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# Civic Participation and Empowerment through Visualization

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**Abstract**

*This article elaborates on the use of data visualization to promote civic participation and democratic engagement. The power and potential of data visualization is examined through a brief historical overview and four interconnected themes that provide new opportunities for electronic participation research: data storytelling, infographics, data physicalization, and quantified self. The goal is to call attention to this space and encourage a larger community of researchers to explore the possibilities that data visualization can bring.*

Categories and Subject Descriptors (according to ACM CCS): H.5.2 [Information Interfaces and Presentation]: Screen design—User-centered design

## 1. Introduction

Since the advent of the web in the early 1990s, prospects of electronic democracy have been viewed as heralding in a new era of political participation and civic engagement. However, empirical studies suggest most initiatives to date have failed to live up to expectations despite large investments in research. For instance, Chadwick [Cha08] states that "the reality of online deliberation, whether judged in terms of quantity, its quality, or its impact on political behaviour and policy outcomes, is far removed from the ideals set out in the early to mid-1990s". In order to provide a future direction for electronic democratic participation, scholars have attempted to systematize current research and identify its main constraints and challenges. Macintosh, Coleman, and Schneeberger [MCS09] identified six main research challenges, barriers, and needs: fragmentation of research, immature research methods and designs, technology design, institutional resistance, equity, and theory. Other scholars have suggested that the problem with electronic democracy goes deeper. For example, Coleman and Moss [CM12] argue that the assumed deliberative citizen is a construction driven by researchers' effort to produce responsible, democratically reflexive citizens modeled on Habermas' discursive ideal of deliberative democracy. The authors acknowledge that the deliberative approach to civic dialogue is "unduly restrictive, discounting other important ways of making, receiving, and contesting public claims". They therefore encourage researchers in the field to be more open to a wider range of practices and technologies and suggest some of the most innovative research is being done in the area of computer-supported argument mapping and visualization. However, the visualization research they are referring to have primarily focused on facilitating large-scale online deliberation within a conventional rationalistic framework. In general, visualization has been an underused technology in electronic participation research [Boh14].

## 2. The Power of Data Visualization

Whereas the conventional deliberative approach to broaden democratic engagement and participation using the Internet has had limited impact beyond academic circles, the past decade has seen a strong growth in the use of data visualization to reach a wide target audience. A prime example is Al Gore's narrated charts in the documentary film An Inconvenient Truth that earned him and the Intergovernmental Panel on Climate Change (IPCC) the Nobel Peace Prize in 2007. Another example is the approach developed by Hans Rosling, professor at Karolinska Institutet, Stockholm, Sweden, and co-founder of the Gapminder Foundation. Using humor and drama of a sportscaster and a piece of software that turns seemingly dry data into colorful animated graphics, Rosling debunks myths about the developing world while making it an enjoyable experience. These

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observations, albeit of a few examples, suggest data visualization has potential for reaching out to a broad audience in innovative ways and facilitate greater citizen engagement in public affairs.

### 2.1. A Brief Historical Overview

To the casual observer, it would appear that data visualization is a recent phenomenon. In fact, the graphic portrayal of quantitative information has a long and rich history. According to Friendly [Fri08a], the beginnings of modern statistical graphics can be found in scientific discoveries, technological advancements, and societal developments in the 17th and 18th century. Many visualization techniques that are still being used today were introduced during this period including the line chart, bar chart, and pie chart.

In the second half of the 19th century, a number of developments combined to produce a "Golden Age of Statistical Graphics" [Fri08b]. Two well-known and much-discussed graphical exemplars from this period include John Snow's dot map of a cholera outbreak in London and Florence Nightingale's polar area charts displaying mortality rates of British soldiers during the Crimean War. Snow and Nightingale used their charts successfully as critical evidentiary statements in campaigning for improved sanitation that eventually led to government healthcare reforms.

In the first half of the 20th century, earlier enthusiasm for statistical graphics was supplanted by the rise of mathematical statistics [Fri08a]. Few graphical innovations were introduced during this period; it was, however, a time for consolidation and popularization. An important factor for the diffusion was pictorial statistics or pictograms. An influential advocate of pictograms was the Austrian philosopher Otto Neurath who developed a visual language known as Isotype with the purpose of explaining societal developments to the broad uneducated public. Due to the association of Isotype with left-wing movements and Soviet propaganda, the method disappeared during the Cold War in the Western world and its legacy has gone either unnoticed or unappreciated [Jan09]. In the last decade, however, the method has received renewed interest and increased attention. For example, Mayr and Schreder [MS14] review Isotype with respect to its potential for today's civic education and participation and propose that we should rediscover its core principles and adapt them to a modern context.

The period from 1950 to 1975 constituted a rebirth for data visualization. Friendly [Fri08a] lists three significant events that contributed to the upswing. First, the publication of John Tukey's book Exploratory Data Analysis [Tuk77]; second, the publication of Jacques Bertin's work Sémiologie graphique [Ber67]; and third, the introduction of computers and software for statistical graphics. In 1983, Edward Tufte published the classic The Visual Display of Quantitative Information [Tuf83] which introduced several important concepts, including "data-ink ratio". At the turn of the century, Card, Mackinlay, and Shneiderman [CMS99] published a collection of seminal papers which established information visualization as a distinct field separate from scientific visualization.

As previously suggested, data visualization has exploded in the last ten years. Along with an increasing body of literature, the past decade has seen the emergence of a vast array of programming languages, toolkits, and libraries for interactive data visualization. Prefuse, for example, was an early visualization framework using the Java programming language [HCL05]. Today, many web-based data visualizations are built with D3, WebGL, and other JavaScript frameworks that utilize web standards and do not require web browser plug-ins.

## 3. Democratizing Data Visualization

In the following subsections, we explore four interconnected themes that contribute to a democratization of data visualization. The themes should not be viewed as comprehensive, but as stimuli to the research community to begin to ask better questions regarding the design of future technologies and practices for public participation.

### 3.1. Data Storytelling

Up to now, data visualization beyond the simple pie or bar chart has been the domain of specialists trained in either statistics or computer science. This was particularly true if dynamic and interactive charts and diagrams were required. However, the last few years have seen the emergence of a new class of self-service applications that support dynamic data querying, visual analysis, and interactive presentation on standard personal computers. These user-friendly data exploration and visualization tools, which are typically available free, empower the average user as it makes them less dependent on technical expertise and enable a broad audience to tell stories with data using visualization [KM13]. An example of an interactive data-driven story using visualization is the New York Times' dialect quiz How Y'all, Youse, and You Guys Talk [KA13]. By responding to 25 different questions about the language the user most likely uses in different situations, the quiz builds a profile of the user's dialect. When all questions are completed, a heat map indicates where in the United States the user most likely would find a person who uses a similar dialect. The dialect quiz became a huge success; in just eleven days (it was published on December 21) it became the most visited content of 2013 throughout `www.nytimes.com`, their mobile site and iOS apps [New14].

### 3.2. Infographics

Information graphics, a popular form of visualization commonly found in news media and often referred to as info-

graphics, has exploded in the digital age. The typical online infographic is a static high-resolution graphic design that attempts to transform abstract information about a specific topic into a format that is visually engaging, easily understood, and easily shared. Infographics combine data with design—numbers, data displays, words, and pictures—in order to inform, entertain, or persuade their audience. Despite the proliferation of infographics in today's fast-paced digital society, little research has been conducted on them. However, they typically share a number of common attributes. Similar to the idea behind micro-blogging services such as Twitter, the main characteristic of infographics is that their purpose is to tell the gist of a story at a glance. They are stand-alone visuals that are easy to digest and do not require additional information to be comprehensible. A second important characteristic is that infographics are meant to be aesthetically pleasing. Indeed, well-executed infographics are often admired for their beauty or for bringing out the beauty in data. A third characteristic of online infographics is that they are viral, easily shared and spread across social networks from person to person through "word of mouse".

Although infographics are generally considered effective for disseminating information to the masses, statisticians and others have criticized them for relying too much on style over substance [Cai15]. Clearly, many infographic works are nothing more than eye candy that publishers and marketers use to gloss up their content, overly designed and convey little meaning. A surprisingly large number of infographics deceive their viewers by cherry picking statistics, warping facts, or providing questionable, vague, or nonexistent data sources [Kru13]. Despite these ethical objections, the sharp increase of online infographics in the last five years suggests that they appeal to a broad audience, a fact that makes them worth investigating further.

### 3.3. Data Physicalization

Physical data visualization, a lesser-known subfield of data visualization, studies alternative data representations where data is not represented through pixels on a computer screen, but via physical modalities experienced directly through the eye (not including ink on paper) or other human senses. In contrast to conventional data visualization where objectivity is the norm, physical representations of data allow for, sometimes even encourage, the inclusion of subjectivity in order to be evocative and increase onlookers' engagement. In an overview paper, Vande Moere [Moe08] explores the design space of physical data visualization in non-professional contexts. He lists five genres: data sculptures, ambient displays, pixel sculptures, object augmentation, wearable visualization, and alternative modalities. Data sculptures are data-driven physical artifacts that can be touched and explored through a tangible user interface. Ambient displays turn architectural spaces into a data display through subtle changes in light, sound, movement, solids, liquids, or gases that can be processed in the back-ground of awareness. Envisioned as being all around us, ambient displays blur the boundary between the physical and digital worlds to create an interface between people and digital information. Pixel sculptures use non-screen-based visual units for representing information. An example is synchronized mass games or gymnastics, often seen at the Olympic Games, where each individual make up an element in a giant mosaic picture. Object augmentation refers to superimposing everyday objects with information. Visual animated projections on building facades and sidewalks is a common example. Wearable visualization draws on miniature computing devices that fits in clothing, jewelry, and other wearable things. The last category, alternative modalities, utilize non-visual representations of data that can be experienced through sound (sonification or auditory displays), touch (tactile or haptic displays), smell (olfactory displays), or taste (palatable interfaces). For instance, an experimental workshop called Data Cuisine explored food using culinary means as an alternative medium for representing data [Ste12].

### 3.4. Quantified Self

Self-knowledge through numbers, the motto of the quantified self grassroots movement [WK15], is quickly becoming a mainstream phenomenon. Currently, it is estimated that one in five U.S. adults are tracking their physical activity, sleep pattern, nutritional intake, and many other things related to their lives through a portable or wearable computing device such as a smartphone, smartwatch, or activity tracker [FD12]. The basic idea is simple: through more granular around-the-clock quantified monitoring, people can make smarter lifestyle choices and live healthier, more active lives. The reasons for self-surveillance are numerous and varied and range from the causal fitness-tracker who monitors his or her own exercise, to tech-savvy patients and citizen scientists who share their medical and lifestyle data online to help others and advance research, to life-logging enthusiasts with a passion for self-discovery through personal analytics. The story of Doug Kanter, who blogs about living with diabetes at `http://www.databetic.com`, offers a glimpse of what the future of personal data quantification might look like. In 2012, he used a suit of medical devices, activity trackers, smartphone applications, and PC software to record all his diabetes data and physical activities. He visualized his yearlong quantified self project as a poster displaying every blood sugar reading, every insulin dose and meal, as well as all activity data. Kanter's systematic self-tracking approach helped him become more aware of his behavior and provided an opportunity for change. As a result, his diabetic control improved considerably, making 2012 the healthiest year of his life.

## 4. Conclusions

In this article, we have explored the potential of using data visualization to promote civic engagement. First, we reviewed some of the challenges of contemporary electronic participation research and found that it cautions us to reduce our expectations of the conventional approach to online participation since there is little evidence of its success. In particular, it suggests the rationalistic model based on deliberative theory has become a straightjacket, impeding wide civic involvement. This predicament has prompted some scholars to rethink their earlier views and suggest the study of online participation should be expanded to incorporate a wider range of technologies and practices. As a response to this call, we examined the power of data visualization through a couple of recent examples and a brief historical overview. We then explored four overlapping themes that suggest data visualization represents a yet untapped potential in promoting a more informed and engaged participation in civic and democratic life. The themes and examples discussed is suggestive (but by no means conclusive) evidence that the time is ripe for scholars to consider the use of data visualization in political participation and civic engagement research. However, the versatility and potential applications of data visualization in the service of democracy remain to be explored. I would like, therefore, to invite my colleagues to join me in exploring and reflecting on the following research questions:

- Techniques of storytelling focus on people, motives and contexts rather than numbers. How can stories help bring data to life?
- Aesthetics reaches us on a different level than words and numbers alone. How can data be combined with art and design to evoke emotional engagement?
- In today's networked society, harnessing the power of human connections is key. How can we make data conversational and sharable?
- Beyond the desktop visualizations may be effective in engaging hard to reach groups. How can we unlock the hidden potential of tangible data?
- Smartphones and other connected devices bring visualization closer to people than ever before. How can we leverage the ubiquity of data in people's lives?

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