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Isotype Visualizations

A Chance for Participation & Civic Education

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Abstract: *In the 1920s, Otto Neurath proposed a pictorial statistics method known as "Isotype". Isotype pictorial statistics were intended to inform the broad public and enable them to participate in society. In this article, the method is reviewed with respect to its relevance and potential for modern-day information visualization. Though some aspects are now outdated, the basic approach still has potential for information visualization and civic education. Possible new media applications are presented and their impact for civic education and participation is discussed.*

Keywords: Isotype, Neurath, information design, information visualization, mass communication

In contrast to language-based communication, information visualization plays an increasing role in media, science, and education. Information visualization can be defined as "the use of computer-supported, interactive, visual representations of abstract data to amplify cognition" (Card, Mackinlay, & Shneiderman, 1999, p. 8). It promises "to help us speed our understanding and action in a world of increasing information volumes" (Card, 2008, p. 542) and to provide insights into complex subjects, both for experts and "for the people" (Danziger, 2008). Such casual information visualizations for the people "depict personally meaningful information in visual ways that support everyday users in both everyday work and non-work situations" (Pousman, Stasko & Mateas, 2007, p. 1149). The recipients of information visualizations provided in casual situations are driven mainly by personal relevance (Sprague & Tory, 2012); they do not analyze the data, but become aware of basic patterns, gain a feeling for the data, and reflect its social and personal relevance (Pousman et al., 2007). Consequently, casual information visualizations offer rich potential for application in civic education (Windhager & Smuc, 2014).

In the participation and civic education context, information visualizations have to meet the requirements of a broad public (independent of their levels of education or prior knowledge) and should encourage a wide range of citizens to actively engage with this information, i.e. to not only perceive it, but also to reflect on and make use of it. Such visualizations should not only inform people about relevant statistical data, they should also motivate them to take action.

This idea is not new. Enabling all citizens to participate in society and politics was one of the Austrian scientist Otto Neurath's central aims. In the 1920s, he proposed the use of pictorial statistics ("Isotype") to communicate facts on demographic development, environmental issues, and economics to the broad public – independent of their level of education. He was convinced that only civic education would allow citizens to really participate in society.

In this paper, we discuss the Isotype method and evaluate its relevance for casual information visualization: What are its particular features? Where is it still used and where not? What potential does it hold for interactive information visualization? And most importantly, can it still assist with civic education and participation?

1. Otto Neurath – Visionary Thinker and All-Round Scientist

Otto Neurath (1882-1945)[1] was a member of the Vienna Circle and engaged in many different fields of study, arguing for a logical positivist perspective and the unity of science. But he did not live in an ivory tower of scientific discourse; instead, he strived to make data accessible for the broad public. In a time when most people received only basic education, he set up exhibitions (e.g., in Vienna city hall) on social and economic topics. His affiliation with socialist politics colored his work as head of the Austrian Museum for Social and Economic Affairs (*Österreichisches Gesellschafts- und Wirtschaftsmuseum*) as well as his interpretation of statistics as a tool for educational purposes: “Statistics is a tool of proletarian battle, statistics is a necessary element of the socialist system, statistics is a delight for the international proletariat struggling with the ruling classes”[2] (O. Neurath, 1927/1994, p. 297).

Among his closest collaborators, his third wife Marie Neurath (1898-1986) and the German graphic artist Gerd Arntz (1900-1988) played a very important role in the conceptualization of the so-called Vienna method of pictorial statistics, which later became known as the Isotype system. Originally, their concept was not intended solely as a method to illustrate information. Instead, Neurath and his team followed a utopian vision of a pictorial international language analogous to artificial languages of the time, such as Esperanto (O. Neurath, 1936). Nonetheless, nearly all such pictures they produced rely partially on written language in their titles and for a precise definition of the meaning of certain icons.

2. Isotype

The acronym Isotype stands for **I**nternational **S**ystem **o**f **Ty**pographic **P**icture **E**ducation. The method was described as a culture-free, systematic approach in which typographic pictures are used to teach relevant statistical facts about social, economic, and political topics. The term Isotype is derived from the Greek words *iso* and *typos* and hints at one of its own main characteristics, i.e. the consistent use of the same symbol to display the same element (M. Neurath, 1974, p. 127).

The main idea behind the Isotype method was to communicate statistical data from science to the broad public in an intuitive, pictorial way. The method established a set of rules for a consistent design of pictorial statistics (Hartmann, 2006): Icons should (1) be used consistently for the same concept, (2) be of the same size, and (3) bear a strong resemblance to the object they represent (“speaking symbols”, O. Neurath, 1926/2006, p. 8). As in verbal language, these icons can be combined with attributes (e.g., factory worker vs. worker, Figure 1b). In an Isotype visualization, the icons are repeated according to their frequency from left to right according to reading direction (O. Neurath, 1936). The icons are countable, and each stands for a concrete number of the respective concepts (as defined in the legend). Icons can be compared across years or countries on a vertical axis (cf. Figure 1a). Additionally, correlations can be shown by combining two different symbols (cf. Figure 1b).

[1]Details on Otto Neurath’s biography and his scientific worldview can be found in P. Neurath & Nemeth (1994) or Hartmann (2006).

[2]Translated from German by the authors: “Statistik ist Werkzeug des proletarischen Kampfes, Statistik ist wesentlicher Bestandteil der sozialistischen Ordnung, Statistik ist Freude für das mit den herrschenden Klassen hart ringende internationale Proletariat”.

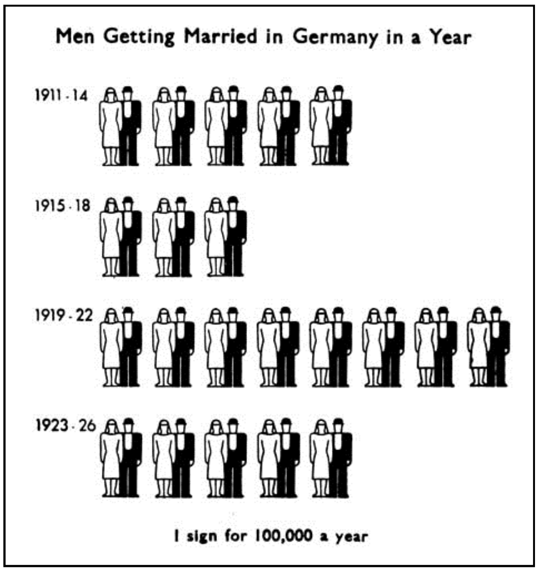

Figure 1a: An early example of Isotype pictorial statistics (O. Neurath, 1936, p. 77)

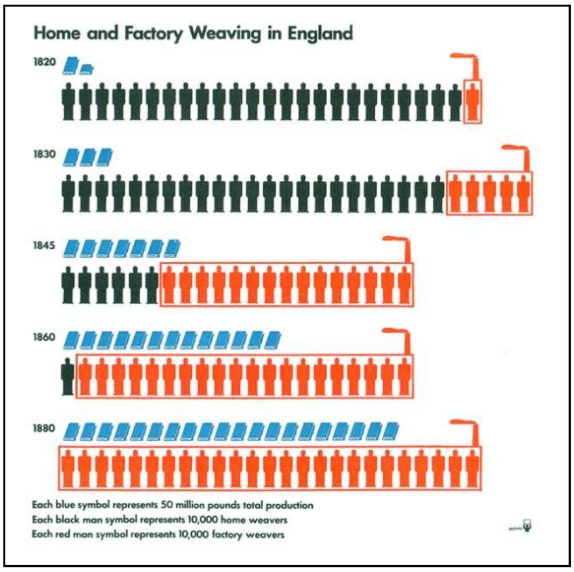

Figure 1b: A later example of Isotype pictorial statistics (O. Neurath, 1939, p. 53).

The use of different colors is intended to support the differentiation between identical symbols with different attributes (e.g., country of origin). Preference is given to strong, pure colors, but the rules on the choice of colors for specific meanings are neither strict nor consistent. Indeed, in some examples given by O. Neurath (1936), they seem to be assigned in a rather arbitrary way (e.g., there is no apparent reason to associate the clothing industry with the color blue as in Figure 1b).

Isotype icons can also be combined with other types of graphics, like maps, to correlate frequency data with information on location, history, duration, density, etc. (O. Neurath, 1936, Figures 2a and 2b).

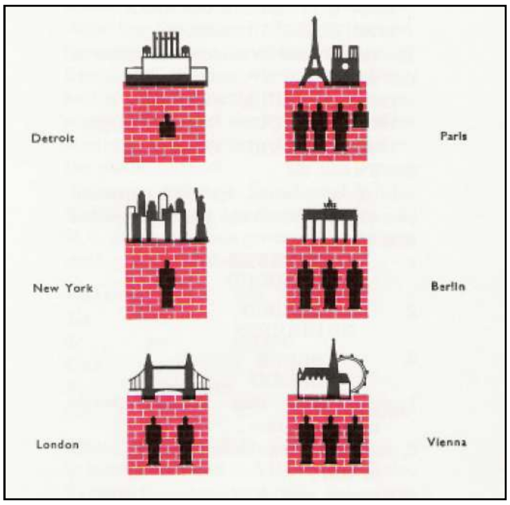

Figure 2a: Example pictorial statistic displaying density (O. Neurath, 1936, p. 89)

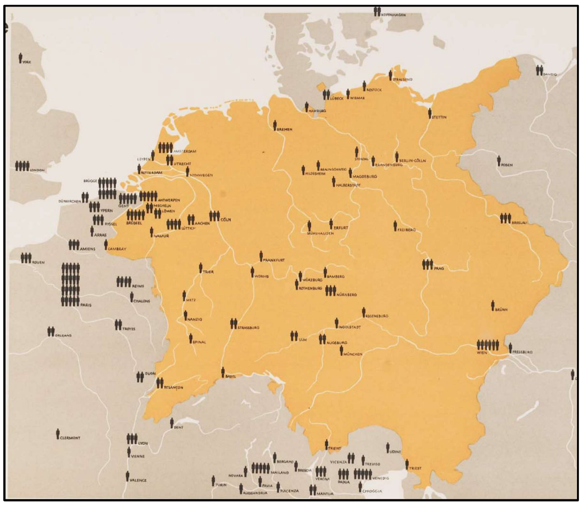

Figure 2b: Example pictorial statistics displaying geographical distribution (O. Neurath, 1930, p. 15)

O. Neurath wanted to communicate statistical facts in a way that made them readily comprehensible and easy to remember. Accordingly, pictorial statistics should not contain too much information. Indeed, the message of in an Isotype visualization should be recognizable at first sight (O. Neurath, 1936). Neurath argued that the actual numbers should not be given in detail, as he was convinced that it is better for people to forget the actual numbers and instead remember the picture as a whole.

Although the resulting visualizations may seem to be very simple, constructing them is not necessarily a trivial matter. At the time of its invention, designing an Isotype visualization required close collaboration within a team of scientists and designers. A special role was given to the “transformer”, who had to translate the selected statistics in a way that was suitable to communicating the intended message according to the set of rules developed by the Isotype team (M. Neurath & Kinross, 2009).

The use of hand-made paper silhouettes had an important impact on the aesthetics and possibilities of the Isotype method. This choice of technique meant that pictorial details had to be vastly reduced, and while this facilitated reproduction, it also influenced the question of how to make each icon unique and easy to recognize. It is therefore not surprising that the resulting pictures draw on clichés and archetypes of the time concerning social roles, ethnicities, and so on (see Figure 3a and 3b). At the same time, this simplicity later influenced the development of pictogram design.

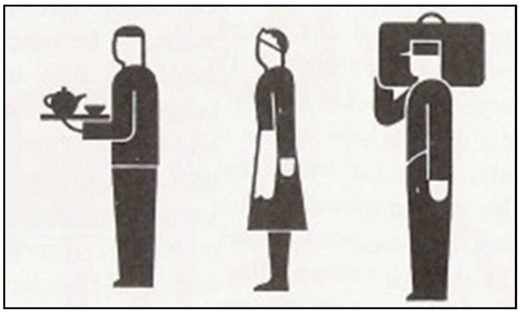

Figure 3a: Icons representing different types of servants (left, O. Neurath, 1936, p. 34)

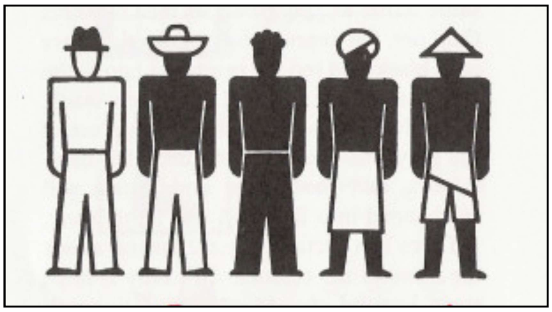

Figure 3b: Icons representing different ethnic groups (O. Neurath, 1936, p. 47)

3. Isotype Then and Now

An important principle in the Isotype method was the consistent use of the same icons, and a collection of more than 2,000 symbols was generated (Hartmann, 2006). However, a frequent critique of the Isotype method is that many of these symbols are old-fashioned and outdated (Holmes, 2001; Medosch, 2006; Rehkämper, 2011). As O. Neurath himself stated (1936, p. 40): “We are not able to take over the old signs as they are. Adjustments have to be made in relation to the forms of today and tomorrow.”

Over the years, the Isotype method proved influential in the fields of information design (e.g., the Olympia pictograms by Aicher; see Figure 4) and information visualization (Holmes, 2001). Nowadays, the use of pictograms inspired by Arntz’s efforts is still widespread (Mijksenaar, 1997). Indeed, most of us are familiar with many of the “graphical symbols for use on public information signs” (ISO 7001, see Figure 4). Pictograms also became part of popular culture, where they are used both for their intended purpose and for entertainment (as in the case of the newer superhero icons, fan art, etc.; see Figure 4). Initiatives like The Noun Project offer large databases of icons by different artists and designers, which users can access to create their own graphics for different purposes such as information graphics or graphical user interfaces (see Figure 4).

Olympia 1972 pictograms by Otl Aicher

ISO 7001 pictograms

Film posters by Viktor Hertz

Examples from The Noun Project

Figure 4: Information design influenced by Isotype[3]

Information visualizations in contemporary mass media sometimes show rudimentary similarities to the Isotype system (Jansen, 2009). In many cases, the use of pictorial icons is either restricted to comparisons of quantities or transformed into a means of demonstrating that large numbers of a certain class of objects are involved (see figure 5). Neither of these usages build on the more complex rules of Isotype, they both only make use of similar pictorial icons. Accordingly, and despite their aesthetic parallels, these information visualizations cannot be regarded as modern examples of Isotype pictorial statistics.

Figure 5: Examples of Isotype-like graphics for mass media[4]

[3] Aicher: http://design20.eu/design20-blog/2012/08/design-olympia-72-otl-aicher http://wayfindinguk.wordpress.com/page/3/
ISO 7001: Film Posters: http://www.onelargeprawn.co.za/2011/05/20/pictogram-movie-posters/
The Noun Project: http://www.thenounproject.com/
[4] Left image: http://www.theguardian.com/world/datablog/interactive/2013/apr/09/north-korea-south-korea-interactive
Right image: http://arcadenw.org/article/journalistic-visualization-a-year-in-iraq

4. Evaluating the Isotype Approach

What constitutes a good visualization of statistical data is a matter of ongoing debate. The same holds true for the evaluation of the Isotype approach. To better judge their value for participation in society and civic education, it is important to understand how Isotype visualizations communicate their message and how they are understood by their intended audience.

From a communication perspective, Stikeleather (2013) identifies three elements that make a data visualization successful: (1) it understands its audience, (2) it sets up a clear framework, and (3) it tells a story. Accordingly, we will now apply these three elements to the Isotype method. (1) Do Isotype visualizations understand their audience? Neurath and his colleagues claimed that the icons used were frequently evaluated during the development of the method to ensure that they could be understood easily and that they communicated the intended message (M. Neurath, 1974; O. Neurath, 1936). Unfortunately, the results of these evaluations were not reported and are consequently lost. But O. Neurath was concerned with the audience for the generated pictorial statistics from the outset, and the popularity of his exhibitions in Vienna city hall would indicate that he did indeed succeed in reaching his audience. (2) Does Isotype set up a clear framework? The Isotype method is clearly defined. The icons are selected, designed, and aligned according to certain rules. Most elements of the pictorial statistics can be understood intuitively without further prior knowledge. Likewise, the transformer has to make sure that a newly generated Isotype picture adheres to the given framework. (3) Do Isotype visualizations tell a story? Isotype pictures are constructed with the aim of transporting a certain message. The icons can be easily perceived as active agents of the development shown in the picture (e.g., how they change over time). This story-like character also influences cognitive processing, as it is likely to activate a narrative mode of thought. A narrative mode of thought is, in turn, associated with better comprehension and better retention of the given content (Glaser, Garsoffsky, & Schwan, 2009). Storytelling is also a new trend in information visualization that is used to offer guidance in interpreting data (Kosara & Mackinlay, 2013). Interfaces with narrative elements which provide structure to the interaction process – and guide the user through it – also reduce barriers for users (Schreder, Siebenhandl, Mayr, Smuc, & Nagl, 2011).

From a cognitive perspective, Cleveland (1994) compares different forms of statistical graphs and argues that “a graphical method is successful only if the decoding process is effective. Informed decisions about how to encode data can be achieved only through an understanding of the visual decoding process, which is called graphical perception” (p. 20). Although Cleveland does not include the Isotype method in his studies, an important argument in its favor is how humans perceive (and consequently cognitively process) pictorial icons. According to O. Neurath (1936), “reading a picture language is like making observations with the eye in everyday experience: […] the man has two legs; the picture-sign has two legs; but the word-sign ‘man’ has not two legs” (p. 20). Similarly, Tversky (2011) argues that such likenesses (i.e., pictorial representations of objects) can be readily recognized, more quickly understood, and better memorized. Indeed, likeness can support the decoding of graphs due to the way humans process visual information: “If the form of the external representation matches the internal form of the mental representation the workload for the cognitive system gets minimized” (Rehkämper, 2011, p. 4112). In a casual context in particular, a low cognitive workload can be desirable for perception, as it allows recipients to discern the topic and the main information quickly without needing to decipher detailed data. Accordingly, information visualization can attract audiences who are not willing to invest much effort in studying a graph. Likewise, a lowered cognitive workload induced by easy perception also means that resources can be redirected to reflection and reasoning, i.e. from elementary to higher levels of graph comprehension (Friel, Curcio, & Bright, 2011). This might be one explanation why the Isotype method – despite being easy to process – is said to activate deeper levels of processing: Recipients are more motivated to engage in active reception and in free opinion formation (Hartmann, 2006). It can therefore be argued that Isotype is especially valuable for civic education, as it supports reflective thinking, reasoning, and discussion instead of simply communicating facts (Coy, 2006). However, to our knowledge, the positive effect of the Isotype method on the depth of processing has so far not been tested empirically.

In spite of this positive evaluation in both a communication and a cognitive context, the Isotype method has not played a prominent role in information visualization in recent decades. There are several possible explanations for this decline in the use of the Isotype method.

1. Results from cognitive psychology (Jansen, 2009): In the 1980s, Cleveland and McGill (1984, 1985) conducted seminal experiments on the comprehensibility of different graph types. While their results support some, but not all, of the rules of the Isotype method (encoding of colors, partial pattern recognition), they may also have accorded preference to other forms of data presentation. Likewise, it is argued that although Isotype visualizations "can facilitate comprehension and memory, they can also interfere" (Tversky, 2011, p. 516). However, a more recent study shows that an Isotype-like graph is superior to a Venn diagram when it comes to facilitating comprehension of Bayesian statistics in laypersons (Brase, 2008). Accordingly, investigating Isotype visualizations in order to identify those elements which provide beneficial cognitive effects and remove those which impede comprehension when designing contemporary Isotype-based information visualizations remains an open challenge.
2. Political and historical reasons: While pictograms proved very successful and frequently replaced written information in public space, O. Neurath's educational impetus and utopian views on the emancipation of the working class through education lost their importance. Furthermore, his association with the Soviet regime (he worked in the Munich Soviet Republic and later also in Moscow) may well have led to the rejection of the Isotype method during the Cold War (Jansen, 2009). On the other hand, Neurath's student Modley successfully built on his mentor's method when he founded Glyph Inc. and Pictorial Statistics Inc., two companies which were both subsequently employed by the US government (Ihara, 2009). Nevertheless, Yann and Loic (2010) suggest that pictorial statistics based on O. Neurath and Modley were later abandoned by social scientists in the USA because they were used in the propaganda machinery of the Roosevelt administration.
3. Aesthetics: To a contemporary viewer, Isotype graphics might appear crowded and outdated given the aesthetic design paradigms that have prevailed since the second half of the 20th century. Functional aesthetics advocate a clear and simplistic design in which parsimonious use of ink is one of the guiding principles, whereas decorative illustrations are said to inhibit a clear look at the data. Tufte (1983), for example, argued that the data:ink ratio should be high for graphs of high quality, but is very low with Isotype pictograms. Although functional aesthetics is now the state-of-the-art in professional (especially scientific and technical) contexts, it is not without controversy. "What is needed nowadays is an adequate transformation from data to pictorial statistics with a maximum data:ink ratio." (Jansen, 2009, p. 237) In their review of graph comprehension, Friel et al. (2001, p. 134) criticize Tufte's data:ink rule, claiming it is not empirically valid. In contrast, they found that additional ink was helpful if it served to expedite perception. Bateman et al. (2010) show that additional figurative elements can facilitate memorization. In their visualizations, the overall message (which includes the topic) and the structural elements of the chart (e.g., the trend) were encoded in the image; the presence of an image along with other content provided an additional encoding in memory which could improve recall (cf. Dual-Coding Theory, Paivio, 1971). Another beneficial aspect of figurative elements is explained by the picture superiority effect (Hockley, 2008), i.e. the notion that pictures are remembered better and can be categorized faster than words. In general, pictures receive a greater degree of semantic and cognitive processing than words, resulting in a more elaborate memory representation (Carpenter & Olson, 2012).
4. Preferences of decision makers: O. Neurath himself was convinced that people who receive a higher level of education are more verbally oriented than people who only complete a basic level of education, hence his assertion that the Isotype method was better suited for people with low levels of education (O. Neurath, 1933/1994). If this assumption is correct, policy makers and

researchers might feel drawn to styles of information design that reflect their own preferences for a more verbally oriented approach.

5. Microsoft Excel did not implement Isotype-like graphs (Rehkämper, 2011): Abstract graphs are independent of their content and can easily be generated automatically. The absence of pictograms from commonly used software not only creates familiarity with other types of graphs, but might also lead researchers and designers to assume that frequently used types of graphs are easier to process, more relevant in society, and therefore of higher importance. Placing the Isotype method within existing visualization taxonomies (e.g., Chi, 2000, Tory & Möller, 2004) or extending it to other forms of information visualization remains a challenge.
6. Isotype has to be learned: While some parts of the Isotype language can be understood intuitively (highly pictorial icons), others have to be learned (visual grammar). O. Neurath argued that this visual literacy should be acquired in schools and therefore invested efforts into implementing Isotype in the school system (cf. M. Neurath & Kinross, 2009). Due to the likeness between the actual objects and the pictograms as well as the intuitive arrangement (see section 2), it is relatively easy to learn how to "read" Isotype, but more difficult to learn how to generate such pictures. While the documentary notes produced by O. and M. Neurath (M. Neurath, 1974; M. Neurath & Kinross, 2009; O. Neurath, 1936) do provide insight into the Isotype method, they do not offer very clear descriptions of the central process of transforming, i.e. of "analysing, selecting, ordering, and then making visual some information, data, ideas, implications" (M. Neurath & Kinross, 2009, p. 6). This would instead appear to be a very intuitive process, more akin to tacit knowledge held on their part (M. Neurath & Kinross, 2009). Extracting this process knowledge from the examples described in more detail also remains a challenge.
7. Lack of adequate representations: According to Müller and Reautschnig (2011), the lack of adequate representations for many contemporary survey or panel items might constitute a further reason for Isotype's decline. By way of example, they mention in this regard social capital, trust in institutions, values, expectations, life satisfaction, or similar constructs. The Isotype system focused on materialistic aspects of history and society and thus on countable entities – demographics, agricultural commodities, manufacturing, trade, and transport were the primary fields of interest of the Museum for Social and Economic Affairs in Vienna.

5. Outlook – Isotype 2.0

In a participation in society and civic education context, some of the possible characteristics of information visualization are especially desirable: Easy access for a broad public, no (or little) requirements regarding level of education or prior knowledge, and a motivation for active reception (i.e., not only perceiving the information, but reflecting on and making use of it). Since the Vienna method of pictorial statistics and Isotype already include these principles, we can conclude that "the Isotype-way of representing statistical facts heads in the right direction and that we should rediscover its basic ideas" (Rehkämper, 2011, p. 3). Nevertheless, the problems outlined above still need to be considered – as do the possibilities that are now available as a result of modern technologies.

First, the rules that are implicit to Isotype have to be extracted from the material available. Numerous Isotype-based visualizations were developed by O. Neurath and his team over the years. These differ not only in the icons used, but also in the alignment of these icons, the number of variables, the aspect of the data emphasized, etc. (for examples of these visualizations and their variations, see M. Neurath & Kinross, 2009). To permit a systematic use of Isotype in information visualization, a taxonomy of Isotype visualizations is required. In addition, the central process of transformation (M. Neurath & Kinross, 2009, p. 6) has to be made explicit. Deducing and formalizing this implicit process knowledge from the more detailed examples available and reading between the lines and pictures to delineate formal rules for the generation of Isotype visualizations remains a key challenge.

In a second step, these rules need to be evaluated empirically. As indicated above, experimental results from cognitive psychology confirm only some of the rules defined in the Isotype system. For example, the position of data along a common scale is easy to perceive and understand in graphs other than Isotype (Cleveland & McGill, 1984, 1985). Although these experimental methods could be applied to evaluate Isotype visualizations, no systematic evaluation of its underlying set of rules has so far been undertaken. The more recent studies on Bayesian statistics (cf. Brase, 2008) strengthen Isotype's potential for communicating scientific data to the public. A series of experiments should therefore be undertaken to provide a better understanding of the forms of Isotype pictures which work best in generating insights. In addition, the assumed cognitive processes (e.g., deeper processing, fully understanding a picture in three glances) have to be tested empirically using a representative sample of the broad public.

In a third step, modern visual analogies of Isotype icons and pictures should be generated. New pictorial statistics based on Isotype should no longer leave the viewer with an outdated or uncomfortable feeling. Figure 6, for example, shows an Isotype depiction of the use of different means of transport on the left alongside a modern, highly aesthetic information visualization of a similar type on the right. Current advances in electronic communication (e.g., smartphones and tablets) mean that "reading" and understanding pictograms – especially if they are pictorial – is no longer a task that has to be learned. In addition, "neutral" icons (like dots) are needed to display more abstract concepts (cf. Müller & Reautschnig, 2011). A further question that also remains is whether the visual grammar of pictorial statistics can be understood intuitively (as proposed in this article) or whether it has to be learned. This is especially relevant for people with lower levels of education.

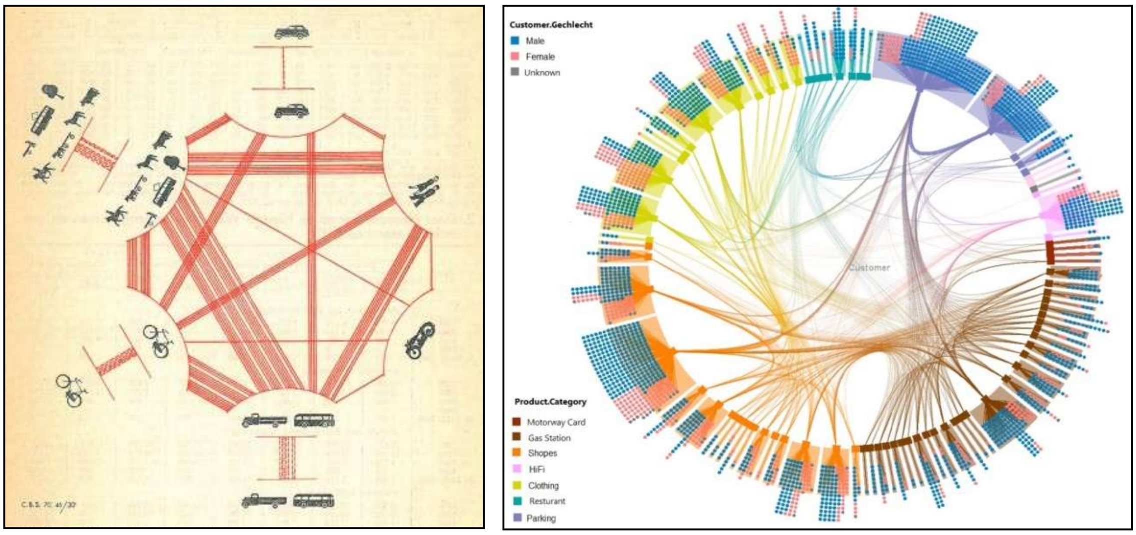

Figure 6: Isotype visualization (Centraal bureau voor de statistiek, 1947) and a modern analogy (Allsallakh, 2009)

In a fourth step, new media applications could be developed based on the Isotype method: "The internet provides an unprecedented opportunity to bring these pictorial statistics, possibly in animated form, within everyone's reach. In this way, the 'E' (for education) in Isotype could regain its former status" (Jansen, 2009, p. 239). Due to its consistent use of the same symbols, Isotype saves memory and bandwidth resources (Medosch, 2006) and is therefore well suited to web applications. In this regard, Zambrano and Engelhardt (2008) differentiated between three different levels of Isotype pictures for the web, namely presenting, interacting, and generating Isotype.

5.1. Presenting Isotype

Similar to their use in traditional media like newspapers (but also as used by O. and M. Neurath for brochures or in museums), Isotype visualizations can also be deployed on the web to display data. In contrast to print versions, the pictures used on the web can also be frequently updated with fresh data (Medosch, 2006).

5.2. Interacting with Isotype

User interaction is an inherent aspect of web-based information visualizations and empowers users to engage with the data: By interactively manipulating an information visualization, users can change their own point of view on the data, and knowledge is constructed, tested, refined, and shared. Interestingly, research indicates that users prefer inferior visual representations with interaction to superior alternatives with no interaction (Saraiya, North, Lam, & Duca, 2006).

Intuitiveness and narrative metaphors which build on prior experiences are important for interaction with casual information visualization formats like Isotype (Blackler & Hurtienne, 2007; Dix, Pohl, & Ellis, 2010). Intuitive interaction should build on the users' prior knowledge (Blackler & Hurtienne, 2007), which is a challenging aspect if the visualizations are designed for a broad user group (Schreder et al., 2011). Many contemporary modes of interaction in information visualization (e.g., Yi, ah Kang, Stasko, & Jacko, 2007) build on metaphors which do not fit with the pictorial character of Isotype and are not well suited to non-expert users.

Interactive information visualizations like Rosling's Gapminder[5] present statistical information to the broad public and allow this data to be explored (Zambrano & Engelhardt, 2008). The Gapminder project and Isotype share a common vision, namely to animate and inspire people to actively engage in processing and interpreting the collected statistical data and to draw their own conclusions. "While probably neither Otto Neurath nor Rosling have much expertise regarding the cognitive aspects of diagram use" (Zambrano & Engelhardt, 2008, p. 287), they chose a visual way of presenting the data – and were both successful with this approach. While Isotype pictures were designed solely for reception of the data (due to the point in time in which they originated), in the Gapminder project users can select the data and the way it is displayed, interact with this data, and view developments over time. An interactive application of this kind allows users whose interest was awakened by a pictorial representation of statistics to dig deeper into the data and satisfy this interest. Yet Rosling doubts in the meantime that he reached his aim with the Gapminder project: "I have no impact on knowledge. I have only had impact on fame [...] But to really make the world understandable, that challenge is remaining" (Provost, 2013). One weakness of Gapminder may in fact be closely correlated to its main strength: The sheer amount of data available can overwhelm users and make it difficult for them to analyze and understand (Fass, 2011).

An emerging trend in visualization design is to use elements of storytelling to offer guidance in interpreting data (Kosara & Mackinlay, 2013). Whereas exploration-driven interactive information visualization concepts do not prescribe any specific order or linearity, and instead allow free interaction with the data, a narrative structure guides the reader through the material. Despite this structure, different layouts and semantic elements can be used to tell stories visually, thereby allowing a balance of author-driven stories and reader-driven exploration (Segel & Heer, 2010). O. Neurath's original museum exhibition concepts also combined these two approaches: While individual panels conveyed specific messages, visitors could choose the order in which they explored the different subtopics that constituted the overall exhibition (Figure 7, image on left). The digital analogy to this approach is known as the "drill-down story structure" (Figure 7, image on right; Segel & Heer, 2010), which visualizes a general theme and allows the recipient to choose between different subtopics to explore specific details or heavily authored backstories.

[5]Gapminder (http://www.gapminder.org/world/) is an interactive web tool developed by Hans Rosling, which allows the user to explore WHO data.

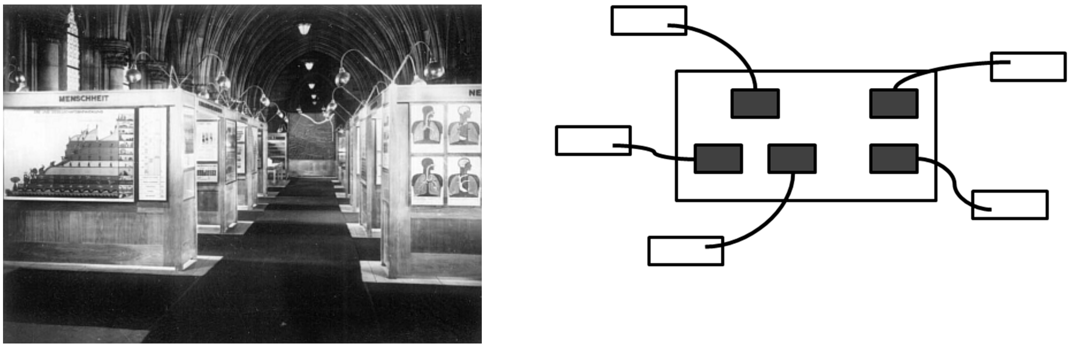

Figure 7: Healthcare exhibition, Vienna city hall (on left; M. Neurath & Kinross, 2009, p. 24), and its analogue genre in narrative visualizations, the drill-down story (on right; Segel & Heer, 2010, p. 1148)

5.3. Generating Isotype

A next step to interacting with the data would be to enable users to generate visualizations themselves and present them for others (Zambrano & Engelhardt, 2008). An “Isotype 2.0” web application of this nature would include templates for frequent pictorial statistics (such as correlations, comparisons, or temporal developments). Users would select icons to resemble the concepts in their data, add these to the available visualization (and perhaps also interaction) templates, and thus be able to generate an Isotype-based picture with a few clicks. Isomatic, an automatic Isotype tool (Borgenheimer & Huber, 2014; cf. Figure 8), is a first attempt to realize this vision. It allows the users to generate Isotype-like visualizations of frequencies, but is restricted insofar as it neither includes other Isotype visualizations nor supports the user in the transformation process (e.g., how to identify an appropriate visualization for the data and the research question; how to select a data-icon-ratio which is easy to perceive and shows the most relevant patterns in the data). Whether the actual acts of transforming can be identified in sufficient detail to automate these processes is also an open issue (e.g., M. Neurath & Kinross, 2009). A more realistic possibility is that different visualizations are generated, and the user selects and adapts the most appropriate option.

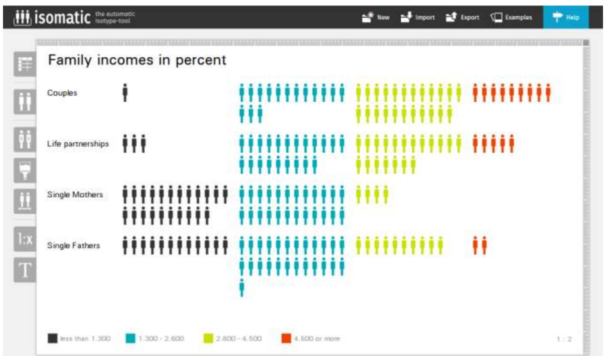

Figure 8: The Isomatic automatic Isotype tool (Borgenheimer & Huber, 2014)

Another problem facing such a tool is the fact that even though Isotype visualizations are intended to communicate data to people with sparse statistical knowledge, “the provision of powerful tools [for open data] does not necessarily lead to empowered citizens” (Ridgway, Nicholson, & McCusker, 2013, p. 3). Tools of this kind may therefore be less suited for use by the broad public, but instead designed for the experts, i.e. the professionals, who present such data to the public.

A promising field of application for such an Isotype 2.0 application is *data journalism*, which "plays an increasingly important role in providing impetus and insight in our increasingly complex and interconnected world" (McGregor & Halevy, 2013, p. 410). While open data makes information available to the broad public, it does not necessarily make it accessible; in other words, not all recipients possess the skills nor want to spend the time necessary to gather, interpret, and make use of the vast amount of complex data that is openly available. Data journalism visualizes this data and makes it more easily accessible (Rogers, 2011), thereby acting "as the bridge between the data […] and the people out there in the real world who want to understand what that story is really about" (Rogers, 2011, section 5).

Data journalists search for relevant data, then analyze, visualize, and use it to tell stories (Baack, 2013). Accordingly, three issues are critical for real-time data journalism, namely having the time, skills, and tools to process (including discovering, cleaning, and contextualizing) and publish such data (McGregor & Halevy, 2013). However, time and resource restraints often prevent a reasonable application of data journalism for day-to-day events (Schwabl & Roither, 2012). Major newspapers like The New York Times or The Guardian have begun offering interactive information visualizations for important topics (Baack, 2013). However, the effort and programming time required to produce such visualizations means that they are mainly offered only for topics of enduring interest. Data journalists rely on tools which allow them to visualize the data quickly and efficiently in line with their story. An Isotype 2.0 application which allowed the development of such interactive information visualizations in a shorter timeframe, yet still produced attractive interactive pictorial statistics would thus be of high value to data journalists.

6. Conclusions

In this paper, we have presented the Isotype method as an approach to visualizing statistical data for the broad public that stems from the 1920s. Although the Isotype method is no longer widely applied, our evaluation showed its potential in casual information visualization for civic education. Isotype visualizations are said to be highly intuitive and therefore easier to comprehend than abstract graphs for people with lower levels of education. To date, there is only limited empirical evidence available on how Isotype visualizations are received and comprehended. Nonetheless, the evidence that does exits supports the beneficial effects of Isotype visualization on comprehension of the underlying data.

Much remains to be done before Isotype can regain its former prominence; the necessary empirical evidence on how Isotype visualizations are perceived and understood must be obtained, and the knowledge implicit within the Isotype system must be made explicit: A taxonomy of Isotype visualizations needs to be extracted, and the rules of transformation must be delineated. Both of these will also have to be adapted to meet modern design standards, data requirements, and levels of education.

We then introduced an Isotype 2.0 approach, which demonstrates the potential that could be realized for Isotype visualizations when combined with modern information technologies. Such an approach empowers the public in a threefold manner: (1) It informs people on relevant social, environmental, or political topics. (2) Information enables them to actively participate in society and politics. (3) They can use such a web tool again to inform others and help them to become active citizens themselves. Such a development lies at the core of O. Neurath's true conception of Isotype. We propose to re-discover his ideas, utilize his method within a modern framework, and let Isotype pictures captivate the public once again.

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