

# *Artifacts of the Presence Era:* Using Information Visualization to Create an Evocative Souvenir

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## ABSTRACT

We present *Artifacts of the Presence Era*, a digital installation that uses a geological metaphor to visualize the events in a physical space over time. The piece captures video and audio from a museum and constructs an impressionistic visualization of the evolving history in the space. Instead of creating a visualization tool for data analysis, we chose to produce a piece that functions as a souvenir of a particular time and place. We describe the design choices we made in creating this installation, the visualization techniques we developed, and the reactions we observed from users and the media. We suggest that the same approach can be applied to a more general set of visualization contexts, ranging from email archives to newsgroups conversations.

**CR Categories:** H.5.2 User Interfaces

**Keywords:** visualization, history, public space

## 1 INTRODUCTION

*Artifacts of the Presence Era* is an art installation that uses a geological metaphor to create an impressionistic visualization of video footage and audio data captured in a museum's gallery. The visualization challenge addressed by the piece is to represent, in a highly compact manner, hundreds of hours of video footage to create a compact artifact that encapsulates and commemorates a particular time and place. The significance of this work is in its novel application of visualization.

Historically speaking, visualization methods have been utilized in the analysis of large datasets mainly for their power to reveal unknown patterns of correlation between the thousands, sometimes millions of data points in a dataset. To that end, several techniques for investigating large datasets have been developed, ranging all the way from multiscale and multidimensional visualizations to clustering and pan & zoom methods. The common goal in all of these techniques has always been to facilitate data analysis and exploration. On the one hand, viewers look, select, zoom in and out, change axes, and perform endless manipulative and navigational steps to become ever more acquainted with the dataset at hand. On the other hand, the data is presented in its entirety and in its full complexity for inquisitive probing and potential discovery in the hands of the capable viewer or scientist. So far, this has been the paramount way in which visualizations have been understood to aid our understanding of the data around us.

In this paper we describe a different motivation and, hence, a different approach to the visualization of vast archives of video footage. The motivation in *Artifacts of the Presence Era* was not to probe or analyze long hours of video but to design a commemorative, historical record of the passage of time inside a museum. Our approach was to create a visualization that would convey the

historical essence of the piece in an aesthetically compelling manner. Instead of being concerned with the analysis of specific pieces of data from the video footage we captured in the museum, we focused on highlighting the long-term temporal patterns in the data. Moreover, instead of subscribing to the scientific preoccupation with data manipulation present in most information visualization work – with its multiple axes, explicit measurements, and different levels of visual abstraction – we chose to let our work be guided by the visual metaphor of geological layers. In choosing a strong metaphor to guide our efforts, we succeeded in creating a unique object that captured the essence of a time and a place through the use of visualization.

Instead of viewing our piece as an isolated effort to represent the passage of time in a museum, we believe that the visualization approach and design lessons described here have implications to personally or collectively meaningful databases ranging from video footage in personal web cams to newsgroups' conversations. We posit that, as the contents of digital archives that permeate our daily lives become more emotionally charged – the accretion of all the computer-mediated conversations people have with their loved ones over email, the growing collection of digital pictures parents keep taking of their kids – data analysis ceases to be the only motivation for visualizing collections of documents. We believe that these archives need to be regarded not only as data repositories but also as the powerful catalysts for memory that they are.

*Artifacts of the Presence Era* addresses the need to take the data in extensive hours of video footage as the starting point of an interesting visualization for posterity. The piece is less about specific information and more about the evolving patterns of people's presence in a physical space.

This paper describes the design choices we made in creating this installation, the visualization techniques we developed, and the reactions we observed from users and the media. We also discuss the implications of this kind of approach to a more general set of visualization contexts, ranging from email archives to newsgroups conversations.

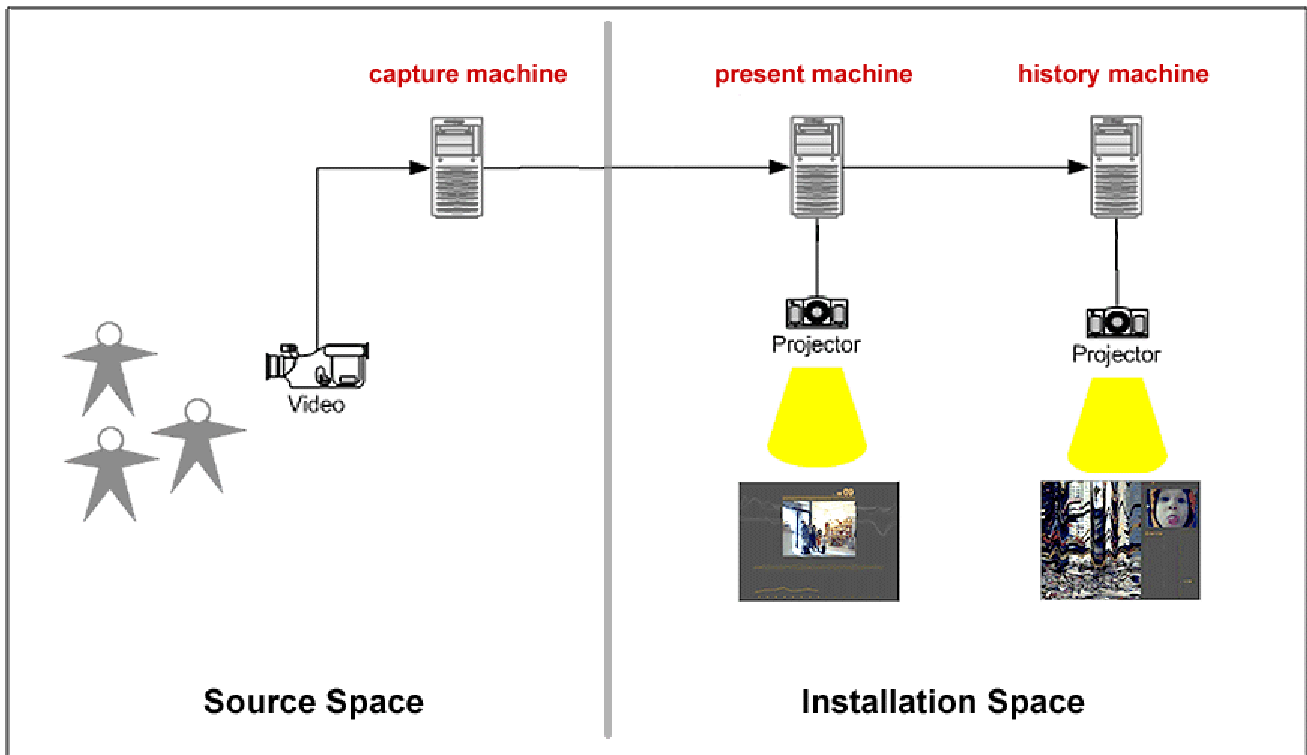
## 2 THE ICA BOSTON

In September of 2002 our research group was contacted by one of the curators at the Institute of Contemporary Art (ICA). The Institute was going through a unique moment in its history with the plans for a brand new building under way. In order to celebrate the beginnings of this new site, the curator asked us to create an art piece that would sum up some interesting aspect of the ICA's current building and something that could be exhibited in the new site as a memory piece about the Institute's current space, a time capsule as it were.

We became immediately interested in the possibility of documenting how the current building was used by its patrons on an everyday basis. We set out to capture the public's presence in the Institute's building. Visitors and their movement through the

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**Figure 1:** Diagram showing the hardware infrastructure in *Artifacts of the Presence Era*. The piece utilizes two main spaces: the source space, where images and sounds are captured in the museum (input), and the installation space where the visualization is shown (output). In the installation space there are two projections: the Present Display (showing real-time video) and the History Display (showing the growing stack of layers from past moments in the museum.)

galleries became the raw data feeding and shaping our visualization. These data came from two sources: a camera that captured the colors, shapes, and movements of people in the space and a microphone that captured the ambient noise in the museum.

*Artifacts of the Presence Era* ran for three consecutive months – January to April of 2003 – and was visited by over one thousand people. It was well received by the public and it was critically acclaimed in the local media.

### 3 METAPHOR

In trying to convey a sense of historical buildup over time, it made sense to look at natural examples of accretion for inspiration. The geological layers in sedimentary rocks and their function as record keepers provided us with such an example. The accumulation of geological layers over time transforms temporal change into legible and appealing visual patterns that can, with care and attention, be interpreted as history. The same possibility existed in the interaction with *Artifacts of the Presence Era*: like archaeologists, visitors could peek back into the past to learn more about what the layered landscape concealed.

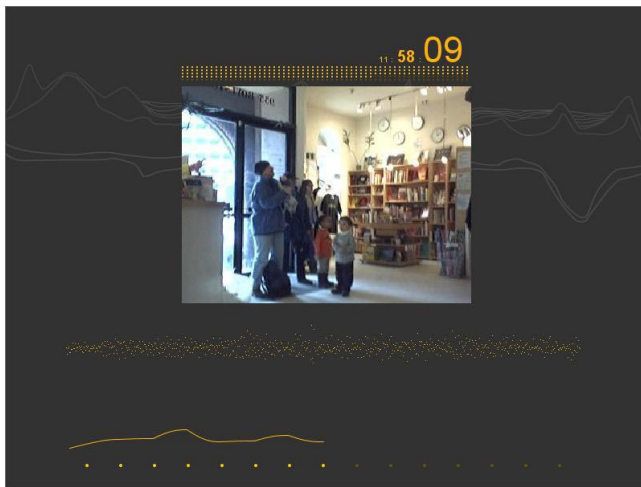
In allowing our work to be inspired by a natural phenomenon such as the formation of layers in sedimentary rocks, it became important to understand the affordances and constraints of this metaphor. The geological formation of sedimentary rocks, especially as it relates to time and its effects on layers, offers some key ingredients for creating a historical visualization:

1. the vertical arrangement of rock layers reveals the passage of time, with the difference in layer composition – thicker v. thinner, distinctly colored sediments – attesting to the different conditions under which each layer was formed
2. rock layers are highly compact representations of millions of years worth of changes in a physical environment; most of what happened during those millions of year is actually *not* embedded in the rocks but has, instead, eroded away
3. as time goes by, new layers continue to be formed on top of rocks, pressuring and compacting even more the ancient layers at the bottom of sedimentary rocks

These elements guided the conception of the historical visualization in *Artifacts of the Presence Era*. In the next sections we describe the installation components and the design decisions that shaped the visualization work.

### 4 INSTALLATION DESCRIPTION

In a small alcove near the front door of the museum – our source space – a camera and microphone unobtrusively recorded all sound and motion occurring in that space, day and night, for three months. As the recording took place, the raw data was processed to create the display visitors saw in a gallery in a separate area of the museum [Fig. 1]. Here, two projections ran. The first, the “Present Display” [Fig. 2], was real time footage from camera. The second, the “History Display” [Fig. 3], showed a growing landscape of layered images.



**Figure 2:** Present Display showing the video being captured by the camera in real time. Below the video image, an audio wave is being formed. After five minutes, the wave is done and is sent, together with the chosen video frame, to the “history machine.”

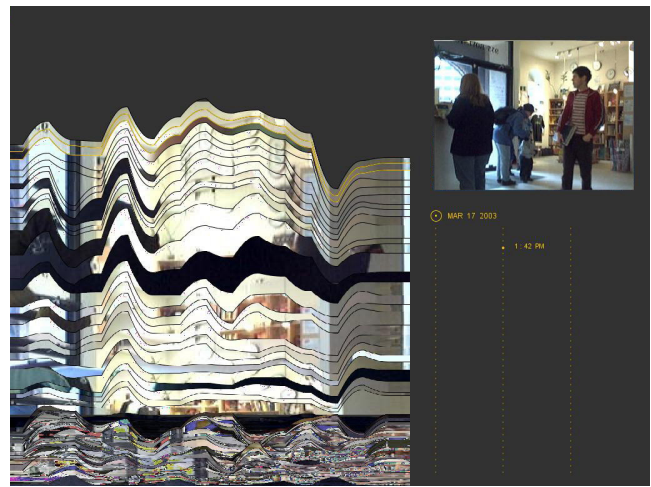
*Artifacts of the Presence Era* used three networked personal computers:

- o **Capture machine:** used a simple web camera to capture video from the source space. This machine had a custom Java application using the Java Media Framework that captured audio volume from the microphone of the web camera. Audio volume values were transmitted every second to the *present machine*. At the same time, the *capture machine* broadcasted a video stream to the *present machine*.
- o **Present machine:** received and displayed data from the video stream as well as the current audio volume in the space. In order to simplify the processing and bandwidth requirements of the piece, one frame of video was sampled – and displayed – every second from the stream of video data.
- o **History machine:** received an image and audio data from the *present machine* every five minutes. This machine then added a “layer” to the sedimentary structure, compressing and combining older layers as time progressed.

Connected to the History machine was a rotating knob controller that users utilize to move vertically through the layers and highlight each one in turn.

#### 4.1 Visualizing History Based on People’s Presence

Because the history we wanted to tell was one of people as they visited the museum, we decided that we would favor images that showed people and ambient sound that captured people’s presence. In other words, footage that showed people and audio that represented what we understood to be people in the space had a much higher probability of surviving in our visualization than footage and audio of the empty space.



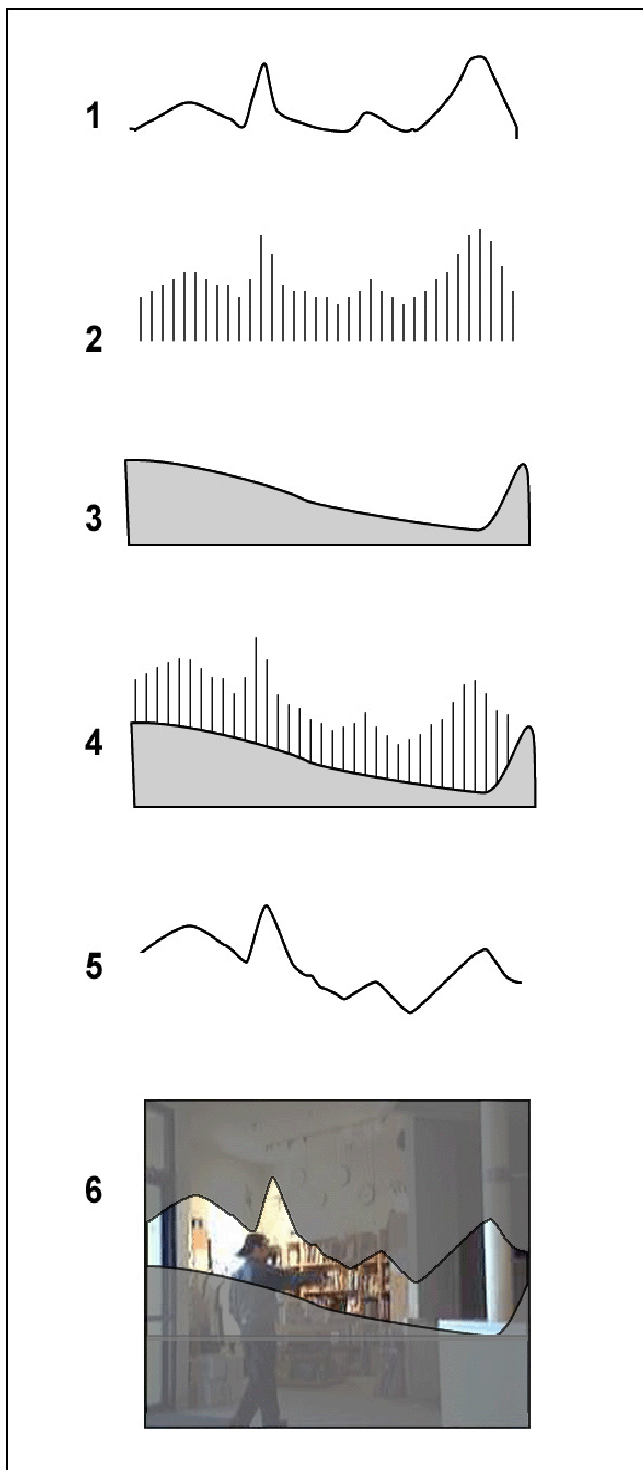
**Figure 3:** History Display showing the growing stack of layers on the left. Within the stack, the currently selected layer is highlighted with yellow lines outlining it. To the right we see the image from the currently selected layer from the stack. Below the image we see indication of the day and time this image was captured.

Each layer in *Artifacts of the Presence Era* represented five minutes of time gone by<sup>1</sup>. During that time, we captured the ambient sounds in the galleries and generated an audio wave. The shape of this wave – with higher values at points where there was more noise in the museum – became the shape of the layer being created. The texture of the layer (its color and shade) came from the images being captured with the camera. Each layer encapsulated one still image from those five minutes of data. The choice of this image was, as with the audio, based on simple heuristics of what we defined to represent “people’s presence in the space”:

**a) Shape - ambient noise:** we assumed that noise, as opposed to silence in a museum, suggested the presence of people in the space. Therefore, we decided to keep more data during the moments of more ambient noise in the museum, that is, “louder” layers showed up as thicker layers in the history stack. The *present machine* processed the audio data. The highest audio value from each 20-second segment of the five-minute layer-creation period was selected. These values were used to draw a curve that shaped the layer for that period [Fig. 2]. We wanted to create curves that were reminiscent of archaeological sedimentary structures and, after experimenting with different possibilities, we found that a 15-point curve seemed to be the optimal resolution to achieve this aesthetic effect given the resolution of our projection screens. We chose the highest value during each period rather than the average value because a short increase in volume in the space was sufficient indication that some activity had occurred in the space.

**b) Color - video images:** we used difference of luminance between video frames as a simple heuristic for defining the presence of

<sup>1</sup> We experimented with different timings for the creation of layers. Because this installation was being shown in a museum environment, we wanted layers to be created quickly enough so that visitors could see the entire formation process. It was important that visitors experienced the connection between the real-time display with its growing audio wave and the addition of a new layer to the history stack. Given these constraints, five minutes per layer turned out to be a good solution for our setup.



**Figure 4:** Explanatory diagram of how layers were shaped:  
 (1) original audio wave created over five minutes of activity  
 (2) sampled height of the audio wave  
 (3) shape of top layer in history stack; this is the landscape on top of which the newly-formed layer will be placed  
 (4) placement of sampled wave on top of previous layers  
 (5) resulting wave form, notice how the shape has changed from #1  
 (6) schematic masque showing how the final layer shape was “cut” from the chosen video image.

people in the space. Our assumption was that whenever the camera captured abrupt changes of luminance in the museum, this indicated that people were in the scene. This was achieved in the *present machine*, which had a custom Java application that compared each frame of video it obtained to the previous image received. It compared the difference in luminance values to identify movement in the space. The image with the greatest change in luminance from each five-minute period was selected. This process was a simple and effective solution for our needs.

**c) Compression over time:** it was clear to us that, as time progressed and we captured more data about the space, the accumulating layers would have to evolve in some way to become more compact. The rationale here was that, as with real rocks, older layers – i.e. the bottom layers – would suffer more pressure from all the data accumulating on top of them and would become more compact. At extreme points of pressure, when layers became too compact, they would start to merge with each other in a morphing process.

#### 4.2 History Display: how layers are formed and stacked

The history display was the heart of the *Artifacts of the Presence Era* installation because it showed the continuously growing accumulation of layers captured in the gallery space [Fig. 3]. As mentioned above, each layer consists of a piece of an image selected from the five-minute video footage for that period. The chosen image is cut into a shape formed from the audio curve representing the audio volume in the space during that period. Each new layer is added to the top of the stack and the resulting shape of the layer depends on the shape of the “landscape” it rests on; see Figure 4 for an explanatory diagram of the layer shaping process.

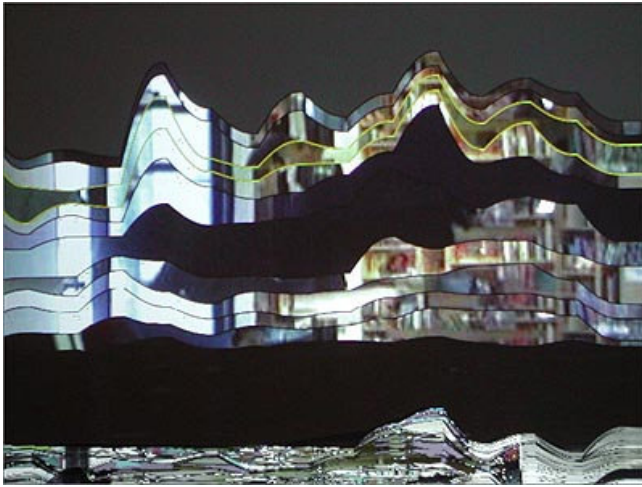
Because being able to navigate the layer stack while understanding the progress of time was key for making sense of the piece, every layer had a timestamp attached to it. To the right of the history stack was a grid of dots that represented the time when each layer was created. As an individual layer was highlighted, its time stamp appeared next to the corresponding dot to the right. The original image for the highlighted layer was shown above the grid of dots.

Whenever a combined layer was highlighted, its corresponding combined image was shown. Below the image, all of the time stamps of individual layers were also highlighted – e.g. if a layer containing 8 original layers became highlighted, all 8 dots of the original layers would be highlighted as well [Fig 7].

##### 4.2.1 Shallow Layers: normalizing the landscape

We captured video every day from 9 AM to 9 PM so that we could generate layers where the colors would reflect the differences between daylight in the museum and nighttime when the galleries were closed. As the stack of layers grew, visitors could see patterns of day and night reflected on the colors of consecutive layers [Fig 5]. The layer-shaping algorithm also had a mechanism to account for extremely quiet times in the museum – for example, when the galleries are closed at night. In these situations *Artifacts of the Presence Era* generated what we call “shallow layers”. These were layers that “filled in” valley regions of the history landscape. That is, these layers only showed up in “depressions” of the stack instead of wrapping around peak areas (as a normal layer would do). These layers were generated whenever the audio being captured in the gallery stayed below a





**Figure 5:** Zoomed view of growing layer stack; the difference in the colors of layers as they transition from day to night is visible; layers at the bottom of the stack are a lot more compact than layers at the top; finally, the yellow outline around one of the top layers indicates that it is currently being selected by a viewer.

minimum threshold throughout the layer formation period. When the entire audio wave lied below this threshold, the result was a shallow layer. These layers played an important role of “normalizing” the stack landscape, allowing the stack to become less bumpy and mountainous after a quiet night. They also added texture to the entire piece by clearly highlighting the different patterns of activity between busy open hours and quiet, afterhours time in the museum.

#### 4.2.2 Compression of layers

After a few hours in the history stack, layers began to be compressed and combined with the layers adjacent to them. When layers got combined, the original images in them got combined as well, the top one being superimposed over the lower one with an alpha value of 50% and, therefore, becoming semi-transparent. This combination of images resulted in “ghostly” pictures, where viewers could see “through” portions of the images from the original layers. People usually became semi-transparent in the combined images of these layers [Fig. 7]. During the three months when this piece was running at the ICA, we got combined layers that had as many as 16 originally individual layers merged into one. The history stack could hold an archive of up to several weeks worth of layers.

### 4.3 User Interaction

We designed the piece so that visitors could move through the layers of the history. In this way they were able to take part in the geological metaphor, behaving as archaeologists, “excavating” the traces left by the visualization to unearth items of interest. The simplicity of the browsing interface – the knob that was used to move vertically up and down chronologically – was critical in a public art environment in which users may have limited time and patience to learn a new user interface. Browsing through the layers also created a time-lapse effect with the images shown in the upper right hand corner of the display. As the viewer scrolled through the layers, these excerpts of events in the space animated, effectively creating another way for viewers to get a sense of what had occurred in the space.

Also important in terms of user interaction, was the fact that visitors could, and did, take advantage of the camera to add images of themselves to the historical record being created. As will be discussed in more detail later, several visitors, after realizing that the history stack was formed by images being recorded in the museum, would walk up to the camera and stand there until their image was captured and added to the collection of layers.

## 5 PUBLIC REACTION

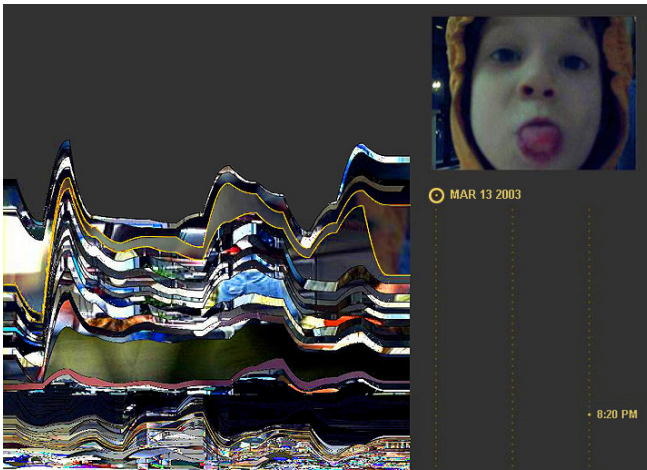
Even though we did not conduct a formal study of how people reacted to the piece, we observed visitors interacting with the installation in the gallery over the course of the three months the piece was running. In general, *Artifacts of the Presence Era* got a very positive response from viewers. The exhibition was viewed by over a thousand people and was very well received by the local media [12] [13]. Some of the key questions we hoped to understand through our observations were: *What drew people to the installation? How did they interact with the piece?*

People seemed to be drawn to the piece because of the imagery in the history stack. Most visitors found the visualization very intriguing. When they knew that a gallery guide or one of the creators of the piece was in the room, they often asked detailed questions about how the image was generated, curious to know what data each visual element represented.

Maybe not surprisingly, seeing a recognizable face in the projections boosted people’s interest in the visualization. Often if groups of people visited the gallery together, one of them would walk in front of the camera, and be seen by the other members of the group who were near the projection screens. When learning that only one image would be saved in the history display every five minutes and that images with more motion were more likely to be captured, some people went so far as to stand in front of the camera for several minutes, sometimes waving their arms in the process, in the hope of being captured.

Most people seemed to have understood that the piece was evolving in real time, as they looked at the Present Display and realized that it was showing what was currently happening in the gallery. Several visitors were struck by the fact that the visualization kept changing and that the layered landscape was continuously growing. We observed visitors concluding that, if they were to visit the piece again in the future, the then “current” stack of layers would look different and most of the information that could be clearly seen on that specific day would be compressed and “merged” as composite layers by their next visit.

This sense of fluid, evolving time seemed to be one of the most attractive aspects of the installation to visitors. Being able to peek back at past moments in the gallery, seeing someone’s glimpse, a person’s movement, a kid’s gesture provided visitors with moments of surprise and amusement while giving them a sense of how the museum space had been inhabited in the recent past. Visitors also enjoyed looking back at the night layers of the history stack because these displayed a peculiar view of the galleries, one that showed what the museum looked like after it was closed to the public. Visitors were excited to explore the unusually thick and dark layers of evening parties held in the museum (regular night layers were thin because they represented times when the galleries were silent). Sometimes viewers would also catch a glimpse of night layers that showed the cleaning staff in the museum, vacuuming and tidying up the galleries.



**Figure 6:** Layer showing a playful visitor who purposefully stood in front of the camera in the gallery in order to have his picture taken and added to the history stack.

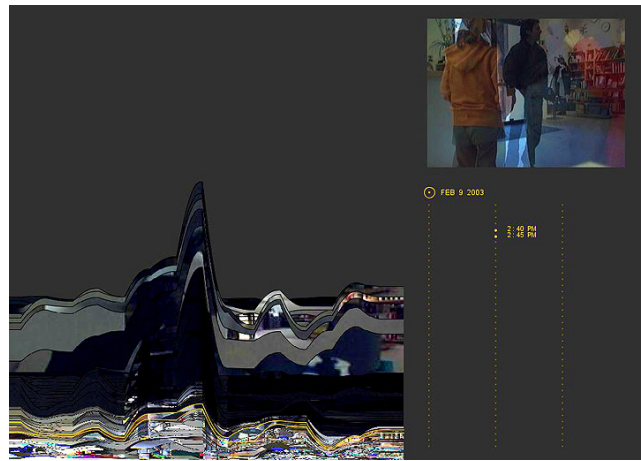
From our observations it seemed that the audio part was the one least understood by some of the visitors. We found out by listening to the comments of visitors that, a lot of times, it was not clear to them what the audio wave being formed at the bottom of the Present Display meant in the context of the piece. It seemed that several visitors never made the connection of the audio wave with the resulting shape of layers being formed. Visitors seemed to think that the thickness of the layers had to do with how many people were in the lobby area when the layer had been formed. This conclusion, while incorrect, points to the fact that even those visitors who did not grasp the technicalities of how the audio input was connected to the rest of the piece could still understand the fact that the shape of the layers reflected the presence of people in the museum.

Finally, one of our main concerns when designing this piece were the privacy and surveillance issues that arise when one sets up continuously running, unobtrusive cameras and a microphones in a public space. Based on previous work dealing with cameras in public spaces [7], we were worried that people might find the setup of the piece intrusive or even offensive. To our surprise, however, visitors were amused by the camera and a lot of times would pose in front of it (sometimes for many minutes in a row) in order to get their picture taken and recorded in the history stack. We witnessed several kids dancing and some others making faces at the camera [Fig. 6]. People’s attitude towards the piece was decidedly playful and light hearted.

## 6 RELATED WORK

*Artifacts of the Presence Era* used the available video and audio footage data as raw material to piece together an overall, impressionistic sense of the history of a physical space. Much of the data captured via the camera was discarded and the motivation for building the visualization piece was not based on a need for data analysis. This approach differs greatly from the traditional focus on annotation, analysis, and retrieval of information from large archives of video footage [2] [8].

This artistic approach to visualizing large data sets places our piece in a growing body of digitally based work that invites people to more deeply consider the temporal patterns present in



**Figure 7:** Composite layer showing a “ghostly” image, which is the result of two originally separate layers having merged.

the data around us. Salavon’s piece of the movie *Titanic* [11], for instance, shows a single image where each pixel is the average color of a single frame in the movie. The image lays out the movie’s visual rhythm in pure color and an impressive pattern emerges. *Last* is a clock visualization [1], in which each hand is made from a slice of live video feed from the place where the clock stands. Even though *Artifacts of the Presence Era* shares some of the same goals as the works mentioned above, we wanted to enable viewers to navigate our visualization. We felt that the simple but interactive nature of the piece was crucial for maintaining its souvenir quality. Its conception and aesthetics were strongly attached to the notion of posterity that the museum curators wanted to convey.

Media artists are not the only ones exploring novel visualization approaches when it comes to the “socially meaningful” digital archives that are beginning to surround us – email collections, newsgroup archives, and IM conversations, to name a few. Researchers ranging from the social sciences to the field of human-computer interaction are starting to realize that the nature of these compilations is so complex and nuanced that thinking about them as solely exploratory territory for data analysis is too limited a way of approaching the problem. For instance, Erickson [5] points out that visualizations of social activity should (1) allow for ambiguity, and (2) should focus on providing grist for inferences, instead of trying to accurately present information. Users have been shown to comfortably make guesses from incomplete information in these visualizations [5]. In addition, a lot of times users utilize visualizations of these archives of social data as objects for storytelling, for sharing memories with others [14]. Such findings suggest that, in these contexts, information visualization should function as more than a probing tool for analysis.

## 7 DISCUSSION AND FUTURE WORK

Data archiving is usually task oriented, designed for users who are searching for a particular piece of information. Our visualization is designed to be an end in itself, a compact and easily perceived object that symbolizes an extensive time in a particular place. In *Artifacts of the Presence Era* we discarded most of the video footage that was captured in the museum. Because of this decision, the piece did not necessarily retain the most interesting

data – and there were many great or poignant moments that it discarded. Its algorithms were meant to be more like the forces and rhythms that shape the geological record than the carefully calibrated heuristics of a semantically based compression tool. Yet the end result was very evocative of the time and place it represented.

Periods of extreme activity, such as evening receptions in the gallery, became dominant in the geological landscape of our piece with large layers in the stack, while periods of inactivity were represented with thin layers, reflecting the lack of notable events. Because we made a decision to compress older layers together as time went on, the piece emphasized the most recent layers more prominently. While this phenomenon fit with the geological metaphor, it distorted some of the patterns by deemphasizing events as they faded into the past. Although designing the piece so that all layers retained the same scale would have provided a more accurate historical overview, it would have lost the sense of temporal perspective the metamorphic process created.

The geological metaphor we used in *Artifacts of the Presence Era* is a very rich one, and we would like to explore it in greater depth. Sedimentary rocks often have embedded fossils – what would be a "fossil" in a metaphoric installation? Some options we considered ranged from retaining images from the video where faces could be seen to allowing the viewer to deliberately leave a spoken message or photographic piece that would be embedded as a fossil.

We believe that this kind of visualization work can also be applied to other sorts of digital archives. Email seems like an obvious candidate: what would your email archive reveal if you could see it as a slow accretion of varied conversations? How would your evolving emailing habits – their rhythm, quality, and frequency – look like over the years? What might a "fossil" be in this geological formation? The same is true of newsgroups' conversations: how would the layers of a particular newsgroup differ from those of another newsgroup? What if one could create an entire landscape where each peak was made up of conversational sediments from different newsgroups?

## 8 CONCLUSION

When the Institute of Contemporary Art first approached us, they wanted a piece that would be an evocative souvenir of the building in which they are currently housed. Our installation, by continuously capturing and visualizing imagery from that space over several months, succeeded in creating an artifact that was infused with meaning and legibility, and that embodied the aesthetic and evocative qualities the museum curators desired.

The same visualization approach used in *Artifacts of the Presence Era* can be applied to a variety of personally or collectively meaningful databases. We live in an era in which a great deal of information accumulates around us, years worth of email, home videos, webcam output. We often hold onto such archives because they feel important to us; their meaning is embodied not only in particular scenes or messages (through some of those certainly exist), but in the entire passage of time that they represent, the overall patterns and simply the vast accumulation of material. Yet in their uncompressed state they are too vast and unwieldy to be comprehended; compacting them into an evocative visualization makes them graspable as a souvenir of their time and place.

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