Weather Report
A Site-Specific Artwork Interweaving Human Experiences and Scientific Data Physicalization

Weather Report is a site-specific art installation that entices visitors to examine climate change at a human scale, both physically and metaphorically. Weather data are displayed using balloons as physical pixels that can be touched, part of an effort to make objective, scientific data graspable by nonscientists. Visitors contrast these objective weather data with weather-related memories they enter at a kiosk to create a subjective weather record from the Twin Cities community.

The historic Stone Arch Bridge, once the railroad gateway to the city of Minneapolis, crosses the Mississippi River at St. Anthony Falls. Walking across this gently curving path on a warm June night, we hear the sounds of the Northern Spark art festival. Held each year in the Twin Cities, Northern Spark has grown to attract tens of thousands of people who view performances, explore temporary installations in the streets and along the riverfront, and gather for one night to experience art as a community until the sun rises.

Looking down from the bridge on this night in 2016, colored lights flicker and reflect off the water, as a stream of local residents and visitors wind down from the bridge, through Mill Ruins Park, and along the walking path to what people are describing as the “balloon tunnel.” More than 800 miniature weather balloons are suspended to form two walls that undulate, like air-filled sheets in the night wind. Both the balloons and the steady stream of visitors perform an animated dance as the Mississippi River flows by on a parallel course (see Figure 1).

Our design collective, MINN_LAB, composed of architects, landscape architects, and computer scientists, created Weather Report in response to theme of “Climate Chaos | Climate Rising.” We identified common threads around the experience we wished to create: making climate personal and connecting objective scientific data to subjective human experiences. Then, over months of interdisciplinary design and discussion, we developed, interwove, and revised these threads drawing upon our plurality of design voices and different technical research interests.
CONCEPTUAL FRAMEWORK AND EARLY DESIGN

*Weather Report* uses local, human experiences with weather as an entry point for discussing the difference between objective weather data and subjective interpretations and memories. Although the data are on the human timescale (45 years of objective data and memories), the objective-subjective comparisons the piece asks visitors to make speak to the broader question of how the earth’s climate has shifted over a much larger period of time, how this is measured and interpreted today, and how rigorous scientific processes differ from everyday discussions of weather.

Scientists often struggle to explain the objective basis for climate change, what it means to the average citizen, and the grand timescale on which it operates. In contrast, our friends and family have no trouble at all explaining everyday human experiences with weather and extrapolating from these: *On the day you were born, there was an amazing blizzard, it took me four hours to shovel the car out of the driveway; that used to happen all the time, but we don’t have storms like that anymore.* Or, just as common, *we have never had a winter with so many violent storms in a row; grandpa had to buy a generator because the power kept going off; this year is the worst ever.* *Weather Report* asks visitors, which of these weather memories is true? How do human experiences and memories compare with objective data? How do human timescale data points relate to the much larger climate timescale, and how do scientists objectively measure those data?

Getting Physical with Balloon Pixels

Inspired by the role weather balloons play in data collection, we came to view the balloon as a simple, physical, relatable manifestation of the scientific process. Each weather balloon provides a small data-driven contribution to the larger picture of the science. Reinterpreting this in the context of an experiential display of data, we reasoned that balloons could function as physical "pixels," changing appearance in response to individual data readings and collectively presenting a broad picture of the scientific data.

The balloon-as-pixel concept could have many interpretations, and this fueled a rich, several month-long period of sketching and ideation within the team. Drawing upon the architectural
tradition, the site for the installation was critical in the design. One of the prominent features of Mill Ruins Park is a walking path that follows the river. Thus, we were inspired to create a walk-through experience—something viewers could experience and touch as they traversed the path.

The method for illuminating or otherwise adjusting the balloon pixels in response to data also required design. We experimented with balloons on strings with motors and internal LEDs but found that the best visual results could be achieved by projecting colored light onto the balloons. Light is transmitted through the balloon, creating the effect of a glowing orb.

**Two Walls for Contrasting Views of Weather**

The final design arranges the balloons into two walls, each constructed from a 12x36 grid of balloon pixels, forming a tunnel around the walking path (See Figure 2). Within the park, the tunnel is positioned so as to be visible at a distance from the Stone Arch Bridge or the hillside looking down to the river and so that light from the illuminated balloons reflects off the water at night.

Conceptually, the mirrored walls create a strong physical basis for visual and body-centric comparisons of the data. Viewers can stand inside the tunnel and point with one hand to a balloon that depicts objective temperature data for a particular hour, day, month, year, or decade and then point directly across the tunnel with the other hand to find the corresponding data point in the subjective record.

![Figure 2. A tunnel of balloon pixels along the walking path in Mill Ruins Park, Minneapolis, MN. Photo credit: Authors, 2016 (Used with permission.)](image)

**ILLUMINATED VISUALS AND USER INTERFACE**

To stay true to the science, we established a goal to make sure that the data-to-visual mapping could be considered accurate. However, we also recognized that, unlike many data visualizations, the primary goal of this site-specific artwork is not facilitating analysis using specific data points but rather creating an experience—a feeling of being aware of and immersed within the data. This creates the catalyst for discussion that is the real goal of the piece.

**Mapping Temperature Data to Balloon Walls**

The objective local weather data were recorded at the US Weather Station KMSP located at the Minneapolis–St. Paul International Airport (retrieved via the Wolfram Alpha computational engine). The dataset contains nearly 4.5 decades of hourly readings for temperature, wind speed, and precipitation (rain and snow) from 12 a.m. on 1 January 1960 to 7 a.m. on 11 June 2016.
All of the multi-decade, multi-variable data are displayed (over time) using only the 12x36 pixels available for each wall. To accomplish this, the balloon pixels are organized into a hierarchical time grid, where each balloon represents a time window, as illustrated in Figure 3. The base color for each balloon is set by applying a warm-to-cool color map to the average temperature within the balloon’s time window.

The animated visualization updates at a rate of one historical hour each half-second of real-world clock time with the “current time” signified by a white highlight. This means that the white highlight for the current hour in the far right column moves quickly from the top to the bottom of the column every six seconds. When it reaches the end, the hourly-data columns each shift to the right by one, paging a new column of twelve hours into the display. Likewise, when the current time reaches the end of the last day in a month, a new month of data is paged into the display.

![Figure 3](image1.png)

Figure 3. The data-to-visual mapping for each wall uses a hierarchical arrangement for time, decades are displayed in the two leftmost columns, with the current decade highlighted, followed by months of the year with the current month highlighted, followed by days of the month, and so on. 7 a.m. on Tuesday, 24 June 2016 is highlighted in this figure.

Animated Effects for Secondary Data Variables

Secondary data variables (rain, snow, wind speed, and cloud cover) are also included, but these are treated as discrete weather “events”. When the current time reaches an hour that includes one or more weather events, a three-second animated weather effect is added to a queue. These effects are applied to the entire display as a semi-transparent overlay, using all of the pixels as illustrated in Figure 4. For a rain event, blue pixels stream down the wall. Snow events create slower, gentler white pixels wafting down the wall. Cloud-cover events tint the top of the wall light gray, and wind events cause gray particles to fly across the wall from one side to the other.

![Figure 4](image2.png)

Figure 4. Frames from an animated blue rain effect superimposed over the objective weather wall.
ART ON GRAPHICS

The Subjective Weather Record

The subjective dataset contains the same variables but is much sparser. Over the course of the night, visitors fill in this subjective weather record, and the visualization interpolates between each data point to fill in the gaps.

The kiosk for entering weather-related memories uses a multi-touch interface. The specific hour for the memory is entered by selecting the decade, then year, then month, then day, and finally hour by touching the corresponding balloons on a diagram (Figure 5, top)—in this way, the data entry process teaches visitors about the data mapping used on the walls. Then, the temperature, rain, snow, wind speed, and cloud cover are entered using sliders with extremes labeled in relative, not numeric terms (e.g., the hottest day vs. the coldest day) (Figure 5, middle). Finally, visitors act out their weather memory, using the multi-touch screen to create an animation (Figure 5, bottom).

Similar to the animated weather effects, these weather memory animations are replayed as semi-transparent overlays immediately after entering the memory and again whenever the animation reaches the time associated with the memory.

Projecting on Balloons: Some Technical Notes

The balloons are lit from outside the tunnel by four short-throw projectors and a custom graphics program with five coordinated output windows. Calibration is critical because the site, next to the river and a hill, requires projecting from extreme angles. The projected graphics are created by first rendering a regular grid of 2D colored circles to an off-screen buffer. Then, this temporary image is texture mapped onto a deformable four-sided polygon. To calibrate each projector, a keyboard user interface is used to interactively adjust the coordinates of the corners of the polygon, skewing it until the colored circles project onto the correct balloons.
THE EXPERIENCE

Thousands of visitors experienced Weather Report at Northern Spark (see Figure 6). People walked through the tunnel and around the sides. They touched the balloons as they walked. More than 200 people contributed memories to the subjective weather record. The earliest entry was for 13 Dec. 1961, and there were 22 entries for the Halloween Blizzard of 1991. It would have been ideal to include additional stations or mobile devices for entering subjective data, as there were often long lines at the kiosk. Visitors who had a chance to act out their weather memories using their hands and then see the result displayed on the balloons said they felt as if they were playing a 36-foot-long instrument.

The biggest surprise was in how viewers reacted to the projection. As designers, we treated the projection as simply a behind-the-curtain technology – the technology that just happened to provide the best method of illuminating the balloons. To our surprise, the projection beams became interactive play areas, places for visitors to dance, pose for pictures with data covering their bodies, and cast shadows on the data that could be seen from across the river and around the festival. Visually, this added another layer of human connection and embodied movement to the data-driven visuals.

CONCLUSIONS

Interdisciplinary collaborative design processes are both rewarding and challenging. Our experience and results reflect months of discussion, much of it devoted to learning to speak the language of each other’s disciplines. The whole team had to work within the constraints of an outdoor, dusk-to-dawn festival and a specific site. Each discipline had to stretch to accommodate the interests and expertise of the other. This process led to a unique result, one that no individual on the team would have created. It also led to new thinking that broadens and refuels our primary disciplines.

Figure 6. Weather Report at Northern Spark 2016. Photo credits: Authors (left, middle), Krista McCullough (right), 2016. (Used with permission.)

This is one of the powerful recurrent themes in the work highlighted in this Art on Graphics column. In our case, we will surely continue to collaborate as an interdisciplinary collective, but even as we return to our primary disciplines we bring new knowledge with us that will impact our future work. Architects have learned to become a little bit more like computer scientists and now have a foundation for further explorations of data and science in the built environment, described in more detail in a companion paper within the architecture community. Computer scientists have learned to become a little bit more like architects and now have a foundation for further explorations of embodied experiences and physicality in data visualization.

Data visualization researchers will connect this work to the emerging theme of “data physicalization.” Although Weather Report includes digital components, the resulting piece is a decidedly physical, real-world, data-driven experience. This is a topic where the computer science community has much to learn from architects, designers, and artists. Collaborations like this one make it
possible to explore concepts of data in physical space at a scale and connecting with the local community in ways that are simply impossible in a traditional computer science context.

ACKNOWLEDGMENTS

This work was supported in part by a grant from the University of Minnesota Digital Design Center.

REFERENCES


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