INDIANA UNIVERSITY

CENTER FOR RESEARCH AND EVALUATION

Lifelong Learning Group

Meaning making through data representation Construction and Deconstruction

Findings from COSI, Koshland, New York Hall of Science, and Wonder Lab

November 2014

Prepared by:
Mary Ann Wojton, Ph.D.
Sasha Palmquist, Ph.D.
Victor Yocco, Ph.D.
Joe E. Heimlich, Ph.D.

Prepared for:
Sense-making of Big Data Team

LifelongLearningGroup.org

COSI | 333 West Broad Street | Columbus, Ohio 43215

Table of Contents

Introduction

The *Sense Making of Big Data project* was designed to study how audiences in public spaces, in this case those in a museum setting, relate to and make sense of representations of large data sets. Building on prior work, this report focuses on what museum visitors felt individual layers of a visual (alone and in combination with other layers) were communicating to them as the visual was constructed or deconstructed layer by layer. Four visuals were used, combining math, science, history, and art to convey four diverse topics. Additionally, a second, separate study involved adult visitors in creating a graphic when given transparencies of all the layers of a graphic. The data represented in this report was collected at COSI in Columbus, Ohio, the Marian Koshland Science Museum in Washington, DC, WonderLab Museum in Bloomington, Indiana, and the New York Hall of Science.

Findings from this project will inform the development of a traveling, hands-on exhibition that will enable visitors to create and utilize representations of big data such as maps and charts. In addition, the project hopes to create a foundation for the design of informal learning experiences that encourage participants to explore, engage with, and make better sense of big data. This project is potentially transformative because big data is becoming ubiquitous and making sense out of data representations is necessary in order to understand and begin to utilize big data.

Methods

The first year of this project was focused on understanding visitors and their relationship to visualizing data and engaging with large data sets. To initiate this work, the first two studies addressed three overarching questions:

1. How do people make sense of big data in their daily lives?
2. How do visitors to museums and science centers react to conceptual science maps?
3. How do people engage with/understand reference systems?

The findings presented in this report are from two studies which build on the initial findings: 1. Construction and Deconstruction, and 2. Free Form Construction.

Construction and Deconstruction

Originally there were three audience groups planned for the Construction and Deconstruction study, but after initial interviews with youth alone, it was determined that youth were reluctant to spend much time/effort in making sense of the graphs without an adult present; therefore, two audiences were included in this study: adults, and groups of adults and youth. Each visualization had a varied number of responses, as sometimes individuals would sporadically engage with another person in the group. There were a total number of 221 adult participants and 105 youth participants at the four museums.

This study utilized a consistent approach and was combined into a single visitor experience. The data collector had four different visualization booklets composed of the layers necessary to create the graph or map (See Appendices A-D). These spiral bound visualization booklets consisted of a base printed in color on white cardstock and laminated, and layers printed in color on transparencies. The booklets were coded on the back by letter for identification. The visualization booklets were used in constant rotation. For example, if the first individual/group constructed A and deconstructed B, the next individual/group constructed C and deconstructed D, and the individual/group after that deconstructed A and constructed B. The order of construction or deconstruction was random so as to not privelige either approach. During construction, the individual/group was shown the base and asked to describe what it was communicating. The evaluator notated what they heard and then asked the individual/group to describe what the base and layer 1 was communicating, then the base, layer 1 and 2, then the base, layer 1, 2 and 3, etc. Each individual/group did this for all layers of a particular visualization.

For deconstruction the individual/group was shown a different visual in its entirety, and asked to describe what it was communicating. The evaluator notated what the individual/group said, and if the individual/group did not indicate they understood the visual, the evaluator removed a layer, again asking the individual/group to describe what the visual was communicating. Layers were removed and comments notated until it was determined the individual's understanding of the visual was not changing.

An interview schedule was prepared to guide study participants through the process of trying to describe meaning made from the various layers of the visualizations (See Appendix E).

Free Form Construction

A second study, conducted by one evaluator, was designed to better understand how adult visitors would construct large data visualizations. These participants thought aloud as they created the graph or map from the color transparency layers of one visual. Adult participants at COSI and Wonder Lab were asked to construct one of two different graphics, Padgett's Florentine Families (PFF) or GapMinder 2012 (GM). Complete transparency sets of one of the graphics were given to 23 adults, 13 of whom constructed PFF and 10 of whom constructed GM.

As this was a qualitative study with semi-structured interview questions, the interview schedule which was prepared to guide study participants through the process of describing how they constructed the graphic contained large spaces for notes (See Appendix F).

Construction and Deconstruction Preliminary Findings

These preliminary findings are organized by visualization.

Airports reachable from Chicago O'Hare International Airport in 2008

The O'Hare Flight Map was described as a flight map by 48 of 58 individual/groups constructing the visual and 53/56 individual/groups who deconstructed the visual.

Construction was completed by 58 individual/groups:
- 14 individual/groups at COSI (6 adult and 8 adult/youth)
- 10 individuals at Koshland (10 adults)
- 15 individual/groups at Wonder Lab (9 adult and 6 adult/youth)
- 19 individual/groups at New York Hall of Science (11 adult and 8 adult/youth)

Deconstruction was completed by 56 individual/groups:
- 11 individual/groups at COSI (7 adult and 4 adult/youth)
- 11 individuals at Koshland (11 adults)
- 14 individual/groups at Wonder Lab (8 adult and 6 adult/youth)
- 20 individual/groups at New York Hall of Science (9 adult and 11 adult/youth)

Construction Observations of Note:

Base   During construction, everyone recognized the map of the United States.
Layer 1   This map was generally understood to illustrate population density. If it was misunderstood, it was most likely described as "camouflage" by youth, or as illustrating some type of landscape feature, possibly forestation or vegetation.
Layer 2   Although the majority understood the dots represented locations of major airports, another common answer was major cities. One participant shared the "dots look like crumbs on the country".
Layer 3   Once again, the majority understood the circle size represented the number of flights per day. Youth described the circles as "bubbles" and adults who thought Layer 2 represented major cities thought the larger circles were illustrating larger major cities.

Layer 4   Although participants generally understood the lines to be flight lines, some adults did not mention O'Hare or Chicago, so it is unclear if they understood this was an O'Hare Flight Map. One child described the lines as "fireworks" and two adults thought the line display "looks like rays of light or a sculpture with wires; Draws attention to Chicago because it makes it look important in a positive way, like rays of light."

Layer 5   During construction, the majority determined the visual was a flight map. After seeing the title layer, one adult commented, "The title didn't really help much because I had already figured out what the graph was about"

Summary: This was a familiar graphic for many. The combination of a common reference system (the map of the United States), simple graphics (lines and circles), and the labels, made this understandable for the majority of participants. Adults often explained what a flight map was to youth who were less familiar with this type of visualization.

[Competitive Eating Records]()
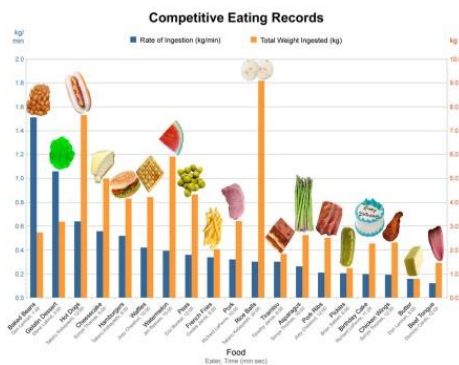
The Competitive Eating visual was associated with food by an overwhelming majority of those who viewed it, additionally 35/53 individual/groups used the term "competitive eating" when describing the graph during construction. During deconstruction, 18/44 individual/groups used the term "competitive eating"

Construction was completed by 53 individual/groups:
- 14 individual/groups at COSI (5 adult and 9 adult/youth)
- 12 individuals at Koshland (12 adults)
- 12 individual/groups at Wonder Lab (5 adult and 7 adult/youth)
- 15 individual/groups at New York Hall of Science (5 adult and 10 adult/youth)

Deconstruction was completed by 44 individual/groups:
- 13 individual/groups at COSI (5 adult and 8 adult/youth)
- 9 individuals at Koshland (9 adults)
- 11 individual/groups at Wonder Lab (4 adult and 7 adult/ youth).
- 11 individual/groups at New York Hall of Science (9 adult and 2 adult/youth)

Construction Observations of Note:

Base   During construction it was generally acknowledged that the base was laying the foundation for a graph that would represent how long it took to eat certain foods. If visitors did not realize the base as representing time and food, they did note this was the foundation for a graph. Other responses included what people like to eat and time needed to cook food.

Layer 1   The first layer was frequently recognized as the length of time to eat or ingest certain foods. There was discussion of the meaning of the word "ingestion" as well as "fast" and "slow" foods—varying ingestion rates between baked beans and beef tongue. Misconceptions included the time of day the food was eaten instead of how fast food was eaten and how much food you should eat in a year.

Layer 2   The majority understood this layer represented how much was eaten in a certain length of time. At Wonder Lab, the most frequent answer dealt solely with the weight of the food item. Several children were coached by the adults with them to fully understand this layer. Two groups at Wonder Lab noted this was a double bar graph, something new to them.

Layer 3   The majority of respondents recognized the pictures of the food. Positive comments about the pictures were made by seven, while two adults felt the pictures didn't add anything. One individual commented after viewing the pictures, they did not need to read, now they "can visualize".   A participant from New York Hall of Science commented, "it all makes sense now, just looking at lines seems foreign, pictures help a lot."

Layer 4   During construction, the majority of groups now understood the graph completely. Some individuals were able to hypothesize it was about competitive eaters before Layer 4. When the title was added, an individual commented that the graph "makes sense now". One stated, "A competitive eater would eat that much," while another wondered why it took so long to eat a hot dog?

During construction several individuals hypothesized the graph was about "Competitive Eating" early in the construction. This hypothesis was based on recognition of a competitive eater's name.

Comparisons between time, foods, and amounts were frequently made. Comparisons were most likely to be made between baked beans, rice balls, and beef tongue, although given enough time, respondents noticed the different foods and commented on their likes and dislikes, amount of time to ingest, and amount consumed.

When **deconstructing this graph, approximately half of the individuals/groups understood it completely. Participants that did not recognize the graph represented competitive eating when they saw the entire graph, did not recognize that as layers were removed.** All who saw the graph recognized it represented some aspect of food, if not competitive eating possibly healthy vs. non-healthy foods. Several of those who continued to participate as layers were removed noted the removal of the pictures of food. One commented, "Now I have to read more," and another said, "pictures provide context."

Summary: Participants understood this graphic dealt with food, but unless they recognized/understood the title or recognized names of the competitive eaters, they didn't have a complete understanding of the visual. The presentation of this data on an X Y graph was familiar to most, as well as the bar graph, however some commented a double bar graph was new to them.

Gapminder World 2012
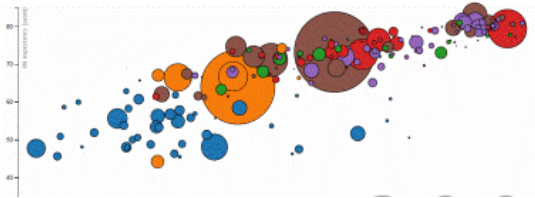
Although 42 of 59 individual/groups who constructed this graph knew at the base layer the graph would be about life expectancy and income, the addition of layers helped a few others grasp the meaning, as 50/59 individuals/groups constructing this graph understood it represented the health and wealth of nations.

Construction was completed by 59 individual/groups:
- 16 individual/groups at COSI (9 adult and 7 adult/youth)
- 11 individuals at Koshland (11 adults)
- 13 individual/groups at Wonder Lab (7 adult and 6 adult/youth)
- 19 individual/groups at New York Hall of Science (9 adult and 10 adult/youth)

Deconstruction was completed by 49 individual/groups:
- 13 individual/groups at COSI (4 adult and 9 adult/youth)
- 10 individuals at Koshland (10 adults)
- 8 individual/groups at Wonder Lab (8 adult)
- 18 individual/groups at New York Hall of Science (11 adult and 7 adult/youth)

Construction Observations of Note:

Base   The base layer was viewed as life expectancy and income by the majority of the respondents; several noted it was a graph

Layer 1   Although many realized the dots represented countries, others indicated the dots represented individuals, or trends. At layer one there was some confusion over the term "axis" by both children and adults. A child remarked that "the earth spins on its axis", one adult suggested it was a "polygraph".

Layer 2   More than half of the individual/groups recognized that the bigger circles added at this layer represented countries with larger populations. One individual interpreted the word "country" as rural, another thought the

circles represented states. At this layer, some individuals began to hypothesize which circle represented which country often based on personal experiences through travel.

Layer 3   The majority recognized the color as representing continents, but a small group believed the color represented countries.

Layer 4   The majority recognized the names of the countries. One school age boy shared, "little overwhelming, school graphs are simpler" One adult shared, "names complicates, good for naming by country, but disrupts global picture. Global picture is better with no names." Another adult looked for Jamaica, her country of origin.

Layer 5   Although 50/59 understood this graphic, the title did not add meaning as the majority understood the graphic before the final layer.

Comments regarding health and wealth began at the base level, with one individual commenting "you live longer with more money" after viewing the base.   One adult felt there was lots of information and they needed more time to review specifics, such as countries, another thought it was "overkill", with too much information on a page. Several began guessing countries at layer three, based on the color and size of the circle.

During deconstruction, 39 of 49 individual/groups recognized the graph as the wealth and health of nations. Those who did not had ideas about planetary maps and islands owned by countries.

Summary: The presentation of data on an x-y axis was familiar to most participants. Although it may have taken some time, up to twelve minutes, the majority understood the information conveyed by this graphic.

Padgett's Florentine Families
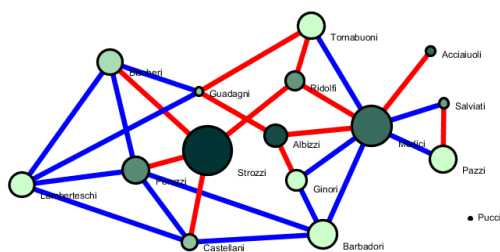
Padgett's Florentine Families appeared to be the most challenging graphic for museum visitors to understand, possibly because it referenced Italian History which was not a common frame of reference for the majority of these museum visitors. At layer 3 or 4 adults who had been making pictures out of the dots and lines began to understand the graphic was about family connections. Individuals/groups who thought the graphic represented genealogy appeared confused because the graphic was not of a traditional family tree. When participants made sense of the graphic they began to discuss the

different family connections with others in their group, noting that no one was connected to the Pucci family, and the Strozzi family had the most wealth and seats on the civic council.

Construction was completed by 45 individual/groups:
- 14 individual/groups at COSI (8 adult and 6 adult/ youth)
- 9 individuals at Koshland (9 adults)
- 11 individual/groups at Wonder Lab (5 adult and 6 adult/youth)
- 11 individual/groups at New York Hall of Science (9 adult and 2 adult/youth)

Deconstruction was completed by 51 individual/groups:
- 13 individual/groups at COSI (9 adult and 4 adult/youth)
- 12 individuals at Koshland (12 adults)
- 11 individual/groups at Wonder Lab (5 adult and 6 adult/youth)
- 15 individual/groups at New York Hall of Science (5 adult and 10 adult/youth)

Construction Observations of Note:

Base   Less than a quarter of individual/groups understood that the dots represented families in Italy, one COSI respondent thought they were families in science and two respondents thought the dots represented where people lived in Italy. When asked what the base layer was communicating, 13 individuals/groups were unsure, the highest number of "Unsure" responses of any of the graphics. Common misconceptions among children and adults were the dots represented constellations, or pictures including an animal, jet, and castle. Many commented that the base was "just dots".

Layer 1   The majority of respondents were able to recognize family names. Six individuals/groups believed the dots and names were cities, five believed the dots and lines were creating a family tree or genealogy representation, one thought the names were names of stars (thought the dots were part of a constellation).

Layer 2   Nearly half of the respondents understood the graphic represented family connections. At this layer, some believed it was some type of family tree or genealogy . Additionally, some participants still viewed the visual as a constellation or picture of a fish, rocket ship or triangles.

Layer 3   At this layer, people began to make connections between the families, wealth and power, although a few respondents still saw it as a map of the solar system or picture. Participants discussed wealth and power, wealth and religion, wealth and royalty, and the one family without connections.

Layer 4   At this layer, respondents identified seats on the council and/or observed that these families had power and influence. Those who were making pictures out of earlier layers were less likely to understand what the graphic represented. There were youth who did not understand the term "civic council", but the adult with them typically explained. One New York Hall of

Science participant believed "too much, theres a clearer way to depict. Looks more like a constellation than anything."

Layer 5   More than half of individuals/groups were able to identify business ties, three participants were still unsure of what this graphic conveyed.

Layer 6   Most individuals/groups were able to identify marriage alliances and examined connections between marriage, business, and wealth. Several noted the Pucci family had no links or connections.

Layer 7   Even after reading the title participants' level of understanding was not always evident. Several wondered aloud about Padgett, asking who or what Padgett was. Two indicated they still didn't know what it means.

During deconstruction, 36 of 51 individual/groups recognized the graphic as representing either powerful families in Florentine Italy, family connections, or a family tree. The removal of the title (layer 7) allowed one individual who thought it was a family tree to see the connections to power; removal of the marriage ties (layer 6) highlighted the business ties (3). When the business ties were removed (layer 5) some individuals noticed the family names for the first time and commented that it was easier to see the family connections.

Summary: Padgett's Florentine Families appeared to be the most challenging graphic to understand, possibly because participants were unfamiliar with the format or the content. Children were likely to make pictures from the dots and lines. It appeared that individuals/groups needed several layers (3 or 4) to begin making sense of the graphic.

Free Form Construction Preliminary Findings

Participants at COSI and Wonder Lab were asked to construct one of two different graphics, Padgett's Florentine Families (PFF) or GapMinder 2012 (GM). Complete transparency sets, randomly-ordered and unattached, of one of the graphics were given to 23 adults, 13 at COSI and 10 at Wonder Lab. Thirteen constructed the PFF and 10 constructed GM.

Observing the participants, there was no one layer-by-layer construction path that appeared; each participant appeared to follow their own logic. One trend observed was that some participants appeared to construct the graphics by shape, with such speed that it appeared they spent minimal time reading the labels. These participants typically matched like shapes, outlines of circles with color circles, lines with links, before adding other layers. A second trend observed was that the title was part of the base or the final layer, usually the final component added during construction. For GM, a trend was to use the grid as the base, adding the data to the graph.

     Padgett's Florentine Families

Constructing graphics appears to lead to a better understanding of the graphic, as the majority of the participants (10 of 13) actively constructing this graphic could explain it

correctly to some level once it was constructed unlike those who constructed or deconstructed the spiral bound graphic, although this could be because this study focused on adults only so no children were involved. Four of the thirteen looked at the different layers and/or read the labels before beginning; the other participants appeared to begin by looking for patterns. Many began by matching the circle layers (outlines and colored circles), and the line layers (connections, marriage and business ties). Construction of the graphic began after preliminary matching. When constructing, many started with the names or the connections piece, believing that was the place to start. Individuals realized the title was an end piece, placing it most often on the top, with the next most likely location the base.

	Top							Base
Title	5	0	0	0	0	2	2	3
Marriage Alliances (Green Links)	0	3	2	3	2	2	0	0
Business Ties (Black Links)	4	0	2	1	2	1	2	0
Seats on Civic Council (Color Circles)	1	3	0	2	1	2	0	3
Families Net Wealth (Circle Outlines)	0	0	3	2	2	1	4	0
Family Connections	0	1	3	3	1	1	0	3
Family Names	1	4	0	1	3	1	0	2
Families of Power (Dots)	1	1	2	0	1	2	4	1

Table 1. Padgett's Florentine Families Construction by Layer (ordered as they are in the construction booklet)

GapMinder 2012

Patterns that emerged during the construction of GM were similar to construction of the PFF. In GM, as with PFF, many participants began by matching shapes, especially the circle layers (outlines and colored circles). In GM and PFF, the title was typically added last, at the top.

Due to the different elements of the graphics, GM and PFF varied. A secondary finding of GM was participants matching the dots with country names. The grid was typically the base, or the first layer atop the base. The population circles (outlines) tended to be placed in the middle of the construction.

Two of ten participants read all the labels and looked at all the individual components before beginning. These participants took longer to complete the construction.

	Top					Base
Title	7	1	0	0	1	1
Country Name	1	3	1	1	1	3
World Region (Color Circles)	1	1	2	4	2	0
Country Population Size (Circle Outlines)	0	0	6	3	1	0
Position of Country (Dots)	1	2	1	2	2	2
Grid	0	3	0	0	3	4

Table 2. GapMinder 2012 Construction by Layer (ordered as they are in the construction booklet)

Recommendation: Continue to explore freeform graphic construction to determine if initial hypothesis of construction based on shapes prevails. Also determine if construction leads to increased understanding of the graphic.

Implications

1. A key insight that emerged from these studies is the relationship between the complexity of a data visualization and guests' ability to make meaning from those representations. Data visualizations exist on a continuum from simple to complex. Guests' knowledge of and familiarity with data visualizations exist on a continuum from unfamiliar to familiar. Although typically science centers and museum visitors have more education than the general population, the visitors in this study represent a range of understanding of data visualizations. Those with less familiarity understood common graphics (map of the United States) and chart representations (XY axis, bar graphs). Those with advanced understanding of visual graphics were familiar with both basic and more complex visuals. To accommodate a wide variety of visitors, we need to meet guests where they are and provide opportunities for increased engagement with and understanding of data visualizations. Given the range of familiarity with data visualizations observed across the four sites and two studies, exhibits should be designed to begin at a basic level and have the potential to increase in complexity to interest those with considerable knowledge of data visualizations. Exhibits can do this by:
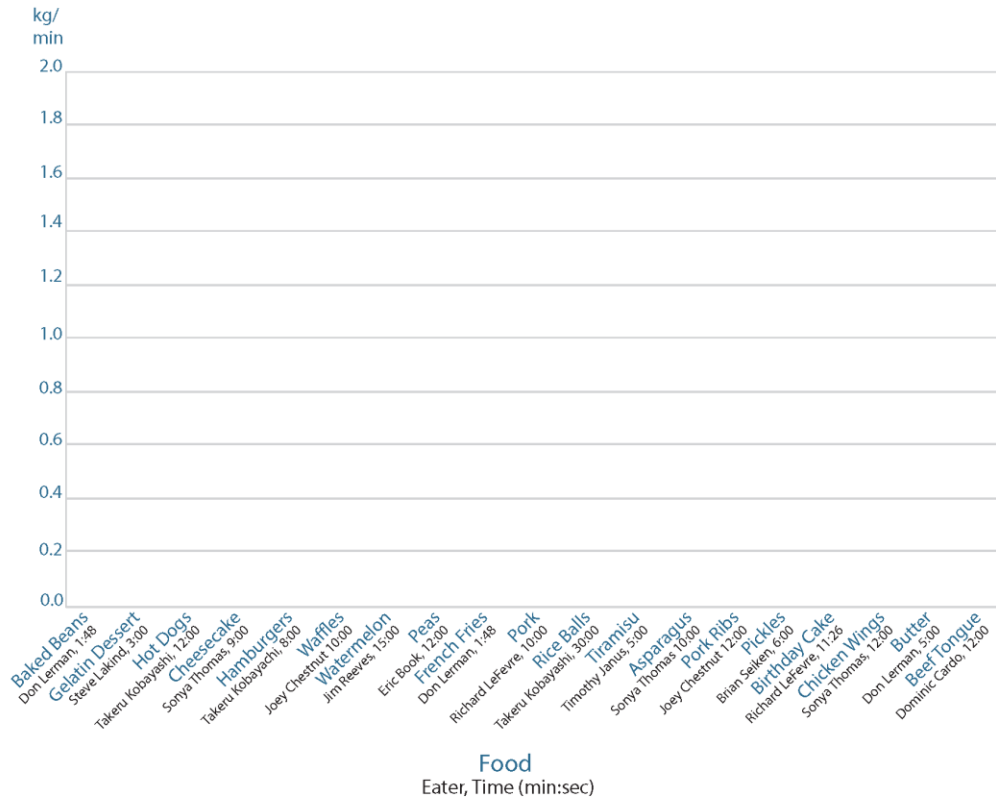- Scaffolding from less to more complex data visualizations.
- Explaining the utility/value of more complex displays of data
- Demonstrating/guiding visitors through how to read these visuals
- Defining key terms and parts of visualizations to ensure that visitors have the vocabulary to understand the basics.
- Providing clear title, key, and labels
- Accommodating a variety of learning styles (linguistic, visual, kinesthetic, etc.)
- Supporting flexible time investment (modular experiences that can both stand alone in short segments and be experienced in sequence for those willing to spend more time)

- Connecting visualizations to visitor's daily lives/personal experiences
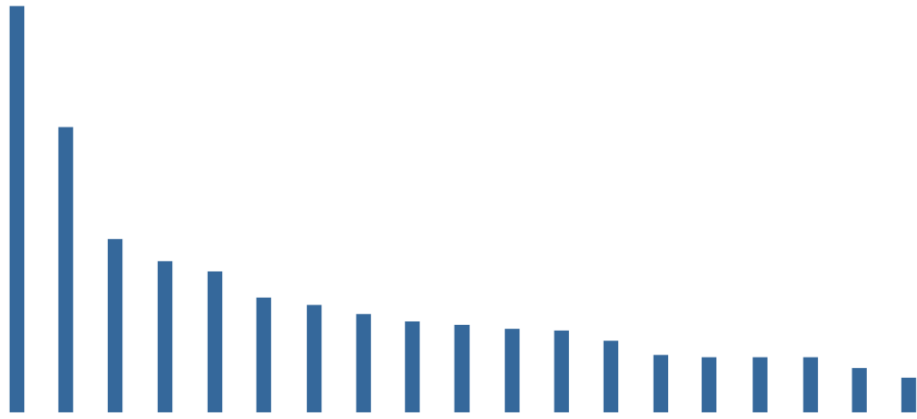- Construct graphic visualizations one layer at a time.

2. Visitors engaged in constructing the graphics were more likely to use cumulative reasoning; making deeper meaning as they viewed the graphic one layer at a time. Also, those involved in the freeform graphic construction appeared to better understand and interpret the visualization.
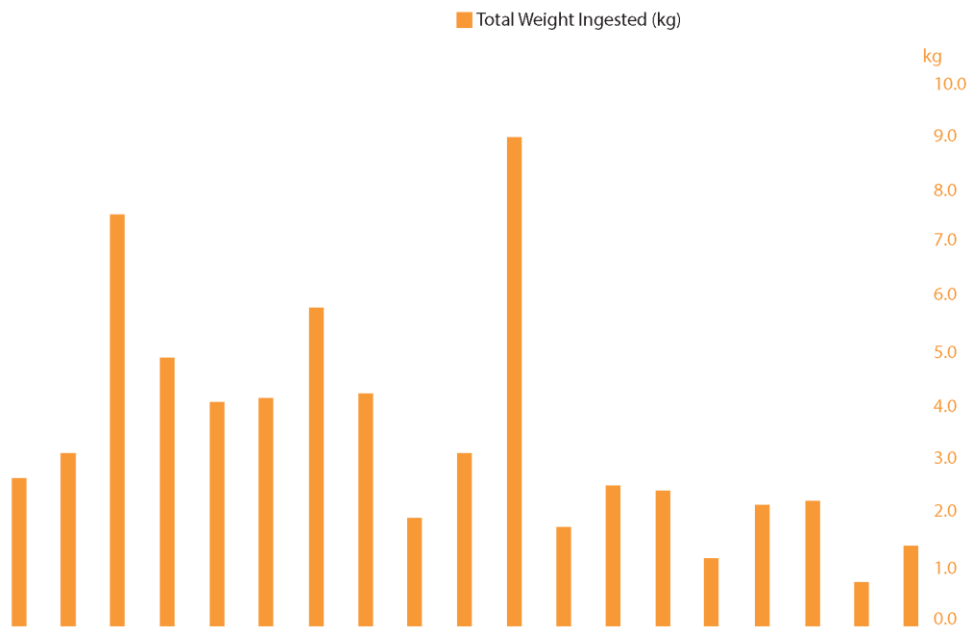
3. Visitors engaged in deconstructing the graphics were unable to "forget" contextual information provided in the complete versions and generally did not articulate new interpretations of the stripped down visuals. This suggests that deconstruction may be a less productive approach to use in an exhibit experience as it does not seem to support sustained engagement or exploration of the data being represented.
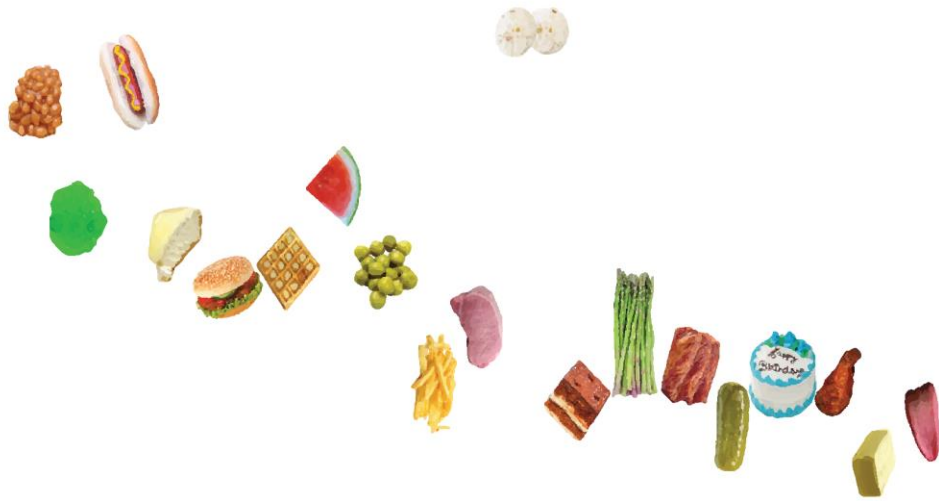
Appendix A. Competitive Eating Records

A chart with y-axis labeled "kg/min" ranging from 0.0 to 2.0, and x-axis labeled "Food" with subtitle "Eater, Time (min:sec)". The x-axis categories are:

- Baked Beans — Don Lerman, 1:48
- Gelatin Dessert — Steve Lakind, 3:00
- Hot Dogs — Takeru Kobayashi, 12:00
- Cheesecake — Sonya Thomas, 9:00
- Hamburgers — Takeru Kobayashi, 8:00
- Waffles — Joey Chestnut 10:00
- Watermelon — Jim Reeves, 15:00
- Peas — Eric Book, 12:00
- French Fries — Don Lerman, 1:48
- Pork — Richard LeFevre, 10:00
- Rice Balls — Takeru Kobayashi, 30:00
- Tiramisu — Timothy Janus, 5:00
- Asparagus — Sonya Thomas 10:00
- Pork Ribs — Joey Chestnut 12:00
- Pickles — Brian Seiken, 6:00
- Birthday Cake — Richard LeFevre, 11:26
- Chicken Wings — Sonya Thomas, 12:00
- Butter — Don Lerman, 5:00
- Beef Tongue — Dominic Cardo, 12:00

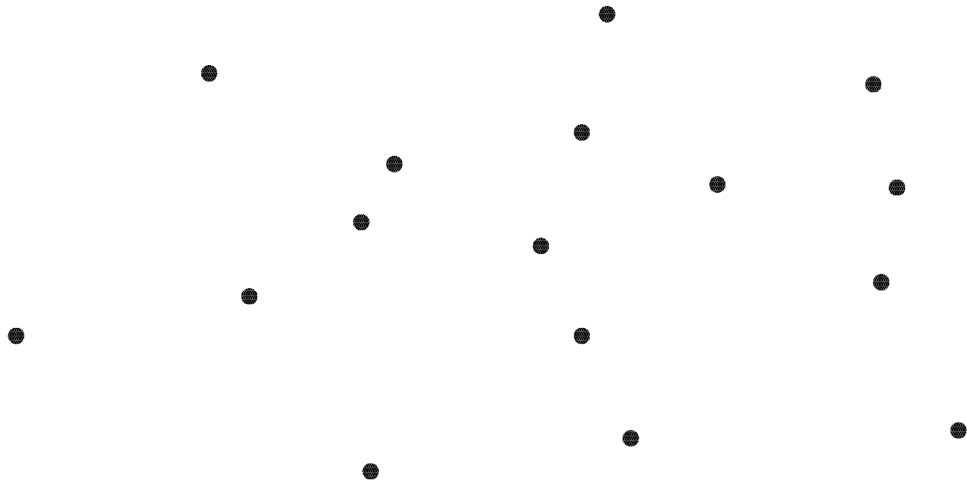Rate of Ingestion (kg/min)

Total Weight Ingested (kg)

Competitive Eating Records

Appendix B. Padgett's Florentine Families

Families of Power in
Florentine Era Italy

Labels: Family Name
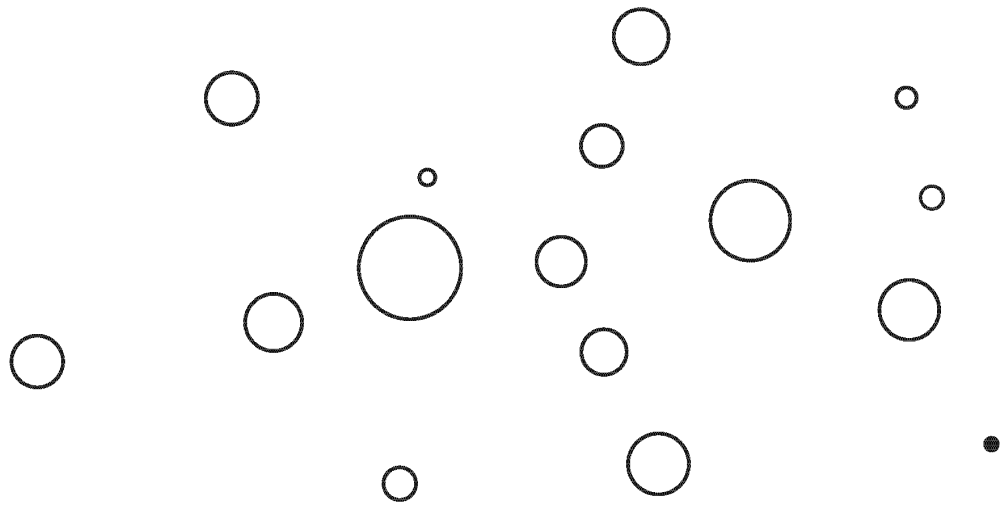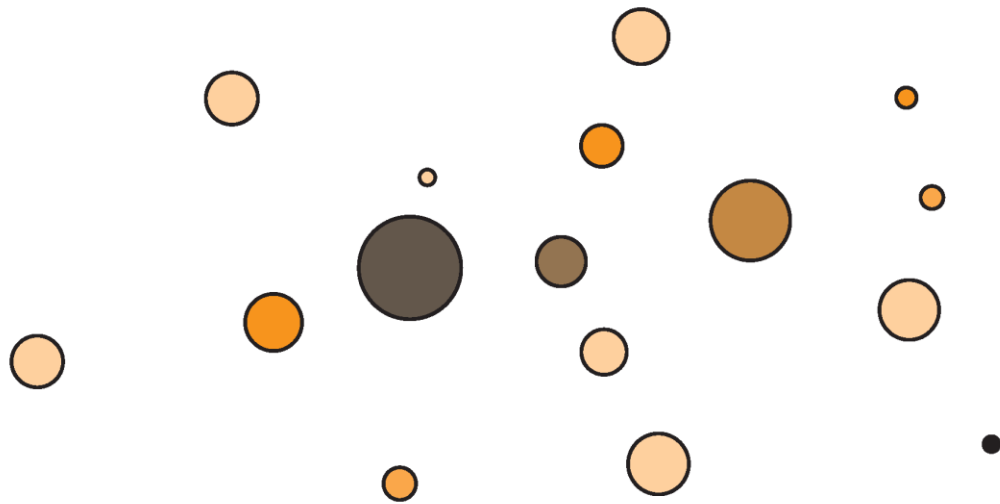
Tornabuoni

Bischeri   Acciaiuoli

Ridolfi

Guadagni
Strozzi   Salviati

Albizzi
Medici

Peruzzi   Pazzi

Lamberteschi   Ginori

Barbadori   Pucci

Castellani
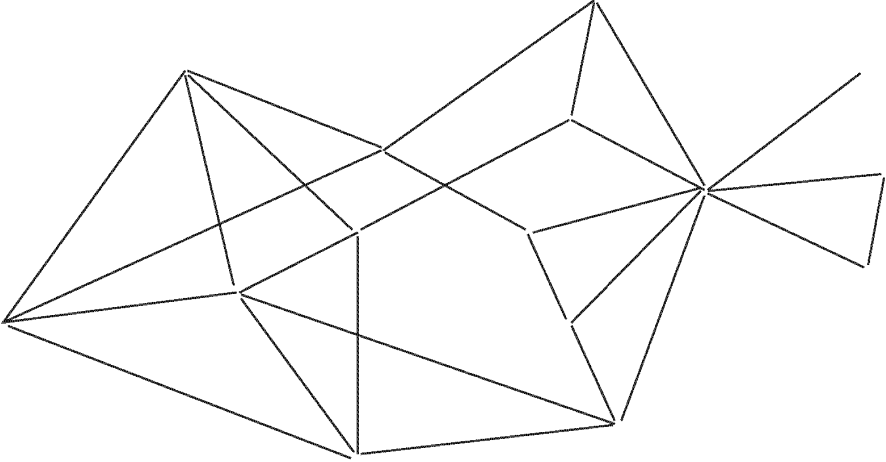
Circle size: Family's net
wealth (in thousands of
lira) in year 1427

Circle color: Number of
seats on the civic council
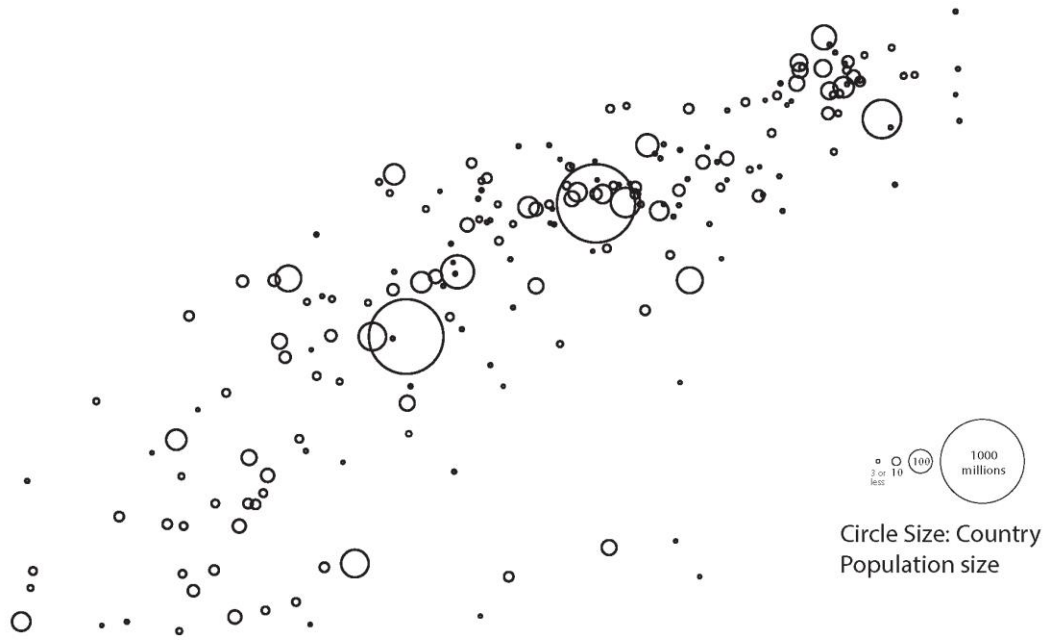held in years 1282-1344

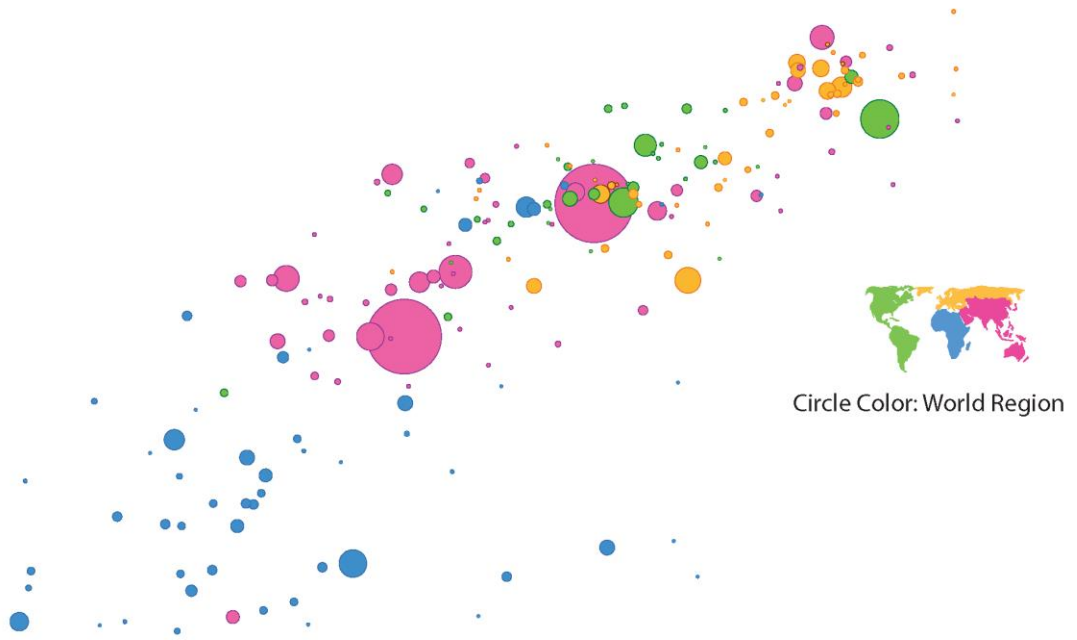Link color:
Business ties
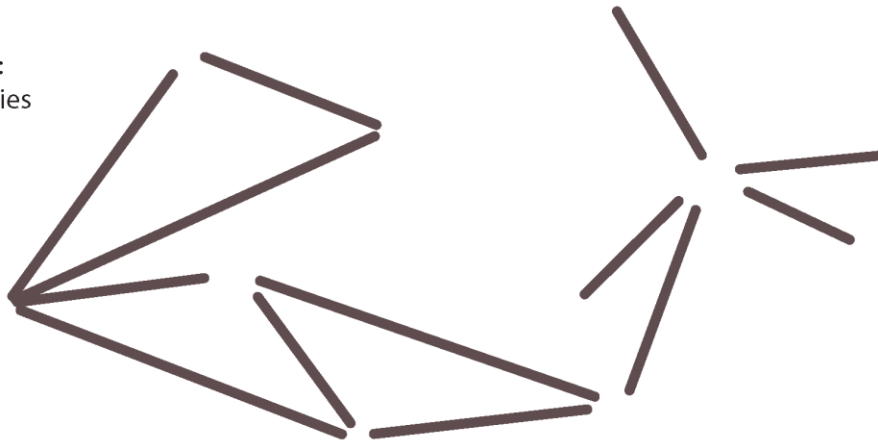
Link color:
Marriage Alliances

Padgett's Florentine Families

Appendix C. GapMinder 2012

Circles: Position of
Countries on Axis

Circle Size: Country
Population size
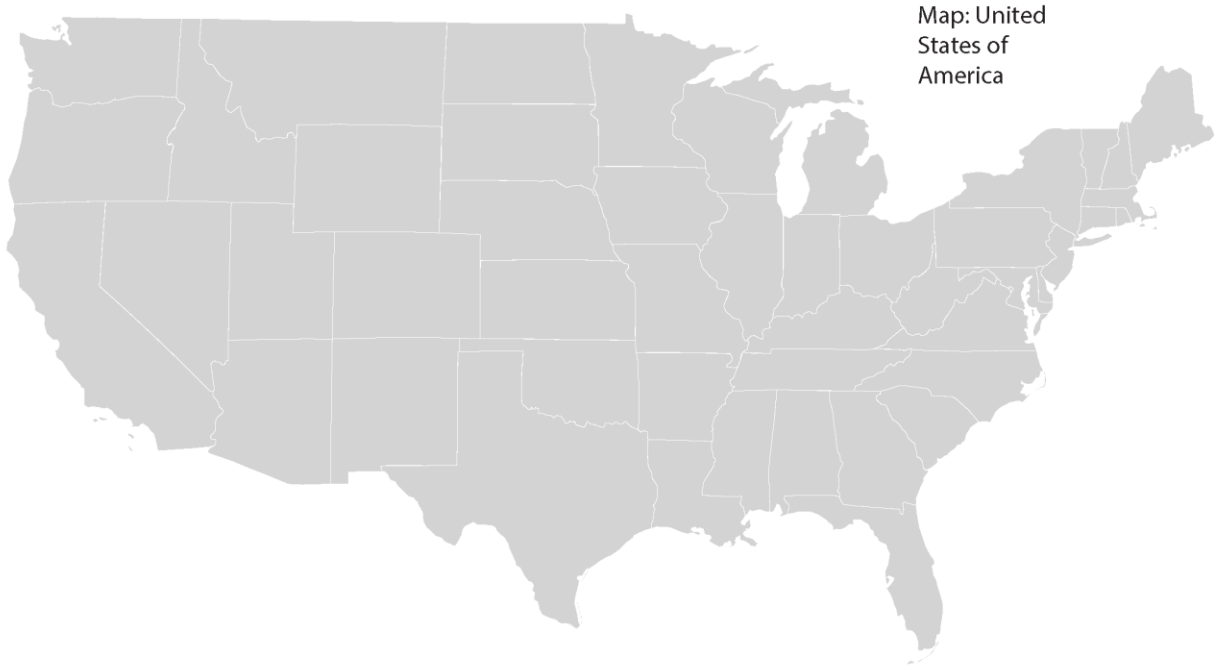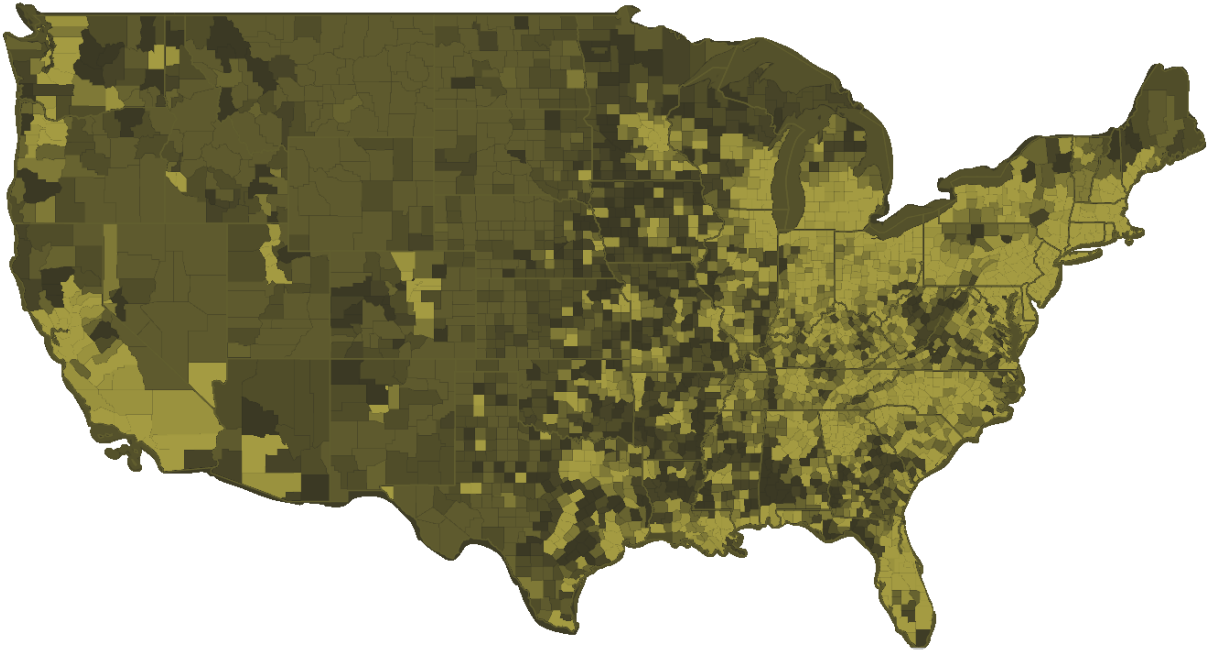
Circle Color: World Region

Labels: Country Name

GAPMINDER WORLD 2012

Mapping the Wealth and Health of Nations

Appendix D. Airports reachable from Chicago O'Hare International Airport in 2008

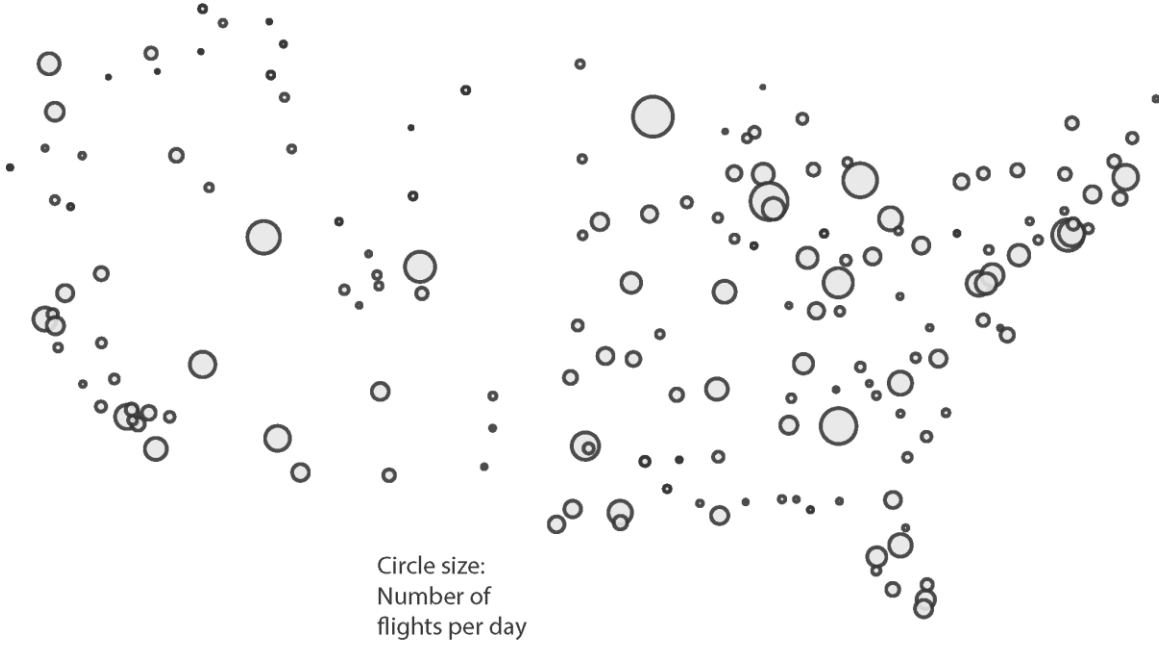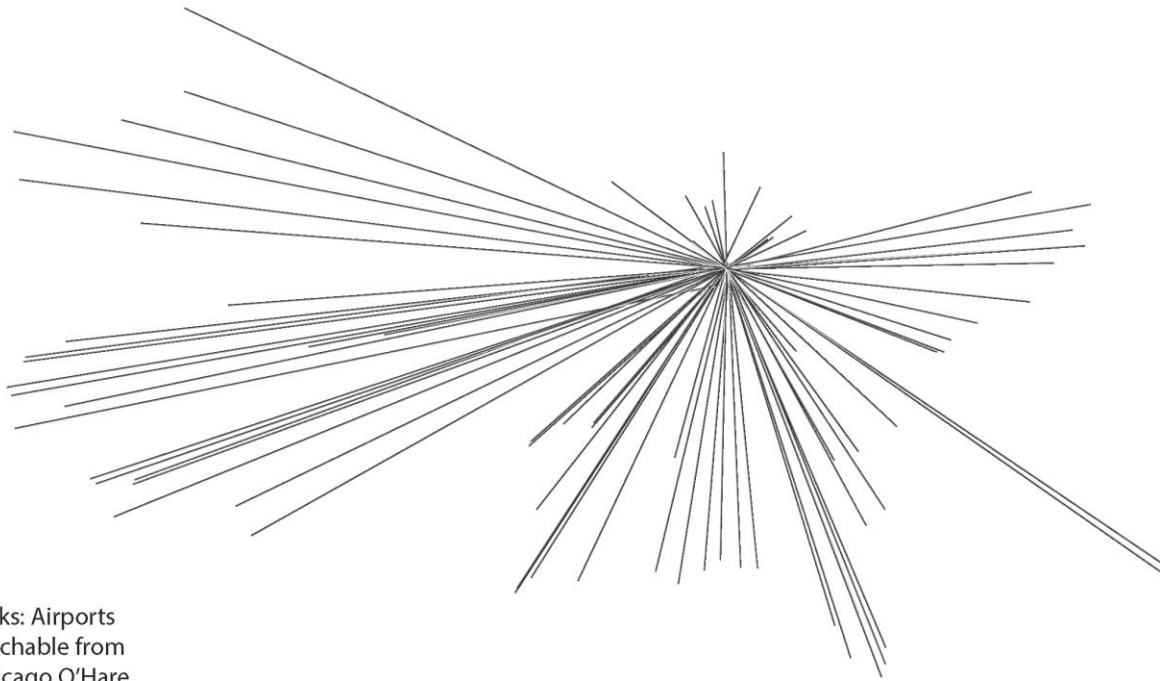Map: United States of America

Gradient: Population
Density in 2010 by
county with denser
regions darkest

Circles: Locations
of Major Airports

Circle size:
Number of
flights per day

Links: Airports
reachable from
Chicago O'Hare
International
Airport in 2008

US Airport Traffic and Chicago
O'Hare Connecting Flights

Appendix E. Interview Schedule Construction and Deconstruction

Meaning making through data representation construction/deconstruction
(indicate perceived sex of those interviewed)

Adult only: _____

How interested in science are you on a scale of 1 (not interested at all) to 10 (totally love it)? _____
How interested in math are you on a scale of 1 (not interested at all) to 10 (totally love it)?   _____
How interested in art are you on a scale of 1 (not interested at all) to 10 (totally love it)?   _____

Which visual did you use? (A, B, C, D)	Construct	Deconstruct

	What do you think this means or is supposed to be communicating to you?	Let me (add/remove) a layer: Now, what do you think this means or is supposed to be communicating to you?		
Start Time	**Construct Base**	**Layer 1**	**Layer 2**	**Layer 3**
End Time	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**
Start Time	**Deconstruct Base**	**Layer 1**	**Layer 2**	**Layer 3**
End Time	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**

Was this easy or difficult to do? Why?

Anything else you'd like to share with me?

Meaning making through data representation construction/deconstruction
 (indicate perceived sex of those interviewed)

Youth and Adult Group _____

How interested in science are you on a scale of 1 (not interested at all) to 10 (totally love it)?Y _____   A_____
How interested in math are you on a scale of 1 (not interested at all) to 10 (totally love it)?   Y_____ A_____
How interested in art are you on a scale of 1 (not interested at all) to 10 (totally love it)?   Y_____ A_____

Which visual did you (A, B, C, D)	Construct	Deconstruct

Place a Y before statements made by youth and an A before statements made by the adult.

	What do you think this means or is supposed to be communicating to you?	Let me (add/remove) a layer: Now, what do you think this means or is supposed to be communicating to you?		
Start Time	**Construct Base**	**Layer 1**	**Layer 2**	**Layer 3**
End Time	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**
Start Time	**Deconstruct Base**	**Layer 1**	**Layer 2**	**Layer 3**
End Time	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**

Was this easy or difficult to do? Why?

Anything else you'd like to share with me?

Appendix F. Interview Schedule Free Form Construction

Meaning making through data representation

Adult only: _____

How interested in science are you on a scale of 1 (not interested at all) to 10 (totally love it)? _____
How interested in math are you on a scale of 1 (not interested at all) to 10 (totally love it)?   _____
How interested in art are you on a scale of 1 (not interested at all) to 10 (totally love it)?   _____

Which visual did you use?	GF	PFF	OH
Start Time	End Time	Total Time	

Hi! This is an example of a complex visualization. These are the pieces of another complex visualization. Can you please put these pieces together for me, and while you are doing it can you tell me:

- What each layer means to you
- Why you are putting the layers in order
- What you think the entire visual is supposed to be communicating to you?

Layer	What it means

Was this easy or difficult to do? Why?

Anything else you'd like to share with me?