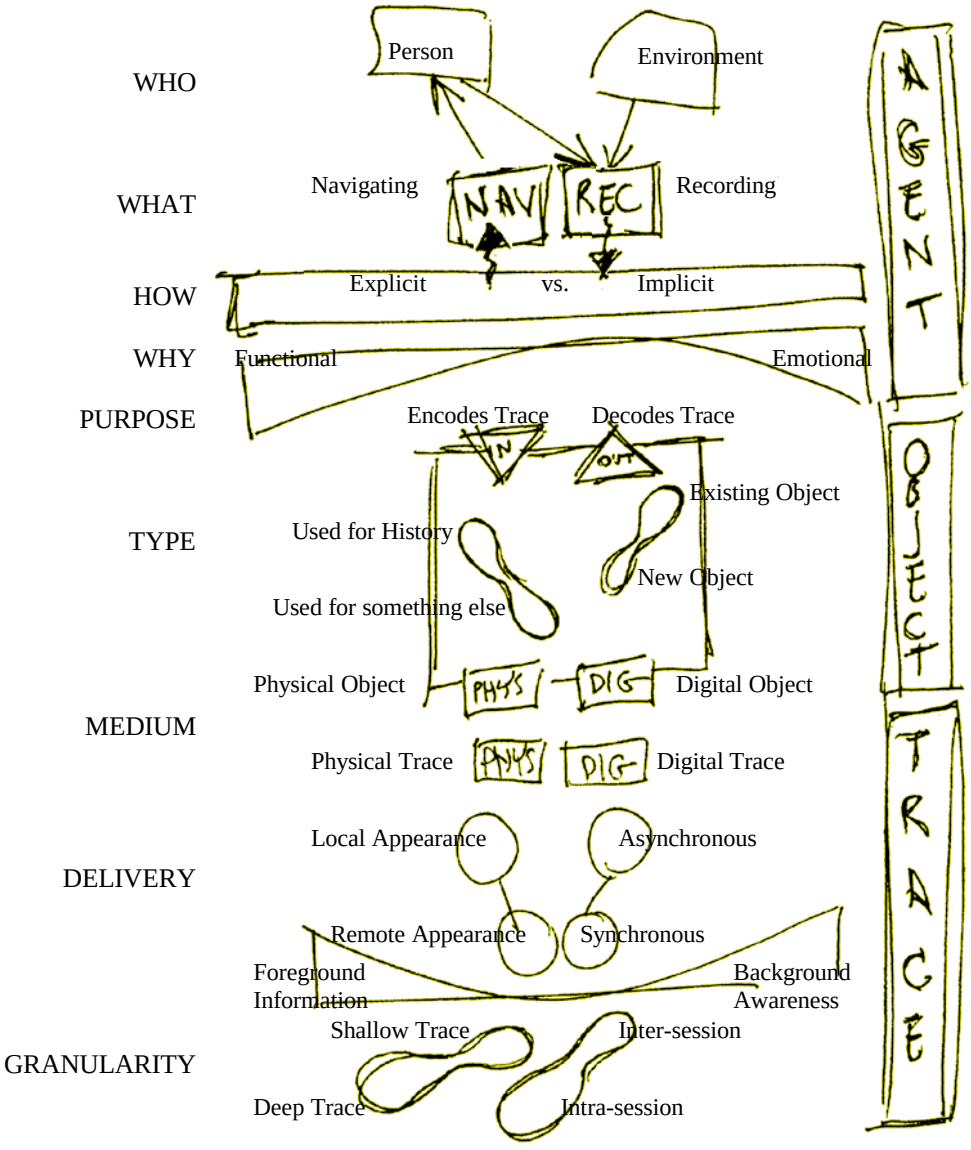
A taxonomy is an "orderly classification of plants and animals according to their presumed natural relationships" (Webster Online, 1994). Based on research of how objects display traces, I have compiled a taxonomy which attempts to establish the axes against which all forms of history-enriched traces can be plotted, both physical and digital. No doubt there are more such axes, but I have tried to isolate the fewest, most universal elements. Some axes represent a continuum between extremes, while others are Boolean. The taxonomy is organized according to the three components that make up history enriched objects: The agent, the object and the trace. Here follows a quick overview of the taxonomy (see chart on next page).

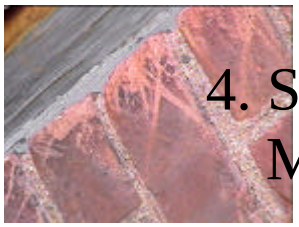
The *agent* is the actor who instigates some interaction with an object. The agent is coarsely defined by who (human or environment), what action (recording traces or navigating traces), how (active to passive) and why (rational to emotional). The latter two are bi-directional continuums. Copper patina on a building, for example, is environmental recording of traces. Reading graffiti is an example of human, active navigation of traces. In many it generates an emotional response.

The agent interacts with the object to create or access a trace. The reverse is true for the trace (it also interacts with the object, either as a result of or to inform the agent). The *object* is coarsely divided into a purpose (whether it encodes or decodes a trace, or both), several types (its applications), and medium (digital or physical object). The chart shows more clearly how these sectors relate with one another. For example, a wall is an existing, physical object, whose application is not primarily for encoding traces. *PatinaMap* is a digital object that can both encode and decode traces from a human agent.

The *trace* is a persistent representation of agent-object interaction. It is divided into medium (physical trace vs. digital trace), delivery (local vs. remote, asynchronous vs. synchronous, foreground vs. background) and granularity (deep vs. shallow trace, intra-session vs. inter-session trace). A web-browser's bookmark is a digital, locally and synchronously presented shallow trace. A draft (from a window) is an example of environmental, physical trace delivered in the "background." A web counter is a shallow foreground trace, delivered locally.

The taxonomy is meant to be helpful when creating new forms of HEDO. It gives the designer a tool with which to consider the issue in greater breadth and it may offer ideas for options not yet considered.





4. Social Presence: By What Means?

> "It is well, at certain hours of the day and night, to look closely at the world of objects at rest. The used surfaces of things, the wear that the hands give to things… Let that be the poetry we search for: worn with the hand's obligations, as by acids, steeped in sweat and in smoke, smelling of lilies and urine… A poetry impure as the clothing we wear, or our bodies soup-stained, soiled with our shameful behaviour, our wrinkles and vigils and dreams, observations and prophecies, declarations of loathing and love, idylls and beasts, the shocks of encounter, politics loyalties, denials and doubt, affirmations and taxes."
>
> - Pablo Neruda, "Toward an Impure Poetry" (Neruda 1990).

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Layers of Change in Buildings
Information Design
Passive Input: the object as interface
Concretizing the Abstract
Hiding in the Background
Audience Evolves Stories

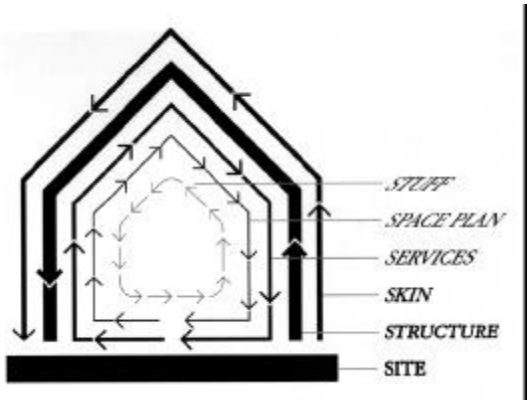
}

In this section I focus on three broad approaches that help establish an awareness of audience and a means by which to benefit from a community of users. This research draws upon a study of the physical object (particularly buildings) and the narratives they acquire over time, the study of representation (information design) and the study of audience participation (focus on storytelling). The subsequent section will revive each of these in specific research projects.

Layers of Change in Buildings

Architecture master Chris Alexander points out, "in nature you've got continuous very-small-feedback-loop adaptation going on, which is why things get to be harmonious. That's why they have the qualities that we value. … Yet here *we* are playing the major role in creating the world, and we haven't figured this out. That is a very serious matter" (Brand 1994). Although Alexander is referring to buildings, his observation is perhaps even more relevant to digital construction. Houses, skyscrapers, apartments, monuments, churches and dormitories – buildings of all kinds – are an excellent case study for assessing the impact of human activity on objects over time. Buildings are appropriate for this thesis because they are socially

constructed and because they are essential to communities and identity in the physical world.



A building's different layers of wear (Brand 1994)

Even in a world where we are accustomed to constant change, we expect architecture to be enduring. Our structures connote the illusion of permanence by employing unwieldy materials such as wood, brick, steel and glass, by resisting the environment and by letting us sculpt a living environment on our own terms. In How Buildings Learn, Stewart Brand sets out to expose this fallacy by examining "buildings as a whole -- not just whole in space, but whole in time" (Brand 1994).

Time punctuates its impact on buildings at differing rates. Brand identifies six discernable rates of decay, based on such forces as technology, economy and fashion. On one end of the spectrum is the "site," the physical land on which a building rests. It "is eternal." A building's "skin" evolves approximately every 20 years spurred by the latest materials and style. At the rate of 7 to 15 years, innovations in wiring, plumbing, heating, etc. – the "services" – require renewal. At the other end, a building sees daily or monthly changes as its "stuff" (e.g. furniture, appliances, pictures) accommodates constantly changing needs of the people who use it. This "layering" of wear is important to consider in the process of mapping digital objects to become "whole in time."

Information Design

Edward Tufte, a political scientist and design guru at Yale University, has derived several excellent lessons on effective visualization of quantitative data. His three books on visualizing information (Tufte 1983; Tufte 1990; Tufte 1997) are crammed with insight, examples and principles for graphical excellence. I will focus on several examples that are pertinent to "visualizing" use-based meta-data. These will serve as design premises, based on which I will provide detail on three essential criteria for creating digital patina: passive input, concrete representation, and background information.

Swiss cartographers use color to label, measure, imitate reality and enliven quantitaive data (Tufte 1983).

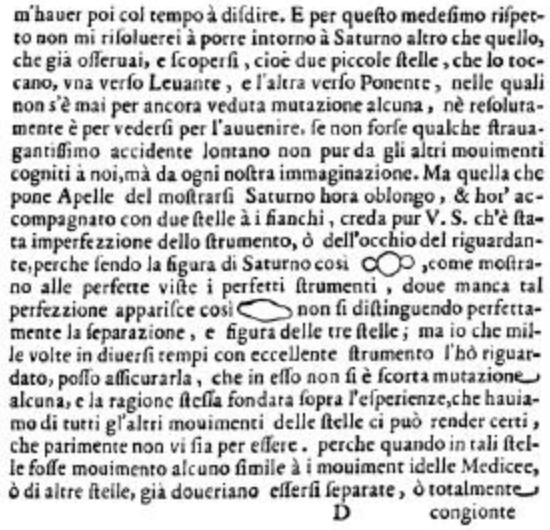
"Graphical excellence is nearly always multivariate" (Tufte 1983). Tufte devotes a great deal of attention on high dimensionality in information design. One strategy is to maximize *data-ink*, "the non-redundant ink arranged in response to variation in the numbers represented." On the computer, this maps to using the fewest pixels to express the most data. This also requires using each pixel to express multiple data simultaneously, for instance by the use of color. In this poor replica of a Swiss mountain map, Tufte points out how subtle use of color "*labels* by distinguishing water from stone and glacier from field, *measures* by indicating altitude with contour and rate of change by darkening, *imitates reality* with river blues and shadows hachures, and visually *enlivens* the topography quite beyond what could be done in black and white alone" (Tufte 1990).

Tufte's favorite examples represent complex data and change by making the smallest effective difference. Each pixel makes maximum impact but attracts minimum attention to it. He advocates eliminating excess lines, contrast and clutter. Regarding Patina, Will Hill advised me to visualize wear "just in time" and "just in the right

Three examples showing use with the "smallest effective difference." In the last, use-data is indiscernible from the image.

place," meaning by making the smallest effective difference. In the design for PatinaMap, I use a grid of 1x1 pixel quadrants and gradients that "dissolve" between one area of use and another, without calling attention to itself (far right figure). My previous experiments had been much cruder visually. This strategy allows for the communication of a digital object itself in the foreground and of its complex meta-data in the background.

"In 1613, when Galileo published the first telescope observations of Saturn, word and drawing were as one. The stunning images, never seen before, were just another sentence element" (Tufte 1990). This seamless integration between text and image inspires the seamless integration between form and function, between the object and its application, between visualizing itself and its history-of-use. "Saturn, a drawing, a word, a noun" became my charge to make the object its own interface, to show its use concretely – on the object itself. *Integrating all parts of content* is perhaps the most important lesson derived from research in history enriched digital objects.



m'hauer poi col tempo à diſdire. E per queſto medeſimo riſpetto non mi riſolueresi à porre intorno à Saturno altro che quello, che già offeruai, e ſcoperſi, cioè due piccole ſtelle, che lo toccano, vna verſo Leuante, e l'altra verſo Ponente, nelle quali non s'è mai per ancora veduta mutazione alcuna, nè reſolutamente è per vederſi per l'auuenire. ſe non forſe qualche ſtrauagantiſſimo accidente lontano non pur da gli altri mouimenti cogniti à noi, mà da ogni noſtra immaginazione. Ma quella che pone Apelle del moſtrarſi Saturno hora oblongo, & hor' accompagnato con due ſtelle à i fianchi, creda pur V. S. ch'è ſtata imperfezzione dello ſtrumento, ò dell'occhio del riguardante, perche ſendo la figura di Saturno coſi ○○○, come moſtrano alle perfette viſte i perfetti ſtrumenti, doue manca tal perfezzione appariſce coſi ⬭ non ſi diſtinguendo perfettamente la ſeparazione, e figura delle tre ſtelle; ma io che mille volte in diuerſi tempi con eccellente ſtrumento l'hò riguardato, poſſo aſſicurarla, che in eſſo non ſi è ſcorta mutazione alcuna, e la ragione ſteſſa fondata ſopra l'eſperienze, che hauiamo di tutti gl'altri mouimenti delle ſtelle ci può render certi, che parimente non vi ſia per eſſere. perche quando in tali ſtelle foſſe mouimento alcuno ſimile à i mouiment idelle Medicee, ò di altre ſtelle, già doueriano eſſerſi ſeparate, ò totalmente congionte

D

Galileo combines picture and text into one (Tufte 1990)

Passive Input: The Object as Interface

Digital objects, like their physical counterparts, are things that can be used. It might be a word processing document or a calculator, a web page or a pop-up menu. Each of these "objects" can be used in a different way. I'm interested here in the object as interface to itself. A piece of paper, for example, doesn't require any additional controls for me to flip from one page to the next. But the only way for me to "navigate" through a document digitally is by using the scroll bar or the cursor. We have constructed an interface – separate from the object itself – to be able to manipulate the object. Through experience, users learn to map the meaning of the little bar on the side of files and folders to the functionality of viewing off-screen information. This mapping is pretty simple in the case of a scroll bar, but many menus and sub-menus are so abstracted from the object to which they apply that even expert users have trouble intuitively dis-covering their purpose.

Chris Hales, a Ph.D. candidate at the Royal College of Art, creates interactive movies in which the object is the interface to itself. Users do not click on a control panel or anything outside of the movie itself. This is a powerful paradigm from an immersivity point of view. It also poses interesting technical issues by requiring the object to handle additional user input and include functionality not otherwise required. In Hale's example, a QuickTime movie takes mouse input on the movie frame, in a specific region at preset times (for interaction, you can't click anywhere, anytime). The movie itself serves as the selection tool for additional clips.

Phillip Tiongson, MS '98, created an example of object as interface. For the Chicago Tribune, he designed a Java applet that allows the user to scroll through the text of an article by clicking directly on the text and dragging it up or down in order to scroll through its content. As the user gets to different parts of the article, the images that illustrate it dynamically reconfigure themselves to appropriately emphasize the focus or angle of the current section of the story. The text is a handle to its own navigation.

Tiongson's ActiveArticle for the Chicago Tribune combines text and scrollbar in one (ic.www.media.mit.edu/tribune)

The object as interface is important when instrumenting a digital object with its history-of-use. A tight coupling between input and output permits use-data to be collected and presented passively and meaningfully. In other words, when planning to track and display an object's history-of-use, it is important to be able to map valuable usage-data on the object without needing to explicitly ask the user how he used it.

Concretizing the Abstract

In the physical world wear becomes an inseparable part of the object itself whose representation is controlled by the object's physical properties. For digital objects to reflect wear, those data need to be generated, updated, stored, retrieved, parsed and represented. Most digital manifestations of wear are abstracted from the object whose use they present. A web browser shows the page history list in a separate menu, for example, and web or newsgroup usage statistics are represented in removed bar charts (Hill 1992). This abstraction literally and practically removes the statistics from the object in question. Patina seeks to represent wear "just in time" and "just in the right place," much like a beach will present footprints just *when* they're made and just *where* they're made. Unlike a beach, however, Patina can also reflect just the recent footsteps, or just the path to the ice cream cart, or it can highlight where there was no traffic for those who want to get away from the crowds. In providing a choice of representation, Patina allows users to interpret the same data in different ways, while retaining the immediacy of concrete representations.

www.phoaks.com shows the frequency and recency of recommended web resources. Note the meta-data (the bars) are removed from the data (URLs)

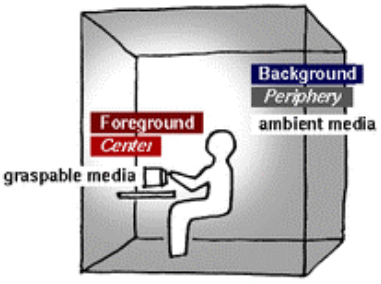
It is additionally difficult to represent dynamic and evolving data on what appears as a stagnant object. Data collected over time accumulates on an object's surface. On many physical objects this information averages out, becoming a nice patina. To keep use-data relevant, it is important to consider both the entire age of the object, as

it is to identify a window of relevant depth. Recent use needs to have a greater impact in the visual representation and older data must average out, in order to maintain both useful information and to differentiate trends on a new object from trends on an old object. I will focus on issues of aging in the "Practice" section, below.

GUIs are metaphors for how the computer stores and executes its data. Just as the desktop has proven a popular metaphor for the computer's file system, PatinaMap is an experiment in how a topography metaphor can illustrate the use of a digital object. By employing a familiar semantics - hue and saturation - the topography metaphor is meant to be transparent, not drawing attention strictly to itself. I have developed several filter objects to which future designers can add their own and from which users can select how to experience the history-of-use. Another example filter object is one which "displays" the history-of-use with sound. As the user moves the mouse over the image-map, less visited areas respond with low-volume, simple sounds. More visited areas trigger higher-volume, more complex sounds, with a range between extremes.

Hiding in the Background

Computers usually present information in the foreground. Dialog boxes, menus, warnings and status windows are all examples of this. Foreground information is often modal and requires some degree of exclusive attention. At the University of Toronto, Bill Buxton is among the first to discern foreground information to be at "the fore of human consciousness – [related to] intentional activities. . . . by *background*, we mean tasks that take place in the periphery – 'behind those in the foreground. Examples would include being aware of someone in the next office typing, or the light in your kitchen going on automatically when you enter it, as opposed to you manually flicking the switch (which would be a foreground intentional act)" (Buxton 1995). At the Media Lab, Hiroshi Ishii and Brygg Ullmer's work in "ambient media" differentiates "foreground activity" from "background awareness" (Ishii 1997). Their *ambientROOM* communicates at the peripheries of our awareness through light, airflow, water and sound. "Subconsciously, people are constantly receiving various information from the 'periphery' without attending to it explicitly" (Ishii 1997). Background channels have enormous bandwidth for data about context, which are critical to any human activity (and sorely inadequate in most computational applications).



Ishii et al distinguish between a user's center and periphery of attention

Patina seeks to increase the society/user communication bandwidth by adding a subtle representation of use on top of digital objects, so that the original object's integrity (e.g. foreground information) is not lost. The user is aware of the recency or types of

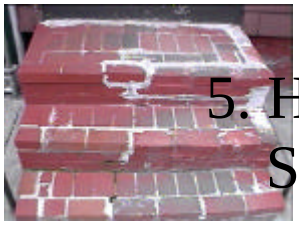
use (communicated in the background through Patina) while primarily focusing on the content of a web page. This layer of meta-information is how Patina provides useful social filtering and guidance. But because it communicates in the background – as ambiance – the layer of Patina simultaneously allows the user to remain involved in the content. Patina taps into the same principle as the comfort we sense when wearing old clothes or the sensation we experience when feeling, folding and flipping through a newspaper which complements the articles we read.

To that end one of my experiments, PatinaMap, simultaneously provides foreground information, in the form of an image-map graphic, with a layer of use-based background data articulated by adjusting the hue and saturation differently around the map. We model this after a geographical map which contains both political and topographical data. Hills and valleys fade to the background, but are still present, as the user focuses on the highways and borders. PatinaMap's users can focus on the choices provided in the story, while information about the popularity and recency of use is immediately available in the background.

Audience Evolves Stories

Most noteworthy here about the role of the audience in traditional oral storytelling, or standup comedy, for that matter, is its impact on the telling of the story. While the roles of artist and audience are well defined, it is clear that the artist is aware of, and responsive to his/her audience. This is true not just within a given story or session, but also between sessions. "Storytelling is a negotiation. Making or encoding the oral story during the storytelling is the shared task of both audience and storyteller. Unlike the printed story, audience and teller negotiate a story into being in a highly dynamic interactive process" (Livo 1986). The audience's actions can be quite subtle or passive and still have a lasting impact on the integrity of the story being told. Their eyes and bodies are easily read barometers of their interest and involvement. The same holds true in interpersonal conversation: we constantly read the non-verbal signals we get from the other and immediately adapt.

"Buildings tell stories, if they're allowed -- if their past is flaunted rather than concealed" (Brand 1994). Like oral storytellers once were the only agents of stories, now they share the stage with numerous other artists, art forms and with the computer. Computer objects, like buildings or storyteller's bodies (or their art objects), *can* also reveal a narrative of their experiences – if their past isn't systematically concealed from their audiences. Understanding how physical objects (e.g. buildings) age endows this research with models for considering digital wear. Tools for representing that wear come from a long lineage of information design. Introducing the dynamic interrelationship between a story agent and its audience provides insight as to creative possibilities in that relationship and the evolutionary capacities of "content."



5. HAS THE PROBLEM BEEN SOLVED?

"Patination and colour pose problems to a faker." -- (1960) H. Hayward Antique Coll. 212/2

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History-of-use
Traces of Memory
Desire for Audience
Virtual Community

}

Observations of how physical objects age, how designers visualize complex data, and how story agents relate with their audiences drive the approach for Patina. In the following section, I describe a set of experiences which test different aspects of these means. I cite three projects that experiment with providing useful information in and through history enriched digital objects. Next, I look at the role of memory and identity on digital objects, attempting to understand why we *feel* for certain aged things. Cinematic storytelling follows. Finally, I provide several examples of what role "aging digital objects" might have in virtual communities. Each of these previous projects is important to where Patina stands.

History-of-use:

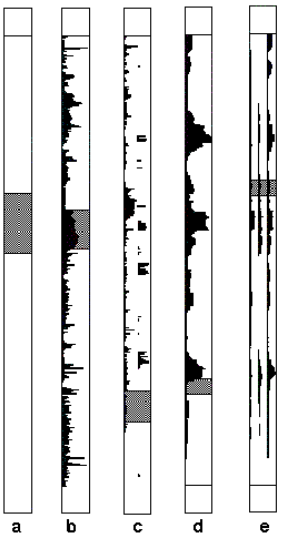
In 1992 Will Hill, Jim Holland and their colleagues at Bell Communication Research (now AT&T Labs - Research) published the results of several prototypes that "offer new opportunities for efficiently informing communities of practice" (Hill 1993). They invented "history enriched digital objects" or HEDO with the intention to allow a virtual community of users to benefit from one another's actions, accumulated over time. As such, a "history-of-use" became a commodity that recorded, stored and displayed persistent information about a digital object. For about five years, Hill et al were the only active researchers intrigued by the power of a social history of information. Although their ideas have clearly influenced research in human computer interaction and collaborative filtering, it is surprising how few others have followed their lead. Besides their own continued work, I will discuss several directly related projects that study a digital object's history-of-use.

Filters and Guides: History Enriched Digital Objects

Will Hill et al. have experimented with adding a history-of-use to "pseudo-public" digital objects, such as shared text documents, email, and software code, in prototypes such as *Edit Wear*, *Read Wear*, *Email Wear* and *Source Code Wear*. They have also performed tests on "virtual community" applications, which are more centrally networked and public. Examples include *videos@bellcore.com* and *www.phoaks.com*. These test the hypothesis that communally shared meta-data can help users improve their performance when using a given object. "We are interested in how such histories might enrich computer-based activities such as reading, writing, and programming as well as how they might improve communication via email and bulletin boards" (Hill 1993). Accumulating data about how a document has been edited by multiple users will help future editors find trouble spots and areas of consensus. Adding helpful URLs to USENET newsgroups will help future users find better URLs from such groups, by synthesizing and adapting that information.

In most tests Hill et al have generated positive results in using HEDO to connect users and improve their effectiveness. As a signifier of their work's impact, they point to the shift from reading and editing as a private to a social activity: "If this were to occur on a large scale, it would represent a significant cultural shift." They also note that the use-patterns result in conversation that would not otherwise emerge. Finally, they report high statistical success based on pre- and post-tests performed for each experiment.

From a design point of view, Hill and friends draw on the wear of physical objects and stress the placement of an object's history-of-use *on* the object itself. "The notion of history-enriched digital objects is similar to physical wear. Usage leaves wear. Physical wear is an emergent property and though it generally remains unremarked upon until it causes a problem, it is also tattooed directly on the worn object, appearing exactly where it can make an informative difference" (Hill 1993). Their "sideways histogram of use" in *Edit Wear* and *Read Wear* is a classic example of embedding complex meta-data into the object, in this case the scroll bar.



Scrollbars from *Edit Wear* and *Read Wear* (Hill 1994)

"The figure above shows five Scroll bars. Think of the marks inside them as vertically oriented histograms. (a) is an unadorned document scroll bar. (b) is edit wear, the width of the mark indicates the relative amount of editing that has occurred on that line of the document. (c) is edit wear of two authors in two bands inside the scroll bar, (d) is readwear, the amount of time spent by readers of the document on various sections. (e) show 3 readers' read wear broken down into constituent parts (by vertical band)" (Hill 1994).

Hill's work is a significant building block for Patina. Studying digital objects based on social usage over time is a central theme in both projects. Representing that information in the fewest number of bits, directly on the digital object is also shared by both. Finally, both Hill et al's work and Patina aim toward using wear to connect and heighten the awareness of a community of users.

Use of Metaphor: Live Web Stationery

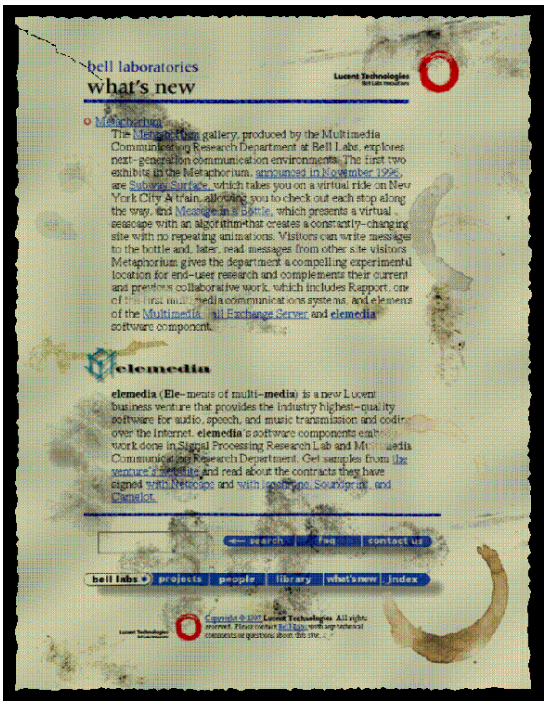
Lucent Multimedia's Dorée Duncan Seligmann and Stephan Vladimir Bugaj produced an experiment for SIGGRAPH '97 in which a web page ages as if it were a physical piece of paper. Based on human and environmental conditions, *Live Web Stationery* web page shows these artifacts of wear: smudges, rips, stains and fading (Seligmann 1997). Many of the project's objectives are similar to Patina's. As such, I have one overriding criticism and one source of high praise: the choice of metaphors is quite weak, but the *Stationery* is responsive to a breadth of usage conditions.

First, on the upside, *Live Web Stationery* clearly benefits from considering the paper page's qualities. Most importantly, its purpose is to enhance a web page with the ability to provide information about its age, how often it is used, and something about the users. This information is (literally) presented in the background. Secondly, use-based information is displayed directly on the document itself, unlike most

experiments in HEDO, which display a history-of-use somewhere other than the object itself. Thirdly, *Live Web Stationery* derives a broad range of human and environmental factors that all affect the "wear and tear" of a web page. Seligmann et al, write:

> "We model the paper, its environment, time, and human manipulation:
> - Paper attributes: color, texture, weight, wear and tear
> - Environment attributes: storage, dust, dirt, light
> - Time: creation, modification, display
> - Human interaction:
>   - retrieval attributes: user, browser, originating link, bookmarking, site-mapping, etc
>   - interaction types: clicking, editing, copying, printing, etc."
>
> (Seligmann 1997)

PatinaMap lacks this degree of breadth in the *kinds* of uses and the *types* of conditions that a digital web-based document is subject to. While these variables are all quite simple, when considered together and measured cumulatively, they can provide rich information about the object's history-of-use and its community of users.



Lucent's *Live Web Stationery* uses fingerprints, coffee-stains, rips and decoloration to show a web page's history-of-use

Metaphors are critical in any abstract data representation, but they must provide the user with the familiarity of the signified (the real object which the metaphor references) without succumbing to the multiple points of departure between the signifier and the signified. Thomas Erickson, of Apple Computer, writes, "an interface metaphor can provide the user with a model of the system, and … differences between the user's model and the real thing can cause problems" (Erickson 1990). For example, using a physical tree to successfully represent a computer's tree-structure is helpful only to a point: Both have a root (or trunk on the physical tree) and branches and sub-branches and possibly even leaves (files or variables on the computer). But a computational tree can add and subtract branches instantly or have any magnitude of branches, which the physical tree metaphor is unfit to represent. Similarly, a physical tree has a rich ecosystem, an irregular shape, sometimes an unclear division of branches, nubs, etc. which are ill-suited for reflection in a computer's tree structure.

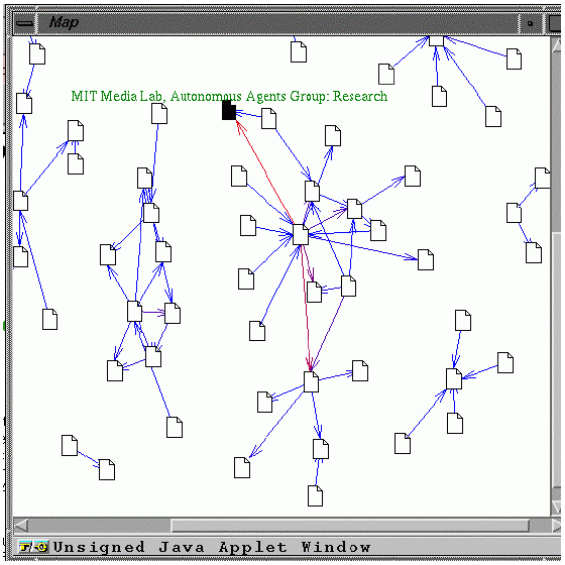
Using a metaphor, then, should rely on careful consideration of which relationships are essential and which are misleading. In the case of *Live Web Stationery*, the breadth of use and environmental attributes informs the paper metaphor it connotes. The metaphor is clumsy, however, in how it maps web page content to paper page content and web page use to paper page use. For example, a coffee stain on a screen appears awkward immediately because I will never put my cup sideways onto a CRT monitor.

The problem occurs in the mapping. The metaphor is taken too literally and too far. The breadth of uses, physical and environmental cues that *Live Web Stationery* draws from physical paper are lost in the mapping of physical forms of wear on a digital page. It is difficult to discern that a coffee stain represents a page that has been read for a long time, or that a fingerprint signifies a frequently followed link. I think that the designers and hypothetical users would be better served if the "lessons" from paper page had been mapped to the native, digital environment, rather than just mapping the features. In PatinaMap, I use a more symbolic metaphor, that of a topographical map. It ties into a common form of quantitative data analysis, is easily scalable and can reside in the "background." Even though everything we interact with on the computer is metaphor, it is certainly possible to pick or invent forms of representation that do not flatly contradict our intuition, or belie their origins. *Live Web Stationery* could have shown all its variables in a way that users can interpret, but consistent to its medium. PatinaMap seeks to do precisely this.

Flexible but Abstract: Footprints

At the Media Lab Software Agents group, Alan Wexelblat is currently implementing a system, called *Footprints*, which visualizes web-browsing histories. The project aims to improve the experience for "naïve browsers" and "information designers" by creating a data map which shows thelocation and frequency of user-made connections among web pages (Wexelblat 1997; Wexelblat 1997).

Footprints collects users' web traversals passively (without requiring any input other than browsing) and presents the accumulated data in a separate window. This data map contains clusters of "page" icons with arrows indicating links that users followed between them. Wexelblat's system is flexible enough to also let the user type in a URL (without clicking on links to get from page to another). The arrows between



Wexelblat's *Footprint* data-map displays color coded user paths

pages are color coded to signify frequency of travel (red means often used, blue means rarely used, with a range in between). "It is a map of the traffic, not of the streets on which the traffic might have flowed," Wexelblat stresses.

While the *Footprints* data-map displays a useful macro-view of social web browsing history, it abstracts this data away from the object it represents. Wexelblat observes how this "view" of browsing can be useful to information designers. Rather than decoding server logs, web professionals can clearly see what information is easily accessed and what stands alone; what is hot and what is not. However, this birds-eye view removes the data from the object which made it, i.e. the navigational features of a browser window, including: the html with its links, the "location" window in which to type a URL, and the various menus by which to select a bookmark. I think this abstract representation compromises the utility of the flexible client-server infrastructure Wexelblat has built. The data is window removed from its origin and assumes the (novice) user will fully interpret this dynamic organizational diagram.

It is a mystery why the web – and indeed most digital domains – have been devoid of tools to track and display a history-of-use. Just recently, I saw one of the first commercial tools, which claims to track "user-paths." *Alexa*, an advertising

supported web navigation service, suggests links based on "overall traffic patterns … [an] ecology of links between Web sites and pages … [and] editorial suggestions from multiple sources" (Alexa 1998). They combine a variety of sources to recommend new sites and display this meta-data pseudo-abstractly – as a popup on a special *Alexa* "bar." This is the first sign that a history-of-use will become part of mainstream computing.

Traces of Memory

Collecting use-data is not only something that interests computer scientists who see possibilities in leveraging people's simple behaviors in order to assist others and develop more collaborative practices. Leaving a persistent trace on any object, whether a book or a spreadsheet, often gives us a means by which to improve future choices. However, it also puts us in touch with the past. A worn object carries with it evidence of someone's identity, however minute, however impersonal. With repeated use, a person's patterns are stored and the object that accumulates them becomes part of a network of objects that serve as evidence of someone's presence, someone's impact on the world.

Identity and the Souvenir: *POEMs/Rosebud*

"Keepsake" objects are distinguished from other objects by the assignment of "personal significance." In my office, for example, I've surrounded myself with objects whose meaning exceeds their original purpose: each has a story behind it, about friends, family and experiences I've had: postcards from friends across the world, my girlfriend's grandfather's Spanish-English dictionary, a painting I traded with a film-maker. POEMs, personal objects with embedded memories, was a project by Media Lab students Jennifer Glos, and Brygg Ullmer. They laid out a framework for making physical objects the storage and retrieval devices for digitized forms of a person's memories (e.g. notes, pictures, images, sounds).

POEMs video shows how a seashell becomes a navigation tool for associated, digitized memories

In a vision video, Glos and Ullmer explore two objects, a seashell and a book. The video describes the explicit connections that are made between, for example, all the digital and physical memories collected during a visit to the beach (pictures, souvenirs, etc). "We imagine each of these physical interactions as setting off a ripple of digital associations, linking the physical seashell with other digital and physical media with special or temporal proximity to the gathering of the shell" (Ullmer 1997). POEMs and Gloss' subsequent thesis work, Rosebud, rely on the wisdom that keepsake objects serve as important vehicles by which we link to memories and with which we establish our identity. Without these objects, we lack material evidence of important events and the meaning they had in our lives.

Rosebud is an interactive storytelling system, "which encourages children to express themselves" (Glos 1997) by linking a child's stories with a digitally enhanced stuffed animal. By means of a computer terminal, the child and stuffed toy exchange in textual dialogue. The toy becomes the interface that retells or further develops the stories, hence augmenting its keepsake nature.

What gives a keepsake the propensity to contain personal significance is related to the context in which it is encountered and the extent to which its integrity yields to external forces which can inscribe it with context sensitive information – whether literally (e.g. POEMs), subtly or symbolically. I argue that it is in part due to the object's ability to yield to external forces, that it *can* become a "keepsake" object. This ability to yield – to show a history-of-use, allows for context sensitive impressions, however small, to be embedded on the object which physically differentiate it from other, similar objects. The object is able to connect external with personal experiences.

Digital objects resist yielding to context sensitive external forces. They stubbornly return to their original state (even if use even changed their representation temporarily). Even though much of the computer world allows us to personalize our digital objects, this process is not passive (requiring action other than using the object to personalize it. E.g. indicate preferences in checkboxes) and unable to persistently connect us to an external context. My "My Yahoo" page might provide the news I'm interested in and contain links that I use regularly, but it does not maintain any traces of these personalizations. This object is not inscribed with the memories I can associate with it – however subtle. There was nothing special on the page the day the Irish Peace Treaty was signed, and nothing remained the day after Good Friday. No evidence of an influx of interest and no sign that something extraordinary happened recently.

Herbert Zettl's Saturation Theory (Zettl 1990) maintains that the more subtle the media (the lower the saturation) the more emotional and interpretive involvement people exert. Written text, for instance, requires more internal interpretation than listening to the radio. And radio, in turn, requires more than watching TV. Literally, more bits are transmitted the higher the saturation of the medium. Therefore, one needn't overtly add links to sounds, pictures, text or whatever other forms "memories" might manifest themselves in, in order to generate some personal emotional investment. In fact the more inadvertent the leaving of the traces and the appearance of the traces, the better.

Patina attempts to provide the necessary building blocks for making digital keepsake objects, i.e. those which have special personal significance. The extent of this significance does not have to be big, but enough for people to feel a greater involvement than an "ordinary" digital object of the same kind. The hope is to provide enough cues that the object's traces are persistent and built up from a cumulative, community-based history-of-use.

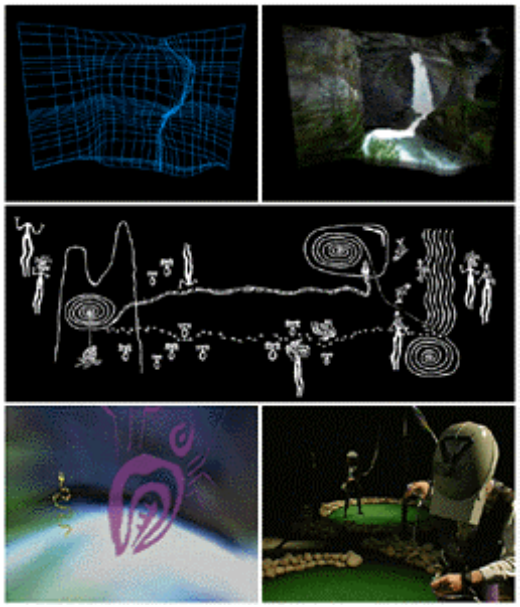
Social traces are links to memories – owned or not. When we ourselves or others we know leave traces on objects, that information serves to make the object more familiar – both in terms of association (this is my hammer), and comfort (it's broken in), but also providing information to others about how the object has been used.

Jennifer Gonzales describes personal objects as a "spatial representation of identity" which, as they accumulate come to constitute an "autotopography," or a "museum of the self." This museum easily outlasts us; it is a link to nostalgia and the host to our personal narrative. "Memories are made manifest in a material form. They obey the logic of decay but also are carefully preserved and located in a semiotic system of placement and display. In this context one could say that memories take place in a way that history does not" (Gonzalez 1995). Gonzales extends her argument to narrative traces. "There is an equally strong demand upon an object to both provide historical "proof" of a particular occurrence and to allow for an imaginary development of narrative. The flexibility of the second is as important to the story as

the rigidity of the first. It is the interplay of these two types of recounting that the object finds its most powerful narrative force."

Collective Memory in Form of Trace: *Placeholder*

In 1994, Rachel Strickland and Brenda Laurel created an important interactive installation that explored "a new paradigm for narrative action in virtual environments" (Laurel 1994). Using head-mounted displays, two participants could concurrently move about, speak and use their hands to manipulate objects in a virtual environment. Discovering a space through its past, its myths and its inhabitants was a central theme to the artists. Each visitor took on the personality and unique visual perspective of a "spirit animal" native to the wilderness around Banff National Park, in Alberta, Canada, where the exhibit was situated. Virtual visitors could explore the space, its spirits and encounter each other: "The virtual landscape accumulated definition through messages and storylines that participants left along the way." These traces were left in the form of "voiceholders," virtual sound storage and playback devices. Visitors could move the voiceholders and leave oral graffiti anywhere. Thus the landscape became populated with constantly changing traces with people's reflections, hints, and exclamations.



Models and scenes from *Placeholder*

Placeholder provides my research with insight on the role of traces on place, on people's need to leave a mark – "the phenomenon of placemarking" – and on the use of audio of leaving a social history. Strickland and Laurel's experience clearly required some means by which people could *become involved* in a virtual environment. The voiceholder signified a device for leaving traces, an invitation to leave a mark and consequently a means by which to connect visitors with a sense of place. This sense of place is tightly coupled with the ability to establish a collective memory of use.

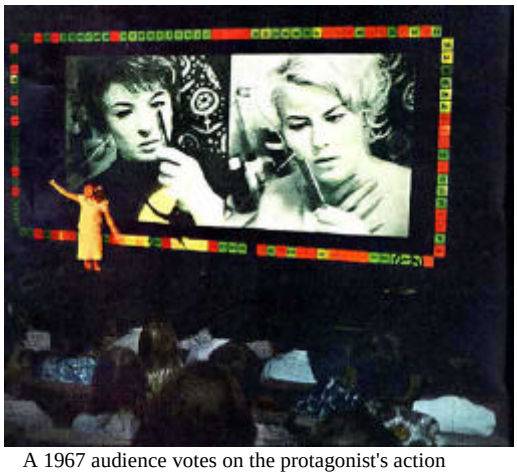
Desire for Audience

I have reviewed work that uses social traces to improve the use of information, and that explores the importance of identity and memory of social traces on things and in

places. In this section, I will look at how cinematic storytelling has evolved its dialogue with an audience. This started with an involuntary action-reaction, as the audience jumped away from the approaching train in Lumière's *L'Arrivée d'un Train en Gare de La Ciotat* and subsequently emerged as a setting for social interaction, as illustrated in *Nuovo Cinema Paradiso* (Tornatore 1988). Simple experiments in audience interaction became more sophisticated as computer scientists and filmmakers started to collaborate, connecting random access movie clips with software and interfaces to control them. Some audiences splintered away from public places and reconnected online to become integral members and creators of their own stories in many forms of virtual communities. Each part of this evolution is driven by a yearning to connect communities of people with the stories that impact them.

Society of Spectacle: Audience in Film

For years cinema has explored ways by which to interact with its audience. Walt Disney prototyped a device that would pipe scent into the theatre at appropriate moments in *Fantasia*. John Waters' *Polyester* was shot in "Odorama." At certain points throughout the movie, a character on the screen requesting the audience to scratch and sniff odor releasing cards. In 1967, Czechoslovakia's Raduz Cinera premiered the first movie whose playout was affected by the audience at the World Fair in Montreal. At five points critical plot points, *Kino Automat* stopped and the audience was asked to vote for one of two choices by pressing a button on their armrest. This lead to numerous similar experiments over the years, each attempting to find a compelling way to involve the audience in the story and with each other.



A 1967 audience votes on the protagonist's action

I am less interested in explicit forms of audience interaction, and more in the spectacle of the public performance. Although active forms of involving audiences are important, they have helped me realize that their focus is on the community of *people*. There is something special about this community of people and their collective involvement in a story, their collective presence at a spectacle. The significance of this "passive" presence is the topic of my research.

People typically consider themselves part of an audience when seated or standing together temporally and geographically, at a performance or public presentation. When an audience dissipates to become a group of people, it has invariably left its mark behind: popcorn, beer bottles, scuff marks, and programs are common forms of post audience debris. These two – an audience and its traces, the experience and its

physical evidence – are extremes that can inform new research in how to establish a sense of audience when people are not together in the same place at the same time.

Society of Audience: *Wheel of Fortune* and *Lurker*

As part of the popular "Workshop in Elastic Movie Time" in 1992, Glorianna Davenport and Larry Friedlander lead a group of MIT students to create a large interactive installation (Davenport 1995). The project was divided into three areas based on the elemental themes of water, earth and air (fire was not implemented), each consisting of a physical installation, a virtual environment and an interactive narrative.

One premise of this project was to explore two audience roles: guide and explorer. The guide sat at a computer outside the installation. His or her role was to guide the other participants – the explorers – who were investigating the installation. The guides, one per area, were equipped with a simple user interface by which they could monitor the explorers, and choreograph their environment in terms of media selection, light control, and narrative pacing. The students were challenged to develop compelling guide-to-explorer communication mappings (e.g. the means by which the guides "talked" with the explorers), the other part on creating an immersive narrative experience for the explorer.

The *Wheel of Life* innovated the audience's role. For the explorers, this installation required an active exploration from its audience. People were expected to step into a whale's mouth, and sing to the whale's ear. More interestingly, the installation turned the guide participants into co-authors, by making them responsible for leading the explorers successfully through the narrative, through the transmission of signs and symbols. For quite some time, Davenport has argued that it's more fun to *make* a story than it is to *receive* it. In the *Wheel of Life* much of the real author's efforts went into making a challenging "secondary" authorship experience for the guides. This idea of "audience as author" is important in much research at Interactive Cinema and beyond.

Not all "cinema" appears on the silver screen, as *Wheel of Life* shows. Not all "cinema" takes place with a temporally and geographically present audience, as digital media permit many-to-many communication. Computer users have been criticized for their social activity while physically isolated behind a keyboard and monitor. Nevertheless, the stories, spaces and information we share online are social commodities. We participate as a distributed society of audience, often unaware how we impact each other's experience.

In 1995 Lee Morgenroth put forward the idea of a "thinkie" as the main currency by which to measure interactivity in cinema. In *Lurker*, Morgenroth creates a multi-user narrative, in which distributed participants are to collaborate in order to solve a mystery. After six people sign up to join a fictitious "Toad Sexers" hackers group,

the web- and email based story commences. Email is used for communication among the six participants as well as to deliver the story material. Morgenroth cleverly uses the temporal medium to encourage the audience to interact, to maintain story structure by chronologically pacing delivery in real-time and to personalize story delivery.

Lurker uses the World Wide Web to solicit interactions from participants in the story as well as delivering movie clips that continue the plot to its next node.

> "Even if all the participants in an experience decide not to interact, the story will continue until its conclusion. Conversely, active participants can try to solve every problem, and can extend their enthusiasm to building relationships with their fellow participants. This sliding metric for interactivity is one important idea that Lurker explores in the medium of interactive cinema" (Morgenroth 1995).

As successful completion of the story is a rite of passage into the fictional hacker's society, so every run of Lurker will increase the size of this story's community. Morgenroth was unable to implement this element, in which, "the Toad Sexers will emerge from its fictional roots and become a real on-line group" (Morgenroth 1995). He proposes that this real group could serve as "re-authors" of the experience, editing, expanding and changing the content for future participants. This model makes a strong case for the dynamic relationship between author and audience, individual and community.

Towards socially evolving story: Games and *Dexter*

Sex and violence have been important driving forces behind the popular adoption of any communication technology. Without gaming and pornography, we would not have radio, film, video, CD-ROM, NC's and probably not even toasters or fondue, or telephones or colored lights, or energy, for that matter. It is, therefore, not surprising that the computer gaming industry has made significant forays into stories that evolve between sessions, between users and the use of social traces – all central to the Patina worldview.

For many years, games have extended the duration of a game beyond one session. The *save* button was a major innovation in interactive narrative. It is still rarely used outside the gaming world in computer mediated narrative. Most such narratives reset themselves after each session of use.

Persistent traces (bodies, blood, etc) in Diablo II

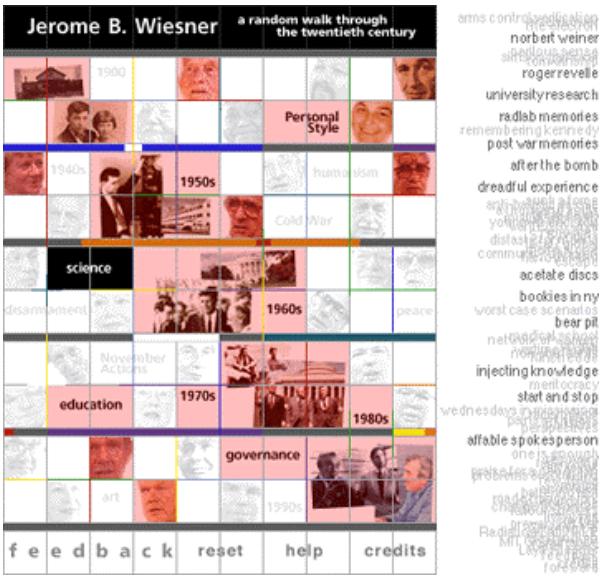
Even before the Internet was popular, ample networked collaborative or competitive games let multiple users participate in a shared environment, whether a flight simulator or text adventure game. In this respect, users affected each other's experience substantially, by

participating, by plotting against one another or by merely being present.

Many graphically sophisticated games leave social traces based on a user's actions. Titles like *Duke Nukem* and *Diablo* leave traces, sometimes persistent ones (that last beyond a single session). Blood stains, dead bodies, footprints, tire tracks, and destroyed buildings are all common Patina fodder in modern games. These traces represent a means by which to establish social presence, even though no one (virtual or physical) may be present, as well as an important continuity device. Seeing the traces from the last session serve as context sensitive, social reminders of experience game developers work so hard to generate.

The next example is hardly a game, but it expands the definition of an "evolving" story in several important ways: Users forge their own path through a set of content. Users may add their own content to the story. Finally, my eyes were opened to some possibilities of "socially" evolving stories.

Michael Murtaugh designed an "evolving documentary" which uses a "spreading activation network" to let user interactively navigate through an extensible set of content. All content for *Jerome B. Wiesner, 1915-1994: A Random Walk through the 20th Century* (e.g. movie clips, pictures or text) is annotated with keywords by an editor. The user can select a keyword by clicking on the "concept map," at which point each piece of content described by that keyword is activated (assigned more energy). Conversely, when a piece of content becomes activated, it spreads that energy to all the keywords that describe it. What results is a network of content that "knows" what content it is similar to – vis a vis the path a single user has chosen. The sequence of the content is not hard-wired, but instead relies completely on the result of simple, decentralized rules based on a shared of keywords that describe an extensible set of content.



Dexter's "concept map" consists of clickable visual keywords (left) that describe each piece of content (right)

Murtaugh's story engine, called Dexter, currently contains an "add your story" section in which audience members can contribute their own comments about MIT President-emeritus Wiesner. While this aspect is not fully implemented, it speaks to the audience's possible role in contributing to the story. Murtaugh's spreading activation algorithm can seamlessly fold new content into the story, provided appropriate keywords are assigned. Hence, Dexter's architecture opens the possibility to extend an individual's immersion into the story.

Many available data are lost every time a single session ends. Every new user needs to (re) invent their path through the documentary. What if the content's activation was to remain persistent between uses? This would allow a society of audience to carve out paths of sequences that are more refined than the high-level keywords can describe, yet just as decentralized and allowing the user total freedom to stray from the path or create his or her own path. This work was an important influence for me when thinking about Patina and the last idea is partially implemented in the form of "paths" in PatinaMap (described below).

Virtual Community:

In this final section of previous work, I will focus on several projects involving computer based multi-user environments, or "virtual communities." These communities can consist of thousands of users, non of whom are necessarily in the same physical space at the same time (let alone the same time zone). These communities continually provide us with new means to associate and engage with others, a society of users based on our interests instead of our location. The absence of physical presence has liberated and disturbed virtual communities since their inception. It has driven technical research to improve graphical, behavioral and narrative algorithms to simulate the appearance, actions and stories of our physical world. The absence of physical presence has allowed us to create places where kids can help each other think, reason, and communicate. Nevertheless, issues of visualization and involvement plague virtual communities.

People and Persistence: *Habitat*

In 1986, LucasArts Entertainment Company made an important advance into multi-user narrative environment with *Habitat*. With the use of a modem, users can connect to a central computer and become part of a virtual place, filled with buildings, characters, puzzles and … other users. *Habitat* was designed for thousands of users to graphically experience an artificial world and each other by using a joystick and keyboard on a Commodore 64 home computer.

Based on this significant project, Morningstar et al made incisive observations about cyberspace, computer design and community that are influential to Patina. "We feel that the defining characteristic of cyberspace is the *sharedness* of the virtual environment, and not the display technology used to transport users into that environment" (Morningstar 1991) (italics mine). Central to their argument is that no advances in science and technology can create an environment that is as rich, complex and deep as what a human brings, "let alone a society." Based on that assumption the LucasArts team set off "to use the computational *medium* to augment the communications channels between real people."

LucasArts' clear lesson of people over technology is important to the premise behind my work in Patina. It seemed perhaps especially significant considering that so many commercial efforts choose just the opposite approach, increasing their graphics and audio capabilities to entice players. Patina applies this lesson to the extreme, seeking to establish a "sharedness" even in traditionally perceived non-shared, single-user environments, like the web.

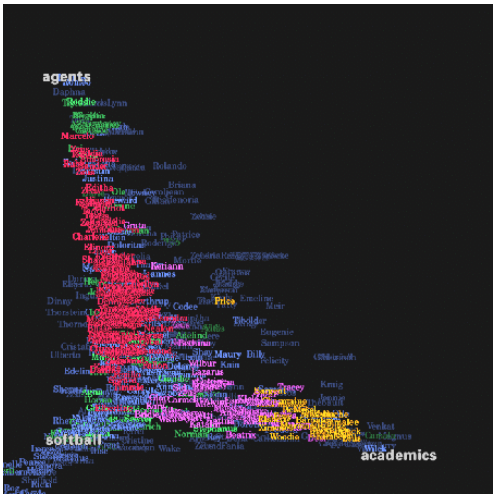
Constructionist Community: *MOOSE Crossing*

Amy Bruckman took the user's involvement in a virtual community further by letting community members construct their own environment. *MOOSE Crossing* is a text based virtual world, or Multi User Dungeon (MUD), designed for kids. In it, participants can communicate with each other and construct the environment itself, thus involving themselves in a "constructionist community" (Bruckman 1997). By typing simple commands, like `say hello` and `look` *MOOSE Crossing* members can communicate and explore the world. By writing simple programs they can construct creatures, things, and places that others can interact with. The community serves as much as a context in which to make buildings, creatures and stories as it is a place to learn from one another. Bruckman discusses at length the importance of a social context for learning complex subjects (such as math and programming), of role models, and of a context in which one can take pride in their work. The *MOOSE Crossing* virtual world is filled with things made by its members. As such, it evolves and grows based on its' members online vicissitudes. These changes remain after their creators log off.

Visualizing Association and Activity: *Visual Who*

Referring to the myriad of virtual communities that we can participate in, from mailing lists to MUDs, Judith Donath complains, "it looks like any other screen: a prompt, some text and a cursor. One has little sense of the presence of others" (Donath 1995). Much of Donath's research focuses on how to represent people and identity in and through the computer. In *Visual Who* she creates a dynamic model by which to show "patterns of association and of activity." Donath uses motion and color to communicate otherwise invisible aspects of a virtual community. In *Visual Who* someone can look at the Media Lab's virtual community – based on the mailing

lists to which each member subscribes. *Visual Who* shows close associations drift towards each other and identifying membership of lists. The user of *Visual Who* can place mailing list names anywhere on the screen. The community will shape in relation to those groups and to each other, in the process showing associations, presence, anomalies, and a sense of a community. In terms of informing Patina, this project's strengths lie in its simple visualization mappings (based on motion, color, opacity and dynamic position) and its inadvertent membership (no one needs to do anything other than what they ordinarily do to be a part of the community's visualization).



Donath's *Visual Who* here shows community association between three anchor mail-lists

6. PATINA IN PRACTICE

{
Initial Experiments
PatinaMap: Mapping a Topography of Use
}

This research represents an initial step in experimenting with layering social traces on digital objects. This section contains the work I did that pertains to Patina. The early experiments were conducted between the Spring and Summer of 1997. PatinaMap and its extensions were developed during the Summer of 1998. Most of the work was produced in collaboration with others, whether other graduate students, or undergraduate "UROPs." Of the latter category, I want to recognize Sumita Pennathur (*Spelunk!*), Jenny Sappington (*Spelunk!*), and most notably Alon Mozes (PatinaMap).

Initial Experiments

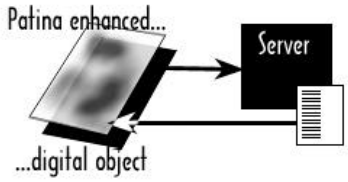
I conducted three early experiments in persistent use-tracking digital objects. *Touch of Time* is a narrative study that explored story from an object's point of view. *Spelunk!* is an accidental community space in which members' contributions are evolving between sessions. Finally, *Burning the Wax at Both Ends* is a tangible interface which tracks computer use on a physical plotter.

A Touch of Time

In the Spring of 1997, I created *A Touch of Time* for Janet Murray's Theory and Practice of Non-Linear and Interactive Narrative class at MIT. The premise behind this project is to reveal the stories found in ordinary objects. Physical objects are witnesses to the comedies and dramas of those who use and live around them. Everyday objects around us are vessels for inadvertent expressions of who we are and what we do. I want the story's reader to start looking at the objects around them, not as just things, but instead as evidence of our lives, our stories. In

this capacity phones, curbs, stairs and books take on a role in addition to their usual one. When probed, they become storytellers, peeling off layers of knowledge and insight into our lives.

This project consists of some stories told by physical objects. The stories cover a period of time that chronicles primarily two households, one belonging to Leon and his family (first his parents', then his own), the other to a group of college students. The stories are told from the object's perspective (sort of) and therefore have little sense of time in the way that we are used to. It is structured in layers to simulate the layers of wear that our lives have imposed on these objects.



Nascent client-server architecture used for *A Touch of Time*

The user moves the mouse over an image-map, which is the interface to the story. When the mouse rolls over the "hot-spots," part of the image pops up to signify there is a path to follow. Clicking on that location takes the user to a story fragment, or lexia. Clicking also deposits a small, slightly transparent imprint (by overlaying a graphic on top of the background) which is persistent and visible to future users. This trace is left behind so that the interface can mirror the narrative impetus of the story's "characters" – a pay phone, a no-parking sign, a playing field and a doorknob. These characters' observations are motivated by and the result of social traces left behind. (Schütte 1997)

Spelunk!

> It was a dark and stormy night. A shot rang out. A web surfer was gliding effortlessly through cyberspace when she suddenly stumbled and fell. Holes in the Net are common: "404: File Not Found".
>
> …the ground crumbles out from under him. He falls past animated creatures taunting his every move, sees his neighbor telling light-bulb jokes to a laptop…and, smiling, drops into the dimly-lit caves beneath the World Wide Web…
>
> Welcome to **Spelunk!**, a shared environment of humor, hysteria, and HTML (Lachman 1997)

Spelunk! is an accidental, humorous, socially evolving community space on the world wide web. People don't go there on purpose, instead it appears suddenly – in place of the all too frequent "404: File Not Found" error. When an invalid URL is selected, *Spelunk!'s* proxy server replaces the error message with a fast paced, lighthearted web-based environment consisting of various puzzles, jokes, entertainment and games.

Richard Lachman and I designed *Spelunk!* in response to Interval University Workshop's challenge to consider how computers and humor could better intersect. We wanted to replace the mild and frequent frustration of getting a bad link with not just something funny, but an opportunity to participate in an evolving community space. "Each community of *Spelunk!* participants use our HTTP proxy-server to filter all web-browsing requests. When the server finds a “404” error, the *Spelunk!* system quickly generates a “play list” for the new episode based on lists of available media, the state of the space as it was left by previous visitors, and particulars about the new user" (Lachman 1997).

"Poetry Magnets" is one of the "activities" that *Spelunk!* could select from. This Java applet is modeled after the popular word magnets that adorn so many fridges. The words that are strewn about the periphery of the screen are generated from the page that the user last came from. In other words, if the bad link which triggered *Spelunk!* is on www.microsoft.com, the words in Poetry Magnets are culled from that Microsoft web page. In addition, words in the center of the screen are previously arranged by other happenstancial *Spelunk!* visitors. What results is a combination between what is specific to one users context and what is evolving, persistent and communal.

Similarly relevant to research in social traces is the "Big Phun" activity. "Big Phun" is a place for users to digitally submit their favorite jokes, comics and urban myths. This applet will display the contents that the community has submitted and allow users to "vote on favorites by throwing rotten tomatoes at will. The vote is preserved, updated and used as a mechanism to continuously select more popular content."

Burning the Candle at Both Ends

This project presents a new tangible form of data visualization involving dripping hot wax onto a moving disc. This tangible history is particularly conducive to representing long-term temporal data sets by mapping them to polar coordinates. Daniel Dreilinger, Chris Metcalfe and I implemented a physical device that produces a permanent, tactile record of long-term processes (Dreilinger 1997). The installation provides a persistent view of the data, unlike the more transient window based environment, in which plots can be "closed" or easily obscured by other data.

Our prototype uses motors to apply wax to any coordinate on the disc. We created a precise system of Lego motors and gears, controlled by small PIC-based "Crickets" designed by the Media Lab's Fred Martin. The Crickets, which are attached to a host computer by an infrared link, can address a polar-matrix of 168 by 24 "waxels" (wax elements). This granularity allows us to map 24 hours in a day for 7 days per 360 degree rotation. On the host computer, a Perl script interprets data sets and sends commands to the Crickets.

We experimented with two plotting techniques. In the first, colored wax is dripped in one of 168 discreet positions according to the angular distance, *q*, which corresponds to the hours in a week. The radial distance, *r*, varies 24 hours of the day. This produces the effect of seven offset spiral fragments (see figure A). In the second approach we vary the radial distance much more slowly -- on the order of one

Figure A

Figure B

increment per week, over eight weeks. This has the effect of producing a spiral originating in the center and terminating on the perimeter months later (see figure B).

We recorded cumulative keystroke activities for the first approach during the course of several months. At an accelerated rate, we plotted this data using different color wax each week, increasing the quantity of waxels for periods of heavier use. In our second experiment, we plotted the cumulative login activity on the Media Lab's most-heavily-used machines. We applied different colors sequentially to represent different ranges of observed values. Thus, in figure D, the red layer emphasizes moderate activity by leaving heavier traces when 40 or more people login. The yellow layer signifies peak uses of 80 or more logins. Applying the wax was a difficult process, requiring a careful balance between short pulses of applied heat and drainage of access drippings, for which we devised an elaborate mechanism, but ended up dripping manually, based on the computer's cues. Keeping the encoding of a history-of-use under control, whether physical or digital, is a treacherous endeavor and prone to error.

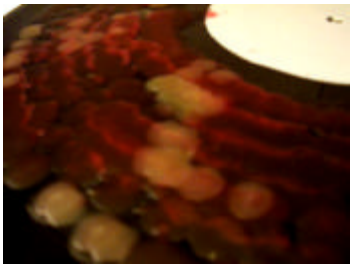
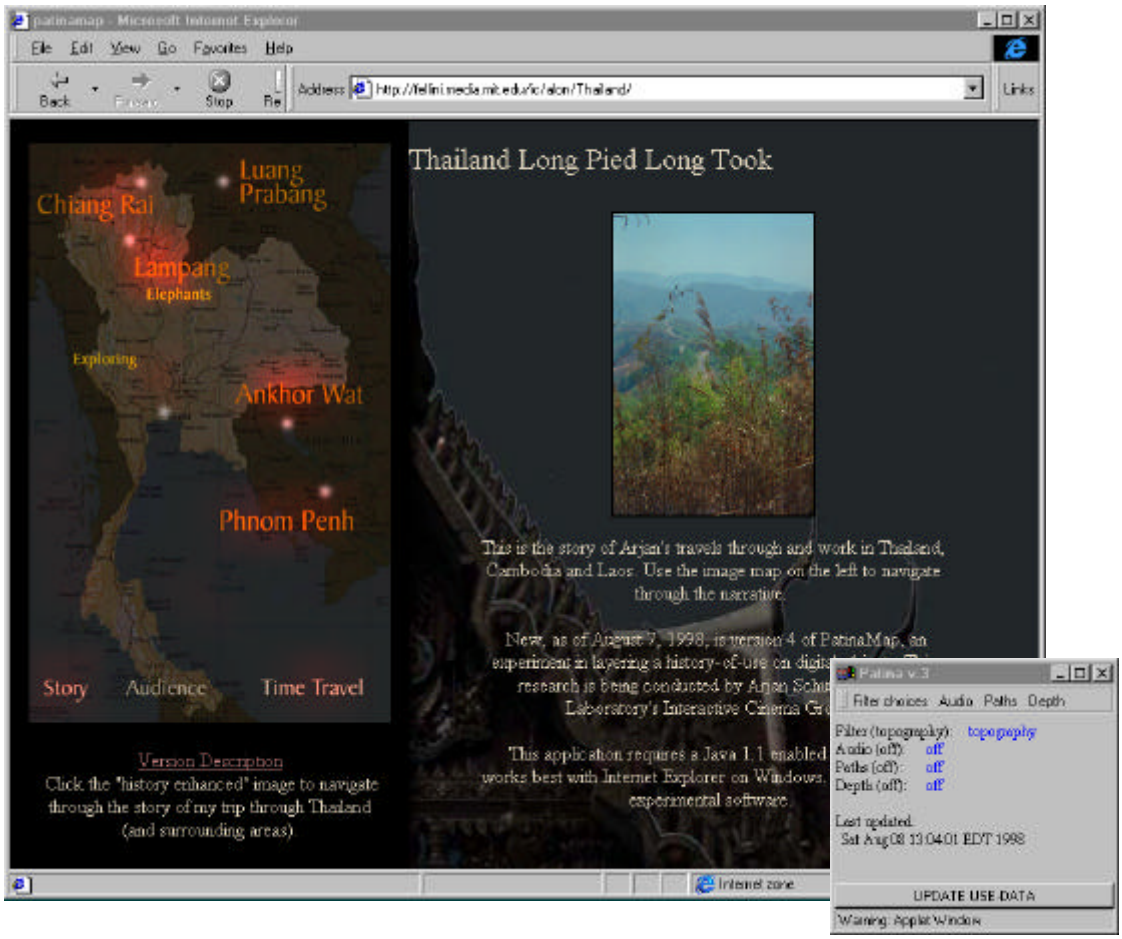




Figure C, D and E (respectively)

The installation (see figure E) is an art piece that tracks digital vicissitudes. The actual drip of wax produces spontaneous punctuation of a data point (such as keyboard use and network logins) and a persistent impact. The physical trace cannot be obscured by other windows or computer processes and therefore is effective in communicating long-term awareness. The installation is built into an old gramophone player to complement the temporal and rotational characteristics of this work. The old encasement signifies the historical nature of the content and makes the piece into an attractive ornament, in contrast to the data it plots.



PatinaMap: Mapping a Topography of Use

PatinaMap is an image-map for the World Wide Web that tracks and represents its history-of-use. It also maintains records to an associated web site. To the user, it appears as a normal image-map. The image is divided into separate areas, which, when clicked, sends the browser to different URLs. PatinaMap will work on any image-map, but in this case the image is a map of Thailand (including surrounding areas) and the URLs contain pictures, text and video constituting several stories of my work and travels in that region during the first quarter of 1998. In addition to linking the user to this story content, the image-map records how people use it and communicates this information via a corresponding server and a control panel which gives the user control over various options the program provides.

The purpose of PatinaMap is multifold:

- To illustrate the impact of a history-of-use on a simple, ubiquitous digital object
- To build the infrastructure necessary for such meta-data transaction
- To experiment with different "visualizations" (including sound) of use-data

- To experiment with "unique digital characteristics" that can enhance someone's use of a digital object – impossible on physical objects.

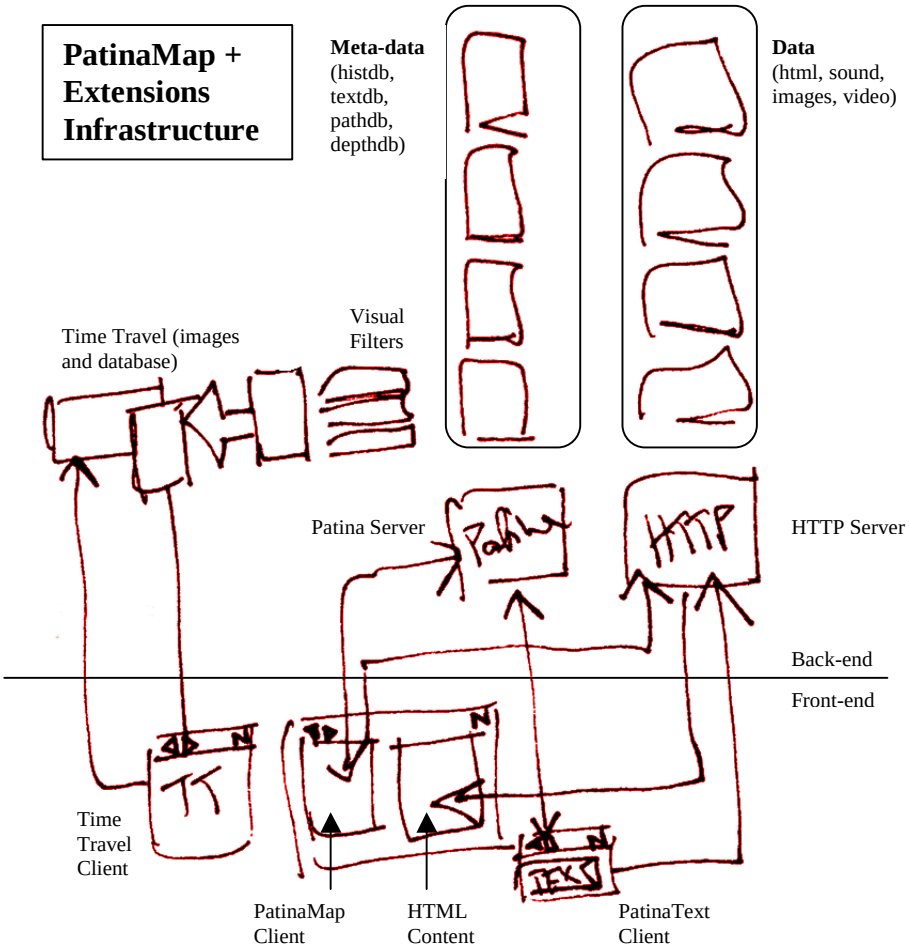
On a conventional image-map (consistent with most digital objects) future users cannot feel part of an audience or benefit from past users' activities. Future users do no know *if* anyone has been there. Future users have no means by which to appreciate *how* and *that* they are changing the meaning of the site simply by using it. The site's designers, finally, have no idea how effective their user interface is. Nor do they have immediate access to how it's being used (without correlating server log statistics to areas on the image-map or other parts of the site).

Program Overview

PatinaMap consists of a back-end a front-end, and a content set. A Patina server, web server, history-of-use database, visual filters, image converter, and media files make up the back-end. The front-end is composed of an HTTP client (web browser), and several Patina Java applets with which the user directly interacts. This entire infrastructure supports the navigation through a story presented in images, text and video clips. The user can access many of PatinaMap's features (below) via a control panel, which was implemented to isolate preferences and effective combinations.

- **Active Visual Filters**: several filters interpret the use-data as a visual layer on the original image-map.
- **Synchronous Use**: each time a user clicks, an icon appears at the same coordinates of every other connected client, signifying simultaneous users.
- **Audio**: a background sound loop reflects the popularity of any area on the image-map by playing at varying degrees of "graininess."
- **Paths**: lines are drawn from the current location on the image-map to other location(s) based on the sequence of previous users.
- **Depth**: based on the amount of links followed from a given location's content, concentric circles signify how deeply previous users have explored the available content.
- **Time Travel**: an animation shows the evolution of PatinaMap from its inception until the current date.
- **Content**: The content is a story called "Thailand Long Pied Long Took" about my travels and work in S. E. Asia. Each page contains some media (text, images, sounds or video) and an invisible applet that keeps track of the user's "depth" (see above).
- **PatinaText**: a Java applet that replaces hot text (links) and displays its history-of-use through color and motion.

All the back-end components reside on a dedicated server computer. PatinaMap works in conjunction with any ordinary HTTP server and client. Below follows detail about all the Patina specific components, including its story content.



Patina Server

The back-end is server application written in Java 1.1. It runs on the same machine as the HTTP server to which clients connect with a web browser. Java security restrictions require that the Patina and web server be run on the same machine. The Patina server listens for connections from new clients, it receives use-updates from clients, it processes the visual filters, it broadcasts synchronous use to all connecting clients, and it updates clients with the latest visual filters. Although a client-server architecture is not necessarily optimal for Patina-like applications, we have spent quite some time honing it for Patina's specific ends.

Most communication between client and server happens when the client is opened and closed. When opened, a client establishes a connection with the server and receives the Patina enhanced image-map for the default visual filter (see below). The connection remains open until the client disconnects, at which point the client sends any use-data it has accrued to the server. Such use-data consists of time stamped x/y coordinates of where the user clicked. Upon receiving those data the server adds

them to a flat file database, called "histdb," which keeps cumulative and persistent track of the image-map's history.

Broadcast is one exception to the communication protocol described above. Broadcast serves to notify all connected clients when one client receives a click. After a Patina client-server connection has been established, each time a user clicks, two data streams result: The client Java applet determines if the click was made in an area with an associated URL. If so, the first stream from the applet sends that URL to the HTTP client (browser), which makes the appropriate requests of the HTTP server for the correct HTML document. The appropriate web page is returned to the client. A second stream is sent to the Patina server (this is the reason a connection remains open while the client is active) containing the x/y coordinates. The server "broadcasts" these coordinates to all currently connected clients, which paint an icon – signifying "remote synchronous presence" – to the screen.

Color and Signifying Use

Several aspects of PatinaMap use color to convey a use-data. The "topography" active filter (below), for example, colorizes the image a range between blue and red or "depth" is indicated with varying levels of darkness for a given hue. PatinaMap filters employ only two assumptions in regards to color's signification of use.

Blue/Red – Blue represents old age and red signifies newness. This classification is based primarily on the vernacular association made with "red is hot" (and hot news is current), and "blue is cool" (old news is cooled off). The red/blue dichotomy is commonly used without a key with temperature, altitudes and age.

Lighter/Darker – Sometimes this means a change in saturation, sometimes a change in color level. In both cases, lighter signifies less quantity and darker more quantity. There are many examples in information design that support this assumption, including cartographic altitudes (high and low extremes are darker), perspective distance (far is darker), data density (the more points, the darker), etc. Consequently, PatinaMap assumes user will guess that a darker line signifies more traffic and a darker blue suggests more hits.

Active Visual Filters

The most dominant means PatinaMap employs to display a history-of-use is through its visual image filters. Through the control panel, the user can select one of *n* visual filters. We have implemented three. The different filters allow users to interpret use-based data differently, by layering it on, in this case, an image-map. The visual filters are also an example of nascent active graphical filters. Corel Paint and Adobe PhotoShop provide numerous graphical filters, which are neither dynamic nor active. After the filter has been applied and the file saved, it no longer actively interprets new data. PatinaMap introduces a paradigm for graphical filters that are active, constantly

interpreting meta-data, specifically based on social-wear. Similar to how Microsoft Excel has a "filter" which will actively map the values in a spreadsheet to a bar graph or pie-chart whenever it is changed, PatinaMap introduces the idea of doing the same for "use data."

Due to the graphic intensity of the visual filters and their small, incremental changes, all processing takes place on the back-end. After the client closes the connection, the server updates the unaltered image to reflect the cumulative usage pattern, according to that filter's algorithm, for each filter. This update time takes approximately 2 seconds per filter. The next client that connects, or the next time a client changes filters, the appropriate image is already buffered and is sent immediately (without requiring the client to perform expensive processing).

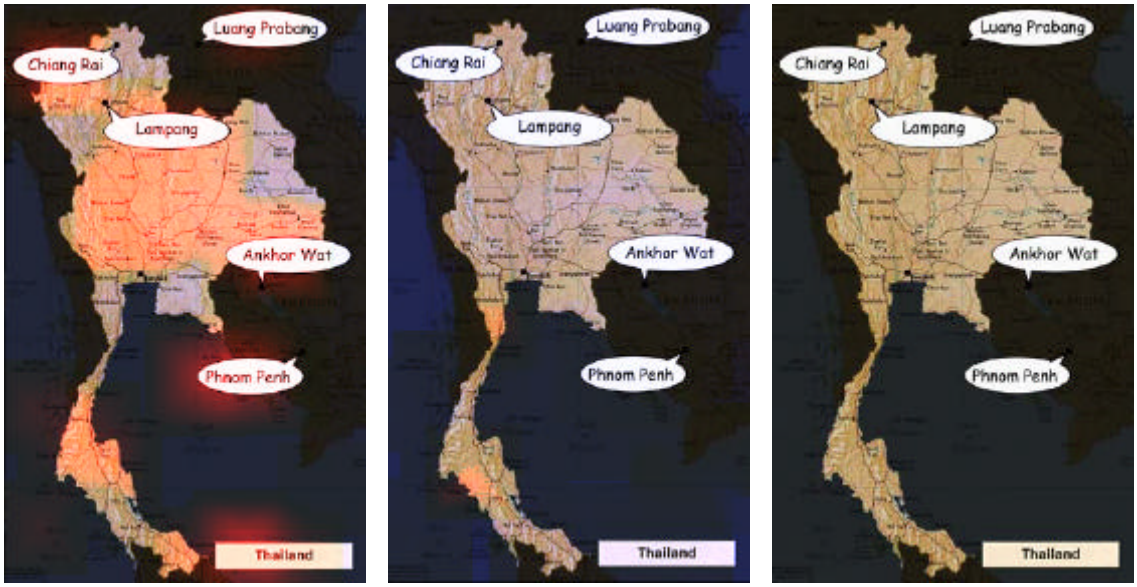
In contrast to a geographical map, which often contains multivariate data on political boundaries, population statistics, vegetation types and altitude, the PatinaMap adds a layer of information based on quantity and recency of use. Thus, in the "topography" filter more recently accessed areas appear redder, while older clicks are bluer. More commonly clicked areas appear more saturated then places where no one has visited.

We have spent significant time on honing the aging behavior for each of these filters. For use-data to be in the background, it may not draw attention to itself. Due to speed limitations, the image was initially divided into a grid of 50 x 50 pixel boxes. The jagged appearance of the use-topography drew attention to it. By employing buffered, server-side graphics processing techniques, we now address each pixel independently (without taking 20 minutes per update, as was initially the case). This was in part possible due to the generous assistance of Ricardo Torres.

Top: 50x50-pixel grid.
Below: 1x1-pixel grid.

```
//g.recent[i][j] is the recency value (-100 - 100) of the box with
//coordinate (i,j)
//g.hitPortion is the portion of total hits that same box has
//received

 percent = 100 + (g.recent[i][j]/10)*(g.hitPortion[i][j]/10);

//If the recency value is greater than zero it reddens it by
//percent,
//If the recency value is less than zero it bluens by percent

//Example of how it colorizes pix (example is
//redden):
 int r = (rgb&0xff0000)>>16;
 int g = (rgb&0xff00)>>8;
 int b = (rgb&0xff);

 r = Math.min(255, (r*percent)/100);
//where percent is the value calculated above
```

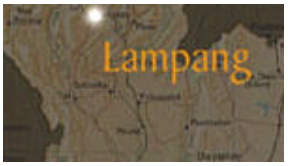
Age and decay are essential to continuously displaying relevant use-data. In earlier iterations of the visual filters, three distinct phases could be discerned: puberty, vibrant maturity and retirement. In the puberty phase (approximately the first 50 hits), the map appears awkward: bright blotches of color, just as jarring as the first stain on a new tennis shoe. Vibrant maturity (approximately the subsequent 100 hits)



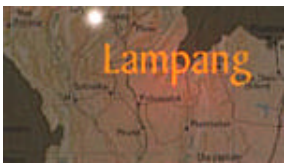
Three stages of an early "topography" aging algorithm with a limited life span. Note the puberty, mature, and retirement stages.

appears worn and provides a range of data – some areas clearly used more recently, others less or longer ago. In the retirement phase, the filters had averaged out all data, resulting in a beautiful, albeit flat patinad landscape with no distinguishing features.

Currently, these active visual filters use only the quantity and recency of hits collected by the applet and use the image itself to represent those data. Of the filters we implemented, the "topography" filter is the default choice for new connections. Here follows a brief discussion of the filters we implemented:



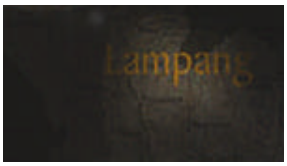
None – although the applet still tracks use it does not display it in anyway. This filter can be used as a control group.



Topography – this filter averages out the relative recency of each hit made to any given section on the grid that covers the image-map. The most recent are red and the oldest are blue. This filter never obscures the visibility of the original image, only changing the color and saturation slightly.

Darken – this filter dramatically darkens the most popular areas, in effect pushing the visual attention of the user to the periphery of use. Each hit has a high visual impact with the

intention of visually obscuring some parts of the image. This filter decays after has hit a peak opacity. (It is quite ineffective)



Brighten – this is the opposite of "brighten." It focuses the user's attention completely on recently visited areas, virtually obscuring the rest of the map.

Synchronous Use

Most filters and other extensions of PatinaMap show asynchronous information about an audience. Most data are accumulated from past use. Asynchronous wear is important when a distributed audience does not share the same place at the same time. However, it is *possible* that individual users are part of a synchronous audience - temporally proximate, even though not physically close. To this end, when PatinaMap receives input – a click – this passed to server and "broadcast" to all currently open clients. Any concurrently running PatinaMap users will see an instantaneous trace in the form of an icon and a sound. If many users are connected at a given time, all of them will see little "hand" icons wherever the originating user clicked on the image-map.

Another, currently connected user just clicked on PatinaMap

Audio

On physical objects, the history-of-use is dictated by the laws-of-physics. PatinaMap, however, gives its users a choice of how to represent its use-data including audio. Audio can function in conjunction with or independently from any of the visual filters. Paul Nemirovsky designed an ambient sound loop to compliment the aesthetic of the story. When "audio" is turned on via the control panel, this sound loop is played as long as the mouse is over the image-map (so as not to interfere with other sounds: e.g. from video). Based on the exact location of the cursor, one of five versions of the same sound loop is triggered. When the cursor passes over an often-visited section of the image-map, it sounds clear and crisp. When it rests on a historically isolated area, the sound sounds distorted and crackly. The same applies for regions in-between those extremes.

This implementation uses only one axis along which to alter the sound (popularity, averaged over life) and only five 8bit, 8kHz ".au" sound files. It did not, for instance, also consider recency, depth, time of day nor did it change its volume, complexity or other properties. As such, it is the first iteration of a promising representation medium. This use of audio is particularly effective in combining ambient information (thematic music) with quantitative use-data, even though the implementation was fraught with limitations (largely due to poor audio handling in Java).

Intra-session Paths

Until this point, PatinaMap's filters only reveal cumulative use, without distinguishing whether a trace was made within one session of use, or between sessions; by one user or by 1000 users. This type of representation of use is specifically well suited for applications which don't require or encourage use of the entire content set. News, for instance, might attract users only interested in a certain beat. Or a company's different areas of operation could easily fit that profile. In both cases, the information timely and users are likely to use a subset of the entire contents. However, for the story that PatinaMap is illustrating, it is quite possible that many users will want to navigate a majority (if not the entirety) of the content that is available. For this kind of use scenario, it is important to provide an additional granularity of use-based information: sequence. In this scenario, it is less important to know that one area was popular a long time ago while another is of contemporary appeal (while this data may still be very relevant). To this end, PatinaMap tracks usage paths within a session.

Paths within a session are based on the areas in the image-map which lead to a URL (instead of any area that a user might click, whether it's a valid link or not – which patina also keeps track of). Within each session – defined as all the user's clicks between initializing and quitting the PatinaMap applet – the system will display the links previous users have taken from the currently selected "hot area." If, for example, most users had gone from the Phnom Penh link to the Ankhor Wat link, the system would display that by a moving arrow from Phnom Penh to Ankhor Wat. If less users had previously gone from Phnom Penh to Lampang, a lighter colored arrow would move between those locations, signifying a less significant previous connection. This data is context sensitive, persistent yet evolving as people traverse the story applet. For simplicity, the system does not track more than one node's relation to other nodes. It does not recommend nodes based on "series" or "paths" of previous nodes. The method of representation is more important here than the depth of recommendation the system provides. Additionally, this level of depth is warranted given the quantity of nodes available in *Thailand Long Pied Long Took.*

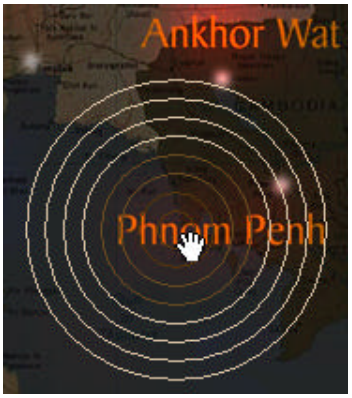
Previous users have mostly gone from Phnom Penh to Ankhor Wat

These paths are significant because they display a micro-granularity of use that can further hone the users' utility of a history-of-use. They also add a level of multidimensionality which the system needs to be able to present without overwhelming the user, just as a geographical map can simultaneously display

population, public transportation routes, topography, vegetation, tourist attractions and political boundaries. In addition to the image-map filter and sound, PatinaMap's path representations have become complex enough to significantly enhance normal digital objects beyond their unaltered instantiations. The paths are also important from a story-telling point of view. Without them, the user would be left to marring a two-dimensional surface, mining for story fragments without any hope of tying more precisely into how previous users had engaged with the story. Still, the story paths are completely derived from use-based information. The author does not arrange the content in any particular order – this connecting work is left to the user completely, in accordance with the bias of this thesis.

Depth or Remote Wear

PatinaMap adds another level of information by extending its tracking beyond the image-map itself, to the pages it links to. This will allow the system to treat a click differently that went to a page and returned immediately, a click that went to a page, which lead to a subsequent page, or a click that lead nowhere. Without this "satellite" awareness, PatinaMap would show each of those previous cases identically. Tracking the extent of "remote use" permits Patina to display more accurately not *that* it has been used, but *how* it has been used.



Depth shows how far previous users have traveled from home

When a user clicks on link on the central PatinaMap, the applet will pass a URL to the browser, which subsequently opens that page in the adjoining frame. Once opened, that page – which contains an invisible PatinaDepth applet – will tell the server that it successfully loaded. If not, the server will assume either a broken link or an aborted download. The server knows that one link has been accessed. If the user clicks on a link within that new page, that next page will communicate to the server the identical information: that it was called and whether it finished downloading. Etc. The server will keep track of how deep the remote path goes – measured in terms of subsequent connected pages – and will display an average of this information to future users by means of concentric circles around the cursor. An outer ring of circles (see figure) signifies the maximum number of links the system has assessed (based on use), while the internal (darker) ring reflects the average depth of use.

Time Travel

Informal user testing clarified that users had trouble appreciating the evolving nature of usage-patterns based on a stagnant image. Time Travel is an applet animation that shows a PatinaMap's history from its inception until time, *t*, when the applet is

activated. Time Travel relies on its own infrastructure and consists of a small application on the back-end and a Java applet in a web browser. On the server side, the program regularly (every 10 seconds) checks to see if the Patina server has created an updated active visual filter. When it finds one, it simply converts the image to a "GIF" graphics file, stores it to a directory and appends a database file ("imgdb") with the file name and a timestamp when it was stored.

The Time Travel applet reads the "imgdb" file in order to identify 20 images at even intervals created throughout PatinaMap's history. Subsequently, it loads those images and plays them back as an animation. Simple controls (reset, frame-back, stop, play, frame-forward) allow the user to move forward and backward to study trends or details more closely.

Content

PatinaMap is made in conjunction with a story called *Thailand Long Pied Long Took*. The title is Thai for "by trial and error," a common expression used in Thailand. The story content consists of written text, images, and video clips that are presented in the right frame of the web browser. PatinaMap is on the left side and consists of an image-map designed for this story: a map of Thailand and surrounding areas (so as to include my travails in Laos and Cambodia). PatinaMap is designed to help its audience experience the story differently and to experience itself (the audience, that is).

The story itself is a collection of lexia (story fragments) organized roughly by location about the time I spent in SE Asia in the first quarter of 1998. Part of that time was spent working with Seymour Papert's Lighthouse project, part traveling on my own. The story fragments, whether in text/images or video, are meant to be independent story fragments, each explicating some facet of how I learned "to be present," a sacrifice that was made to that end and something gained from that change. Kevin Brooks suggested that I make each clip with some common, personal theme. This would serve as a catalyst, a reward for "scratching the surface of the map." Consequently, there are seven geographic areas on the map which link the user to one or more of such lexia. Several locations consist of multiple pages, linked to each other by PatinaText links. The title of the story is appropriate both in terms of my adventures in Thailand, but also in terms of the user's navigation through it.

PatinaMap is intended to change the audience's perception of the story and create an awareness of itself, but it is *not* a story engine. Most rudimentarily, it is simply an image-map, which links to several URLs. Therefore the "story structure" is mostly flat. However, there are several ways in which PatinaMap changes the user's experience of the story: active filters, audio, paths, depth and the map itself.

The "brighten" active filter is a good example of how PatinaMap's features impact the user's experience of the story. By only showing very little of the image-map, it biases the user's selection significantly. Ostensibly, the only clues the user has is based on

the "paths" feature. Paths are a simplified model of recommending a sequence within a given session. From each location, Paths will send lines based on where previous users have traveled, and with what frequency. If certain paths become well used, this feature can significantly impact the story. Depth impacts the story in terms of providing richer structure than a one level deep exploration. Finally, audio and the color schemes of the other features are all based on the story's ambiance.

Nota bene: The map used to navigate the content creates an interesting "triple" map effect. It is a geographic map of the physical region, the "topography of use" metaphor for the active visual filters is another map(ping) and finally, PatinaMap is based on an image-map.

PatinaText

The purpose of PatinaText is to take the same design criteria that apply to PatinaMap, and tie "hot text" (links) into the same infrastructure for tracking and presenting use. On the one hand this is much simpler in functionality to Hill's text based work, as PatinaText does not track the amount of time text is on the screen, or whether it is being edited, or by whom, etc. On the other hand, PatinaText is designed for use in a ubiquitous domain, like the World Wide Web. Its design leaves a lot to be desired in terms of making any web-based hot text into PatinaText. That is to say, the current version of PatinaText requires quite a bit of setup, especially in comparison to writing normal html.

Nevertheless, the idea is more important from an end-user perspective: can text compellingly, unintrusively reveal how it's been used? The PatinaText applet will take several parameters: textfield (of which there can be many), textsize, textlinks, bgcolor, and the necessary server calls. These define the name of the link, the size of the text, the URLs to which they link, the page's background color and the means by which to communicate with the Patina Server. The applet appears no taller than HTML text, so that it can appear in a line of text, essentially invisible, short of showing some "hot text" to the user.

Similar to Richard Lachman's work, PatinaText can provide information at a variety of background-to-foreground levels depending on what the user's actions are and in part on the level of the applet's significance (Lachman 1997). In its least intrusive form, the applet can display either recency or frequency of use based on the colors with which it displays the text in question. PatinaText uses differing levels of saturation based on an averaged frequency of use. In the second version, the applet added animation to color level to signify frequency of use: stagnation or slow movement suggests no, or marginal activity levels. Conversely, quick and frantically moving text reflects that many people have used that link. Clicking the text will simply take the user to the appropriate URL.

Evaluation

Assessing PatinaMap's effectiveness has been based primarily on informal data collected from visitors to the Interactive Cinema lab. Although great pains were taken to make PatinaMap accessible outside the Media Lab (on normal PCs with slow dial-up connections), we had mixed success and this seriously limited the ability to gather more evaluation data. Alas, the highly technical experimental nature of this project resulted in frequent server downtimes.

Nevertheless, approximately 30 people played with PatinaMap during the course of Summer 1998, most in the Media Lab but some remotely. Here follows a summary of comments I collected (my comments in parentheses):

- Where is the history-of-use? (looking at the Patina enhanced topography filter)
- I see all these hands. Are those other people? (in reference to the synchronous user icons)
- What is the topography filter supposed to do? (compared to looking at the other two filters)
- That's beautiful. (referring to the topography filter)
- The story is really, really interesting this way (email from someone who navigated the site via PatinaMap)
- I tried it again, and the left frame is still blank (all to frequent response from my readers)
- This way I don't need to dig through the server logs (designer's response)
- The audio is cool, but needs more complex variations (about the audio filter)
- How come those lines only point at each other? (because the path data was biased by our testing instead of "normal" use)
- It's great to know how interested others were in that topic (in reference to "depth")
- How generalizable is this? (thinking about other applications for Patina)
- I'd like to see the map respond more dynamically
- Beautiful pictures (on the pictures from Phnom Penh, specifically)

In many cases people's enthusiasm increased notably after I explained Patina's objectives, suggesting either an overall design flaw, or an idea which people are quite unused to. People resonated to the "feeling of being part of an audience" more than "benefiting from other's use." As the system matured (we released four significant upgrades during the course of our eight-week development cycle), people's general response improved dramatically. Partially, I attribute this to significant enhancements in the filter appearance and additional features that enriched the system.

7. CONCLUSIONS

"The disorder was not a mere evening's untidiness. It had taken time to build up that rich patina of squalor." -- (1978) J. Thomson Question of Identity x. 97

{
What worked?
What didn't?
What's next?
}

PatinaMap and its extensions are but early first steps in visualizing use-data to establish the feeling of audience and to benefit from other users' presence. In this thesis, I have chosen one primary domain in which to experiment - the World Wide Web. I have isolated several design influences, from physical objects to evolving conversations. Several related prior projects were analyzed and finally the thesis describes in some detail my experiments to date. Inadequate data prevents me from making definitive conclusions about the hypotheses I started with. Nevertheless, I am optimistic about the significance of the domain - history enriched digital objects - and believe there is much to be gained, both in terms of feeling part of a distributed audience as well as benefiting functionally from a community of users.

What worked?

Early on, Will Hill wrote me via email, "Working on digital wear also means you have to be satisfied with a free lunch of just a few significant bits. Wear is never going to write Shakespeare onto an object. You have to be happy with building systems that impose tiny costs infrequently and that yield small benefits frequently." It is very difficult to appreciate background information. At best, it does no harm to the foreground task. At worst, it sticks out and becomes irritating. After much iteration, we came up with a satisfying aging algorithm that not only had an indefinite duration (e.g. the applet didn't expire after 150 uses) but also a pleasing appearance. Many people quickly understood the utility of using PatinaMap for information designers, as well as the idea of "active visual filters."

The dynamic components of PatinaMap were much better received and understood: synchronous use, audio, depth, paths and Time Travel. We added an "update" button in order to accommodate the numerous demo situations that require evidence that "I make a difference." We finally added Time Travel (without an interface) to the

beginning of PatinaMap - resulting in the "evolution" of the final static image appearing as an introduction - which helped people understand much more readily the image they interacted with.

Based on the short time of deployment, the informal comments I acquired and my own observations and experience, I feel most confident about the "means" employed here and the lessons derived from prior work. Based on PatinaMap, I believe there was merit to starting with physical objects, serving information in the background and on the object itself (concrete representation), the metaphors used, and the emphasis on socially evolving information.

What didn't?

The two main problems associated with this project are its simplicity and the lack of real user feedback. PatinaMap's simplicity is a mixed blessing: on one hand it was designed precisely to be simple and common, on the other hand the breadth of usage variables is quite narrow and the visualizations unimaginative.

Specifically, the static appearance of the active visual filters prevented people from understanding the data it represented. Technical limitations prevented the audio filter from really being compelling. Paths were awkward: their rigid appearance and ill timing (at the beginning of a clip when path information is not yet useful). The content for *Thailand Long Pied Long Took* falls short of my ambitions for it. As such the story itself provides too little impetus for continued engagement. Finally, PatinaText needs the most work. Its color and movement are uni-dimensional and un-expressive.

Technically, PatinaMap and its extensions are not as portable and extensible as could be. Ideally, these tools could be applied to any image-map, text and content without major performance costs or authoring complications. Unfortunately, this is not the case.

What's next?

I would like to apply the techniques developed here to an entire web browser, so that it becomes completely Patina-enhanced: menus and buttons and everything contained in the browser frame. This would advance both goals of this project: allowing users to benefit from each other and feeling like they are part of an audience.

One aspect largely ignored here is "weathering," or environmental wear. With digital objects that means providing feedback from the system: its speed rhythms (what times of day are congested), its errors (broken links), its relation to other objects (on the server and via the network).

Using some of the uniquely digital attributes and re-applying social traces back onto physical objects - in the vein of *POEMs* and *Burning the Candle* - could offer

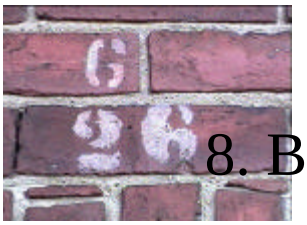
fascinating opportunities to learn how to use new objects, who shares them, and what they are exposed to.

Passive involvement with a distributed audience will continue to be an important area of inquiry. We need to develop more ways in which we intersect with each other inadvertently, like we do around the water cooler. Ambient communication channels, à la Ishii, seem like an excellent means by which to do this.

Another area would be to take the active visual filters into further development. This could result in self-reflective objects, able to represent their own meta-data. The evolution of an image, or video, or sound would be out of any single person's control, like an architect who loses a building to time once its inhabitants move in.

Socially evolving stories are an excellent way to intersect the technology's attributes, our need for stories and our reliance on one another. Dramatically expanding the capacity of the "paths" feature in PatinaMap is one way to create socially evolving stories.

Personally, I leave with an appreciation for time and people, their evidence embedded on the mundane things around us.



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