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VOUCHERS

# TIMESCAPE AND MEMORY

## Visualizing Big Data at the 9/11 Memorial Museum

*Lauren F. Klein*

For visitors to the 9/11 Memorial Museum in New York City, the dominant experience is one of sensory and emotional overload. Set deep in the ground at the site of the former World Trade Center, the museum is explicit about its desire to “convey the scope and scale of loss” experienced on September 11, 2001, to its millions of guests—most of whom did not directly witness the events of the day (“The Museum’s Exhibitions” 2014). As visitors proceed through the Historical Exhibition, as the permanent collection is known, they encounter an array of physical artifacts: a fire truck reclaimed from Ground Zero, grotesquely disfigured from the blaze; the antenna from the North Tower, toppled on its side; documentary photographs, news footage, audio recordings, and a range of other media objects that, taken together, reproduce the initial trauma of the terrorist attacks. By deliberately placing this “collection of monumental and authentic artifacts” on display, the museum seeks to convert individual affective response into national cultural memory (“About the Museum” 2014).

But the enduring effects of 9/11, both political and affective, are far more difficult to put on display. Of this challenge, too, the museum’s designers and curators seem keenly aware. Upon exiting the Historical Exhibition into the stark surrounds of Foundation Hall, visitors encounter two additional artifacts, each purposefully constructed to evoke the lasting impact of the attacks. To the left stands the original retaining wall from the North Tower, resurfaced and reengineered to serve as the room’s southwest side. With its exposed concrete, punctuated by steel tiebacks, the wall bears the symbolic weight of two messages: the first of the permanence of the events of September 11, 2001, and the second of the city’s strength and resilience. In the hall to the right, projected across 34 feet of sanded concrete, is *Timescape*, a data visualization of 9/11 in the news. An artifact no less engineered than the retaining wall, *Timescape* (see Figure 44.1) remains far more difficult to interpret on the basis of its surface alone.

Visualization has long been recognized for its ability to bring the “big picture” of a particular dataset into view (Shneiderman 2014: 730). As early as 1786, William Playfair, the Scottish political economist often credited as the “inventor” of modern data visualization, remarked upon the power of statistical charts to “giv[e] form and shape, to what otherwise would only have been an abstract idea” (Playfair 1786: 9; Tufte 2001: 32). Today, we can describe the



Figure 44.1 *Timescape* as installed in the 9/11 Memorial Museum’s Foundation Hall.

Source: Photo by Jin Lee, courtesy of the 9/11 Memorial.

benefits of data visualization more precisely: visualization enhances human understanding by “offloading” the basic tasks associated with data processing from cognitive to perceptual systems, abstracting individual data-points into recognizable shapes and patterns, and facilitating more advanced interactions with the dataset as a whole (Card et al. 1999: 16). We now encounter visualizations of data all around us—think of an interactive map of election returns, a network diagram of celebrity tweets, or even a basic bar chart that you might create for a lab report using Microsoft Excel. As these examples show, data visualizations can serve different purposes: a visualization can provide a pathway to insight, as in the case of an interactive map; or offer proof of results, as in the case of an Excel chart. In all cases, however, visualizations must be interpreted so as to better understand the assumptions and arguments embedded in their construction. In bringing these assumptions and arguments to light, a media studies approach to data visualization—that is, an approach that considers a visualization’s formal features as well as its technical design—helps us better understand how visualizations facilitate the production of new knowledge at the same time that they render visible a particular view of the data themselves.

The knowledge produced by data visualization is always partial, as the example of *Timescape* in the 9/11 Memorial Museum makes plain. No quantity of data, however large, and however it might be visualized, can be made to represent the global impact of 9/11 in a single view. *Timescape*’s designers, the design consultancy, Local Projects, working in collaboration with media artist, Ben Rubin; data journalist and statistician, Mark Hansen; and artist/designer, Jer Thorp, faced an impossible task: to portray an event that, to most, still feels unimaginable—too traumatic to ever fully comprehend. But as an event characterized by extremity—a term valuably theorized by Paul Benzon elsewhere in this book (see Chapter 31)—9/11 becomes

a limit case for thinking through the issues of scale that pervade all aspects of life in the twenty-first century. The global media networks that enabled the collective experience of the trauma of 9/11 represent one instance of this amplified scale, and the rise of big data that enabled the creation of *Timescape* represents another. Considering *Timescape* as a work in which affective and quantitative scales align helps to expose how data and their visualization, in the contemporary moment, are always implicated in issues of politics and power.

To identify these issues, and to be able to critique them “*in and through* our objects of study,” as Tara McPherson has advanced, we must understand how data visualization produces knowledge on multiple fronts (2009: 120). In the pages that follow, I work through three levels of meaning-making that are on display in *Timescape*: (1) the level of the data-image: in other words, what the viewer sees; (2) the level of data-processing: that is to say, the underlying algorithms and their implementation in software; and (3) the level of the dataset itself: that is, the dataset’s contents and structure, as well as any preprocessing involved in preparing the dataset for use. By exposing and interpreting the multiple layers of *Timescape*, this chapter demonstrates how humanistic inquiry must stand alongside data visualization and related computational practices if we are to most fully address the scale and complexity of life in the digital age.

### The Story as Seen: *Timescape*’s Data-Image

“Historical museums typically serve as a way to tell the official story of something that happened and what it means,” explains Cliff Kuang (2014), a journalist who reported on the opening of the 9/11 Museum for *Wired* magazine. But, he continues, “this one is different.” Kuang’s sense of the “difference” of 9/11 seems to derive from an awareness, echoed in the design of the museum itself, of how the impact of September 11, 2001, continues to reverberate across the globe. Kuang’s observation also underscores how the meaning of 9/11 ranges widely, depending on both personal consequences and political stakes. For the victims’ families, for instance, 9/11 is most likely synonymous with tragedy and loss. For the additional persons who witnessed the attack first-hand—some but not all of whom lost loved ones—9/11 might summon somatic as well as psychological trauma. At the level of national affiliation, consider how, for certain U.S. citizens, 9/11 became a literal call to arms, a recommitment to the nation’s founding ideals through military engagement, and a renewal of centuries-old geopolitical, religious, and sectarian conflict. By contrast, for many of those in the Middle East, 9/11 was equally catalyzing, but for a different range of reasons and to various other effects. In attempting to acknowledge this complexity, the museum’s designers and curators realized that “conventional narrative wouldn’t cut it,” as Alice Greenwald, the director of the museum, explains (in Kuang 2014). The idea of an algorithmically generated data visualization held appeal because it could convey the desire for—if not the reality of—an objective curatorial stance.

*Timescape* consists of an approximately 10-minute cycle of three “scenes” in which clusters of keywords related to 9/11 are traced through an ever-expanding dataset of newspaper articles from 2001 to the present day. The current article count is nearly four million, according to Jake Barton, Principal at Local Projects (2015). The first scene, “9/11 in the News” (see Figure 44.2), begins with a note on method:

Every day, this database of millions of news articles from September 11, 2001, to today is updated with new content. An algorithm searches the database for related key terms and groups them into timelines that demonstrate 9/11’s ongoing impact.  
(Local Projects 2014)



Figure 44.2 The first “scene” of *Timescape*, “9/11 in the News,” displaying a note on method and a visualization of clusters of statistically significant terms.

Source: Image courtesy of the 9/11 Memorial.

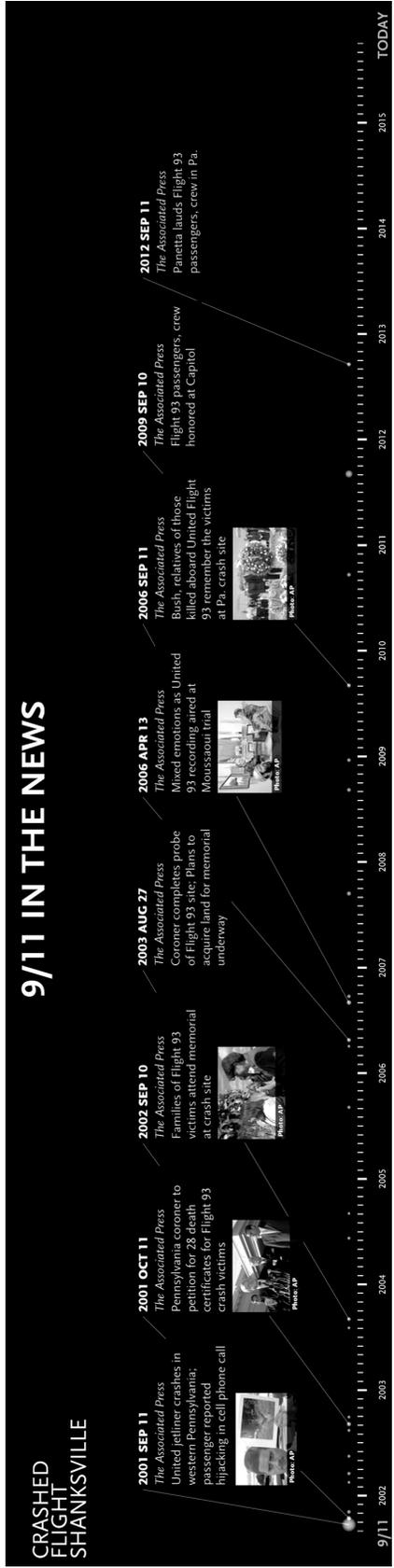


Figure 44.3 A timeline scene from *Timescape*, displaying newspaper headlines from 2001 to the present that contain the terms “crashed,” “flight,” and “Shanksville.” Some headlines are accompanied by photos.

Source: Image courtesy of the 9/11 Memorial.

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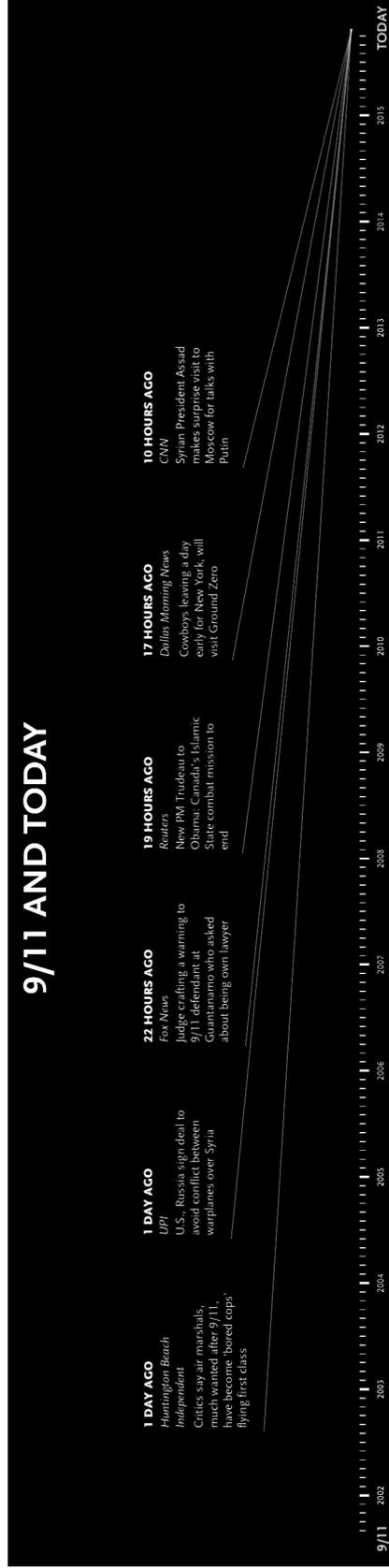


Figure 44.4 The final scene of *Timescape*, “9/11 and Today,” displaying recent newspaper coverage of 9/11.

Source: Image courtesy of the 9/11 Memorial.

The clarity of the explanation, underscored by the simple sans-serif font in which it is displayed, enforces the sense of objectivity that the museum's designers and curators seem intent to convey. With the text remaining on the wall, the date "9/11" appears in the lower left corner of the frame, followed by the word "today," which then appears in the far right. A standard timeline fades into view from left to right, followed by a nebula-like cluster of translucent dots of varying size, numbering in the hundreds. The dots emerge from the "9/11" at the lower left, floating up and across the timeline. As they move farther from the origin, their arrangement becomes clear: lines, loosely structured, each indicating the temporal trajectory of a particular set of terms (e.g., "passengers," "airport," and "Transportation Security Administration"). Visually, the image most closely resembles a spray of lens flares, radiating from a central source. The monochromatic color palette keeps the viewer centered on the visualization's formal features and temporal flow, each of which accentuate the continually expanding albeit increasingly diffuse impact of the events of 9/11 on the present day.

No sooner do the lines cohere than they begin to fade. In the end, all that remains visible is a single set of dots corresponding to a single set of terms. The dots slowly sink toward the bottom of the frame, as if to anchor the abstraction of the image and its associated terms in recorded time. Shifting from abstract visual imagery to more recognizable graphical typologies, *Timescape's* designers employ the associations of the timeline—horizontal, with a single axis, punctuated by events—to convey the very real impact of this penumbra of effects. As Daniel Rosenberg and Anthony Grafton observe, the timeline "seems among the most inescapable metaphors we have" (2010: 14). And yet, it represents a relatively recent innovation in the long history of visual display, one that advances a very particular view of the unfolding of time: its "uniformity, directionality, and irreversibility" (19). Compared to the circular shape and motion of the clock, for instance, the linear form of the timeline suggests a conception of history as progressing from past to present. The effects of 9/11 may be multiple, *Timescape's* cyclical structure suggests, but any single effect is irreversible—the result of a single event on a single day that forever changed the world.

This conception of the inevitable forward progression of history is enforced through *Timescape's* second scene, "Through the Lens of 9/11." It begins with a bar of white light that scrolls from left to right like the bright light of a flatbed scanner, separating past from present. As in the final phase of the previous scene, the three terms that rest on the timeline appear in much larger type in the upper left of the frame. Trailing the vertical bar of light, diagonal lines sprout from the timeline, connecting the terms to a set of newspaper headlines, sometimes accompanied by photos, in which the terms appear (see Figure 44.3). Again, abstraction gives way to text and image and translucence to solid form. Here and throughout *Timescape*, opacity serves as a visual metaphor that underscores the conceptual shift that the scene enacts: from general impact to specific consequences, sharply felt, as evidenced through the coverage of 9/11-related terms in the news.

In the third scene, "9/11 and Today" (see Figure 44.3), the same visual template is applied in reverse, as lines project backwards from the timeline's endpoint of "Today." Instead of articles (presumably) selected randomly from the years between 9/11 and today, the articles displayed are selected only from a set of more recent news. Rather than print the headlines, as in the previous scenes, the articles are labeled according to how long from the present moment they were published (e.g., "8 hours ago," "11 hours ago," and "17 months ago"). The scene thus reorients the viewer's perspective through text as well as image. It appears less frequently than the first two scenes, which alternate several times before moving on. The relative frequency of the first two scenes places the emphasis of the piece on the continually unfolding implications of the events of September 11, 2001, rather than the retrospective

view encouraged by this particular scene. Like the museum itself, *Timescape*'s primary goal is to encourage an eternal return to the events of the day. The present meaning of 9/11, the piece suggests, is best understood—and experienced—by reliving the events of the past.

### **The Story as Constructed: Engineering and Reverse Engineering *Timescape***

As the dynamically generated timeline indicates with its relative endpoint of “Today,” *Timescape* was designed to be open-ended. But more than a representation of the unfolding nature of the interpretive process, the museum's designers and curators, in commissioning *Timescape*, sought an expression of objectivity—an indication of the suspension of judgment they believed was enforced through the algorithms that determined the terms and images projected on the wall. Describing the various document-clustering algorithms that were synthesized to identify the terms related to 9/11, and then the natural language processing techniques applied post hoc to pull up the relevant news stories. Barton explains that the algorithmic basis for the system “lets the curators say they haven't set an agenda” (Kuang 2014). Greenwald confirms this view. “We're still living in the aftermath of this event. It's not something that happened 50 years ago, or 150 years ago and we know the consequences of that event,” she reports to NPR. “So we weren't, from a curatorial point of view, able to wrap things up” (Shahani 2014).

The installation's algorithmic basis has yielded some insightful results, as the developers themselves have observed. “You have some expected answers, like Pakistan and Osama bin Laden or Afghanistan, George W. Bush,” Barton explains in a video interview in the *Wall Street Journal*:

But then you have these very unexpected timelines like the airlines industry, or a terrorist event in Bali, or looking at the arc of Dick Cheney as it begins with that moment and then goes toward the end of his career. And that's what's been interesting about it, is that the *Timescape* has both cut down on some of the work and labor that the museum might have to do to tell the post-9/11 world story. But frankly it's produced insights that I don't think anyone expected. Certainly not us. And as we were working on it there's a funny way in which we ourselves would be surprised and say, “Woah, there must be some mistake here!” And then we'd say, “Oh no, this is right, because you can basically trace this back to this original cluster from the day itself, and see how it evolved over time.”

(Weiss 2014)

Barton's account of the development process accentuates many of the ways that visualization is thought to lead to insight: the reduction in human labor and processing time, the unexpected connections forged by automated pattern recognition techniques, and the way in which automated results can be reverse-engineered, so to speak, to more fully understand how they came to be.

But while reverse-engineering, as Nick Seaver has observed, “might be a useful strategy for figuring out how an existing technology works, it is less useful for telling us how it came to work that way” (2014). Seaver's primary example is Ian Bogost and Alex Madrigal's attempt to reverse-engineer the Netflix movie classification algorithm. In his analysis, Seaver identifies how reverse-engineering, as an interpretive technique, “fails to piece together how engineers imagine and engage with culture.” The same might be said of reverse-engineering

the output of *Timescape's* algorithms or, for that matter, reverse-engineering *Timescape's* algorithms themselves. In other words, reverse-engineering might indeed allow us to better understand the algorithmic processes by which *Timescape* “produces the knowledge it draws,” to borrow a phrase from Johanna Drucker, but it cannot be made to reveal the social or cultural conditions of its making (2014: 5). Rather, some of what is revealed through the process of reverse-engineering, or of interpretation more generally, is how we ourselves construct knowledge about the images, objects, and events that we encounter in the present. When interpreting an image, derived from data or otherwise, we must therefore remain attentive to what gaps in the technical process—in the surrounding social or cultural context, or in our own knowledge—we might also expose when our ability to reverse-engineer falls short.

From a blog post by Andreas Borg (a member of the development team), we know that *Timescape's* algorithm for selecting the featured terms relies upon a metric known as “term frequency-inverse document frequency” (TF-IDF) to generate the “original cluster [of terms] from the day itself” (n.d.). TF-IDF is a method by which individual terms in a set of documents are assigned a numerical value that corresponds to their statistical significance in the document set. The significance increases in proportion to the frequency with which the term appears in a particular document, but it is offset by the frequency with which the term appears in the entire document set—its “inverse document frequency.” In a set of news articles from September 11, 2001, “Osama bin Laden,” for example, would likely have a high TF-IDF value, while “plane”—because of its more varied general use—would have a lower value. An even more common word such as “and” or “the” would have a TF-IDF value so low as to be negligible. But we do not know how the set of documents “from the day itself” was assembled, nor do we know whether the “clusters” that are displayed in the installation were determined by comparing all of the news articles from 9/11 with a larger set of articles, or whether another term-selection algorithm—Borg suggests Named Entity Recognition, a computational technique for automatically identifying the names of people and places that occur in a set of documents—was used to select the terms from a dataset consisting of only news articles from the day.

Questions of reverse-engineering aside, the composition of the dataset itself raises questions. Art historian, Mary Anne Staniszewski, observes that, since the news articles appear to be English-language only, they reflect an “American point of view” (Shahani 2014). This may well be true, although without any detailed knowledge of the dataset’s sources, it is impossible to determine the validity of this or any content-based claim. We do know that issues of access influenced the composition of the dataset, however. Barton himself admits that securing access to the data, not only of the day’s events, but in perpetuity, was a challenge in itself. “The algorithms are a tour de force,” he states, “but the legal agreements have just been incredible” (Manauagh 2014). In an interest of scale quite common in digital humanities, Barton (2015) admits to employing “everyone we could license.” But in spite of its massive size, the dataset remains radically incomplete. In other words, while it is easy to conflate “big data” with “all data,” the two are not one in the same. Visualizing the former may confer insights that could not otherwise be perceived. However, those insights must always be measured against what the dataset does not or can never contain.

The insights of *Timescape* relate to its particular perspective on the mainstream news—one that, under the auspices of the emerging field of “data journalism,” has become increasingly prevalent everywhere from BuzzFeed to the lobby of *The New York Times*. But data journalism, like any other form of journalism, is not bias-free. The dataset itself presents a particular perspective on the coverage, not only because of its Anglo-centric focus, but also because of the various factors—the financial flexibility associated with a major news organ-

ization, the legal counsel required to negotiate such an agreement, the willingness for original reporting to be repurposed without editorial oversight—that led the particular news sources to be included in the dataset. There is no way for *Timescape*'s viewers to determine what sources go into the dataset, and yet it is presented in an institutional context where it is interpreted merely as “the news.”

TF-IDF is also not a bias-free method of determining significance, as it is able to identify individual words (e.g., “terrorism”) with more readiness than larger concepts or ideas (e.g., global religious strife). Named Entity Recognition, mentioned above, which is also incorporated into *Timescape*'s underlying algorithms, is similarly non-neutral; as the name suggests, it identifies only proper nouns (e.g., “bin Laden”) and cannot identify unnamed individuals or groups (e.g., “firefighters”) who influenced the narrative of 9/11. It is a fundamental irony of the post-9/11 world, characterized as it is by geopolitical alliances that transcend nations and cultures, conflicts that emerge from no single point of origin, and increasingly inchoate notions of what we mean by “enemy,” “warfare,” and “threat,” that the quantitative methods that we increasingly rely upon for analyzing big data are so poorly equipped to identify this complexity on a global scale.

While the 9/11 Museum has chosen to emphasize the sense of objectivity associated with the idea of an algorithm, Barton himself acknowledges the complexity of the picture that *Timescape* presents: “We wanted to focus the design on something that wouldn't render it overly simply, but would tell the story of both the data and how we were deriving the individual timelines” (Rosenthal 2014). The “story” of *Timescape*, it seems, is of the interpretive process, one that involves data and algorithms, to be sure, but also acknowledges that data are created and assembled by people, and that algorithms are designed and implemented by people as well. As such, *Timescape*—indeed, all visualizations—must be analyzed through a composite lens, one that takes into account both materials and makers, as well as the limits of each.

### ***Timescape as Media Event***

9/11 has come to be theorized as a media event, both for how it confirmed the uneasy kinship between terrorism and the media coverage required for its impact, and for how it exemplified a new form of collective trauma made possible through the media's global reach. In point of fact, most of the world experienced the events of September 11, 2001 through media, and the same media coverage that accorded 9/11 its initial collective impact soon became the medium—that is to say, the news—through which the world would process its implications. Thus *Timescape* does not only produce knowledge in the particular terms that its algorithms identify and visualize; it also represents the more general process of twenty-first century knowledge production. Its location in the 9/11 Memorial Museum, itself situated in the footprint of the original Twin Towers, accentuates the site-specific nature of the knowledge that it brings to light. The three Christie projectors, two Nvidia graphics cards, one top-of-the-line Dell computer, and a rack-mounted server that together work to generate *Timescape* emphasize that all data-driven knowledge is social, cultural, and, at some level, material. *Timescape*'s messages are determined by issues of access and authority as well as by who is empowered both financially and politically to present those messages to the public. None of this is to say that data visualizations should not appear in sites such as the 9/11 Memorial Museum, nor that we should cease to design them. Rather, we must continue to insist upon a rigorous interpretation of the images we see and the interactions we explore. As we increasingly seek to create visualizations that do more than merely “reveal” knowledge,

we must more fully account for the multiple layers—formal, technical, and political—through which data visualization produces meaning, advances arguments, and performs critique (Coopmans 2014: 38).

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