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Statistical representations from popular texts for the ordinary citizen, 1889–1914

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Abstract

Statistical representations in the popular almanacs published at the end of the 19th century in the Habsburg Empire are an early prototype of visualizing statistical data for popular consumption and informing the public of an ethnically and linguistically differentiated society. The purpose of this article is to analyze these statistical representations using a combination of humanistic and visual analysis methods. The article focuses on the persuasive aspects (rhetoric) of diagrams, how they visualize knowledge and information (pragmatics), and the nature and structure of visual sense making (semantics). The form and content are related to the social context and materiality of images. These early popular diagrams predate functional design defined by positivism and science. They are interpreted as a historical practice of knowledge visualization in the context of a post-Enlightenment information regime (epitomizing rational government and the privileged position of statistics as instrument of increasing the efficiency and social control of the state). The modernist approach shapes the same information regime in information science discourse. The analysis—based on principles of information visualization and functional design requirements—shows that these examples possess a sound visual structure based on functional design criteria, and that they integrate cultural context without distorting the data. The advantages of naturalistic and culturally rich visualizations that enable ordinary citizens to acquire knowledge through leveraging simple visual reasoning skills, reliance on mental models, and narrative conventions are identified.
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1. Introduction

In an increasingly visual world, it becomes important to understand how some of the visual techniques used to represent quantitative information have developed. Such understanding can provide novel insights into the nature of visual literacy and visual information. This article examines an early form of visual representation of statistics from popular almanacs distributed in the Habsburg Empire at the beginning of the 20th century. The iconography of these knowledge visualizations demonstrates how culturally encoded presentations of quantitative information rely on narrative presentation, stereotyping, and support common-sense interpretation for a general audience. These techniques are contrasted to later developments of functional design, which abandons naturalistic in favor of functional and minimalist representations. This study fills in the gaps for understanding the history of knowledge visualization and the methods that preceded functional design.

2. Problem statement and research procedure

The authors collaborated in combining humanistic approaches to the study of knowledge visualization with visual coding and functional design methods, thus exploring a "combination of historical and semantic approaches" that a recent review of visual studies in communication identified as one that "may be[come] the cutting edge of visual studies in the next decade" (Barnhurst, Vari, & Rodríguez, 2004, p. 638). This research emphasizes the importance of information seen as historically and socially situated, mediated through discourse, technologies of production, and power structure. Thus, it contributes to a key debate in information science about the importance of social and cultural context of knowledge creation, circulation, and use and critiques the classic modernist notion of information that needs "no collective, no network, no mediation" (Latour, 1993, p. 122), and tunnel-vision approaches to information science research.

The authors started from the assumption that methods of communicating knowledge in visual form using naturalistic representations can convey complex information and facilitate comprehension of new forms of content for a general audience. The contextual frames are inherent in naturalistic (and anthropomorphic) representations. Thus, they resolve the problem of absorption of quantitative data into popular discourse, making it accessible to the ordinary citizens. Although nonlinear and unscientific, contextual ingredients can be effective mechanisms for visual learning. Therefore, the main research objective of this paper is to understand knowledge visualization of a particular historical context through an associated documentary practice (distribution of popular illustrated almanacs) and to examine how visualizations presented information and facilitated its processing.

Specific objectives are as follows:

- Establish a broader context in information science for the analysis of knowledge visualizations for the ordinary citizens using an early popular form of statistical diagrams that are exemplary in a particular documentary practice;

- Analyze the visual rhetoric, pragmatics, and semantics of statistical representations and identify how they relate to the historical context in which these diagrams were used to inform the ordinary citizen; and
- Compare the statistical representations and narrative design used in the early visual statistics to functional data displays and analyze them in terms of how they support visual reasoning; assess whether narrative aspects and cultural categories undermine or enhance structural coherence and intelligibility of visual statistics.

The research procedure is a combination of historical and cultural interpretation and visual analysis methods. Using exemplary artifacts of popular statistics for the ordinary citizen circulated in the context of the Habsburg Empire, the analysis proceeds from examination of persuasive aspects of statistical representations (visual rhetoric), through examination of how knowledge and information is made visible (visual pragmatics), and the nature and structure of visual sense making (visual semantics). These levels of analysis are related to historical and theoretical contexts in which these early statistical representations for popular consumption can be interpreted.

3. Visual studies and knowledge visualization: Relevant literature

At the end of the 19th century, the accumulation of large periodic series data created the need for the invention of visual representations to manage large data sets. Such visual displays can be studied in terms of the visual coding principles used to present information (Ware, 2000) and how the visual encoding supports analysis (Tufte, 1990, 1997, 2001). Although relying on historical examples to identify principles for designing analytical visualizations, Tufte (1990, 1997, 2001) does not address the broader context of knowledge production within which the interpretive process of obtaining information occurs. Cognitive science focuses on the activity in the mind through which mental constructs (cognitive maps) affect the processing of visual information, recognizing preconceptual sensory inputs, representational forms, and conceptual aspects of that process (Spence, 2001, p. 3).

Visual studies, with their traditional roots in the arts, came to the public's attention during the late 1950s due to seminal work of Roland Barthes, Daniel Boorstin, and Stuart Hall (Barnhurst et al., 2004, p. 616). Visual studies today are concerned with pragmatics, rhetoric, and semantics of visuals in an interdisciplinary arena of sociology, anthropology, psychology, education, communication, visual arts, and history (Barnhurst et al., 2004; Pink, 2003). Some approaches are relevant for the nexus of visual representations, information, and modernity. Some are concerned with post-Enlightenment visuality, history of scopic regimes (Jay, 1994), a shift from vision to visualization (Virilio, 1994), and the alienation of the sighting subject (Foster, 1988). The arts, book arts, and design disciplines study aesthetic aspects of visual information.

The approaches to the analysis of visual representations include the following perspectives:

- visual studies (interdisciplinary cultural studies methods);
- visualization techniques (visual design, graphic arts);

- visualization tools (statistics/computer science); and
- visual reasoning processes (cognitive science).

These different approaches and their distinct literatures had varied impact on information science, which focuses on visualization from how it can support information retrieval and knowledge representation.

The early examples of visual statistics analyzed in this article are considered in a multidisciplinary context related to these theoretical concerns, focusing on a modernist view of information, the politics of legislative reason and the rise of the modern state (Bauman, 1992), and the historical framework in which visualization artifacts conveyed information.

4. Information science context: Information regimes and documentary practices

Identifying documentary practices (Frohmann, 2004) that reflect particular "information regimes" (Frohmann, 1995) can provide an empirical basis for understanding information and its relationship to the theories of truth and truth seeking (Goldman, 1999). This article examines a post-Enlightenment documentary practice that combines visual and statistical argumentation for knowledge creation in the public domain. Visual statistics for informing and educating a population is considered in the context of consolidation of belief in rational government and science as a central concern of the modern state, and as a historical form of information literacy dependent on the materiality of print. Common definitions of statistics imply the context of state affairs and refer to the role of statistics in decision making, uncertainty resolution, and inference (Pruim, 2005). Statistics became established as a language of objective science by the mid-19th century (International Statistical Congress, 1858). The uses of statistics by the government to collect information about its population signal the emergence of national policies, planning, and the 19th century information revolution. Its documented uses in the state context of 19th-century England point to a transformation of knowledge processes to information management strategies (Stieg, 1980). The collection and dissemination of information (census, blue books, government reports) were radically new ways of gathering, categorizing, sharing, and using information (Leary, 2000, p. 62). The statistical principles of collection, analysis, and interpretation of masses of quantitative information were established by the end of the 19th century; they become a basis for realist and pragmatic pursuit of science, policy, and commonsense knowledge. In the first quarter of the 20th century, the stabilization of secular thought, scientific worldview, and materialist culture occurred (Hall, 1995, pp. 3–18).

At that tail end of the Second Enlightenment (Latour, 1993), the positivist worldview implied the final separation of the modern world from an obscurantist and prescientific past, thus establishing the central task of "sorting out the kernels of science from the chaff of ideology … for generations of well-meaning modernizers" (Latour, 1993, p. 35). With the logico-positivist framework perceived as the privileged venue for objective knowledge about the world, "information" separated out from the context assumed its current ontological status

of culture-free "quasi-object" (Latour, 1993, p. 52). The past contained in hybrids that mix the scientific and the ideological is in the realm of the popular and the ideological. Such information hybrids combine metaphor and fact; they exemplify access to knowledge "through a glass darkly."[1]

The documentary practice of statistical representation considered in this paper is such a "hybrid," a mixture of statistical fact and narrative, rational, and intuitive reasoning, exemplifying the creation of knowledge through a social process. Starting with what can be perceived, then incorporating this perception into a discursive structure to establish negotiation and dialogue, these information artifacts lead to knowledge that can be agreed upon as knowable and believable. The anthropomorphic qualities of the visual diagrams facilitate comprehension and consensus; they can also distort facts because they depend on cultural stereotyping to make an argument. It is through naturalization that utilizes common sense, narrative conventions, and everyday visual reasoning skills that such visual forms can be effective. Modern, abstract knowledge is thus merged with nonmodern metaphorical thought. Such merging of the natural and the cultural contrasts their proper separation in modernist thought (Latour, 1993, p. 32).

The scale of reproduction, circulation of knowledge through bureaucracies, and reliance on visual processing of large quantities of data together supported an increased objectification of knowledge that is organized in categories and defined by educational, cultural, and political institutions; the effect is a hegemony of universalized systems (Bowker & Star, 1999; Foucault, 1970, 1972, 1977) and an emergence of common culture.

5. Historical context: Statistical information at the beginning of the information age in the Austrian context

The emergence of visual statistics does not only coincide with a desire for designing and circulating accessible information for the ordinary citizen by a hegemonic state. Providing accessible information for the ordinary citizen through visual education was a central issue of information design for Otto Neurath, the early 20th-century socialist and member of the Vienna Circle. His work on visual education and the visual language provides a historical link to consider the historical development of visual statistics. Printing methods at the beginning of the 20th century increased the ability to circulate illustrated texts and shape the cultures of reception. Therefore, the circulation and use of visual statistics at the beginning of the 20th century also calls to be understood in relation to publishing practices. The development of pictorial information design and contemporary publishing practice are key components for understanding visual statistics in its historical context.

[1] This phrase originates from the Apostle Paul (1 Corinthians 13:12 KJV): "For now we see through a glass, darkly; but then face to face; now I know in part; but then shall I know even as also I am known."

5.1. The Viennese connection

> The ordinary citizen ought to be able to get information freely about all subjects in which he is interested, just as he can get geographical knowledge from maps and atlases. There is no field where humanisation of knowledge through the eye would not be possible (Neurath, 1939, p. 3).

Otto Neurath's practical utopianism resulted in the development of nearly two thousand "pictographs—he called them Isotypes—which personify integers by means of gaily colored little men, houses, boats and so forth," which were meant to be applied for communication between nations and to instruct the illiterate (Johnston, 1977, p. 194). They were meant to bring statistics to life and convey socialist politics. This method of knowledge representation provided the basis for government policy on social services and public health in Austria in the 1920s and 1930s (Hollis, 2001, p. 18; Broos & Hefting, 1997); and Neurath's principles are still influential in information design (Holmes, 2001). Questionable validity and reliability of the Isotype system, as well as Neurath's involvement with Soviet and British propaganda efforts in the 1930s and 1940s, contributed to the dismissal of these representations as agitation tools and mere objects d'art (Chizlett, 1992, p. 303).

Regardless of the debates surrounding it, the Isotype system is an early form of popular representation of statistics. Willard Brinton's (1914) illustrated manual, *Graphic Methods for Presenting Facts*, preceded the Viennese proto-Isotype by about ten years, and is considered as a possible source for Neurath's system (Chizlett, 1992, p. 309). We propose that a more likely source is an existing local tradition of quantitative illustration represented by the pictorial diagrams published in popular almanacs from the end of the 19th century. The almanac statistics and Isotypes emerged in the Austrian context and both aim to make statistics accessible. They also differ in important points. While the Isotypes are modernist and minimalist, parading as scientific and analytic representation of truth, the anthropomorphic pictograms reflect an ornate aesthetic on the surface, appear to defy the principles of functional visualization, and present no claims to be scientific. While the Isotype method advocates visualization as a means of the socialist struggle for a democratic society (Neurath, 1939; Hegselmann, 1979), the earlier form of visual statistics belongs to the ideology of an ethnically and socially divided undemocratic empire. Further, graphics representing quantities that resemble cartoons are found in French, Italian, and American graphical practice at the end of the 19th century (examples can be found in Tufte, 2001, pp. 69–73); statistical diagrams also appear regularly in American textbooks from 1910 (Friendly & Denis, 2005). Therefore, the visual methods for representing statistics were interesting to a range of modernizing educators concerned with information literacy.

5.2. The publishing context: Multiplication and circulation of pictorial statistics

The almanacs in which the pictorial diagrams appeared were widely read, providing a mainstream source of informative images. The almanacs were intended primarily for the urban literate population (Dalbello, 2002). They were entertaining, demagogic, and propagandist. In terms of information need, they were equivalent to a popular

encyclopedia. In function and impact, they were comparable to modern mass media because they disseminated information widely about the social, political, and economic conditions of the contemporary world to the citizens of a multinational and multilingual Habsburg Empire.[2] Although the firm J. Steinbrener that produced the almanacs operated under royal privilege, profit making relying on the economies of scale constituted the primary motive for their publication. While commercially viable, the firm was also working within an establishment ideology. It supported the elite structures as a state-supported operation that maintained a political motive as well. The line of military almanacs had limited free distribution to the conscripts in the Austrian army (according to information in the advertisements) (Dalbello, 2002), thus assuming the character of official and sanctioned publication. The texts themselves are politically conservative, a sophisticated enactment of the Habsburg myth through glorifying the imperial family and the imperial wars.

The firm distributed its publications (in at least 21 different languages) throughout the Habsburg realm, Europe, and overseas (Dalbello, 2002). The almanacs composed a quarter of its output; they were aimed at a more compact market in Central and Eastern Europe. The examples for this analysis come from almanacs for the Croatian market published between 1900 and 1908, but they exemplify a broad-ranging book trade. J. Steinbrener perfected publishing by formula using systematic translation. The almanacs and the pictorial diagrams analyzed here are direct translations of widely circulated counterparts in German, Czech, and Polish.[3] Variant titles aimed at a particular language market were assembled at once[4] and plates were revised for editions in other languages.[5] The output of almanacs by J. Steinbrener was over 8 million in 1900; by 1910, production increased to 10 million.[6] These profusely illustrated almanacs were of superior quality. Their illustrations were meant to engage the reader and provide information. Along with the new ways of presenting information (particularly statistics), the almanacs were replete with minutiae about imperial wars, European royalty, and customs of people in distant lands. Such information is related to the total context of the almanacs, which was close to oral folk tradition. The visual statistics in the almanacs can thus be contextualized within an established textual tradition and knowledge structure within which they were informative.

[2] Some of them were distributed to the conscripts of the then-largest standing army in Europe on the eve of World War I, in a society with literacy levels as low as 10%.

[3] A comparison of titles in the sample from the Czech National Library, with these Croatian titles, shows a direct correspondence (Dalbello, 2002).

[4] Bibliographical evidence is found in binder's marks at the bottom left corner of some gatherings ("Hr.," with a number added), probably an abbreviation denoting "hrvatski" or Croatian edition.

[5] Designations "Hr." or "Hrvat." (both abbreviations for "hrvatski" or Croatian) are found in the bottom margin of all advertising pages. Such binder's notes in our examples indicate that the plate would be included in the Croatian edition of the almanac. This means that the firm recycled plates, but also used the same advertisements for all editions distributed in the Croatian market.

[6] By 1930, over 34 million almanacs were launched annually into the market that ranged from North, Central, and South America to Egypt, Indochina, and New Zealand according to Kádoch František's, Sto let knihtiskárny ve Vimperku (Vimperk: Stráe tisk. závody, 1972, pp. 14–15). The figures quoted in the Oesterreichisch-Ungarische Buchhaendler-Correspondenz: Festnummer anlaesslich des 50jaehrigen Bestehens, 1860–1910 (Wien, 1910), I, 20; II, 11 slightly vary from the ones reported by Kádoch František.

6. An analysis of visual statistics as tool for world making

The analysis of the visual statistics circulated in popular illustrated almanacs starts by introducing the exemplary diagrams from a sample of Croatian almanacs, followed by analysis of that research corpus from three perspectives:

- visual rhetoric (persuasive aspects);
- visual pragmatics (how they make knowledge and information visible); and
- how they create meaning through visual semantics and historical context.

The analysis integrates historical and cultural interpretations with visual analysis methods. Thus, it combines macro-level (historical interpretation, modernization theory) with micro-level analysis (visual sense-making, rhetorical analysis). The nature of visual reasoning and the relationship of texts and images are considered first, followed by the analysis of the nature and structure of visual sense making. The historical context and the culture of reception for these early statistical representations for popular consumption are presented last.

6.1. Diagrams

The diagrams provide a record of the official state ideology in a period preceding the dissolution of the multilingual and multinational Habsburg Empire in 1918. They present data about relative military strength of world powers, export/import ratios, relative wealth, emigration statistics, and currency relationships (see Fig. 1) to the readers for analysis, comparison, differentiation, and decision (Tufte, 1990, p. 105).

The plate titled "Languages of the World" (D4)[7] personifies hierarchical relationships within the language families by stereotypical representations of their speakers. "Population Growth in Various Countries" (D2) presents incremental population growth from 1880 to 1920. Both examples fit within a European tradition of stylized stereotyping[8] that conceptualizes the world as unit divisible by nation. Rooted in what was common sense for their readers, the diagrams could be intuitively understood by someone with a limited understanding of statistical methodology. They were aimed at "image-thinkers" close to the oral tradition (Havelock, 1963, pp. 3–19, 266) who relish the mimetic and are averse to abstraction. Information presented in the diagrams merges scientific rationality with culturally defined categories.

[7] D1–D12 refer to diagrams referred to in the text of this article. Table 1 provides a list and the description of the diagrams. Fig. 1 reproduces them. D12 reproduces an ISOTYPE chart.

[8] Running parallel to national differentiation, this tradition is reflected in another visual artifact from Steiermark (Austria), dated ca. 1720/1730, known as "Völkertafel" (Table of Nations) (Stanzel, 1998). This artifact is one of the early examples of diagrammatic stereotyping presenting a typology of national traits of the Europeans that was disseminated in a wide range of cultural texts and literature. Commercially circulated imagery of the "Perfect European" is an ironic continuation of that tradition.

6.2. Visual rhetoric: Representation and persuasion

The graphics are labeled with colloquial titles in the form of a question (see Table 1). These questions anticipate an information need. Diagrams convey information through anthropomorphic presentations that link conceptual and abstract data to experiential reality.

These diagrams explore relations of power among the nations on the eve of World War I. They focus on the contemporary underlying structures of the economic, military, and population development of the nation–state in a balance-of-power system. In the tableaux, the nations and countries become objects with distinct visual attributes that can be compared, measured, and treated as essential qualities attached to a population. They exemplify stylized stereotyping but are also concrete and memorable representations of a world system and the ideology behind it, reflecting doctrines that informed popular opinion in Austria-Hungary at the time. They provide an insight into the interpretations of national identity in the period preceding World War I. They depict a world mapped into a system of competing colonial powers in a state of war readiness as a frame of reference. Organized around military and economic supremacy, the balance of power implies an industrial order and rational social management.

The functional responsibilities of the modern state combine the welfare and material security of its citizens with the traditional goals of maintaining security and order (McGrew, 1995, p. 249). This is in agreement with the themes found in a number of diagrams that deal with population statistics and statistical inference. The statistics are related to rational management—focusing on population, urbanization, military strength, and emigration. Their focus on the growing cities, large-scale migrations, and the military–industrial complex exemplify the preoccupations of modernity.

6.2.1. Argumentation: Text/image

Although the visual diagrams could be comprehended independently (and used as wall charts), each of them has an associated narrative, which presents the underlying numerical values. Thus, the movement from data to text and from data to image can be seen to work as parallel. And, it is in that movement that the problem of bias can arise, and persuasive arguments can be introduced. Even though the images and the text can be read separately, the full reading emerges once the data are explored by means of the text, and the text contemplated by means of the image.

The argument of the narrative is often introduced with a rhetorical question. In a typical example, the "almanac" addresses the "reader":

> Each person wants and needs to eat and drink, because he wouldn't be able to survive without food and drink. What do you think, dear reader, how much have you eaten and drunk in your life? (Šareni svjetski koledar, 1901, pp. 81–82) (D1).
>
> What do you think, dear reader, how many languages would a person need to know or at least understand, to be able to travel the whole world using the knowledge of languages? Would you need to know all the languages that are spoken in the whole world? (Šareni svjetski koledar, 1903, pp. 89–90) (D4).

The knowledge structure into which such arguments are mapped is encyclopedic. This encyclopedic purpose is elaborated in narratives that accompany each of the diagrams. The

narratives present the data though they do not reveal the identities of first-hand sources of data. They do not indicate whether statistics were based on systematic observations of whole populations, or randomized sampling. Nevertheless, the omission of sources is expected in the context of a popular almanac because these diagrams do not make claims of being scientific. They use membership in a class and representation of a prescribed quantity as basis for reasoning. The following example shows how factual knowledge is tied into a commonsense system, thus integrating into the life-world of the readers what would not constitute their immediate experience.

> Each year a large multitude of people moves across the ocean, to establish a new home for themselves and to seek a new country and new happiness. You will ask me, dear reader, to which countries are most people moving to? And, I can tell you immediately: to the United States of America. (Šareni svjetski koledar, 1905, p. 113) (D7).

The discussion of emigration facts and figures follows. The narrative is concluded with a twist as the meaning of the diagram is turned into a cautionary tale:

> While the circumstances of the New World seem so attractive, all is not gold that shines. Many people have emigrated with the best of hopes, and they left their best years in the service of a foreign people greedy for profit, and what happened? [description of hardships they experience omitted]. *Therefore, let anyone think very well, before they leave their country, so that they wouldn't regret it badly afterwards!* (Šareni svjetski koledar, 1905, p. 113) (D7).

The narratives are used for the purpose of presenting numerical values as a table would (though the values for some variables are missing). They shape the intended reception of the diagrams through the use of morality tales and commonsense calculations.

In another example (D6) the size of the Russian army is described thus:

> Russia by itself could, in the case of war, send some 3,700,000 to the battlefield today, with military training and fully equipped, which could, together with the civilian uprising, be increased for another 1 million. Would you, dear reader, to get at least some notion about that great military mass, imagine how the whole Russian army in war readiness is lined along a road, the infantry units in four-row alignment, and cavalry in two-row alignment, cannons and mobile units one after another: and then let that enormity pass in front of you. Do you know how long would that last? 18 days and 18 nights, without stopping! (Šareni svjetski koledar, 1904, p. 113) (D6).

Comparison to other armies follows—integrating the reader into the diagram as a viewer, using familiar geography and a temporal variable defined in relation to the viewer. These arguments exemplify mathematics practiced by "just plain folks" in the context of everyday life (Lave, 1988). Information presented ranges from linguistic taxonomies (hierarchical systems) to descriptive and comparative statistics. These diagrams structure knowledge in the context of policy presented for the ordinary citizen.

6.3. Visual pragmatics

6.3.1. Design and evaluation principles

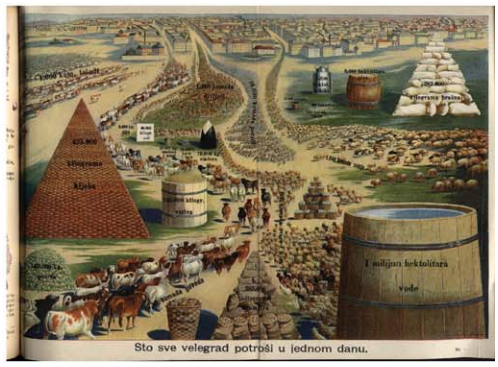
First, visual representations aggregate information (a) to enable processing of large quantities of data; and (b) to provide an enhanced understanding or to act heuristically to generate new ideas (Tufte, 2003). Secondly, people process visual information in stages: (1) rapid parallel processing that can detect pre-attentively differences in position, distance, length, size, color, texture, and between simple shapes; (2) serial goal-directed processing that can perform more complex spatial reasoning and object



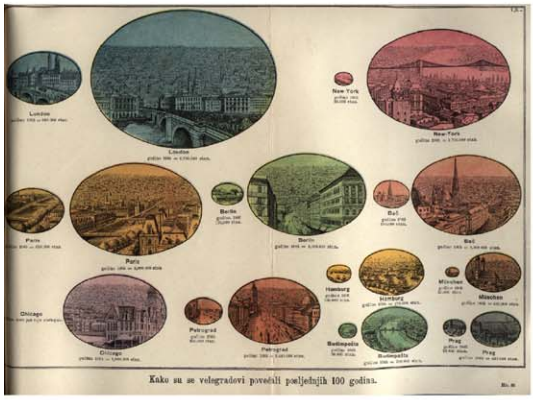
Fig. 1. Diagrams published in Šareni svjetski koledar (1901–1909): "What Different Nations Eat and Drink" (D1); "Population Growth in Various Countries" (D2); "Which Countries are Able to Feed their Population, and Which ones Need to Import their 'Daily Bread' from Abroad" (D3); "Languages of the World" (D4); "Where does Money Come From and Where Does it Go To?" (D5); "Military Power of Various Countries on Land and on Sea in 1904" (D6); "Where Most People are Moving To and From?" (D7); "What Does a Metropolis Consume in a Day?" (D8); "Increase in the Size of Cities in the Past 100 Years" (D9); "How Many Civilians are There per Soldier and the Cost of One Soldier per Year" (D10); "USA and Japan in Relation to Each Other" (D11). By permission of the National Library of Croatia. "Casualties in the Great War 1914–1918" ISOTYPE chart, ca. 1933, by Otto Neurath, Gerd Arntz, and Marie Reidemeister-Neurath (Hollis, 2001, p. 18) (D12).



D7



D8



D9



D10



D11



D12

Fig. 1 (*continued*).

recognition tasks (Ware, 2000). Further, Tufte (1990) has identified a set of principles for designing visualizations of numerical data that are relevant for the analysis of these visualizations (see Table 1 for their application): (1) enable visual comparisons (T1);

(2) show multiple variables (T2); (3) use small multiples to visualize multivariate data (T3); (4) show comparisons adjacent in space (within the eye-span) (T4); (5) use direct labeling by integrating words, numbers, and images (T5); (6) avoid distorting the data size of the effect created in the display is proportional to the effect in data—by minimizing the "Lie Effect" (T6); (7) avoid "chart junk," such as adding visual flourish that is not related to the data (T7). Therefore, the underlying structure of visual statistics can be analyzed in terms of the visual coding principles used, the type of visual processing required, and how they conform to the design principles identified by Tufte (see Table 1). The degree of distortion (or "Lie Factor") that is introduced by a particular visualization is also analyzed because it is an important threat to the analytical integrity of these diagrams. In particular, the use of visual areas to compare values can lead to distortions, since if both the visual height and width are doubled, then the visual area is quadrupled. In the pictograms analyzed, this type of distortion is minimal.

6.3.2. Perceptual and design properties of anthropomorphic visualizations

The visual coding and design principles are identified in Table 1. The displays encode the data using visual properties that can be easily detected by rapid and parallel visual processes, thus not requiring a great deal of cognitive effort on the part of the viewer. Simple shapes are used, such as rectangles, symmetrical triangles, circles or ellipses, and human figures to visualize categorical data properties. Smaller objects are placed in front of larger ones to create a depth effect. People are very proficient at inferring depth relations based on simple occlusion cues and using them to infer size difference between visual items (Ware, 2000). The introduction of depth cues taps into human spatial reasoning skills—what is in front, what is behind, what is larger, what is smaller—and facilitates the comprehension of abstract data. The diagrams do not make gratuitous use of perspective effects that undermine the data integrity. All diagrams enable visual comparisons (T1), and use direct labeling (T5). Most displays do not distort the data (T6). If they do, the distortion is due to the use of human figures to represent the data, and the "Lie Factor" is minimal because the heights of the figures encode the data accurately.

6.3.3. Anthropomorphic visualization: Facts, narrative structure, formalization (a case study)

"What Different Nations Eat and Drink" (D1) provides a good example of how the numerical data is translated into a visual form that leverages intuitive visual reasoning skills. This diagram is a hybrid representation of numerical and categorical data. Although not providing a visible scale, it enables the viewer to infer the relative importance of foods and beverages consumed by eight different nations. Naturalistic icons are used to indicate the type of food or drink being consumed (teapot for tea, loaf of bread and pretzel for bread and flour, images of animals for meat); the height, width, or area of an icon is used to encode numerical values.

One can identify the representatives of eight nations (Austrians, Germans, Italians, French, Russians, English, North Americans, Chinese)—designated through conventional iconography

Table 1
Statistical diagrams published by J. Steinbrener, 1900–1908 (N = 11)

Title (code-source)	Subject (data type)	Visual coding/design principles
What Different Nations Eat and Drink (**D1**-SSK 1901)	Food and drink (quantitative) by nation (nominal)	Shape, color, and texture for food. Length (height or width) or size (area) as well as fore-/background for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T2, T3, T4, T5, and T6.
Population Growth in Various Countries (**D2**-SSK 1902)	Population growth (quantitative)	Height for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, (T2), T3, T4, T5, and T6.
Which Countries are Able to Feed their Population and Which Ones Need to Import Their "Daily Bread" from Abroad? (**D3**-SSK 1903)	Export/import (quantitative) by nation (nominal)	Height (and width) for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T5, and (T6).
Languages of the World (**D4**-SSK 1903)	Language families (nominal)	Height (and width) and fore-/background for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T4, T5, and (T6).
Where Does Money Come From and Where Does it Go To? (**D5**-SSK 1904)	Flow of currency and goods (quantitative) for different nations (nominal)	Shape, color and texture for type of goods. Area of square for quantity, and height of figure for size of nation. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T2, T3, T4, T5, and (T6).
Military Power of Different Countries on Land and on Sea in 1904 (**D6**-SSK 1904)	Military power (quantitative) by nation (nominal)	Shape, color, and texture for ground and naval forces. Flag symbol for nation. Height for ground and width for naval strength. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T2, T4, T5, and T6 for height, not T6 for width.
Where Most People are Moving To and From? (**D7**-SSK 1905)	Emigration and immigration (quantitative) by nation (nominal)	Flag symbol for destination. Height for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T2, T4, T5, and (T6).

Table 1 (*continued*)

Title (code-source)	Subject (data type)	Visual coding/design principles
What Does a Metropolis Consume in a Day? (**D8**-SSK 1906)	Consumption (quantitative) by food type (nominal)	Shape, color, and texture for food. Length (height or width) or size (area) for quantity. Depth and perspective effect to accommodate large dynamic range. Tufte's principles: T1, T2, T5, and T6.
Increase in the Size of Cities in the Past 100 Years (**D9**-SSK 1906)	Population (quantitative)	Color and iconic shapes for city. Area of ellipse for quantity. Tufte's principles: T1, T3, T4, T5, and T6.
How Many Civilians are There per Soldiers; the Cost of One Soldier Per Year (**D10**-SSK 1907)	Ratio of civilian and military power (quantitative)	Flag symbol for nation. Height of bag as well as length and number of shapes for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T3, T4, T5, and T6, not T7.
USA and Japan in Relation to Each Other (**D11**-SSK 1909)	USA/Japan comparison (quantitative)	Shape and texture for different types. Height or area for quantity. Stereotypical human figure for nation using color, texture, and subshapes. Tufte's principles: T1, T2, T3, T4, T5, and T6.

Source: Šareni svjetski koledar (SSK) (1901–1909). Codes (D1–D11) in the text of the article refer to specific diagrams. Fig. 1 displays the diagrams. T1–T7 refer to Tufte's principles of analytical design discussed in text.

of dress in which, for example, the Englishman sports a tropic explorer outfit with an umbrella, the North American a broad-rimmed hat, and the Russian a military service hat. Foods are indicated in terms of vessels, animal types, and shapes. The consumption of nine food and drink categories are visualized for each nation. Shape, color and texture coding are used to visualize the different food and drink categories (potato, bread/flour, rice, tea, beer, wine, brandy, fish, meat). In terms of the shape used to represent meat, there are variations. The symbol of the cow is used to represent meat throughout except lamb and cockerel used for Italy and France, respectively. The size variations apply to the food and drink data only, while the "nationality" objects are independent variables that remain unchanged. The range of the numerical data is visually communicated through variation in the size of visual area (potato, bread/flour, and tea), height (rice, beer, wine, brandy) or width (meat and fish); all these visual attributes can be easily detected and measured by the human visual system (Ware, 2000).

The data are arranged in small panels of equal size to enable comparison, which is consistent with Tufte's principles of using small multiples (T3) to facilitate visual comparisons (T1). The spatial position of a specific food or drink is not necessarily the same in each panel but its visual icon can be easily detected because of its distinct visual shape. The display places the smaller items in front of the larger items so that the latter do not completely occlude the former, thereby creating a depth effect and reinforcing the size differences between the food items.

6.3.4. The underlying structure of anthropomorphic visualization

It is possible to display the data without the cultural and narrative features used in the originals. The same statistical data can be visualized with the most abstract way of representing the data using length, color, and position coding, and then adding progressively more visual cues. Fig. 2 shows how the food consumption diagram (D1) can be decomposed into its basic form, and then reconstructed by adding more visual coding cues.

This series of visualizations makes it possible to measure the reliability of visual encoding used and the degree of the "Lie Effect." To achieve a naturalistic appearance, visual objects may have to be rendered to appear larger or smaller than the numerical value they are supposed to represent. An analysis of the visual dimensions of a food item, such as its height, width, and areas, shows that the numerical data are visualized accurately and proportionally, except at the lower end of the scale where items in the diagram are larger than the actual food consumption. Table 2 displays the numerical values for each food and drink category. Since values vary greatly in magnitude, a logarithmic scale is used to display them in a bar chart. Visual height and width of the objects used to encode the data are measured. Finally, the ratios between the numerical values and the visual dimensions (width, height, or area) are computed, and visual dimensions whose ratios have the smallest variance or highest number of similar values are selected. Table 2 shows that the ratio values are highly similar, except for the smallest values (shown in italics) or the greatest values (shown in bold). Thus, the underlying visual structure of the diagram is sound and the "Lie Effect" is minimal for the major items in each food and drink category.

Fig. 2 (top left) uses multiple bar charts. Each bar chart encodes a specific food type using the same color and placing it in the same position. Fig. 2 (top right) displays the same data but adds shape coding and a simple form of depth coding by placing the smallest items in the very front and the largest in the very back to create a visual ranking of the items. Now, the same item is not necessarily in the same position. However, this display taps into human pattern recognition skills and uses different shape and color coding to represent different food items. This makes it easier to find the same items in different multiples. In Fig. 2 (bottom), shading and texture coding are added to make the food items visually more distinct and easier to detect and compare. This increase in visual realism makes the displays more compelling and easier to comprehend for an ordinary person. This type of visualization also introduces cultural innuendo that reinforces stereotypes, which may make the data appear as more arbitrary and less truthful than an abstract bar chart display. As Fig. 2 shows, the naturalistic display has an underlying abstract visual organization that represents quantitative data accurately (T6) and achieves a balance between communicating the data truthfully and making it accessible.

6.4. Visual semantics: Visual design of statistics and the concerns of the modern state

The integration of statistical arguments into a commonsense system creates an integrated knowledge structure and thus may provide justification for collective rationality and policies of the state. This section explores how these few exemplary statistical representations can be

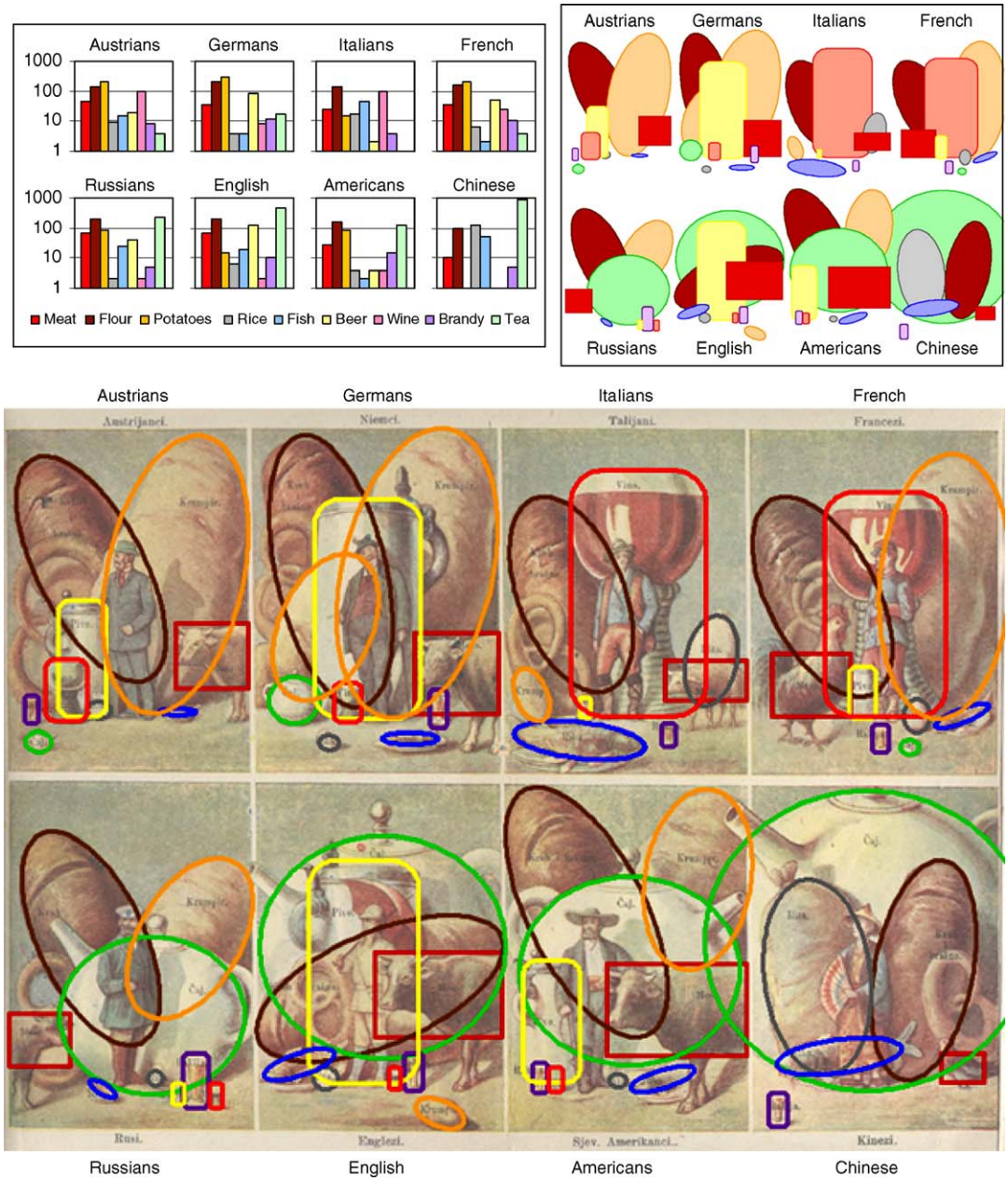


Fig. 2. In the diagram titled, "What Different Nations Eat and Drink," from Šareni svjetski koledar (1901), visual structure and coding principles are employed to encode the food consumption by different countries. Top left displays the data using bar charts, where the order of the bars is identical to the order of the food types in the legend. Top right shows the shape coding used to encode the food types. Bottom superimposes the shape coding on top of the actual figures.

Table 2
Numerical values for food and drink categories for diagram "What Different Nations Eat and Drink" (1901)

	Meat	Flour	Potato	Rice	Fish	Beer	Wine	Brandy	Tea
America	70	206	80	2	25	40	2	5	230
England	68	200	15	6	20	120	2	10	450
France	44	142	190	9	15	20	98	8	4
Germany	38	190	300	4	4	90	8	12	18
Austria	34	164	200	6	2	50	24	10	4
Russia	28	155	90	4	2	4	4	15	118
Italy	25	138	15	18	45	2	100	4	0
China	10	100	0	120	50	0	0	5	900
	W|H	W|H	W|H	W|H	W|H	W|H	W|H	W|H	W|H
America	120|79	131|220	93|156	15|11	55|22	49|105	12|21	13|26	189|162
England	108|73	211|126	42|26	21|19	60|33	94|192	10|19	16|32	211|191
France	67|54	120|172	113|228	22|29	46|21	23|45	104|197	14|24	16|13
Germany	72|70	105|234	138|249	17|13	48|10	91|189	23|34	15|33	43|40
Austria	60|56	128|194	126|239	20|15	31|6	41|100	36|53	12|24	22|18
Russia	52|45	119|184	108|138	13|13	22|15	10|18	11|21	22|47	159|135
Italy	70|34	106|168	31|46	46|78	112|33	9|17	116|212	12|20	0|0
China	37|25	90|189	0|0	93|168	107|32	0|0	0|0	16|29	279|258
	⇩ Width	⇩ Area	⇩ Area	⇩ Height	⇩ Width	⇩ Width	⇩ Width	⇩ Width	⇩ Area
America	1.7	110	142	*5.5*	2.2	2.6	*10.5*	*5.2*	105
England	1.6	104	*57*	3.2	3.0	**1.6**	*9.5*	3.2	70
France	1.5	114	106	3.2	3.1	2.3	2.0	3.0	*41*
Germany	1.9	102	120	3.3	*12.0*	2.1	*4.3*	2.8	75
Austria	1.8	119	118	2.5	*15.5*	2.0	2.2	2.4	*78*
Russia	1.9	111	130	3.3	*11.0*	*4.5*	5.3	3.1	143
Italy	2.8	101	75	4.3	2.5	*8.5*	2.1	*5.0*	0
China	*3.7*	*134*	0	**1.4**	2.1	0.0	0.0	*5.8*	63

Note. (Top) The numerical values for the different food and beverage categories, measured in terms of "kilos" or "liters" as appropriate. (Middle) The visual width (W) and height (H) of the shapes used to encode the numerical data, measured in terms of pixels. (Bottom) Shows which visual property (width, height, or area) most accurately and proportionally represents the data as well as the ratio of the visual value and the numerical data. Food or beverage values that have relatively small/large data values are shown in italics/bold and using a smaller/normal font size; the ratios that are highlighted do not accurately reflect the data.

analyzed in the context of the Austrian state and the concerns of its citizens. (The authors make no claims about the actual reception of the diagrams by contemporary readers of the almanacs because of a lack of historical evidence. The publishing and distribution patterns and the large size of editions are taken as indication of impact.) The semantics of the diagrams can be interpreted in the information policy context of the modern state, though further research is needed to connect them to specific policies of the Habsburg monarchy on immigration and international relations. The visualizations of statistics circulated in different national markets of the empire can be seen as an attempt to define a national community through quantitative relationships and statistical facts. Therefore, it is justified to apply the

analytical framework identified by the theorists of the modern state development to a monarchy context because they reflect a distinct national point of view as Austria-Hungary is depicted in relation to other players of the world system. These information artifacts recreate a multinational empire into an "imagined" national community (Anderson, 1991).

6.4.1. The human river on the move: A century of mass emigration

"Where Most People are Moving To and From?" (D7) deals with an immediate reality for many of the readers of the almanac. Large masses of people were on the move between 1880 and 1910 from the Old to the New World, with 1905 as year of peak migration from Austria-Hungary. Such movements and ruptures in the identities of citizens challenged the state while epitomizing modern subjectivity (Appadurai, 1996, pp. 4, 156).

The iconography of national stereotypes is used to represent immigration/emigration statistics for 1905. The Austrian émigré is a beggar-like figure carrying all her possessions in a satchel. A desolate figure of a displaced person must have struck a chord with the readers of the almanac, playing upon the reality of emigration from Austria-Hungary and Italy, which mostly involved rural populations. A peasant woman who represents Austria-Hungary follows an Italian peasant male figure. The female and male figure in succession can be read as a couple emigrating together, a woman more fragile in stature; the man's gaze is straight to the left and "into future," whereas the woman's gaze is cast down. The succession of émigrés include a Russian peasant (muzhik), an Englishman in a safari suit with an umbrella and a valise (hardly an image of an impoverished emigrant), and a Spaniard dressed as a toreador, which adds a comical effect to the image. The semantic frames for interpretation of the realities of emigration are its connection to rural poverty and disillusionment (resulting in the desire to evade conscription for Austria-Hungary's imperial wars).

The objective quantity represented by this diagram is semantically enriched through narrative (metaphoric) play. A "Lie Factor" can be introduced when known objects, such as people, are used to represent the numerical data. If the height of a familiar object is linearly proportional to the numerical value it represents, as is the case in this display, then the object's width has to be scaled accordingly to maintain its natural and recognizable appearance. The width and height of a visual object tend to be perceptually nonseparable—its height cannot be judged independent of its width. This makes its visual area perceptually dominant (Ware, 2000). This display scales both a person's height and width so that the resulting area is not proportional to the numerical value being represented, and thus it introduces a "Lie Factor." It can be argued that people are able to judge another person's height irrespective of the person's width. According to Tufte's principles, to display the data without distortion (T6), the visual integrity of this diagram is slightly compromised; on the other hand, the ordinal relationships are preserved and a figure's height accurately reflects the numerical data. Overall, the diagram preserves conceptual integrity and at the same time facilitates visual processing and visual argumentation.

6.4.2. Rise into the sky and rush into the future, or the birth of metropolis

The metropolis is the central protagonist of modernist cultural narratives from the turn of the century and into the 1920s. The modern urban environment provides challenges for

rational management of masses of population and political crowds. The city is a cross-section of the public and the private spheres, of utopian and dystopian narratives of modernity. It is an important consideration in the ideologies of the modern state. The metropolis is the theme of two of the diagrams—"Increase in the Size of Cities in the Past 100 Years" from 1906 (D9) and "What Does a Metropolis Consume in a Day?" from 1905 (D8). The first provides an examination of urban development for 11 cities (London, New York, Paris, Berlin, Vienna, Chicago, Petersburg, Hamburg, Munich, Budapest, and Prague). This diagram is a multivariate design that combines time and quantity, comparing the 11 cities in terms of size at different points in time. An ellipse represents the size. Its area is proportional to the numerical value it represents, and the data are encoded without distortion (T6). The ellipse shape is an excellent choice because it affords flexibility in terms of its width and height and it still remains recognizable. The features of the cities in the oval-shaped medallion represent cityscape instantly recognizable to a traveler's eye. Distinctions are achieved through the iconography of city landmarks and color. The display taps into the genre of an oval medallion portrait, a peephole, as if seen through a camera lens or a postcard. The shape is reminiscent of the image genres widely distributed in the 19th century, thus setting the cultural context for viewing this image and tapping into different genre frames.

The city is the stage for movement of human multitudes matched by the rivers of food of a metropolitan cornucopia in the diagram "What Does a Metropolis Consume in a Day?" (D8). Urban exuberance and urban management are seen in the perfect harmony. The metaphor of the city combines travelers' tales with futurist focus on speed in the movement of pigs and deer, a monumental cattle drive, and droves of chickens, all heading to the city in an organized frenzy and with an overwhelming sense of purpose. Mountains of bread, stew, and salt—endless rivers of food—complete this futurist theme.

This display presents the challenge of how to represent very large and very small values simultaneously and accurately. The diagram creates a sense of depth by having the animals move into the distance and their size is progressively reduced to create a perspective effect. An analysis of the visual attributes used to encode the different foods and beverages shows that most items are visualized accurately (T6). The beverages have the greatest dynamic range, and their visual area is used to encode their numerical values. Although a nonlinear scale is employed, the ordinal relationships are preserved.

6.4.3. Balance of power system: Competitive states in an international system

The modern state was forged by an intersection of external and internal forces. In an established world order, rational management of state resources is balanced against the resources of other players. In a diagram from 1909, titled "USA and Japan in Relation to Each Other" (D11), this aspect is explored in a visual argument. Compared are relative sizes of the two countries, population density, and the deficit in relation to government income and debt. Texture coding is used to show density of population—and people are good in detecting texture differences (Ware, 2000). The existing debt is slightly higher for the United States, but compared to the income, it is lower than in Japan. Visual height encoding is used without distorting the data (T6). The next panel focuses on militarism, comparing the standing armies of the two states. Taking into account the passive army (which is represented by a shadow

behind the image of an active soldier), the military strength and the fleet of the United States are greater than Japan's. The data are encoded using visual height without distorting it (T6). This diagram interprets and explains the balance-of-power system. Comparison of quantities is integrated with arguments about the arms race. That the political community consisted of favored and nonfavored nations is conveyed through iconographic subtlety and narrative explanation accompanying this diagram.

6.4.4. The discourses on welfare and warfare in a global society of nations

The preoccupations with welfare and warfare dominate as themes for the pictorial diagrams. This reverberates with the functional responsibility of the modern state in addition to the traditional goals of maintaining security and order—to provide welfare and material security of its citizens (McGrew, 1995, p. 249). Theorists of modern state development identify a transformation from the warfare-dominated to welfare-dominated state in advanced capitalist nations in the post-World War II era. The consistent rise for nonmilitary expenditures (as a percentage of the GNP) in Britain, France, United States, and Japan begins in the 1920s (McGrew, 1995, p. 249). In the earlier period, military expenditure as a percentage of state budgets was highest in 1900 (for France, United Kingdom, Netherlands, and Denmark).

6.4.4.1. The welfare state. The supremacy of states is based on their ability to provide material security and to balance internal and external economic forces. Two of the diagrams provide an insight into common features and broad similarities of nations: "Which Countries are Able to Feed their Population, and Which Ones Need to Import their 'Daily Bread' from Abroad" from 1903 (D3) and "Where Does Money Come From and Where Does It Go To?" from 1904 (D5). They both explore the issues of sovereignty (based on economic self-sufficiency) and comparative GNP, thus focusing on the interplay of external and internal forces in a nation–state system.

6.4.4.2. The warfare state. The profound significance of war and modern warfare has been recognized as a central preoccupation of the advanced capitalist state (McGrew, 1995, p. 249). The modern state is synonymous with military force and security. The logic of militarism and an arms race in the balance-of-power system emphasize expansion, military preparedness, and war as catalyst in remaking the world order. The maintenance of a standing army from the point of view of the nation–state secures defined borders. Involvement in an international system of the distribution of power is managed through alliances among nations. Two diagrams, "How Many Civilians are There Per Soldier Per Year" from 1907 (D6) and "Military Power of Different Countries on Land and on Sea in 1904" (D10), explore the relative size of the standing armies and the military strength of states. The contemporary state of the arms race (D6) shows Great Britain as the predominant naval power. Russia has the largest standing army. In succession of size of the standing army are Germany, France, and Austria-Hungary, Italy, Great Britain, Turkey, and Spain. Following these are a number of small forces, many of which do not have a navy. China and Japan, Morocco, Mexico, Venezuela, and the United States are listed last. The United States—as we learn from the narrative—may become a surprise factor, in comparison to European players in relation to each other.

The image plane is divided diagonally. The bottom triangle displays the ground troops, which are ordered horizontally (based on troop strength and geographical continent), and use visual height to encode the data without distortion (T6). The top triangle depicts naval strength, where the ships are positioned vertically so that they are aligned horizontally with the corresponding ground troops icon; the ships' width encodes the data proportional to navy strength in most cases. The bottom triangle acts as the foreground and represents the land forces, whereas the top triangle represents the background sea in the distance, thereby creating a subtle depth effect and spatial organization of the data.

A simple statistical description is imbued with the narrative of political debates, building a quantity image around an existing cultural text. Popular discourse and literature on the inventory of causes for World War I agree on the importance of nationalism, imperialism, Otto von Bismarck, alliances and their collapse, the arms race, crises in Africa, Bosnia (1907), and the assassination of Archduke Ferdinand. In a text published in an article in 1915[9] in one of the almanacs, the causes of World War I are explained by a dynamic in which nations are endowed with emotional purpose. According to that text, "hating Russians," "English jealousy," and "French vindictiveness" fuel the war machine, preferred to an explanation based on a struggle over dominance and resources. This was obviously intended as wartime propaganda, reflecting a contradiction in which the documentary and the fictional are merged.

6.4.4.3. . . . And the aftermath. The falling dominoes of the existing balance-of-power were a combined result of an over-reaching ideology of the nation–state. A diagram that depicts in an abstracted style the aftermath of World War I, published in 1933, shows in typical Isotype fashion the two hostile alliances in conflict (Fig. 1; D12). The objects (each character stands for a number of units) are abstract human images representing warring partners. They are action figures and their activities carry the meaning of this diagram, while the quantitative information cannot be easily inferred, because the viewer has to employ visual counting routines and cannot use simple shape comparisons to infer size differences. Further, the troop units are arranged in rows of ten, but the row lengths are not identical for the two armies being compared, introducing noticeable distortion. This visualization aims to present the data in a compact and abstract way, unencumbered by cultural baggage, perspective distortions, and spatial occlusions. However, by applying such a minimalist data mapping, the viewer can utilize fewer pre-attentive and parallel visual processing skills (Ware, 2000). Instead, the reader has to employ serial cognitive processes, such as visual counting, to infer data relationships. Still, the Isotype is aesthetically well executed, with a powerful central argument around the number of dead and crippled soldiers.

The sanitized objectivity of the Isotype representation jars with the emotional force conveyed in the naturalistic visualizations of the earlier period, in which the narrative is built around the interpretive possibilities of a world ordered in relation to fixed entities of nations. Both of these designs are meant to inform the ordinary citizen, though the Isotype display applies the aesthetics of functional modernist design, while it retains some narrative features and requires more cognitive effort on the part of the viewer.

[9] Šareni svjetski kalendar (1916, p. 119).

7. Information "through a glass darkly": A tenable paradox after all?

Symbolic and referential uses of information cannot exist separately. The analysis of visual statistics in the examples presented here points to the effectiveness of integration of universal knowledge within the frames of everyday life, life-world (phenomenological Lebenswelt), and commonsense knowledge in addition to the visual and cognitive skills of the intended audiences. The anthropomorphism of the diagrams and the use of depth and shading effects provide the context to support visual reasoning. The analyzed visual representations merge context dependent with factual, exemplifying "information as metaphor" in presenting information for popular consumption.

These examples have shown that it is possible to build upon representations that ordinary people have of technical information (Latour, 1993, p. 100) without compromising the rationality of information. The resulting "information–knowledge" hybrids construct information as social language and encompass localization and universality. Considering popular venues for technical information as co-extensive with formal channels, that is, as a means for social negotiation of knowledge and participation of ordinary in knowledge creation in education and democracy, need not be limited to technocrats and politicians. Applied to the design of information displays, this approach conforms to the veritistic ideal of truth seeking because it taps into the visual structures with the most common denominator and not the avant-garde representations.

Visual design that presents complex data sets for popular consumption and makes them accessible can increase usability of information and increase the scale of its transfer while assuring the integrity of information. The early visual diagrams discussed here demonstrated how the use of natural representations supports processing of complex data. The question of fictional, inept, corrupt, or banal in relation to visual representation of statistics is a question of liability of statistical information in general. Likewise, the use of cultural material in visualization may contribute to ease of comprehension, but the use of cultural iconography (based on traditions of stereotyping) is problematic because of its ability to exclude or offend. The naturalistic iconography needs to be adapted to a multicultural and diverse audience in today's cultural context. The creative uses of cartoon-like scientific visualizations have shown the benefits of naturalistic representations for the comprehension of abstract information. Information visually conveyed (through picture-symbols) in contexts that are in transition from preliteracy to literacy and for visual communication may increasingly depend on such an approach to visualize multivariate data sets. The specific conclusions related to visualization and implications for information science are discussed next.

8. Conclusion

Larger data sets are ubiquitous today. In contrast, the need to aggregate large sets of numerical data for popular use was just beginning at the start of the 20th century. Designers of early instructional graphics developed the principles of visual design that worked from the basic principle of "humanization of knowledge for the eye." At the root of that principle was a

realization that information processing was dependent on everyday discourse by means of visual properties that users can easily process. By leveraging simple visual skills and relying on existing mental models and narrative conventions, people acquired knowledge. Thus, abstract statistical information not connected to the everyday experience of the users was made meaningful through the use of naturalistic and anthropomorphic visualizations, as well as the association with everyday skills and connection with commonsense knowledge. The mechanisms for reasoning in these diagrams were not esoteric, but they were heavily dependent on the use of spatial reasoning skills and narrative structures. Their anthropomorphism was used as a narrative device, invoking a mental frame for processing. The visual diagrams were state-of-the-art artifacts for the time; they presented and distributed the same media content to different language markets throughout the Habsburg Empire. The global agenda of the empire in a local context was expressed through naturalization at the visual, narrative, and cultural level that made these visuals intuitive. It is argued that such a process has high veritistic (truth-seeking) potential because it makes information about the world accessible to the ordinary citizen. The information policy agenda of the state (although before the time when information policy would be identified as such) threatens the veritistic value of these information displays through selectivity although the distortion of information is for the most part not significant.

The known examples of the diagrams date from a time that precedes the dissolution of the Habsburg Empire and the height of a balance-of-power system. It cannot be ascertained with certainty when these artifacts of visual statistics disappeared. (This requires further archival research.) Nevertheless, it may be speculated that their relevance diminishes together with the decline of the culture of reception established by the documentary practice represented by the almanacs of the J. Steinbrener firm and the cultural context of the monarchy. The end of an established textual tradition thus corresponds to the decline of knowledge structure within which the almanacs were informative. The ascent of modernist visual design may have been coincidental with the demise of an old regime and the disappearance of an earlier tradition of visualization of statistics.

9. Implications for information science scholarship

Information science is often limited to research of micro-level phenomena and with little concern about the social context. A critique of science and modernist thought has shown the limits of instrumental positivism and statistics (by extension, also the naturalization of the languages of the social sciences). In that context, critically re-examining a logico-positivist tradition in information science calls for studying information as a social language (empirically and historically). The hybrids of statistics and metaphor, of data and stereotypes, of information and mnemonics—combining cultural, historical, and information science frameworks—are a productive area for understanding knowledge creation and its dissemination in a social context. For an (information) historian, these documents provide an insight into the shaping of information policy for the ordinary citizen, the culture of the everyday (DiMaggio, 1997) and its “structure of feeling” (Williams, 1977).

By acknowledging that knowledge production is material and social in nature, modernist information science can increase the analytical effectiveness of information tools and be engaged more actively in contributing to popular involvement and information policy. Historical artifacts reflect cultural perspectives that a logico-analytical brand of information science cannot process because they are outside of delineated information-seeking behaviors and in the realm of popular culture and entertainment. The analysis has shown that visual representations, through shaping information as metaphor, are effective sources of information for the popular masses, for the "image thinkers" (Havelock, 1963, pp. 3–19, 266). They also incorporate otherwise naturalized and hidden aspects of information—its demagogic, enticing, and hyperbolic uses.

Because this article argues that knowledge depends on the materiality and scale of reproduction methods, it points to the need for the historians and sociologists of knowledge to study information tied to cultures of reception outside of disciplinary and scholarly communication and in the realm of specific documentary practices that emerge from popular culture and everyday life. This is in tune with the recent focus in information science shifting from individual to social, from an ideal, timeless, and transcendent view of information, to one that is pragmatic, historical, and integral to social processes. Considering information contextually has been a goal of knowledge management as practice; information policy research considers medium and macro-levels (institutional aspects of information flow in a social and political context). The informatics approach similarly presents a view of information that integrates technology and social processes and focuses on the concept of information as hybrid—both abstract and historically determined. These approaches recognize continuity of modernist information science but acknowledge the cultural and social nature of information.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.lisr.2005.11.015.

References

Anderson, B. (1991). *Imagined communities: Reflections on the origin and spread of nationalism* (2nd ed.). New York: Verso.

Appadurai, A. (1996). *Modernity at large: Cultural dimensions of globalization*. Minneapolis, MN: Minnesota University Press.

Barnhurst, K. G., Vari, M., & Rodríguez, Í. (2004). Mapping visual studies in communication. *Journal of Communication*, *54*, 616–644.
Bauman, Z. (1992). *Intimations of postmodernity*. London: Routledge.
Bowker, G. C., & Star, S. L. (1999). *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.
Brinton, W. (1914). *Graphic methods for presenting facts*. New York: McGraw-Hill.
Broos, K., & Hefting, P. (1997). *Dutch graphic design: A century*. Cambridge, MA: MIT Press.
Chizlett, C. (1992). Damned lies, and statistics: Otto Neurath and Soviet propaganda in the 1930s. *Visible Language*, *26*(3/4), 299–321.
Dalbello, M. (2002). Franz Josef's time machine: Images of modernity in the era of mechanical photo-reproduction. *Book History*, *5*, 67–103.
DiMaggio, P. (1997). Culture and cognition. *Annual Review of Sociology*, *23*, 263–287.
Foster H. (Ed.). (1988). *Vision and visuality*. New York: The New Press.
Foucault, M. (1970). *The order of things: An archeology of the human sciences*. New York: Pantheon.
Foucault, M. (1972). *The archeology of knowledge*. New York: Pantheon.
Foucault, M. (1977). *Discipline and punish: The birth of the prison*. New York: Vintage.
Friendly, M., & Denis, D. J. (2005, January 7). *Milestones in the history of thematic cartography, statistical graphics, and data visualization*. Retrieved August 7, 2005, from http://www.math.yorku.ca/SCS/Gallery/milestone.
Frohmann, B. (1995). Taking information policy beyond information science: Applying the actor network theory. In H. A. Olson, & D. B. Ward (Eds.) *Proceedings of the 23rd Annual conference of the Canadian Association for Information Science, 7–10 June 1995, Edmonton, Alberta*. Retrieved August 6, 2005, from http://www.cais-acsi.ca/proceedings.1995/frohmann_1995.pdf.
Frohmann, B. (2004). Documentation redux: Prolegomenon to (another) philosophy of information. *Library Trends*, *52*, 387–407.
Goldman, A. I. (1999). *Knowledge in a social world*. Oxford: Clarendon Press.
Hall, S. (1995). Introduction to "Formations of Modernity". In S. Hall, et al. (Eds.), *Modernity: An introduction to modern societies* (pp. 3–18). Cambridge, UK: Polity Press.
Havelock, E. A. (1963). *Preface to Plato*. Cambridge, MA: Harvard University Press.
Hegselmann, R. R. (1979). ISOTYPE: Neurath als bildstatistischer Aufklärer. *Otto Neurath, Wissenschaftliche Weltauffassung*. Frankfurt am Main.
Hollis, R. (2001). *Graphic design*. London: Thames & Hudson.
Holmes, N. (2001). Pictograms: A view from the drawing board or, What I have learned from Otto Neurath and Gerd Arntz (and jazz). *Information Design Journal*, *10*(2), 133–144.
International Statistical Congress. (1990). Emploi de la cartographic et de la méthode graphique en général pour les besoins spéciaux de la statistique. *Proceedings* (pp. 192–197). Vienna. 3rd Session, August 31–September 5, 1857. Retrieved August 7, 2005, from http://www.math.yorku.ca/SCS/Gallery/milestone.
Jay, M. (1994). *Downcast eyes: The denigration of vision in twentieth-century French thought*. Berkeley, CA: University of California Press.
Johnston, W. M. (1977). *The Austrian mind: An intellectual and social history, 1848–1938*. Berkeley, CA: University of California Press.
Latour, B. (1993). *We have never been modern*. Cambridge, MA: Harvard University Press.
Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, UK: Cambridge University Press.
Leary, P. (2000). A Victorian virtual community. *Victorian Review*, *25*(2), 62–79.
McGrew, A. (1995). The state in advanced capitalist societies. In S. Hall, et al. (Eds.), *Modernity: An introduction to modern societies* (pp. 239–279). Cambridge, UK: Polity Press.
Neurath, O. (1939). *Modern man in the making*. New York: A.A. Knopf.
Pink, S. (2003). Interdisciplinary agendas in visual research: Re-situating visual anthropology. *Visual Studies*, *18*(2), 179–192.

Pruim, R. (2005, January 1). [Course materials]. Retrieved January 1, 2005, from http://www.calvin.edu/~rpruim/courses/materials/stats/overheads/what-is-stats.shtml.

Šareni svjetski koledar: za godinu 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1909. (1900–1908). Winterberg: J. Steinbrener.

Spence, R. (2001). *Information visualization*. New York: ACM Press/Addison-Wesley.

Stanzel, F. K. (1998). *Europäer: Ein imagologischer Essay*. Heidelberg: Universitätsverlag C. Winter.

Stieg, M. F. (1980). The nineteenth-century information revolution. *Journal of Library History*, *15*(4), 22–49.

Tufte, E. R. (1990). *Envisioning information*. Cheshire, CT: Graphics Press.

Tufte, E. R. (1997). *Visual display of quantitative information: Images and quantities, evidence and narrative*. Cheshire, CT: Graphics Press.

Tufte, E. R. (2001). *The visual display of quantitative information* (2nd ed.). Cheshire, CT: Graphics Press.

Tufte, E. R. (2003, August 19). *Presenting data and information*. Unpublished seminar notes, New York.

Virilio, P. (1994). *The vision machine*. Bloomington, IN: Indiana University Press.

Ware, C. (2000). *Information visualization: Perception for design*. San Francisco: Morgan Kaufmann.

Williams, R. (1977). *Marism and literature*. Oxford: Oxford University Press.