The Liminal Space Between Art and Data: Du Bois’s Data Graphics as Disciplinary Misfits

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The Liminal Space Between Art and Data: Du Bois’s Data Graphics as Disciplinary Misfits

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by
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to
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and
The Department of History of Art and Architecture

in partial fulfillment of the requirements
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The Liminal Space Between Art and Data: Du Bois’s Data Graphics as Disciplinary Misfits

Abstract

At the 1900 Paris Exposition, renowned sociologist and civil rights activist W. E. B. Du Bois presented over sixty hand-crafted charts, graphs, and maps documenting the conditions of African Americans since the end of slavery. Part data and part art, these data graphics do not fit neatly under the scholarship of a single discipline. This thesis analyzes the significance of these graphics using an interdisciplinary approach, applying semiotic, psychoanalytic, and socio-historical frameworks that are inspired by the methodological traditions of art history and Visual Culture Studies along with the graphic theory of Jacques Bertin. In a novel interpretation of Du Bois’s data graphics, this thesis elucidates how through the medium of data, Du Bois visualizes African American “Progress” as non-linear and complex. This study broadly discusses how visual encodings capture cultural meanings that inherently complicate the narrative of the data itself, presenting a counterargument to several of the conventional data visualization principles established by Edward Tufte. This study also theorizes a novel semiotic framework, in which visual elements are evaluated based on a continuum of semantic complexity, to analyze how data visualizations communicate meaning beyond the data.
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The fields of art and data visualization are seldom encountered within the same discourse. Historically, these two disciplines have been viewed as categorically incompatible, each grounded in principles that are fundamentally in opposition. Data visualization is rational, technical, and objective; art is emotive, theoretical, and subjective. Data visual-
izations are scientific instruments used to process and communicate information; art in the purest sense has no utilitarian function at all. Data visualization is generated from a set of algorithmic rules mapping data to form; art on the other hand is produced from the creative mind of the artist. Data visualization belongs to the sciences; art to the humanities. Data visualization is not art, and art is not data visualization. Or so the thinking generally goes.

Yet, if this is the case, then what are we to do when confronted with W. E. B. Du Bois’s data spiral [Figure 1], for example, a striking data graphic, composed of a multicolored line that kinks and spirals, representing city and rural populations of African Americans? This is just one out of sixty-three data graphics that Du Bois presented at the 1900 Paris Exposition, which displayed the findings of his sociological studies on the condition of African Americans since the end of slavery. At first glance, this image confuses the eye—we are not sure what we are looking at. The form, however, is without a doubt evocative, and we wonder about the potential for symbolic meaning. As a whole, the image slightly resembles a musical note, or a droplet of blood perhaps, but it is not obviously depicting any recognizable object or symbol in reality. Then there is that bold red spiral, mesmerizing and pleasing to stare at, yet at the same time ominous and unsettling. We forget, if just for a moment, that this is a display of quantitative data and not a work of art.

Examining the rest of plate, our attention is brought to the title, “CITY AND RURAL POPULATION. 1890.”, written so boldly and in such a technical font that it snaps us out of our trance and reminds us that this is indeed a statistical and scientific chart, and that the forms represent information, not a figurative image. Our attention might then be drawn to the labels, their thin, delicate lettering rendering them practically invisible at
first glance. “78,139 Negroes” in cities of over 10,000 inhabitants,” the top label reads. So, these different lines represent population numbers in cities of various sizes, we might think to ourselves. Yet, we are still somewhat unsure of what to make of that information. Because the line zigzags diagonally left, right, and then left again, producing jagged angles that make it perceptually difficult to follow, the length of these segments are difficult to compare. Then, perhaps it hits us, that the size of the spiral vastly outweighs the length of any of the segments. After reading the caption, “Negroes living in the country and villages,” we

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1I generally try to avoid the use of the term “Negro” due to its pejorative connotation in a modern context. When I do use the term “Negro,” I use it only when quoting an author, or when it is explicitly in the context that Du Bois would have used the term.
perceptually feel the weight of just how many African Americans lived in rural areas, and conversely, how few lived in cities.

What might a data visualization expert say about this graphic? They might argue that it is an ineffective display because it is difficult to perceptually compare the relative sizes of the line segments. The author has also performed operations that have no conventional or explicit correspondence to the data, bending the line to seemingly arbitrary degrees and spiraling the red segment without a clear reason why. Not only is the information on the graphic difficult to perceive, but the author’s design choices confuse us even further, muddling meaning rather clarifying it.

At the same time, a data visualization expert may also find aspects worthy of praise. At the very least, Du Bois does not intentionally misrepresent the data—the lengths of the lines do proportionally correspond to labeled values. On this front, Du Bois can be praised for his attention to graphical integrity. The spiral can also be seen as an innovative technique to represent very large values at the same scale as very small ones without distorting their relative lengths, at the same time making economical use of the space on the page and providing a visual sense of balance. However, this spiral technique has not been picked up by other data visual designers throughout time, likely because the length of the spiral is perceptually challenging to judge with any sort of accuracy. Ultimately, in the historiography of data visualization, which normally only includes the “first” and the “best” examples of visualization types, Du Bois’s work is seldom mentioned.

What would an art historian say about such a work? Would they call it art? At a first glance, probably not. Of course, this raises the question “what constitutes art?”, an impossible question posed so often it has become a cliché, but given that Du Bois’s intent for
this image was primarily to present information and not to exist as an aesthetic object, it likely would not be seriously considered. And over time they have not been. Du Bois’s data graphics have been forgotten about, shipped to the Library of Congress less than a year after the conclusion of the fair to be placed in secure storage, inaccessible to the public. It is only recently, in the past decade, that scholars and the public have rediscovered these graphics, yet art academics have not shown much serious interest.

Du Bois’s data graphic thus presents a clear disciplinary problem. It does not quite fit in either the disciplines of data visualization or the history of art, despite having undeniable intellectual and scholarly value. This graphic confronts these disciplinary boundaries by refusing to be categorized into an established genre. Indeed, the phenomenological experience of reading this chart constantly shifts our attention back and forth between the contexts of art and science, never landing solidly in either. In the vast majority of data graphics, decorative elements appear secondary to the data. In Du Bois’s spiral, no primacy is established; form and data are equal. Not only are they equal, but they are forged into one. One cannot be analyzed without the other. It thus demands of us the use of an interdisciplinary approach to understand the nature of this image, an approach that negotiates between art history and data visualization.

This is not a new problem. Visual objects that are difficult to classify under traditional disciplinary studies have led to the establishment of the Anglo-American discipline of Visual Culture Studies and its Germany parallel, Bildwissenschaft (“image studies”), which expand the range of visual material to include cultural objects that fall outside a narrowly defined idea of art. Bildwissenschaft in particular is more focused on the question of how images function rather than on their historical dimension. Though the field of Vi-
Visual Culture Studies is extraordinarily diverse, it has its origins in art historical traditions, borrowing many of its methods, including semiotics, Marxism, Feminism, historiography, social history, psychoanalysis, queer theory, deconstruction, and postcolonial theory in its study towards all forms of visual culture. Visual Culture Studies is an example of what Roland Barthes, paraphrased by Mieke Bal, says of interdisciplinary studies, that it “consists of creating a new object that belongs to no one.” In this sense, Du Bois’s data graphics, belonging strictly to no genre or discipline, can be created anew under interdisciplinary study.

Scientific images have been studied under the premise of visual culture and Bildwissenschaft before, perhaps most eminently by German art historian Horst Bredekamp. Bredekamp has published in a series of books his systematic studies of scientific images and imagery in the publications of Thomas Hobbes, Gottfried Wilhelm Leibniz, Charles Darwin and Galileo Galilei. The work of Bredekamp illuminates how images instill a unique and independent kind of understanding, which even precedes or at least occurs simultaneously with actual thought.

Beginning in the year 2000, Bredekamp chaired a research project titled “Das Technische Bild” (in English “The Technical Image”) which focused on studying scientific and technical imagery using an approach that was “firmly rooted in the methods of art history.” The research operated under the hypothesis that “the forms of imagery are of no less import than the content and objects they show . . . The transformation of observations, findings, and insights into images partakes actively in the construction of knowledge.” In relation to data visualizations, this would mean that the act of transcribing data

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3 David Craven. “The New German Art History: From Ideological Critique and the Warburg Renaissance to the Bildwissenschaft of the Three Bs”. In: *Art in Translation* 6.2 (June 2014), 144.
into visual form produces new knowledge outside of the content of the data, without exception. Thus, even visualizations that propt to be “objective” or “neutral” are in fact participating in a socially constructed reality. As Bradekamp says, “If scientific images play a constructive role in shaping the findings and insights they illustrate, the representation of an observation in images, however mechanical, however detached from the individual researcher’s choice their appearance may be, likewise becomes an instance of the style of a period, a mindset, a research collective, and a device.”

Taking cues from Bradekamp, this thesis undergoes a study of Du Bois’s data graphics using methodologies rooted in art history, taking influence from the fields of Visual Culture Studies, Bildwissenschaft, data science and visualization, sociology, psychology, and history of science. In particular, this thesis focuses on the application of semiotics in reconstructing the system of signs that Du Bois employs in his data graphics. This exploration also includes support from the methods of psychoanalysis and social history of art. Psychoanalysis is used to explain the graphical operation of doubling used in some of the graphics in association with Du Bois’s concept of double consciousness. A sociohistorical approach examines how tensions in America during the Jim Crow era between White and Black, urban and rural, educated and uneducated, upper and lower class permeate throughout the graphics.

This thesis is split into three chapters. In the first chapter, I provide a broad discussion on the connections between data visualization and art, ultimately linking them

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5 In my thesis, I capitalize the terms “Black” and “White” when referring to the racial groups, and use these terms as adjectives and not nouns. Additionally, I use the terms “Black” and “African American” interchangeably to refer to people living in America of African descent whose lives and histories have been indelibly marked by the legacy of racialized slavery.
through shared ontological and epistemological issues that are at stake. I attempt to pro-
provide a semiotic framework for understanding the nature of meaning in visual objects and
how we can come to know it. In the second and third chapters, I embark in an art historical
study of Du Bois’s data visualizations. The second chapter provides the historical context
for these graphics, in particular the context of the American Negro Exhibit at the 1900
world’s fair in Paris. The third chapter analyzes several of the sixty-three total visuals using
methods that are rooted in an art historical tradition. Thus, in addition to this study serv-
ing as a monograph of Du Bois’s graphics, this thesis presents them as an important case
study for the wider discussion about the interdisciplinary space between the fields of data
visualization and art history.

I propose the five following questions as central motivators for this thesis. (1) How
does the study of art intersect with the study of data visualization? (2) What is the par-
ticular system of signs that Du Bois uses in his data graphics, and how are they different
from the data visualizations that predate it? (3) What were the social, cultural, political, and
biographical factors that contributed to the production of these graphics? (4) Why were
Du Bois’s graphics ignored in scholarship for such a long time, and what implications do
they have for contemporary art history and data visualization principles? (5) How do these
graphics challenge conventions in the history of data visualization, and how do we unpack
what these challenges mean for developing a comprehensive theory of data visualization?

What I hope to accomplish in this study is to confront the barrier between art and
data visualization, to examine the different ways in which these two disciplines of study
intersect, and to illustrate how the frameworks and ideas from one are productive in un-
derstanding the other. It is in this setting that Du Bois’s data graphics become all the more
compelling, of course as fascinating images on their own merit, but also as works of anti-
genre that put into question our notions of data visualization and art altogether.

**A Brief Note on Terminology**

It is important to take a moment to discuss the terminology that is used throughout this thesis. There is no established term for Du Bois’s collection of data visualizations. In the title plate of the collection, Du Bois himself refers to these works as “charts, maps, and other devices.” Du Bois’s inability to choose a singular word to describe the entire collection illustrates how wide the range of visualizations are, in addition to how these graphics defy categorization. Du Bois himself only refers to thirty-two, which is just around half, of the graphics as “charts,” even though there are forty-eight which could be reasonably be called chart-like. We cannot be sure which of the graphics Du Bois viewed as charts and which of them he viewed as “other devices”; however, one possible split may be between those which follow traditional data visualization typologies, namely bar, line, circle, and pie charts, and those which do not. It is precisely the fact that so many of the graphics refuse to fit into traditional types that makes them difficult to classify, but it is also what makes them fascinating objects of study. It is not even especially clear what constitutes a “map” in the traditional sense of the word, as some of the graphics use the borders of countries as mere icons rather than as depicting geographical relationships. Would these constitute maps to Du Bois? Due to these ambiguities in Du Bois’s original categorizations, I tend not to refer to these objects using these terms.

Whitney Battle-Baptiste and Britt Rusert in their *W. E. B. Du Bois’s Data Portraits: Visualizing Black America*, a book that showcases the sixty-three data visualizations in full
color for the first time, invent the term “data portraits” to describe Du Bois’s graphics, a Frankenstein phrase that attempts to encapsulate both the quantitative basis for these images as well as their artistic representation. The reason they have used this terminology, as Rusert explains, is to signal the relationship between the infographics and the collection of Black photographic portraits that Du Bois exhibits together. Rusert argues that the photographic and the infographic representations serve complementary roles, both needed to complete Du Bois’s portrayal of Black life. While I empathize with the Rusert’s intention, the word “portrait” as a technical term in the field of art history refers specifically to a pictorial representation of a person usually showing the face, and to avoid confusion, I avoid the use of the term to describe the data graphics throughout this thesis.

Additionally, the word “diagram” has previously been used to describe these objects. While it is more technical and categorically accurate than “portrait,” the word can imply both data abstractions like charts and graphs as well as schematics, which are symbolic representations of systems or physical objects. Implicit in the word “diagram” is also the simplification of the thing that is being diagrammed. Part of the argument of this thesis, however, is that Du Bois’s data graphics do not always try to make simple; instead, the graphics take on sophisticated forms that are worthy of interpretation in and of themselves and which often complicate the message of the raw data alone. Instead, I have elected to use the phrase “data graphic,” and variations such as “infographic,” “data visualization,” or simply “graphic,” to refer to these objects. Webster’s Dictionary defines a graphic as “a graphic representation (such as a picture, map, or graph) used especially for illustration.” This terminology is broad enough as to encompass all of Du Bois’s “charts, maps, and other devices” without implying the simplification of its subject.

Data and Art: Bridging the Disciplinary Gap

There is nothing straightforward about art. Throughout time, the definition of art has been in constant flux, from its origins in mimesis, to expressions of emotion and
ideas, to explorations of perception, to “art for art’s sake,” to the readymade, to even its
own nonexistence. Art is long past the point of being possible to define. Works of art them-
selves are complicated to understand. Meaning in art is multiple, contextual, and often very
difficult to access.

Data visualization, however, generally aspires for the opposite effect: to make simple.
Renowned statistician and data visualization specialist Edward Tufte wrote in his seminal
1983 work *The Visual Display of Quantitative Information*, “Excellence in statistical graph-
ics consists of complex ideas communicated with clarity, precision and efficiency.” Tufte
shows that there is great communicative power in being able to simplify. Many in the disci-
pline would agree that a fundamental objective of data visualization is for meaning in data
to be presented as efficiently as possible, in other words, in a way that is immediately per-
ceivable without much cognitive effort. This is an objective that stems from the historical
origins of the field. According to nineteenth-century French engineer Charles Joseph Mi-
nard, a pioneer in data visualization, the principle that characterizes his graphs and quanti-
tative maps “is to have the proportions of the numerical results appreciated immediately by
the eye, as much as possible.” Indeed, data visualization throughout time has been used as a
solution for conveying information faster than the speed it would take to read it.

French cartographer and graphic language theorist Jacques Bertin formalized this
concept of “efficiency” in his 1967 book *Semiology of Graphics*, which represents the first
and widest attempt to provide a theoretical foundation for data visualization. In the book,
he defines “efficiency” by the following proposition:

If, in order to obtain a correct and complete answer to a given question, all

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other things being equal, one construction requires a shorter period of perception than another construction, we can say that it is more efficient for this question.\(^2\)

Embedded in Bertin’s formalization is the assumption that data graphics provide a “correct and complete answer to a given question.” This brings up a longstanding epistemological and ontological position in the discipline which considers data visualizations as devices of measurement. In other words, they are commonly seen as transparent geometric representations of objective reality. Assuming the data has been accurately and validly transcribed into a visual form based on a set of rules, then it is a tool by which questions can be answered and facts can be verified. For example, using a line chart that shows the price of stock X over the past week, one could answer a specific question like, “What was the price of stock X on Tuesday?” or a more general question such as, “In which direction did the price of the stock go in?” Furthermore, the answers to these questions could be agreed on by any logical observer, and thus for each question one could pose about the data, there is a single correct answer or interpretation provided by the graphic.

Art does not have such strong assumptions about presenting an objective reality. Art is thought of as being subjective, that is to say, the meaning of an artwork is not fixed or predetermined and is dependent on each individual viewer’s interpretation. Art historians assume that art is fundamentally historical, that is to say that art is influenced by the social, cultural, political, religious, and artistic factors of the time and place in which it was produced, and that it cannot be understood in the same way from a different spatiotemporal context. Meanwhile, a data visualization from the eighteenth century could be interpreted

by a logical observer from today, as long as they were provided the set of rules to decode it. With art, while some interpretations may be better than others, it seems we can never be sure what the correct interpretation is, or whether there exists one, many, or any at all.

For art purists, the practical function of data visualization itself is enough to disqualify it from being viewed as art, which strictly speaking has no practical purpose at all but to be aesthetic or provoke intellectual thought. In the way that the function of a chair is primarily to be sat on, and the function of an advertisement is primarily to persuade viewers to purchase a product, the function of data visualization is to make visible trends in data. Therefore, at best, it could be classified as an “applied” or “low” art, but certainly not “fine” art.

On the other side of the aisle, purists in data visualization rail against the excessive use of “art” in quantitative displays, including Edward Tufte, who coined the term “chartjunk” to refer to the visual elements in data graphics that are not essential for comprehension or distract the viewer from the information represented. He wrote:

> The interior decoration of graphics generates a lot of ink that does not tell the viewer anything new. The purpose of decoration varies—to make the graphic appear more scientific and precise, to enliven the display, to give the designer an opportunity to exercise artistic skills. Regardless of its cause, it is all non-data-ink or redundant data-ink, and it is often chartjunk.  

In Tufte’s view, a designer should strive to use ink to display data alone, since the meaning should come from the information, not from the style it is represented in. Furthermore, it is standard practice for technical designers to try to avoid the use of emotion altogether. In

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A Unified Theory of Information Design, authors Nicole Amare and Alan Manning state, “The plain style normally recommended for technical visuals is directed toward a deliberately neutral emotional field, a blank page in effect, upon which viewers are more free to choose their own response to the information.” Plainness is associated with neutrality, which in turn enables the visualization to be viewed as more objective and thereby more true. Conversely, decorative elements are associated with a lack of neutrality and scientific rigor, as well as potentially unethical attempts at emotional persuasion, distraction, or misrepresentation.

Towards a Holistic Perspective: Du Bois’s Criteria of Negro Art

However, taking these views of art and data visualization would be extremely limiting. Indeed, each of these basic principles discussed about both fields cannot and should not be taken for granted. They have been heavily debated throughout time and serve as ongoing ethical, ontological and epistemological problems for both disciplines. For art, this includes issues of whether art has a function, if art presents propositional truths, and what the nature of meaning in art is. For data visualization, issues focus on to what extent they are devices of measurement versus devices of rhetoric; in other words, are they are reflections of objective truth or do they participate in a social construction of reality? These fundamental and unanswered questions leave room for much more overlap between these two fields than what first meets the eye.

As for the first question, “Does art have a function,” the common position is generally speaking, no, for that is what makes it art. However, in 1926, Du Bois himself delivered

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a speech later published under the title “Criteria of Negro Art” in which he controversially declared that

All Art is propaganda and ever must be, despite the wailing of the purists. I stand in utter shamelessness and say that whatever art I have for writing has been used always for propaganda for gaining the right of black folk to love and enjoy. I do not care a damn for any art that is not used for propaganda.5

Du Bois was at the forefront of a heated debate about the political meaning of the Harlem Renaissance in the 1920s. This debate took place between those who argued African Americans should be making “pure” artistic expressions devoid of racial and political connotations, and those, such as Du Bois, who thought that African American art should be used to advance the social and political standing of their race. As Martina Mallocci notes, Du Bois’s interpretation of art does not apply only to the 1920s, but that “Du Bois’s The Crisis also made a sophisticated use of visual arts to both challenge racial stereotypes and dignify blackness since the early 1910s. Du Bois’s ideas about artistic expression and his political commitment were strongly linked since the beginning of his editorial experience, and even earlier.”6 Although in the year 1900 Du Bois was less explicit about his views on the political nature of art, his idea of his work as propaganda can also be seen in the way he viewed his scientific work. In Du Bois’s autobiography, he discusses the role of his African American sociological studies at the University of Atlanta as part of a larger political agenda:

The object of these studies is primarily scientific—a careful search for truth conducted as thoroughly, broadly, and honestly as the material resources and

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mental equipment at command will allow; but this is not our sole object; we wish not only to make the Truth clear but to present it in such shape as will encourage and help social reform.\(^7\)

Du Bois saw his data visualizations as not only presenting an objective truth inherent within the data, but also as part of a larger visual rhetoric to bring about the social and economic uplift of African Americans. In the question of whether data graphics are objective or rhetorical devices, Du Bois implies here that they are both, as he at once recognizes the influence of the editorial hand on shaping the data graphic’s message while also suggesting that “capital T” Truth remains unaltered.

To Du Bois, art and science in the African American context shared a racial and political purpose, to persuade the world towards justice and equality between the races. He thus connects the two under the same ontological framework, linked by their common rhetorical function and basis in objective truth. Nancy Muller Milligan described Du Bois’s philosophy as a new form of American Pragmatism:

Pragmatism, as expressed by DuBois [sic] and other philosophers of his time, proposed that all who investigated a “Truth” would independently arrive at the same conclusion . . . DuBois developed a “DuBoisian” pragmatism, i.e., if and when someone arrived at the truth s/he would see the injustice of racism and a social change would take place.\(^8\)


Du Bois believed that different approaches towards investigating “Truth,” whether it be through empirical methods or through art for example, result in the same endpoint, that racism is unjust. Extrapolating his philosophy beyond the African American context, it becomes clear that there is extraordinary value in analyzing data visualization and art under the same framework of visual rhetoric.

**The Treachery of Images**

In modern discourse, however, many scholars would question Du Bois’s belief that images have the ability to present objective truth. American philosopher of science, Peter Galison, discusses this tense relationship science has with images in his essay “Images Scatter into Data, Data Gathers into Images”:

> By mimicking nature, an image, even if not in every respect, captures a richness of relations in a way that a logical train of propositions never can. Pictures are not just scaffolding, they are the gleaming edifices of truth itself that we hope to reveal. So goes the brief for the scientific image: pictures are pedagogically, epistemically, and metaphysically inalienable from the goal of science itself. And yet: we cannot have images because images deceive. Pictures create artifactual expectations, they incline us to reason on false premises.⁹

In the essay, he claims images have the remarkable ability to present truth in a way that is in some ways more effective than pure logic, or in Roland Barthes’s words, “Pictures . . .

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are more imperative than writing, they impose meaning at one stroke, without analyzing or diluting it.” As previously discussed, we are often able to understand information and insights much faster from a data visualization than from a table of numbers. This is largely due to the fact that our perceptual processes work much faster than our cognitive ones.

At the same time, as Galison notes, images also have the dangerous ability to deceive. Take for example *The Treachery of Images* (1928) by Belgian surrealist Rene Magritte. The painting is of an image of a pipe, with the caption underneath, “Ceci n’est pas une pipe,” French for “This is not a pipe.” In order to resolve this clear contradiction, we must come to the realization that indeed, this is not a pipe, but a representation of a pipe. However, in the process, it forces us to question the way we often perceive and understand images not as representations but as the objects they represent. With this painting, Magritte exposes the paradoxical nature of images, that images merely represent and do not reproduce the reality they attempt to portray, and as a result, inherent in every image exists a treacherous deception.

Similarly, data visualizations do not present a perfect one-to-one correspondence between the data and our perception of its graphical representation. More formally, the process of visually decoding quantitative meaning is imprecise. This problem in data visualization is well understood and has been investigated experimentally by William S. Cleveland and Robert McGill in their seminal 1984 paper titled “Graphical Perception and Graphical Methods for Analyzing Scientific Data,” in which they report their findings on how accurately subjects could perform elementary perceptual tasks related to data visualization, such as judging the length of a bar or the shade of a hue. These elements are often called visual

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encodings, the ways in which data is mapped into visual structures. They found various degrees of accuracy depending on the type of visual encoding, which they ranked in order from most to least accurate: (1) position along a common scale, (2) positions along non-aligned scales, (3) length, direction, angle, (4) area, (5) volume, curvature, and (6) shading, color saturation. They also made the following claim:

A graphical form that involves elementary perceptual tasks that lead to more accurate judgements than another graphical form (with the same quantitative information) will result in better organization and increase the chances of a correct perception of patterns and behavior.\textsuperscript{11}

This development in the theory of data graphics strongly relates to the idea of “efficiency” being the primary objective that was proposed by both Bertin and Tufte. However, a consequence of Cleveland’s contribution is the idea that the human ability to perceive is fundamentally imprecise, putting into question the belief that scientific graphical forms can ever achieve “objectivity.”

**Neutrality as a “God Trick”**

Images deceive in another way. Data visualizations that proport to be objective and rational have the potential to be the most deceiving of all. Feminist scholar Donna Haraway coined the term “god trick” to describe this phenomenon in her 1988 essay “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective.” She uses the

term to refer to the false objectivity that is often attributed to scientific knowledge, “the god trick of seeing everything from nowhere.” Scientific “visualization technologies are without apparent limit,” she writes, but “of course, that infinite vision is an illusion, a god trick.” It is a trick because images can make the viewer believe that the author is all-knowing. She argues that without transparency, there can be no objectivity, as even scientific knowledge that tries to be neutral comes from what she calls a “partial perspective.”

This concept is explored further in Catherine D’Ignazio and Lauren Klein’s book, Data Feminism, in which they suggest that Tufte’s principles have ingrained this god trick into modern best practices for data visualizations. Tufte proposed data visualizations should minimize the amount of superfluous visual elements in a graphic, to strip it down to just what is needed to convey the information. To Tufte, background, decoration, and embellishment only serve as distractions, and eliminating them makes the visualization more rational. However, D’Ignazio and Klein imply that these principles create a sense of distance between the visualization and a human author, resulting in the graphic artificially appearing more objective.

D’Ignazio and Klein point out two interesting cases of this concept of “objectivity” as rhetoric. First, this concept was investigated in a sociological study by Helen Kennedy and coauthors, who determined that several conventions work to make data visualization appear objective, transparent, and factual: (1) two-dimensional viewpoints, (2) clean layouts, (3) geometric shapes and lines, and (4) the inclusion of data sources at the bottom.

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It is shocking to think that even these most basic techniques in data visualization carry a rhetorical burden. Additionally, in 2011, Jessica Hullman and Nicholas Diakopoulos published a paper that discussed how visualization rhetoric prioritizes particular interpretations over others. They primarily argued that visualizing data involves editorial choices, which results in framing effects that ultimately impact how the graphics are interpreted. Just as Du Bois declared all art to be propaganda, all data visualization is rhetorical.

Connections to the Semiotic

The first goal of this chapter was to confront the disciplinary barriers between art and data visualization by showing how the uncertainty in their ontological and epistemological positions reveals an overlap between the two fields, in which data visualization, interpreted as fundamentally rhetorical, could be viewed as art when interpreted as propaganda. They are also linked through the connection to the image, which as Bildwissenschaft, Visual Culture Studies, and the history of science have shown, function in universal ways regardless of whether the image classifies as “high” or “low” art, scientific or non-scientific.

As the second goal of this chapter, I aim to establish a semiotic framework for understanding the nature of meaning in visual objects, which I use as the basis for this study of Du Bois’s data graphics. Such a framework is relevant to this study because both data visualization and art operate as sign systems, collections of signs (things that stand in for something else) that have a relationship within the context of a system. Although throughout I have been arguing that the fields of data visualization and art overlap, I now make an

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even stronger claim, that data visualization and art actually exist as different regions of the same continuum, a continuum of sign systems.

In order to specify the parameters of this theoretical continuum, I first turn to the semiotic model proposed by Jacques Bertin’s *Semiology of Graphics*. He describes the meanings which we attribute to signs as being monosemic, polysemic, or pansemic. A system is monosemic when the “meaning of each sign is known prior to observation of the collection of signs.” Each sign in a monosemic system has a single, unique meaning. For example, a mathematical equation is a monosemic system because the meaning of each symbol is uniquely defined. Conversely, a system is polysemic when the “meaning of the individual signs follows and is deduced from consideration of the collection of signs.” In a polysemic system, “signification becomes subjective and thus debatable.” A sign in a polysemic system could mean many different things and is dependent upon its context and relationship to the other signs. Bertin explains how figurative images, for example, constitute polysemic systems:

A figurative image, and for that matter, an ordinary photograph, or an aerial photograph, is always accompanied by a certain amount of ambiguity: “Who is this person?” “What does this black mark or that shape represent?” To these questions, each person will respond individually, since interpretation is linked to the repertoire of analogies and structures characterizing each “receiver.” And this repertoire varies from one individual to another, according to personality, surroundings, period, and culture. Faced with the polysemic image, the perceptual process translates into the question: “What does such an element or collection of elements signify?” and perception consists of decoding
the image. The reading operation takes place between the sign and its meaning.

Finally, pansemic systems are extreme forms of polysemy. He gives the example of an abstract painting, which “its attempt to signify ‘everything’ it no longer signifies anything precise and so becomes ‘pansemic.’”

Bertin establishes this categorization of types of sign systems in order to make the case that graphics occupy the “monosemic domain of spatial perception.” He views graphics as being composed of strictly monosemic signs, with predetermined, agreed upon, and singular meanings. Thus, as a monosemic system, graphics become tools of logic. However, as was previously discussed, by virtue of being visual, data graphics cannot completely escape a visual rhetoric, always carrying some emotional meaning that exists outside of the data itself.

Thus, I propose a modified semiotic framework, based on Bertin’s three categories. I believe these categories should be points on a continuum, ranging from purely monosemic to purely pansemic. Individual sign systems may fall anywhere on this continuum, with their placement determined as a function of the complexity of their individual signs. With this fluid theoretical spectrum, one can imagine data visualization having a range of possible values that may be closer to the monosemic end of the spectrum, whereas art has a range that exists largely between the poly- and pansemic regions. This allows us to view the difference between data visualization and art as a difference in degree rather than in kind. Unlike Bertin’s model, this semiotic framework allows for the possibility for data visualization to be composed from a combination of mono- and polysemic elements, just as art can. On

17 Ibid., 3.
this continuum, Du Bois’s data spiral would fall somewhere in the middle, composed of both monosemic visual encodings (segment lengths) and polysemic ones (bends and the spiral).

By systematically placing a sign system on this semiotic spectrum, we can gain a clarified understanding of the nature of meaning in that system, which informs us on how to more appropriately read and interpret sign systems as we encounter them. We can then study the properties of different parts of this spectrum, from the monosemic to the pansemic to everything in between. In Chapter 3, I employ this system in the systematic study of several of Du Bois’s data visualizations.
Du Bois’s Exhibit of American Negroes at the 1900 Paris Exposition

Renowned sociologist and civil rights activist W. E. B. Du Bois presented more than sixty data visualizations at the 1900 Paris Exposition that depict through a series
of boldly illustrated charts, maps, and graphs the progress of African Americans since the end of slavery. Produced with the help of his team of African American students from Atlanta University, these graphics visualized data sets regarding the development of African American demographics, economics, industry, literacy rates, urban migration, education and other measures of progress. The graphics were presented in two sets, the first illustrating data relating to “the typical state of Georgia,” and the second presenting data across the entire United States.¹ They were hand-drafted in gouache watercolor, ink, and graphite on twenty-two-by-twenty-eight-inch sheets of heavy pasteboard.² Du Bois and his team utilized a surprisingly modernist aesthetic for the data graphics through the use of bright color fields, sharp lines, and geometric forms. Du Bois and his team also experimented with new and modified modes of data representation, using unconventional visual encodings such as spirals, oblique bars, and pictograms, as well as modifying commonplace chart types, like bar and pie charts, through operations such as weaving, wrapping, and splitting. The effect was a diverse collection of aesthetic and information-rich data graphics, designed to counter the global racist conceptions of the American Negro, which, in the era of Jim Crow and “race science,” construed people of African descent as biologically and culturally inferior. The power of the graphics stemmed from their ability to capture the curiosities of an international White audience and present to them a fact-based and candid depiction of African American progress that would be difficult to refute.

The Exhibit of American Negroes

The Exposition Universelle of 1900, better known in English as the 1900 Paris Exposition, was a world’s fair held in Paris to celebrate the technological, social and economic advancements made during the past century while pushing forward developments in the next. It took place along the Left and Right Banks of the Seine from the Eiffel Tower and Champ de Mars to the Esplanade of Les Invalides. Many technological wonders were displayed, including the Grande Roue de Paris Ferris wheel, a moving sidewalk, diesel engines, talking films, escalators, and the telegraphone. Some fifty million people attended the fair, the largest number of visitors ever at a world’s exposition. The fair was set in a context of fierce nationalistic competition in which countries were eager to show off at the fair their industrial, economic and especially colonial prowess on the world stage.3

Du Bois’s data visualizations were featured as a part of the larger Exhibit of American Negroes, [Figure 2.1] which put on display a series of photographs, books, and objects showcasing the life and accomplishments of African Americans.4 The exhibit was located separately from the national United States pavilion, in a corner of the US hall of the Palace of Social Economy and Congresses. It was headed by prominent lawyer and friend of Du Bois, Thomas J. Calloway, who had successfully petitioned the US federal government to allow for the first time the participation of Black Americans at a world’s fair. This was a key breakthrough for African Americans, who had previously been refused participation at 1893 Columbian Exposition, an issue that was heavily protested and publicized by civil

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rights leaders such as Ida B. Wells and Frederick Douglass.\(^5\)

Prior to appealing to Congress, Calloway had sent letters to over one hundred African American leaders in the US to amass statements of support. In the letters, he argued that the upcoming world’s fair in Paris would be an important opportunity to demonstrate the progress achieved by African Americans to an international White audience:

"Every one who knows about public opinion in Europe will tell you that the

Europeans think us a mass of rapists, ready to attack every white woman exposed, and a drug in civilized society . . . How shall we answer these slanders? . . . To the Paris Exposition, however, thousands upon thousands of them will go and a well selected and prepared exhibit, representing the Negro’s development in his churches, his schools, his homes, his farms, his stores, his professions and pursuits in general will . . . do a great and lasting good in convincing thinking people of the possibilities of the Negro. Not only will foreigners be impressed, but hundreds of white Americans will be far more convinced by what they see there than what they see, or can see, every day in this country, but fail to give us credit for.⁶

The approval of the exhibit was ultimately owed to the backing of the highly influential Booker T. Washington, who had personally appealed President William McKinley in support of Calloway and the Negro Exhibit.⁷ Washington, principal of Tuskegee Institute, had risen to national prominence after his delivery of an extremely popular oration at the Atlanta Exposition in 1885. In his speech, he called upon Black Americans to give up their struggle for social and political equality in exchange for the opportunity to acquire education in industrial trades and participate in the economic development of the New South. Through this process of self-help, education and labor, he posited, African Americans would eventually achieve the respect of their White counterparts and gain full citizenship.⁸ His speech, which later became known as the “Atlanta Compromise,”

fied the nation, elevating him to the status of the most influential man of color in America. Calloway became a devoted follower of Washington, praising him as “the most conspicuous and the wisest servant of his race,” and was utterly in support of his “Hampton-Tuskegee model” of racial integration. Calloway concurred with Washington that African Americans had put too much effort towards “proving our equality by competing for places which have hitherto been forbidden us,” and instead should be “bending our energies to hold the positions which slavery left to us.” In other words, Black Americans should focus on pursuing industrial education, labor, and gradual economic independence as a means of integrating into American society. This accommodationist view was precisely the ideology Calloway wished to convey through his American Negro Exhibit.

Fortunately for Calloway, the US government’s imperialist agenda for the fair was very much in line with his. As a new colonial superpower, it aspired to demonstrate to other nations at the fair how conditions in the United States had uplifted people of African descent and solved the conflict between the races through political compromise. As a result, Congress had little issue approving Calloway’s plan, which in the eyes of the US government, could serve as a kind of “how-to-guide” for other countries on civilizing “the Negro.” Other countries could learn from Calloway’s exhibit, Congress reasoned, which would show how a strategy of industrial education and self-help could improve the condi-

tions of the populations that European countries were colonizing. In November of 1899, just four months before the opening of the Paris Exposition, Calloway was appointed special agent for the exhibit, and Congress allocated fifteen-thousand dollars to fund the project.

However, not all the organizers enlisted by Calloway for the exhibit shared his accommodationist vision. Two individuals in particular, Daniel P. Murray, a librarian at the Library of Congress, and W. E. B. Du Bois himself, took exception to Calloway’s emphasis on industrial education. Instead, they produced displays devoted to the achievements of African Americans in literature and scholarship along with the socioeconomic condition of Black people in the American South. For the exhibit, Daniel Murray compiled the titles of fourteen hundred publications by African American authors, two hundred of which were on view at the fair, demonstrating, as Du Bois put it, “the development of Negro thought.” Besides the data graphics, Du Bois also contributed a three-volume hand-copy of the Black Codes of Georgia—repressive laws that sought to restrict the political and economic rights of recently freed enslaved people. Doing so directly contradicted the accommodationist nature of the exhibit, providing content that depicted the conditions for Black people in a critical light. Additionally, he curated over three-hundred photographs depicting what Du Bois described as “typical Negro faces,”13 a compilation of professional headshots and group photos as well as images of Black communities, businesses, churches, and homes. These photographs defied racist stereotypes of African Americans, presenting people of color as dignified, accomplished, and demographically diverse.

The contributions made by Murray and especially Du Bois thus presented a counter-

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argument, though not overtly, to Washington’s prevailing model of Black accommodation, hinting at an alternate strategy of agitation and protest, liberal over industrial education, and the cultivation of what Du Bois would later call “the Talented Tenth,” his term for the African American intellectual elite. Even though it would be another three years before Du Bois would publish his critique of Washington in *The Souls of Black Folk*, his incipient criticisms and diverging ideology had already begun to take form in the materials he contributed to the American Negro Exhibit. This was asserted perhaps most clearly in the data visualizations themselves. On the title plate, Du Bois prints for the first time his most famous declaration, “The problem of the 20th century is the problem of the color-line,” a phrase which would not gain recognition until 1903 with his repeated use of the statement in *The Souls of Black Folk*. With this statement, Du Bois references Frederick Douglass’s 1881 use of the term “color line” to describe the deep inequalities, prejudices, and segregation faced by Black Americans after the abolition of slavery. Du Bois’s clear-cut conception of the racial divide between White and Black Americans as not only a problem, but as the fundamental problem of the twentieth century, reflects the fearlessness of Du Bois approach towards tackling issues of racism from a political standpoint. His central role in organizing the American Negro Exhibit elevated Du Bois to a position of national prominence, just as Washington’s “Atlanta Compromise” had done for him, suggesting the power of his ideas towards race relations as a compelling alternative to those of Washington.
All art is propaganda and ever must be, despite the wailing of the purists.

W. E. B. Du Bois

The Visual Rhetoric of Du Bois’s Data Graphics

Du Bois’s data graphics [Figure 3.1] were presented in two distinct sets. The first, titled “The Georgia Negro: A Social Study,” presented Georgia as a case study for the
sociological status of Black people in America. This set contains twenty-nine charts, three maps, and four tables, and was based on data collected through surveys by Du Bois and his Atlanta Sociological Laboratory. The title plate attributes this set to W. E. B. Du Bois himself, although little is known about the true extent of his role in their physical production. It is likely he received production help on these from his students, but contributors to individual plates were not specifically credited. The second set, titled “A Series of Statistical Charts Illustrating the Condition of the Descendants of Former African Slaves Now Resident in the United States of America” was national and international in scope, and is attributed to the “Negro students” of Atlanta University. Consisting of twenty-seven diagrams, this set included comparisons of Black literacy rates to those of other countries, the distribution of Black populations across the nation, and the ratio of Black landowners to tenants in various Southern states, among other visualizations. Most of the data for this set was drawn from sources such as the United States Census, the Atlanta University Reports, and various governmental reports.  

Du Bois was allocated a mere twenty-five hundred dollars by Calloway to produce and assemble materials for the exhibit, the vast majority of which went towards the production of his data graphics. Du Bois recalls in his Autobiography the challenge of finishing “50 or more charts, in colors, with accuracy” when he had “little money, limited time and not too much encouragement.” The immensely tight budget and time constraints helps to explain the deployment of a minimalist aesthetic throughout the graphics. Such a design strategy would reduce labor time and material cost, and it would additionally enable his

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team of sociological students, untrained in design, to contribute to the production of these graphics through the standardized use of templating tools for the typography, maps, and various geometries.

Given their impressive designs and provocative subject matter, it is both surprising and disappointing that Du Bois’s visualizations have historically been ignored by scholars, both in the fields of art history and data visualization. As Linda Barret Osborn commented in *A Small Nation of People*, “Du Bois’s charts and graphs have been superseded, a footnote to history” in comparison to his compilation of Georgia-based photographs that have garnered much more attention from historians and scholars of visual culture, namely

Figure 3.1: Complete Collection of Du Bois’s Data Graphics in *W. E. B. Du Bois’s Data Portraits*. Compiled by Whitney Battle-Baptiste and Britt Rusert. 2018.
Deborah Willis, David Lettering Lewis, and Shawn Michelle Smith. Additionally, in the historiography of data visualization, Du Bois’s visualizations are seldom mentioned. Several historical factors have contributed to their rather modest reception. For one, after the fair had concluded, the collection of infographics quickly left the control of Du Bois, and within a year, they had fallen into the possession of the Library of Congress. There, the graphics remained in secure storage ever since, inaccessible to the public, where they have been treated as ephemera rather than cultural or artistic artifacts. Not to mention that there was very little coverage of the exhibit in the American press, despite the fact that American Negro Exhibit was highly praised and had won numerous accolades at the fair, including a Grand Prix, the fair’s highest honor, and a Gold Medal for Du Bois as its compiler. Additionally, Du Bois himself curiously wrote very little about these data graphics or of the exhibit as a whole, writing only a description of the exhibit titled “The American Negro at Paris,” published in the American Monthly Review of Reviews, and mentioning the exhibit only briefly in a few of his other works throughout his lifetime. Rebecka Rutledge Fisher speculates that it may be “Booker T. Washington’s shadow-like involvement” in the exhibit that “caused Du Bois to downplay his own participation,” as Du Bois had already begun to diverge from Washington’s accommodationist ideology by the time the exhibit took place and became a vehement critic of it throughout the remainder of his life.

However, it cannot go without noting the direct link between the lack of attention given to these data graphics and the widespread racist exclusion of African American aca-

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2Lewis and Willis, A Small Nation of People, 41.
Academic contributions from history and the public conscience in this era. Du Bois in particular has historically been ignored by the discipline of sociology, despite his groundbreaking scientific work and pioneering community studies. According to Aldon Morris, “Definite political, economic, cultural, and personality factors led white social scientists to suppress Du Bois’s scholarship of race and his unique contributions to the developing social sciences at the dawn of the twentieth century. That scholarship stood in direct opposition to the dominant racist views held by most social scientists, especially white sociologists.”7 Later in Du Bois’s life, he reflects on his exclusion from the scientific world when he writes, “So far as the American world of science and letters was concerned, we never ‘belonged’; we remained unrecognized in learned societies and academic groups. We rated merely as Negroes studying Negroes, and after all, what had Negroes to do with America or science?”8 It follows that these data visualizations, products of Du Bois’s sociological research at Atlanta University, would not have been taken seriously by scholars of the time, nor would they have been allowed by those in power, specifically the conservative Booker T. Washington, to take hold in the public imagination given their depiction of the African American race as anything but inferior to Whites.

There has, however, been a recent rediscovery of these graphics and a resurgence of popular and scholarly attention. In the past decade, Du Bois’s graphics have captured the interest of several artists and visualization designers due to their unique modes of representation, powerful and relevant subject matter, and astonishingly modernist and abstract qualities. In his 2017 exhibition, *But To Be A Poor Race*, Chicago-based artist Theaster

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Gates displayed a series of paintings that redeployed Du Bois’s visualizations without their textual content, presenting them as their underlying abstract color fields and geometric motifs. That same year in The Guardian, data journalist Mona Chalabi created her own rendition of the charts using updated statistics from the present day, displaying current population, wealth, illiteracy and occupation data which tells a story of continued racial inequity in the US.\(^9\) In 2018, the complete set of graphics were reproduced in full color for the first time by Whitney Battle-Baptiste and Britt Rusert in *W. E. B. Du Bois’s Data Portraits: Visualizing Black America*, a book that includes essays by scholars Aldon Morris and Mabel O. Wilson, and designer Silas Munro.\(^10\)

In the book, Silas Munro provides the most comprehensive formal analysis of the data graphics to date, largely through the detailed captions he contributed for each of the sixty-three infographics. In these captions, he describes the visual effect produced by each of the individual pieces using the lexicon of visual design. Additionally, his work situates these charts for the first time in the historical lineages of design and data visualization. He acknowledges the work of pioneering data visualists that influenced Du Bois’s graphics, including William Playfair’s inventions of the bar chart and line graph (1786), and the pie chart and circle graph (1801), as well as Florence Nightingale’s Rose Diagram (1858), arguably the first use of statistical charts for political persuasion and social impact, convincing the British government to improve sanitary conditions for soldiers.\(^11\) He also comments on how Du Bois’s graphics predate modular design elements considered to have their origins in Russian constructivism, De Stijl, and the Bauhaus. In addition, according to

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Munro, the graphics anticipate critical developments in the history of data visualization, notably the use of simplified pictographs, a method that has been attributed to Otto and Marie Neurath for their development of the Isotype over twenty years after the exhibition of Du Bois’s graphics. In many ways, this thesis builds off of the work done by Munro, reaffirming Du Bois’s importance in the historiography of data visualization, as well as contributing to the modest but growing art historical and design discourse on these data graphics.

The next section is dedicated to uncovering the political aspirations of Du Bois through his data visualizations through an art historical analysis, a task which has not been attempted before in existing literature. While several scholars have investigated the historical consequences of the American Negro Exhibit as a whole as well as the cultural implications of Du Bois’s photographs, the data visualizations remain relatively unexplored. And although a few authors have provided analyses of individual graphics from the field of graphic design, none have scrutinized the graphics thoroughly as art objects. In the next section, I employ a semiotic, psychoanalytic, and socio-historical analysis in my treatment of both sets of data graphics as a means of applying art historical methods to reveal deeper ramifications of Du Bois’s political ideology at the turn of the century.

It is true that Du Bois himself may not have intended for these works to be considered “art” in the traditional sense of the term, choosing to describe them in terms of “charts,” “maps” and “statistics.” However, there is no doubt there is plenty about the data graphics that is indeed artful. The transformation of data into the visual register inherently introduces the subjectivity of the maker into the work, but the radical forms produced by Du Bois and his students are worthy of artistic study on their own. Africana Studies scholar
Reiland Rabaka writes that “a truly comprehensive understanding of Du Bois simply cannot be gained without engaging him as an artist and, even more, as an artist who was in constant dialogue with, influenced by, and incessantly influencing other artists.”12 As mentioned in Chapter 1, Du Bois announced in 1926 that “all Art is propaganda and ever must be.”13 Although uttered by Du Bois over a quarter of a century after exhibiting his data graphics, it is thoroughly plausible that Du Bois was thinking about art as propaganda at the time he was producing these graphics.

Art historical methods have the power to uncover meanings and connections within art objects that are completely external to the possible range of intentions by the artist. A psychoanalytic study of art is particularly apt at extracting meanings from art that derive from the artist’s subconscious, reinforcing both a deeper, psychological understanding of both the art and the artist. Semiotics is useful in identifying the signs and processes through which meaning is communicated and interpreted, or coded and then decoded, which is a process that can be analyzed without the limitations of the supposed intentions of the artist or the original context that the art was displayed in. Signs continue to express meaning, independent of time or place, as long as humans are there to interpret them, and thus a semiotic analysis can produce new meanings for Du Bois’s 1900 data graphics that are especially relevant for a contemporary world. In fact, this type of analysis may be made more relevant given that Du Bois may have had further plans for these data graphics beyond the limited context of the Paris Exposition. He penned a letter to Calloway in 1909 asking how

13 Du Bois, “Criteria of Negro Art”.

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he might secure the return of the materials of the exhibit from the Library of Congress.\textsuperscript{14} While Du Bois never received the materials back, this does suggest that Du Bois recognized the potential for his data graphics to operate meaningfully in contexts outside of the original exhibit.

From the perspective of the exhibitors, Du Bois’s data visualizations showed continuity with the established goal of the exhibit to demonstrate Black advancement, presenting data that depicts a growing Black population, achievement in industry, accumulation of land and wealth, and an assortment of other indicators of progress. However, through a semiotic, psychoanalytic, and socio-historical reading of the images, I speculate the formal representation of Du Bois’s data visualizations allude to a more controversial message, encoding elements of Du Bois’s agenda of Black nationalism, his burgeoning theory of double consciousness, and wider critique of America’s historical treatment of Black Americans. Additionally, they anticipate the arguments Du Bois would fully realize throughout the remainder of his career, producing a counternarrative to Washington’s Tuskegee model that promoted full civil rights and increased political representation brought about by a Black intellectual elite. In doing so, he uses sign and symbol to subvert ideas of American paternalism that the organizers of the exhibit sought to promote.

A Note on Methodology

Semiotics is the study of signs and sign processes, where a sign is defined as anything that stands in for something else. There are two major schools of semiotics, the French school

of Ferdinand de Saussure and the American school of Charles Sanders Peirce. Saussure’s formulation of semiotics suggests the division of a sign into two distinct components, the signifier, or the material form of the sign, and signified, which is what the sign means. Another important contribution made by Saussure is his idea that the meaning of a sign depends upon its relation to other signs within the system, that is, meaning is produced through difference.

Charles Peirce’s formulation divides the sign into three categories, icons, indexes and symbols. Icons are signs that resemble in likeness the thing that they signify, for example a painted portrait of a person. Indexes signify through a causal relationship, for example a bullet hole is an indexical sign for a bullet. Symbols signify through convention, such as most words which signify their definition. Peirce’s taxonomy of signs enables one to differentiate between various kinds of signs within a visual sign system.

Peirce’s semiotics is much more applicable to the study of data graphics than Saussure’s. Saussure’s semiotics is typically applied to the field of linguistics, whereas Peirce’s semiotics has been more influential in its application to visual sign systems. Additionally, Peirce viewed semiotics as a form of visual philosophical logic and himself was fascinated with diagrams as a mode of thinking, which makes his frameworks especially interesting for the application to data visualizations. Coincidentally, Peirce and Du Bois were contemporaries. Both Peirce and Du Bois were good friends with the renowned psychologist and philosopher William James at Harvard University. Peirce and James founded Pragmatism as a philosophical movement, and Du Bois became a student of this philosophy during his time as an undergrad at Harvard from 1888 to 1890. Thus, there exists the real possibility that Du Bois was familiar with Peirce’s notion of semiotics and diagrams, and thus took
inspiration from Peirce’s ideas for the creation of these graphics. However, Saussure’s differential theory also plays a minor role in the analysis.

I also rely heavily on the modified version of Bertin’s semiotic model that I proposed in Chapter 1, in which signs are analyzed for their ranges of possible meaning in order to place sign systems on a spectrum of semantic complexity, from monosemic to pansemic. This approach helps to discern the ways in which certain elements of Du Bois’s graphics express meaning and how they should be read and interpreted.

Psychoanalysis is a set of theories used to study the unconscious mind, established by Sigmund Freud. This thesis relies mostly on psycho-iconography, in which the iconography of a work is analyzed psychologically; psycho-iconography can also provide insights into works of art when the artist’s life is well known and can be related to the meaning of the imagery. In a few of the graphics, Du Bois employs a technique of doubling that is not usually seen in data visualization. I use psychoanalytic theory to relate this doubling to Du Bois’s theories on double consciousness.

Sociohistorical methods in art attempt to identify the social, economic, and historical factors that help to explain the production of an artwork. They begin with the premise that art is not autonomous but rather a product of the social factors of an era and society. Thus, a change in society is always accompanied with a change in art. A social history of art tries to uncover the factors that influenced this change in art. In this study, sociohistorical methods are used to show how Du Bois’s graphics exhibit the societal tensions between the dimensions of White and Black, rich and poor, rural and urban, among others.
I – Negro Property in Two Cities of Georgia.

This visualization [Figure 3.2] uses two overlapping bar charts to show the relative values of Negro property owners and property values in Savannah and Atlanta, translated as lengths and heights of the bars. Yellow bars represent values for Savannah, and baby blue bars represent values for Atlanta. The horizontal bars represent the number of “Negro” property owners in each city, and the numbers increase from the year 1880 to 1899, with the rate of growth apparently faster in Savannah. The vertical bars represent total property value owned by Black people in each respective city, and in this case the values for Atlanta ap-
pear to rise faster than those for Savannah. These are the monosemic visual elements of the graphic, in which the unique meaning of each sign has been specified by the legend or a label.

The straightforward goal of this visualization is to present the growth in the number of Black property owners and total value of Black-owned land in the time between 1880 and 1900. Silas Munro in *W. E. B. Du Bois’s Data Portraits: Visualizing Black America* identifies the representation as a novel chart type, which he calls the woven bar chart. This refers to the design choice to have bars overlap in areas of intersection. In Munro’s interpretation, Du Bois, as a statistician, would be interested in showing correlation and even causality. Du Bois may be weaving the horizontal and vertical bars together to imply the correlation between the number of Black owners and the total value of land.

To briefly comment on the effectiveness of this visualization from a data visualization standpoint, it does not particularly communicate the trends in the data clearly. The plotting of two separate charts on the x and y axes is ultimately confusing to read, as the viewer is forced to switch contexts between the horizontal and the vertical readings of the graphic. Additionally, if Du Bois wanted to show correlation between owners and property, it would have been much clearer had the y-axis been inverted, so that the years both increase orthogonally from the bottom-left corner. However, Du Bois, being an experienced and rigorous sociological professor, would have been aware of these conventions.

He previously published a study in 1899 called *The Philadelphia Negro*, a sociological and statistical account of conditions of African Americans in Philadelphia in which Du Bois

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includes several traditional data charts that demonstrate his attention to graphical clarity and representing data accurately and precisely. Thus, this thesis takes the position that generally what appear to be “mistakes” in proper graphical representation likely have a deeper intended purpose, especially in the first set of graphics that was specifically authored by Du Bois.

From a socio-historical perspective, the production of this graphic can be explained as a response to the “sciences” of biological rationalism, race science, and eugenics during the time. These widespread ideologies labeled people of African descent as “the essence and emblem of the ‘primitive’ and ‘savage,’” which would inhibit them from ever ascending in White Western civilization without the help from Western “civilizers.”16 The Paris Exposition was set in a context that embraced these ideologies, as many countries, including the United States and France, sought to utilize world’s fairs at the time, including the Paris Exposition, to visualize social Darwinist theories of civilizations that placed Europeans and Anglo-Americans above non-White peoples. Doing so would be a means of justifying their imperialist projects disguised as projects of “uplift” and to show off their imperial prowess and national superiority on the world stage. For example, Belgian colonial officials utilized their Belgian Congo exhibit to show “the moral evolution accomplished by the natives of the Congo” under Belgian rule, just as American commissioners hoped to show through the American Negro Exhibit how the treatment of the Black race in the US had helped to educate, industrialize, and thus “civilize” millions of newly freed enslaved people.

As previously discussed, Calloway and Washington were not just complicit in these ideas, but actively advocated for this accommodationist vision of the American Negro Ex-

hibit. This socio-historical context helps to explain how a graphic like “Negro Property in Two Cities in Georgia” came into being. The trends in the data clearly depict a rapid growth in both number of Black landowners as well as total value of owned property in two cities in the American South. It depicts Black Georgians, and as an extension Black Americans, as hard-working individuals who are ascending in American society through gradual accumulation of land and wealth. Calloway, who had to approve each of the graphics that would be showcased at the exhibit, would certainly have been pleased with this depiction.

Through a semiotics and psychoanalytic view, however, I speculate that Du Bois utilized signs in this piece as a rendering of his notions of a double consciousness as well as to implicitly address elements of the nation’s horrid past. By the time Du Bois had participated in organizing the exhibit, Du Bois had not yet broken away from Washington, as he shared the idea that economic independence was a crucial step in achieving the full emancipation of African Americans. However, at this point, he had already begun to increasingly critique the notion that the Black race should be absorbed into a superior White culture and emphasized that Blackness should be a source of pride, rather than self-hatred. Many of the data graphics, including this one, suggest this split in Du Bois’s ideological alignments, in which the graphic at face value is complicit in the accommodationist view of Calloway and Washington, but upon deeper contemplation reveals a subversion of these ideas.

There is a distinct doubleness throughout the image: the pattern of alternating yel-

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low and baby blue horizontal bars is doubled in the vertical direction; both of which grow in length in the same way. Additionally, the choice of depicting two cities, represented by bars back-to-back, signifies a doubleness as well. Du Bois’s concept of the double consciousness is especially relevant here, which he first discussed in an 1897 essay published in The Atlantic Monthly titled “Strivings of the Negro People,” but which became popular from his 1903 book The Souls of Black Folk. In the article, Du Bois describes a “double-consciousness, this sense of always looking at one’s self through the eyes of others . . . One feels his two-ness, — an American, a Negro; two souls, two thoughts, two unreconciled strivings; two warring ideals in one dark body.” Double consciousness explains the internal split or “two-ness” that is experienced by African Americans due to racialized oppression in a White-dominated society. The choice of labels, “owner” and “property,” to describe two aspects in relation to Black people, suggests a split soul, one in which the Black man sees himself as exerting his own agency – an “owner,” and one in which the world sees him as a slave, or “property.” The way in which this chart forces the viewer to switch contexts between the horizontal and vertical orientations mimics the way in which Black people grapple with a split identity. The interwovenness of the bars may further index the tightly bound nature of these two parts of a Black person’s soul, rendering Du Bois’s notion of a distinctly African American “longing to attain self-conscious manhood, to merge his double self into a better and truer self.”

Additionally, the use of the word “property” without specifying “land” carries additional baggage, as it would have also invoked the historical categorization of enslaved people as property that was a legal reality just three decades prior. The invocation of enslaved peo-

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ple as property is reinforced by the orthogonal label of “owner,” which recalls slave master as “owner.” The choice of these polysemic terms seems rather intentional, and in doing so Du Bois takes the apparent meaning—Black land owners and their land—and subverts it by analogizing it to terms of the past—White slave owners and their slaves.

In a similar graphic [Figure 3.3], also from the first set, Du Bois illustrates percent of Black Georgians who are illiterate over four decades. Despite the similar use of weaving and doubling as operations, this visualization type is distinct from the previous one. Rather than using single bars, Du Bois uses a bar for both the horizontal and vertical variables, connecting them at the cartesian point representing an individual pair of data. The horizontal bars are white, and the vertical bars are black. Where they intersect, Du Bois introduces a rounded corner and an edge at a forty-five degree angle. The data shows a decrease in the percentage of illiterate Black people from ninety-nine percent in 1860, the decade when Emancipation took place, to sixty-seven percent in 1890. The chart extrapolates the data to the year 1900, represented by the parenthesis and question mark around the predicted value, estimating that illiteracy rates would drop to fifty percent.

This graphic deserves plenty of critique for lacking visual clarity and effectiveness. For both axes, values increase in the non-conventional direction, towards the bottom-left corner. This confuses the notion of increasing and decreasing, as longer white bars actually correspond to a decrease in illiteracy while shorter black bars correspond to more time having passed not less. Thus, the trend of decreasing illiteracy is not made immediately clear and is arguably even more challenging to understand than reading a table of values. Additionally, even though the years are incremented in consistent intervals of a decade, they are not evenly spaced. Rather, the spacing between horizontal bars seems to increase at a
constant rate between each consecutive decade. This is what the famed data visualization expert Edward Tufte would describe as having a “lie factor,” which occurs when the size of an effect shown in a graphic differs from the size of effect in the data. However, in this case, the effect of the graphical lie is that the rate of decrease in illiteracy actually appears slower, which seems like the opposite message that Du Bois would want to convey. This apparent lapse in graphical integrity is uncharacteristic of Du Bois, but one way to reconcile this is that the intention of this graphic was to be more diagrammatic of a general fall in illiteracy rates than to accurately depict the rate at which it falls. This may indeed be a graphic that Du Bois would classify as one of the “other devices,” meaning an illustrative
diagram, rather than a statistical chart. By presenting drops in illiteracy as slower, Du Bois also implicitly complicates the notion of African American Progress, showing it to be systematically and artificially hindered by White America.

If we read closer into the visual encodings on the graphic, we again see operations of doubling and weaving. The white horizontal lines are the graphical counterpart to the black vertical lines, and these bars are again weaved together, with the white bars overlapping on top of the black, forming a lattice structure that is architectural. The context switching required of the viewer between the horizontal and vertical lines may again be a representation of double consciousness—a conflict between the way in which Black people view themselves (black bars) and the way in which White people view them (white bars). The visual tension between white and black bars could also be a metaphor for American society, representing the complex relationship between White and Black people. Although the white bars overlap on top of the black bars, representative of America being dominated by White influence, the black bars provide the architectural support for the white bars, inferring that the prosperity for White people is a result of the struggles and hard work of Black people.

Du Bois may be using these graphics to hint at the limitations of pure data alone in representing the truth. The numbers in and of themselves cannot represent an entire race. The use of signs and abstraction provide powerful visual tools that help the viewer viscerally experience the data, through implicit metaphor and narrative, in ways that may not be straightforward or immediately comprehended.
**II City and Rural Population. 1890**

Using lengths of lines in various orientations, this graphic [Figure 3.4] shows the relative populations of city and rural Black populations in 1890. A horizontal green line that stretches about a third of the page represents the Black population in cities of over ten thousand inhabitants. A much smaller blue line in the direction of the bottom left represents the population in cities between five thousand to ten thousand people. And a longer yellow line going toward the bottom right represents the Black population in cities between twenty-five hundred and five thousand people. Finally, a long red line in the direction of the bottom-left, and curves into a spiral, represents the Black population living in the coun-
try and villages.

In Munro’s interpretation, he reads the text paired with each segment more like describing a narrative than a typical key. He describes it as a “memorable, and experimental, presentation of data,” through its “tricolor palette and fragmentary construction.” Additionally, it has been described as having a hypnotic quality.\textsuperscript{19} Data visualization designer Jason Forrest interprets this graphic as a stacked bar chart on an extremely long scale. Since the single red section is much longer than the other sections, he uses a method of spiraling or snaking in order to both distinguish it from the other categories as well as to conserve space.\textsuperscript{20} As an extension of this interpretation, Du Bois is using the spiral as a strategy of converting a one-dimensional visual encoding into a two-dimensional one, as in the form of the spiral we read the magnitude of the data in terms of the area of the spiral rather than its length.

From a sociohistorical perspective, this image contributed to the narrative of Black progress by documenting Black migration out of the countryside and into the cities in Georgia. It is produced in a context in which it would have been common knowledge that slave plantations existed in the “country and villages.” The dominant beliefs of “civilization” at the time were that that modernization and industrialization were closely associated with urbanization. Movement into higher populated areas would have been associated with several other economic indicators of progress, such as attaining industrial jobs, pursuing higher education, and being more productive for society.

Using semiotics, the direction and position of the lines can be interpreted as iconic

\textsuperscript{19}Munro, “Plates”, 62.  
and indexical signs denoting the migration of Black people into the cities. With the country and villages represented at the bottom of the graphic and higher populated areas represented at the top, Du Bois could be signifying the geographic location of these areas. In Georgia, the lower populated areas are in the southern part of the state, whereas more densely populated areas, such as Atlanta, are located in the north.

Additionally, the shape produced by these lines as a whole is likely iconically referencing the shape of Georgia itself, as Georgia exhibits a flat northern border (the green line), followed by a jagged zigzag (green to blue to yellow), and a slanted eastern border (yellow line). The red spiral then could represent the southern area of Georgia. While this point may sound speculative, Du Bois has cleverly used the shape of data to represent Georgia before.

In one of the earlier data graphics in the first set, Du Bois visualizes acres of land owned by Negroes in Georgia each year [Figure 3.5]. Beyond the fact that this graphic produces a stunning Moiré effect, the resulting shape of data strongly resembles the geography of Georgia. Du Bois makes this relationship clear by presenting a map of the state of Georgia as the immediate next plate in the sequence [Figure 3.6], displaying acres of land owned by Negroes in geographic format. It is clear that Du Bois is playing with the shape of data, using what can only be described as a visual pun. The data about land in Georgia is also in the shape of the land of Georgia.

It thus seems extremely plausible that the graphic of City and Rural population, in a similar maneuver by Du Bois, is being manipulated to approximate the shape of Georgia. He even uses the same Moiré pattern out of red bars in the spiral as in figure 3.5. The difference is that instead of Georgia being represented by its area, it is represented by a single
one-dimensional line that bends and spirals to produce an internal schematic of the state. It is a schematic not of land, but of movement, or in other words, migration. Indeed, the line is depicting the migration of African Americans out of the countryside and into the cities. The fact that the red line forms a spiral with such visual gravity to it suggests how difficult it is for African Americans to escape the countryside, poverty, and the repercussions of slavery.

Du Bois also included a map of the US depicting the migration of Negroes from and into Georgia [Figure 3.7]. Not only does this make it clear that the migration of African Americans was important to document for Du Bois, but it also demonstrates a similar visual language of using lines to represent the direction of migration. Du Bois thus depicts African Americans as a people not only in motion, but also in control of that motion, in
the face of systems of oppression that have historically restricted their freedom to move with agency.

**Figure 3.7: Migration of Negroes 1890.** W. E. B. Du Bois. 1900. Ink and gouache on pasteboard, 22 by 28 in. Library of Congress.

### III Slaves and Free Negroes

A black and red rectangle, split irregularly down the middle, shows the percent of free Black people in America over time [Figure 3.8]. The left side has a rough, jagged, textured edge, but all other edges are crisp. The red field on the right corresponds to the “Percent of Free Negroes.” The black field corresponds to percent of enslaved Black people. Thin, horizontal breaks in the rectangle cut through at set intervals, representing ten years each.
The decades move forward in time from the top to bottom of the page and span from 1790 to 1870, for a total of seven decades. Labeled on the top are percentages, “1%,” “2%,” and “3%,” going from right to left. The colors are vibrant, the black contrasting with the bright red. The area of the red, increases slightly between 1800 and 1810, before dipping again. The moment that is starkly different is the last year, 1870, when the percent of free Negroes reaches “100%,” and the red field goes out of the rectangle at a steep angle. The straightforward narrative of this graphic is that the percent of free Negroes hovered between one and two percent between 1790 and 1860, until the emancipation of one hundred percent of enslaved people by 1870. Taken at face value, it is aligned with the goals of
the exhibit, as it illustrates the complete freedom of Black people in America after the Civil War.

However, a semiotic approach to the image tells a different story, one that subverts this idyllic narrative through various semiotic elements. Firstly, the rough edge is an indexical symbol of the graphic having been torn, and not torn cleanly. The tear is a common shorthand in data visualization, which is interpreted as a break in the graph. However, it is normally represented as a small zigzag in the axis, and it is not usually as intricately or as poetically drawn as the one shown here. With its intricate design, it reads as a realistic tear. In Munro’s caption for this image, it is described as an area chart, “tensely arranged,” with a “deckled” left edge and a “sculpted” red field, producing an image that is intense to look at. This tear in the black area representing enslaved Black people could be alluding to the horrors of slavery: Africans ripped from their homes in Africa; Black slave babies torn from their mothers; whips tearing up the backs of Black bodies; the destruction of the Black family structure. The allusions this tear invokes produces an unsettling, highly charged image. The contrast between the jagged line on the left and the perfectly straight line on the right reinforces the effect of both.

The torn line is also indexical of the information that is not shown—the part of the graphic where the percent of freed people reaches “100%.” This value, the most significant value in the entire graphic, is cut off from view, robbing the viewer of the feeling of being able to physically see the moment and impact of Emancipation. The viewer is left to assume and imagine the remainder of the graph. It is as if to say, perhaps Black people in America are not so free after all—that enslavement and racism persist in new forms, or that the work of Emancipation is not done yet.
The use of a torn edge to represent a break in the chart can also be found in Du Bois’s previous work, *The Philadelphia Negro*, in a chart titled “Proportion of Negroes in the Total Population of Philadelphia and of the United States” [Figure 3.9]. In this chart, the graph is torn at around the twenty percent mark, which shows that the data is confined to below that value. The difference is that in *The Philadelphia Negro* version, the tear is rendered in a caricatured, comic-book like style, which does not evoke the same emotion as the tear in the “Slaves and Free Negroes” version. In the graphic for the fair, the tear is intricately detailed and starkly realistic. It is also directly torn through the black area where “slaves” is represented. It is clear that this tear is a polysemic sign with deeper symbolic meanings that is meant to evoke a reaction in the viewer.

Munro also notes that Du Bois uses Pan-African colors in this graphic, a movement
that he was heavily involved in and whose conference he would be attending in the sum-
mer of the same year. The reference to Pan-African colors may be interpreted as a sense of pride for being Black. Du Bois advocated heavily for Black nationalism, seeking to develop self-determination for Black people. He believed that the Black race has unique gift to con-
tribute to human progress, as he stated, “We believe that the Negro people as a race have a contribution to make to civilization and humanity which no other race can make.”21 Thus, his use of Pan-African colors, with its charged symbolism, may have been in implicit sup-
port of the Pan-African and Black nationalist movements.

It is interesting to compare this graphic with one produced in the second set by Du
Bois’s students, which shows the percentage of free slaves in the same years as the graphic from the first set, but across the entire US [Figure 3.10]. The visual effect of this graphic is complementary to the first, in the sense that the truncation of the y-axis is no longer present, and the viewer is shown the full percentage of slaves, represented by a massive field of black gouache, with the words “SLAVES ESCLAVES” written in bold letters stamped in the middle of what reads as a vast void. The towering mass representing enslaved people is now what is in focus, as opposed to the previous graphic in which the tiny proportion of freed slaves was the emphasis. Here Du Bois’s students even show the moment of Eman-
cipation in 1863, where the proportion of enslaved people goes to zero, but this moment looks insignificant compared to the decades of slavery that precede it.

The only other graphic that uses a similar tear motif is this one titled “Assessed Val-
uation of all Taxable Property Owned by Georgia Negroes” [Figure 3.11] in which the tear is used to represent these jagged ruptures that pierce through each layer of this circle area

chart. In this graphic, the radial distance between each layer represents the additional value of taxable property owned by Georgian Negroes accumulated every five years. Each year adds a layer of growth, depicting an increase in taxable property over time. The spikes are an interesting addition to the image, as they appear to be purely decorative.

From a semiotics perspective, these ruptures are indexical of something having pierced through, piercing all the way to the center. Similar to the “Slaves and Free Negroes” graphic, the torn edge of these indents is polysemic, evoking a sense of pain and violence. The core of the chart, which is black, may be representative of slavery, as a time in the past. However, the reaching of these ruptures back into slavery implies that its repercussions reverberate
Incessantly throughout historical time. There is a great sense that the image is on the verge of implosion.

Another graphic which utilizes a similar circular motif is this spiral, which describes the increasing value of domestic furniture owned by Georgia Negroes over time [Figure 3.12]. This unconventional visualization type takes the standard bar graph and curls it into a spiral. One motivation for this format is that it makes economical use of the space on the page. With bars of differing magnitudes, it would have been the case that the sizes of the bars would have to be shrunken down immensely in order to fit on a page, rendering the smallest bars impossibly thin. By curling the bars, each of the magnitudes can be rep-
represented with a visible length. While the data implies progress—the value increases every year—the form implies that said progress is cyclic in nature, and perhaps, as in the previous graphic, heading towards an implosion. Du Bois may be using this as a critique of the current conditions for Black Americans under the leadership of Washington and the Tuskegee model. Perhaps Du Bois is commenting on the fact that the terms of Black “progress” presented in the exhibit, those relating to gradual social and economic improvements, are delusional, that real progress will not be made until Black Americans fight for and achieve political equality.
Through the use of signs and abstraction, Du Bois subverts the message of American paternalism promoted by Calloway and Washington by symbolic reference to America’s complicated racial conditions and his own vision for political and social equality. This thesis thus provides a novel interpretation of W. E. B. Du Bois’s 1900 data graphics,
suggesting that the formal qualities of data visualization can encode not just data, but also cultural meanings that can work to intentionally complicate the narrative told by the data presented. The range of meanings that a visual encoding can express can also be quantified on a spectrum between monosemy and polysemy, which informs the way in which we produce and read graphics. These polysemic elements can leave more room for the viewer to produce their own interpretations of the work, interpretations that transcend above decoding insights from data and towards a place that, like art in the traditional sense, interrogates aspects of humanity and reveals something deeper about ourselves in the process.

Du Bois’s data graphics represent a rift in disciplinary boundaries. Belonging neither fully to data visualization nor to art, they operate as disciplinary misfits in a liminal space between data and art. Their presence in this space forces us to question the nature of meaning in both. They demand study under an interdisciplinary approach that places art and data graphics on the same spectrum of varying semantic complexity. The hope is that this work brings to light the centrality of Du Bois’s data graphics to a comprehensive scholarship of both disciplines, as well as their importance in understanding Du Bois and the racial issues he fought against at the turn of the twentieth century.


— *Strivings of the Negro People*. Aug. 1897.


Rabaka, Reiland. “‘To Make a Name in Science, To Make a Name in Literature, and Thus Raise my Race’: Du Bois in Our Time, in His Time, and in the Future”. In: *Ten Contemporary Artists Explore the Legacy of W. E. B. Du Bois in Our Time*. Ed. by Loretta Yarlow. Amherst: University of Massachusetts Press, 2014, pp. 41–53.


