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Neurath, Arntz and ISOTYPE: The Legacy in Art, Design and Statistics

Wim Jansen

To remember simplified pictures is better than to forget accurate figures.[1]

In the first decades of the twentieth century, Otto Neurath and Gerd Arntz invented the 'Vienna Method of Pictorial Statistics' (Wiener Bildstatistik). The method was renamed in the late 1930s as ISOTYPE—'I(nternational) S(ystem) O(f) TY(pographic) P(icture) E(ducation)'—and was used in the 1940s and 50s in the Netherlands, Great Britain, Greece, the USA and the USSR. In this article, we explain the origins and basics of the Vienna Method/ISOTYPE, stressing Neurath's aim of clarifying developments in society by means of pictorial statistics and of raising the awareness of the uneducated by displaying these pictorial statistics in a museum-like setting. In this educational aspect, the ISOTYPE philosophy can be linked to the Vienna Circle (Wiener Kreis) and the International Unity of Science movement. It is noted that while the concept of ISOTYPE retained its influence in the world of art and design, it completely lost its impact on statistical graphics during the second half of the twentieth century. Several explanations for the curtailment of ISOTYPE's influence in statistics are given.

Keywords: ISOTYPE—Otto Neurath—Gerd Arntz—Vienna—statistics

Introduction

The use of pictures in education goes back to 1658 when Johann Amos Comenius published his *Orbis sensualium pictus*, an atlas of the visible world.[2] Since then, authors have tried to capture aspects of society in pictorial statistics or statistical charts. In the nineteenth century, the economist William Playfair developed pictorial statistics for showing the balance of trade in his *Statistical Breviary*, published in London in 1801.[3] Another popular application of pictorial statistics was devised by the Irish writer, journalist and statistician Michael George Mulhall, whose acclaimed *Dictionary of Statistics* was published in 1883.[4] His approach of illustrating quantities by means of smaller or larger images had its critics, among whom was the engineer Willard C. Brinton, who published a new *Graphic Methods for Presenting Facts* in 1919, in which he advocated the use of sets of symbols to represent quantities.[5]

From the end of the nineteenth century, popular almanacs, showing everyday life in picture diagrams, were published in at least twenty-one different languages throughout the Habsburg Empire in Europe, and in many other countries, with an output of 10 million in 1910.[6] In the 1920s, the Viennese philosopher/mathematician/sociologist Otto Neurath and the artist Gerd Arntz developed their 'Vienna Method of Pictorial Statistics', which was later renamed ISOTYPE—'I(nternational) S(ystem) O(f) TY(pographic) P(icture) E(ducation)'. Clearly, ISOTYPE has its roots in the pictorial statistics and graphics from Playfair and Brinton and in the picture diagrams of the almanacs, but its unique grammar and syntax were developed only gradually.

The landmark ISOTYPE publication is the 1930 *Society and Economy Atlas*, containing 100 pictorial charts, each depicting an aspect of the present and past of social and economic life, to be displayed in a museum-like setting. Despite its popularity at the time, the greatest lasting impact of the atlas and other ISOTYPE

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publications has been in the field of art and design. Artists Alice Creischer and Andreas Siekmann exemplify this. Since 2003, they have worked with the University of Lüneburg's art room in actualizing some of the ISOTYPE charts from 1930 and updating the 1930 maps to contemporary situations. As part of a series of pictures on urban development, they created a map of Dubai in 2008. Following the original educational goals of ISOTYPE, Creischer and Siekmann have tried to stress two aspects of urban development: industrialization, '[which] replaces climatic or geographical conditionalities of urban growth', and migration, which records 'movements from the countryside to the city implying economic upheavals, refugee movements driven by poverty and concentration of people in workers' districts. Both apply to Dubai in extreme fashion.'[7]

In the field of design, Otl Aicher sketched the 1972 Munich Olympic Games pictograms, drawing from the ISOTYPE example according to a grammar and simple rules: all figures have to move within a square according to a combined orthogonal and diagonal grid. So, all arms, legs and bodies of the figures representing various sports intersect at 45° or 90° angles. Nigel Holmes designed pictorial statistics for *Time Magazine* and referred to ISOTYPE in his 1984 book and 2001 article.[8] ISOTYPE is also referred to in the survey book on information graphics by Peter Wildbur.[9] And, in the opinion of Paul Mijksenaar, ISOTYPE 'contributed to the development of pictograms and, indirectly, of the 'infographics' that are becoming increasingly popular in newspapers and magazines'.[10] In art, Victor Burgin combined isotypical pictograms with photographs in his installation *Office at Night*, and Matt Mullican has designed his own ISOTYPical collection of pictographic signs.

New interest in the original ISOTYPE work has arisen in recent years in publications by Ellen Lupton, media philosopher Frank Hartmann and graphic designer Erwin Bauer, the Dutch Neurath protagonist Ferdinand Mertens, exhibition curator Marion Ackermann and visual communication expert Martin Krampen.[11] Since 2000, exhibitions featuring ISOTYPE have been held throughout Europe,[12] with the museum and exhibition applications of ISOTYPE having been recently documented by museologist Hadwig Kraeutler.[13] ISOTYPE's contribution to town planning and architecture and its relation to the International Congress of Modern Architecture have been studied by historians of architecture Enrico Chapel and Nader Vossoughian.[14] Despite its original purpose and initial popularity, and the renewed interest of designers, artists, museologists and historians of architecture, the ISOTYPE legacy has been completely lost in statistics. Why did this happen? We look at some explanations for the curtailment of ISOTYPE in statistics, below, but before answering the question, we need to look at the origins and basics of ISOTYPE and its founders: Otto Neurath and Gerd Arntz.

Otto Neurath, inventor of the Vienna method of pictorial statistics

The extraordinary biography of Otto Neurath shows us a man of many facets, mastering subjects from mathematics to sociology, from physics to philosophy and from history to town planning. Born in Vienna in 1882, Neurath studied at the universities of Vienna and Berlin, taught at a trade college in Vienna, acted as an economic adviser for the Austrian government, founded the German Museum of War Economy in Leipzig, became an adviser of the Munich soviet republic in 1918,[15] was imprisoned, released and returned to Vienna in 1920.

The 1920–30 period was crucial in the development of the so-called Vienna Method of Pictorial Statistics. In 1923, Neurath, being secretary general of the Austrian Housing and Garden Plot Association, suggested creating a Museum for Housing and City Planning, in Vienna, after a very successful exhibition on the subject in the

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centre of the city.[16] Instead of a Museum for Housing and City Planning, the 'Gesellschafts- und Wirtschaftsmuseum' (Social and Economic Museum—GWM) was founded in 1924 by the Municipality of Vienna (led by the Austro-Marxists) and the Viennese Chamber of Workers and Employees, together with leading social insurance institutions. The museum was a workshop with exhibition rooms in the Vienna city hall. Neurath was its director.

In this workshop, Marie Reidemeister, who had met Neurath in 1924 just before her graduation from the University of Göttingen, 'transformed' numerical data into sketches of pictorial statistics.[17] Initially, these sketches consisted of silhouettes on paper, but from 1926 on, linocuts were used. In the museum, visitors, particularly the working class, were educated about production, emigration, mortality, interior furnishing, unemployment, the fight against tuberculosis and alcoholism, physical and mental development and the state of industry through the use of pictorial statistics. These were used to illustrate the state of the nation and trends in society: 'to give fundamental, strictly scientific information for social understanding, even to the less educated, without depressing them in the way learned books and statistical tables do'.[18] Or, in a less general way: 'take the matter of housing for example; the aim is not to show what a particular building project looks like, but to help the citizens see different types of homes that are included in the plan for the city's development, realize for what groups of the population these different types are intended, how they are going to modify the lives of the people, to what extent they are going to help improving health, reducing mortality—especially that of infants, and so on'.[19]

The basis of the Vienna Method are the signs, which are simple stylized symbols and which are used to characterize social concepts: men, women, cogwheels, vacuum cleaners, coffins, homes, ships, etc. A famous example is the sign for the unemployed: a man with both hands in his pockets. A sign always represents the same, and the signs are displayed in horizontal lines in groups of five or ten. A greater number of things is always represented by a greater number of signs, not by varying the size of a single sign (which is not as reliable because it is not clear whether it is the height, width, area or some other dimension that is to be taken into consideration). This rule was taken from Willard Brinton's critique on illustrating quantities by means of smaller or larger images, advocated by Michael Mulhall. Figures 1 and 2,[20] showing the number of marriages (note the use of masculine language in that period) in Germany for the period 1910–26, illustrate the incorrect (using signs that vary in size) and the correct way of using symbols to illustrate trends [**1**] [**2**]. Whenever possible, familiar signs are used. If familiar signs are not available, new ones are invented. Seven colours are used (white, blue, green, yellow, red, brown, and black), and colours retain their familiar meaning if possible: green for farming/agriculture; red for power, industry, warmth; blue/black for cold; yellow for Asia; brown for Africa, etc. A pictographic statistic is read like text (from left to right), with a bold title at the top. All text is set in 'Futura', a typeface designed by Paul Renner in 1929. If a trend in time is involved, time is always located on the vertical axis.

In addition to education, there were other arguments for using pictures. According to Neurath's famous slogan *Worte trennen, Bilder verbinden* (words separate, pictures unite), verbal language is burdened with positive and negative judgements; pictorial statistics eliminate this bias and force spectators to form their own conclusions. Also, pictorial statistics do not depend on a specific language; they are an international form of communication that can be understood everywhere and are equally understandable to both literate and illiterate people. Of course, pictograms can also be misunderstood. In introducing new pictograms for disaster areas, designers Gert and Derk Dumbar present a pictogram having an ambiguous meaning: a pictogram of a fire, a basket containing water and a red diagonal. In their words: 'Many will read the pictogram as a rather absurd prohibition in case of fire "don't extinguish!" The pictogram, however, means to say "don't extinguish with water". It is attached to a transformer

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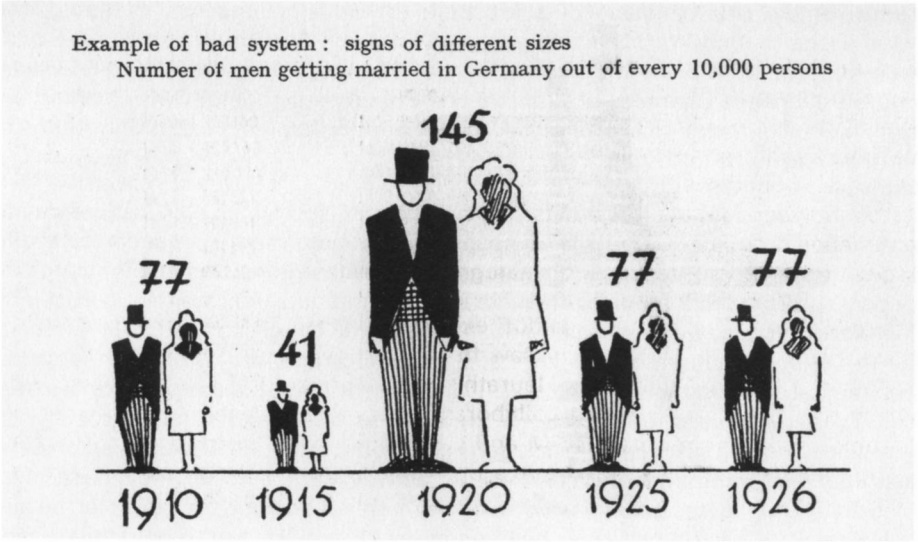

Fig 1. The incorrect way to use pictographs. Otto and Marie Neurath Isotype Collection, University of Reading.

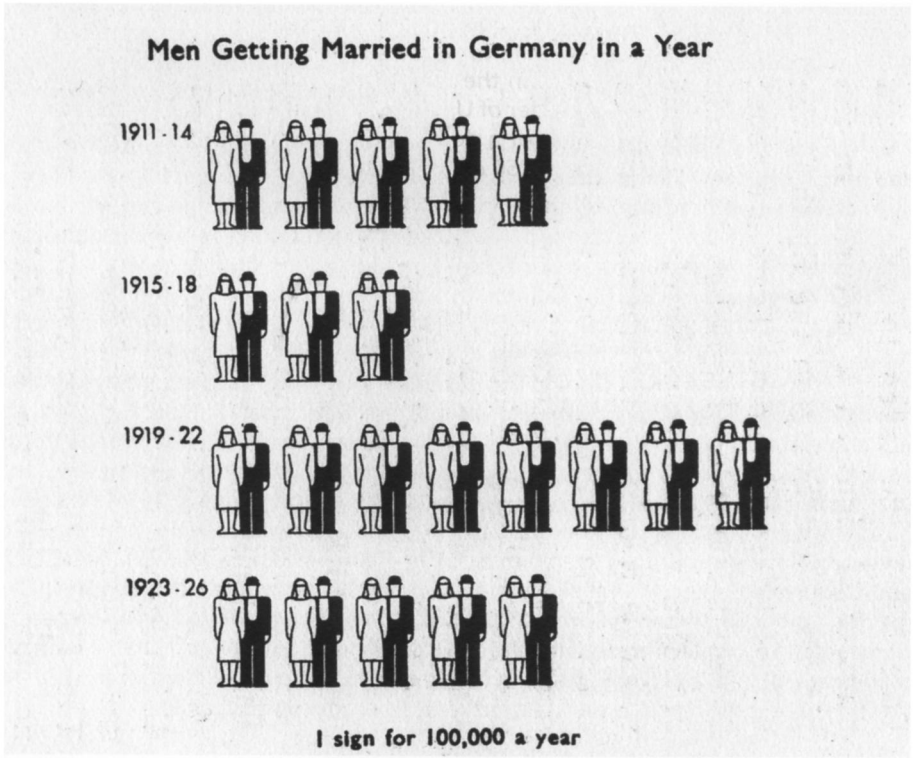

Fig 2. The correct way to illustrate trends. Otto and Marie Neurath Isotype Collection, University of Reading.

kiosk, where water could cause a catastrophic short-circuit and electrocution of the person who would use water to put out the fire.'[21]

Pictorial statistics can be used for communicating results from science and from the humanities, from scientific knowledge and from everyday knowledge. It is understandable why Neurath made frequent reference to Comenius' *Orbis*. In fact, Neurath planned to publish an atlas on the history of civilization as the new *Orbis*, in cooperation with Paul Otlet and the Mundaneum in Brussels.

The arrival of a graphic artist from Germany—Gerd Arntz—resulted in changes to the basic rules of the Vienna Method and in more elaborate images.

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Gerd Arntz, graphic designer at GWM

Born in 1900 in Remscheid, near Solingen in Germany, Arntz enrolled in the Düsseldorf Art School and became a member of the Cologne-based 'Gruppe progressiver Künstler' (Progressive Artist Group). The socialist- (communist-) inspired realism developed by this group could easily be applied in the Vienna Method of pictographic statistics. A good example of Arntz's 'socialist realism' is his woodcut *Mitropa* from 1925, showing society's social stratification (second and fourth class) in the dining and sleeping cars of this railway company [**3**]. This print is one of a series of 'sociological graphics' reproduced in a monograph of Arntz's graphical work.[22]

When Neurath visited the Düsseldorf exhibition of the 'Gruppe', he was struck by these graphics and immediately saw the correspondence between Arntz's work and that of the GWM. In 1928, Neurath asked Arntz to join the Vienna museum, which was the start of a long collaboration. Starting in 1929, Arntz headed the graphics department of the GWM and greatly improved the pictorial method by using linocuts instead of silhouettes on paper, as well as flat and less abstract characters.

In addition to Arntz, the GWM employed Erwin Bernath and Peter Alma as graphic designers, as well as the architect Josef Frank, for setting up the exhibitions.[23] Alma had been associated with Bart van der Leck before he worked with Arntz in Cologne and, later, with Neurath in the GWM.[24] Rudolf Modley was an early co-worker of Neurath's and the founder of US Pictorial Statistics, Inc., and the Pictorial Corporation, selling pictographs for a dollar apiece. He wrote an influential handbook on pictorial symbols, with 3,250 examples.[25]

The Vienna years

The most comprehensive representation of the pictorial work of the Viennese team is the publication *Gesellschaft und Wirtschaft. Bildstatistisches Elementarwerk* (1930).[26] This loose-leaf collection, unbound in a folder, contains 100 pictorial charts printed in colour. It should be noted that this publication

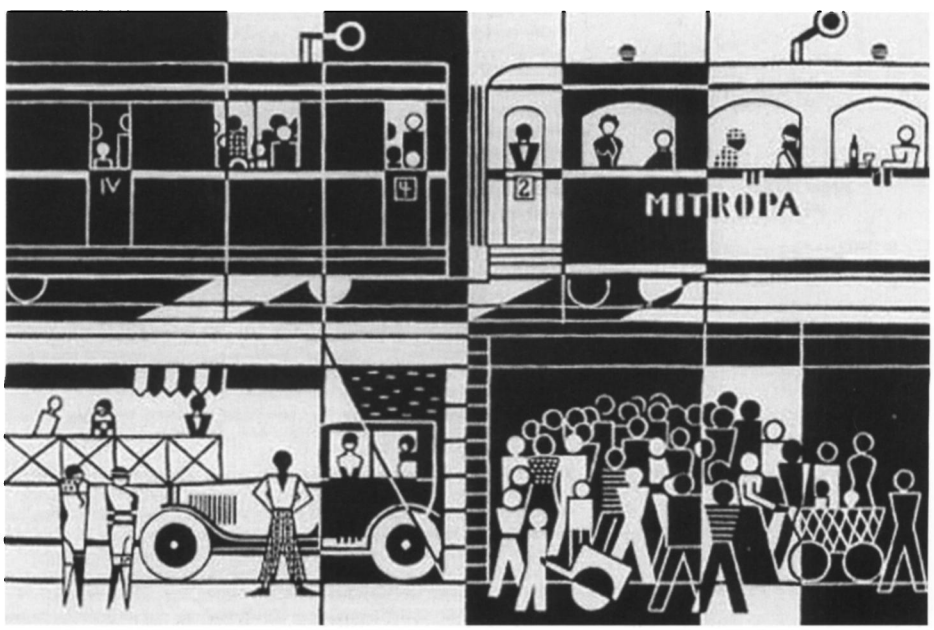

Fig 3. Arntz's socialist realism: *Mitropa* 1925. © Gerd Arntz, Mitropa, 1925, c/o Pictoright, Amsterdam, 2009.

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served as a showcase for the method, with its final goal not being print, but charts on plates for the use in exhibitions and in public space—a portable museum. One can read text, but not pictures that are simply designed to be looked at: 'A picture produced after the rules of the Viennese Method shows the most important details of the object at first glance; apparent differences must strike the eye immediately. At second glance, it should be possible to distinguish the more important details, and at third glance, whatever other details are to be seen. If a picture gives further information at a fourth or at fifth glance, it should be rejected as pedagogically unsuitable according to the Viennese School.'[27] The underlying statistics for the charts in the *Bildstatistisches Elementarwerk* are presented in thirty additional sheets.

The name of Neurath is also closely connected with the philosophers' group known as the Vienna Circle, established in autumn 1924 by Moritz Schlick.[28] The members of the Vienna Circle stressed the importance of making empirical (factual) propositions about the state of the world. They were positivistic and strongly anti-metaphysical. They wanted to unify the exact and the social sciences, to be expressed in a 'physicalist' language so that the events described would, in principal, be observable by all users of the language. The Vienna Circle members considered it axiomatic that only two types of knowledge exist: the purely formal and the empirical. In the latter realm, only statements that can, at least in principal, be put to scientific test have philosophical validity.[29]

Next to Vienna's GWM, a satellite institute (ISOSTAT) was founded in Moscow in 1931, as the result of a decree from Stalin, prescribing the Vienna method for social and economic enlightenment and propaganda. This institute was set up by Arntz, Reidemeister and Scheer and employed dozens of people in its heyday, with Peter Alma leading the Charkov ISOSTAT annex. Picture books were published for the first five-year plan (1929–33) and the Soviet aerial fleet, and new signs for exhibitions were developed. For a while, pictorial statistics were published daily in *Pravda* and *Isvestia*. The presumably misleading information provided by the Stalinist regime through ISOSTAT caused some authors such as Clive Chizlett to categorize these publications as 'how to lie with statistics'.[30]

The Dutch period, the birth of ISOTYPE

In 1934, the GWM moved to the Netherlands. Some years before 1934, when Neurath and Arntz fled Austria, Neurath had explored the possibility of moving the GWM to another country. Exhibition rooms and offices were made available through Neurath's contacts with the historian and founder of the International Institute of Social History in the Netherlands, Nico W. Posthumus, and the GWM was moved to The Hague, forming a new organization: the 'International Foundation for the Promotion of Visual Education'. In The Hague, Neurath was asked for help by Charles K. Ogden.

Ogden was an inventor and proponent of 'Basic English', in which he reduced the English vocabulary of about 250,000 words to a basic core of 850 words. His acronym 'Basic' stood for 'British American Scientific International Commercial'. He asked Neurath to design an illustrated primer for this language. Neurath agreed but asked Ogden to publish a book, written in Basic English at the same time—to explain the principles of International Picture Language. As a result, *International Picture Language: The First Rule of Isotype* was published in 1936 and *Basic by Isotype* was published in 1937.

The term 'ISOTYPE' was coined by Marie Reidemeister during the preparation of the books, and the ISOTYPE symbol was drawn by Gerd Arntz. Ogden's acronym provided the stimulus for this. Out of the 850 Basic English words, 250 were represented by

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ISOTYPE pictures. The 'International Picture Language' book and subsequent publications gave Neurath an opportunity to explain the development of ISOTYPE:

> 'The first step in ISOTYPE is the development of easily understood and easily remembered symbols. The next step is to combine these symbolic elements. For example there is a symbol for shoe and a symbol for factory. By joining these two symbols we can talk about a factory in which shoes are made. By another combination, we can discuss shoes made by machinery and shoes made by hand [**4**]. Similarly, we can add the symbol for coal to the symbol for worker and we can make an ISOTYPE for mechanised mining and for pick mining.'[31]

During the Dutch period, another important publication, *Modern Man in the Making*, was produced.[32] It could be considered as an outline for any country's social and cultural report.[33]

The Encyclopaedia of Unified Science and the International Institute for the Unity of Science, set up in The Hague by Neurath and Frank, were closely connected with ISOTYPE and the Institute in The Hague. As in the times of the encyclopaedists Diderot and D'Alembert, the aim of both organizations was to bring about a new era of enlightenment. In line with the philosophy of the Vienna Circle, the unification of the exact sciences and the social sciences was emphasized, as was the attempt to bridge the gap between high science and everyday life, much as the GWM had sought to achieve in Vienna. The Encyclopaedia was to consist of thirty-six volumes, to be published in English, French and German. A series of the volumes within this project would include a Visual Thesaurus, which would be a World Overview in Pictures as in Comenius' *Orbis* atlas.[34] In the end, only two volumes of the International Encyclopaedia were published (in 1938 and 1939).

Like many of their colleagues, Neurath and Reidemeister fled to England when Holland was invaded by the German army in May 1940. Neurath was taken prisoner by the British, but eventually released. He lectured in Oxford and founded the British ISOTYPE Institute in 1941. Many improvements in the making of ISOTYPE elements were made in collaboration with British designers K. R. James, B. R. Young and D. L. Young during this time.[35] Also, animated pictorial statistics were developed and ISOTYPE elements were used in documentary movies directed by Paul Rotha.[36] The most famous is a six-minute ISOTYPE animated film, 'A few ounces a day', commissioned by the UK Ministry of Information, stressing the importance of limiting the stream of goods coming from the USA by ship in 1940–41, since many of these vessels were destroyed in transit by the Germans. Reducing the consumption level in each household by just a few ounces a day would substantially reduce the number of shipments.[37]

Another example of the successful use of ISOTYPE stems from Greece, where the architect and urban planner Constantinos Doxiadis used ISOTYPE in a publication on the devastating damage inflicted on the country by the German occupation forces.[38] The publication was instrumental in communicating the problems of the country after the war and in securing financial assistance from the Western allies.

Arntz remained in The Hague after the German occupation and was asked to work for the Nederlandse Stichting voor de Statistiek, founded by the director of the Central Bureau of Statistics, Ph. J. Idenburg. He worked for the Stichting until 1943, when he was enlisted in the German army. After the war, he returned to The Hague and resumed his work for the Stichting, illustrating the statistical yearbooks of the Netherlands Central Bureau of Statistics to 1966.[39] Apart from these illustrations, ISOTYPE statistics are rarely found in the period after the Second World War. By 1968 (the last year of Arntz's artistic career), the number of pictographs (signs) had grown to over 4,000.[40]

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The ISOTYPE legacy

From time to time, newspapers and magazines use the ISOTYPE symbols to illustrate statistical information. A good recent example of this is shown in the *New York Times* illustration of the type and location of each casualty in Iraq for the month of January 2007, representing various groups (American and coalition forces, Iraqi forces, police officers and civilians) [**5**].[41]

Richard Saul Wurman's social and cultural report of the USA, published in 1999, illustrates the state of the nation using Neurath's principles of ISOTYPE.[42] In 2003, a group of scientists and artists gathered at the University of Lüneburg to update some of the sheets from the 1930 *Bildstatistisches Elementarwerk* in a new atlas.[43] The work of the economist Stephen Rose on social stratification in the US is still being used in sociology classes.[44] Included in the book is a poster with colour-coded pictograms that make it possible to understand how income distribution is related to race, sex, family structure and occupation. More examples can be found, but they are scarce. Numerous incorrect visualizations of statistics by means of variation in size can still be found in newspapers and magazines.[45]

Aside from these few examples and the work from the Institute Vienna Circle, the interest in Neurath's work seems to have vanished from the scientific world since his untimely death in 1945.[46] In the opinion of the historian William Johnston: 'Perhaps the most startling fact about Neurath is his eclipse after 1945 ... Who else conducted original research in physics, mathematics, logic, economics, sociology, ancient history, political theory, history of German literature, architecture and graphics?"[47]

The language of ISOTYPE has not found its way into computer-related media, either. David Skopec has described the problems in translating ISOTYPE to the field of digital media in the early 1990s.[48] Although most of the problems mentioned (poor resolution and absence of user-interactive tools) have been solved, there are only a few Web-related ISOTYPE-like applications.

In the history of statistical graphics, ISOTYPE seems to be a hidden chapter.

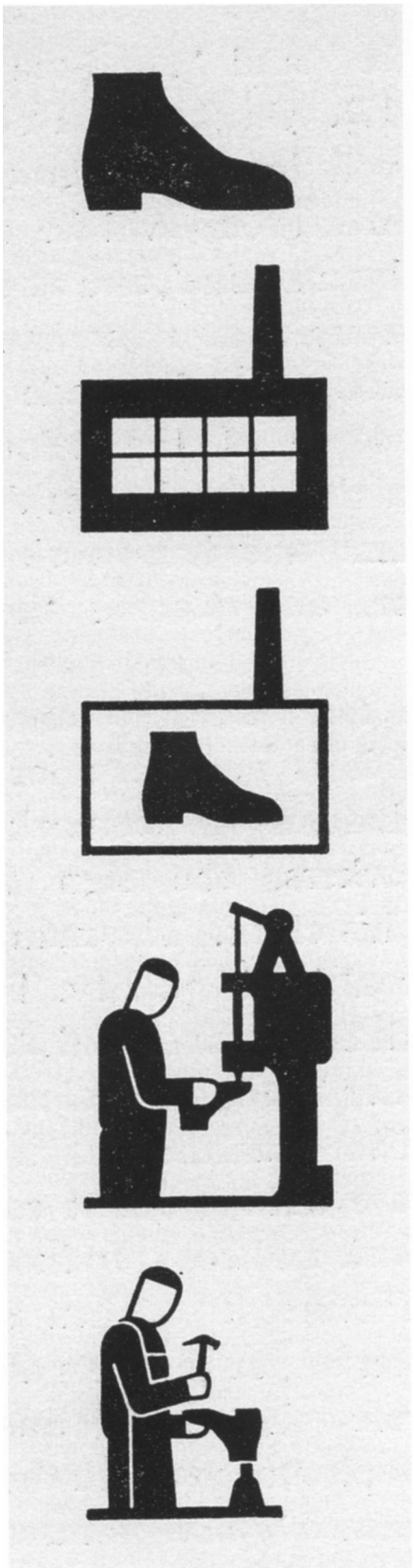

Fig 4. Examples of how pictographs can be combined to represent different concepts. Otto and Marie Neurath Isotype Collection, University of Reading.

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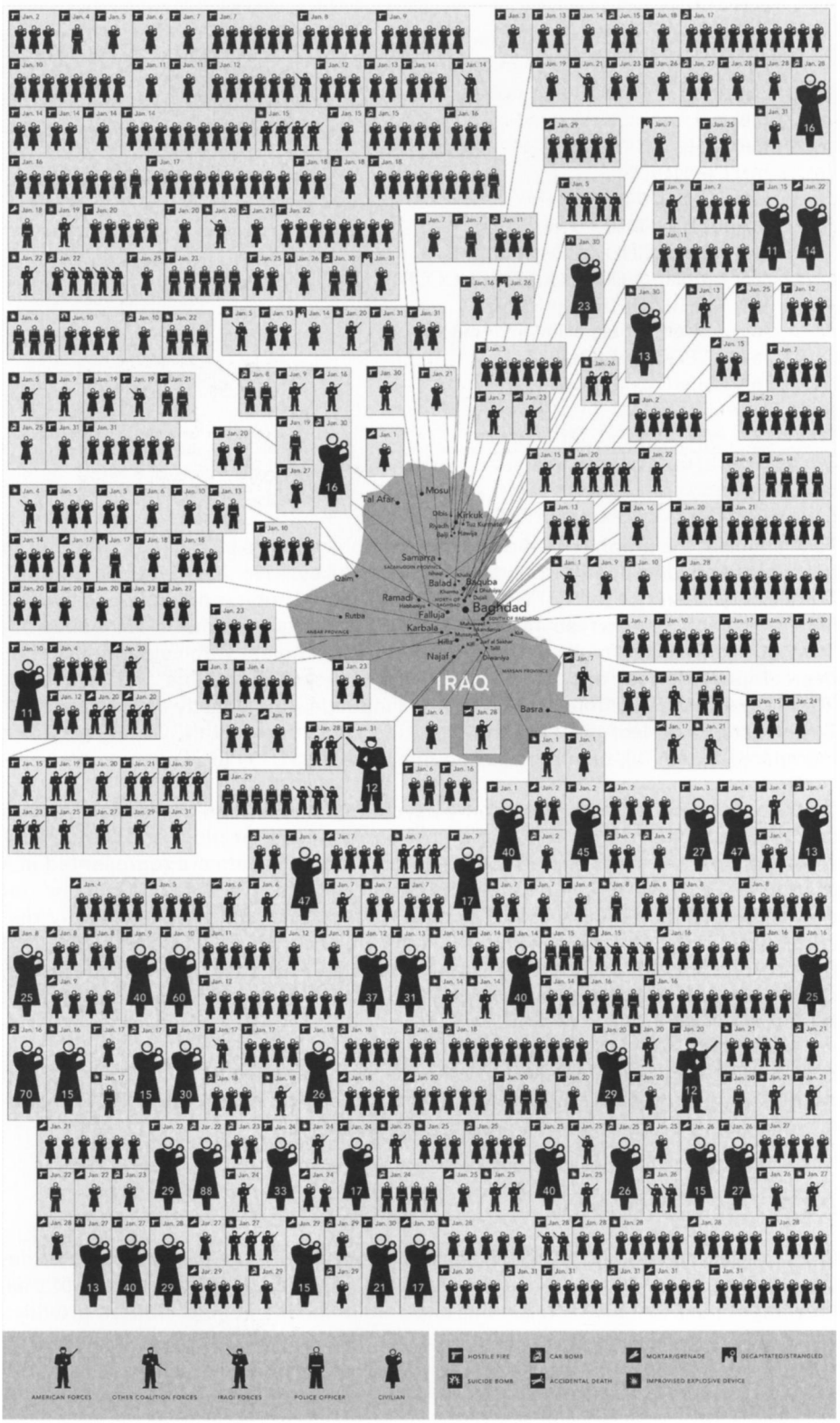

Fig 5. Type and location of casualties in Iraq, January 2007. © Alicia Cheng.

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'64| ABBCCCDDghIIIMOPPrs134
'65| AbBBCCCCCCCCCCCCCCCCCDDFHIIOOpPrS2445
'65| AbBBDDFHIIOOpPrS245
'66| ABCCCfFFFhhhIJmOpPtvvv1334
'67| ACFGGmmPPPvV
'68| DHpp

(b: Bonneville; B: Buick; A: Cadillac; h: Chevelle; 2: Chevy II; C: Chevrolet; H: Chrysler; 1: Classic; 3: Cornet; 4: Corvair; D: Dodge; E: Eldorado; F: Ford; f: Futura; g: Galaxie; G: Grand Prix; I: Impala; J: Jaguar; L: Lincoln; M: Mercury; m: Mustang; O: Oldsmobile; p: Plymouth; P: Pontiac; r: Rambler; 5: Simca; s: Studebaker; S: Sunbeam; t: Tempest; T: T-bird; V: Valiant; v: Volkswagen)

Fig 6. Stem-and-leaf display: Collection of model year and name information for advertised used cars (Ads for three or more cars, 'Sunday Standard-Times', New Bedford, MA, for 18 August 1968).[52] (Adapted from Tukey, 1977).

Take a look at the graphics in the statistical graphics bibles by Edward Tufte[49] or in the exploratory data analysis handbook of John Tukey.[50] Neither mentions Neurath. Tufte's only reference to ISOTYPE is in his 1997 book, but it is not very positive. He illustrates John Snow's research on the London cholera epidemic in 1854, showing 'how pop journalism might depict Snow's work, complete with celebrity factoids, overcompressed data, and the isotype styling of those little coffins'. And, similarly: 'decorative clichés of "info-graphics" (the language is as ghastly as the charts)'.[51] Tukey's stem-and-leaf displays show striking similarities with ISOTYPE statistics (compare [**2**] and [**6**]), but he makes no reference to ISOTYPE.

Or, take the experimental research by psychologists Stephan Lewandowsky and Ian Spence on discrimination of multiple strata in scatter plots and the conclusions drawn from these experiments: 'When different strata are represented in a scatterplot, the use of color to code different groups is advised. If color is not available, shapes, amount of fill, or letters—provided that they are highly discriminable—may be used with little loss in accuracy.'[53] Lewandowsky and Spence did not use ISOTYPE or similar symbols in their experimental design, simply because the statistical graphics handbooks of the 1970s and 80s did not refer to ISOTYPE.

Why is there such an imbalance between the attention given to ISOTYPE in art and design and the attention given to it in statistics/science, where ISOTYPE has actually disappeared? There are six possible explanations.

ISOTYPE is overrated

Clive Chizlett states that ISOTYPE has been overrated by many historians of design.[54] If scientists and statisticians interested in graphics became aware of this, they might have lost interest. But this explanation does not hold. Chizlett provides no single reference to those historians. On the contrary, Meggs, Holmes and Wildbur all devoted two pages of their books to Neurath and ISOTYPE before 1992.[55] The works of Mijksenaar and Krampen are more recent.[56] The Holmes article from 2001 (in which Holmes describes his own career as a graphic designer and explains how ISOTYPE and Gerd Arntz greatly influenced his own and other current graphic work) may be an example of overrating ISOTYPE, but it appeared years after the Chizlett article.[57]

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History

The political climate in the Western world became unfavourable for further development of ISOTYPE as a result of the cold war in the 1960s, the involvement of the ISOTYPE creators in the 1930s left-wing movement in Germany and Austria and the association with Soviet propaganda. The Soviet propaganda argument is related to Chizlett's charge that Neurath lied with statistics (a charge we have already evaluated and rejected). The political climate argument has been raised by Paul Lewi, although in a non-convincing, speculative way: 'Perhaps, the association [of Marie Reidemeister after the death of her husband] with so-called left-wing educationalists (such as Lancelot Hogben) did not help in the end.'[58]

Data : ink ratio

The data : ink ratio is defined as the ink area devoted to the data divided by the total ink area of the figure, or, equivalently, as 1.0 minus the proportion of a graphic that can be erased without loss of data information.[59] The data : ink ratio has to be maximized for a high-quality statistical graph. Take the update of Table 90 in the 1930 *Elementarwerk* on real wages to Table 90A in the atlas of the Lüneburg group [**7**] [**8**].[60] The new table is beautifully designed but has too many symbols and too much information that make the graph less readable. And the data : ink ratio is far too low. Another example is Stephen Rose's splendid US social stratification poster, which suffers from a low data : ink ratio. Using various colours to depict ethnic and racial groups, squares and circles for family types, coloured backgrounds for occupational categories different signs for men and women and using all kinds of combinations in depicting the US income distribution asks too much from the average reader. It is a study object for economics and sociology students.

The data : ink ratio is linked to the principles formulated by Neurath for making good use of his ISOTYPE system: 'At the first look, you see the most important points, at the second, the less important points, at the third, the details, at the fourth, nothing more—if you see more, the ... picture is bad.'[61] What is needed nowadays is an adequate transformation from data to pictorial statistics with a maximum data : ink ratio. This is also related to the last argument given below.

Results from cognitive psychology

William Cleveland, a leading researcher in the field of visualization of statistical data, conducted experiments in pattern perception, colour encoding, use of texture symbols and reference grids.[63] It is interesting that some of the results of these experiments fit the ISOTYPE basics, such as those on colour encoding. Also,

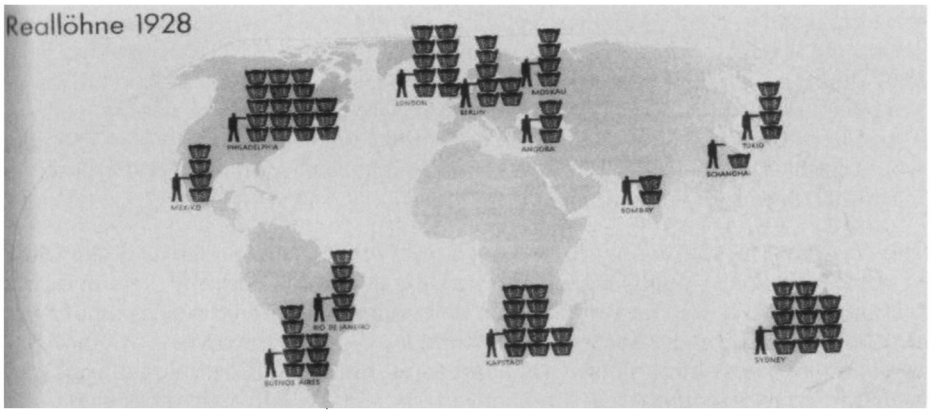

Fig 7. Table 90 from the 1930 'Elementarwerk'. © Österreichisches Gesellschafts- und Wirtschaftsmuseum.

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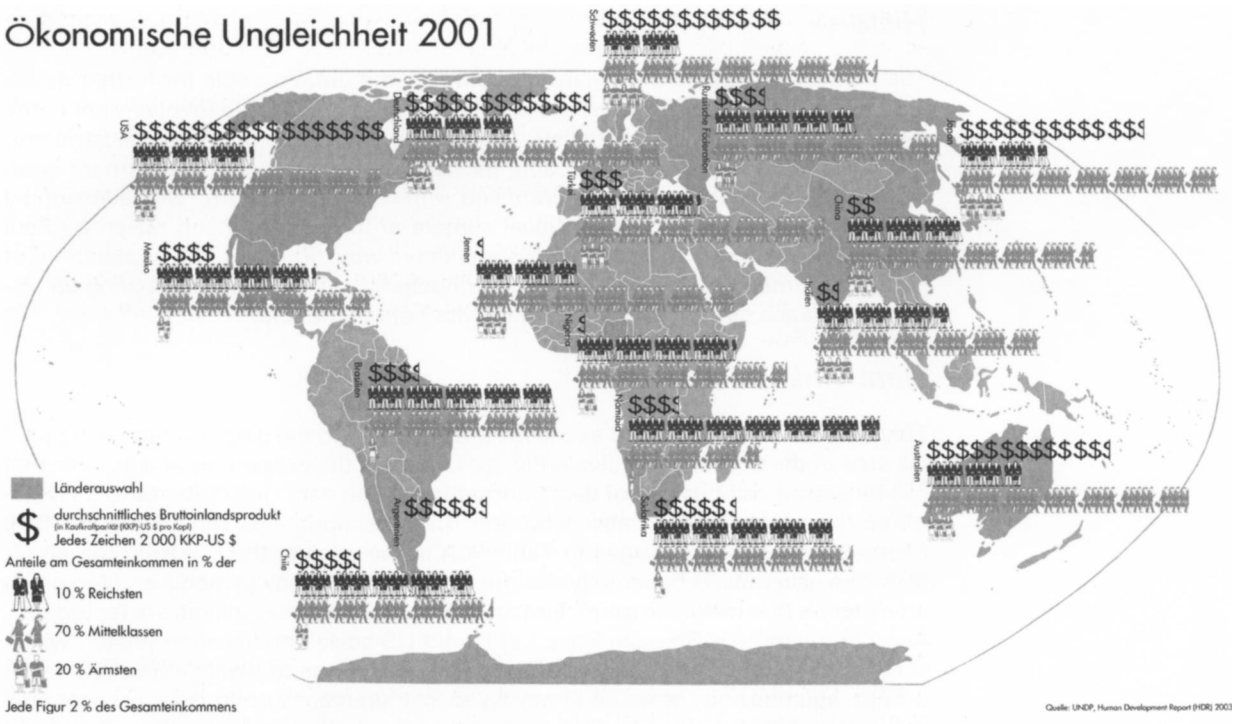

Fig 8. Table 90A from Behnke et al.[62] © Generali Foundation Collection, Vienna.

some elements of the results on pattern perception are in line with the ISOTYPE rules. For other elements, there is no such equivalent. Take the famous import–export graph from Playfair.[64] Cleveland shows that it is difficult to evaluate the time trend in the difference between import and export from the distinct lines. He draws a new graph, plotting the difference against time, which gives a clear trend. Designing a sign for such an abstract concept as a 'difference', according to the ISOTYPE rules, and showing this same trend by such a sign seems to be rather complicated.

Internet era

ISOTYPE has become obsolete in the new era. Web 2.0 and Wikipedia have taken over; the new 'Orbis', the history of everything, is always available—anywhere and anytime. But the Internet era also provides immense opportunities for new ISOTYPE-like applications. The tools are available, as are the original Arntz pictograms in digital format. The Netherlands Institute for Social Research (SCP), a government agency that conducts research into the social aspects of all areas of government policy, announced its intention to use some ISOTYPE elements in its 2007 report on the state of the nation. Given the large number of descriptive statistics in their bi-annual reports and the SCP policy to make the information available not only in print but also electronically on their website, ISOTYPE-like graphics would certainly attract more interest. Unfortunately, inclusion of ISOTYPE graphics in the 2007 report did not happen.[65]

The Austrian Museum for Economic and Social Affairs, the successor of the GWM in Vienna, annually publishes a survey of the Austrian economy. The booklets, both in German and in English, contain data, diagrams and tables, some of them in an ISOTYPE-like style. Some diagrams and tables, from the surveys 2000–08, are available as overhead projector transparencies, but are not downloadable. Other diagrams have been prepared, together with the Vienna University of Education, to

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implement the Vienna method of pictorial statistics for instruction at secondary schools in Austria. But all this is still in an early stage of development.[66]

For several years, data archives have offered the possibility of searching and downloading social science data from surveys. Instead of collecting their own (primary) data, researchers can use files from these data archives, which are still growing in number, for secondary analysis. Linking digital data with digitalized pictograms would open up new ways of displaying results. Recently, the Austrian data archive announced this linking facility, but it is not yet in operation.[67] For state-of-the-nation reports as well as for secondary analysis of data from archives, the unique combination of a visionary scientist, an artist/designer and a transformer appears to be missing.

Synergy

The success of ISOTYPE was the result of the unique and exceptional combination of Neurath, Reidemeister and Arntz, with Neurath as the person with the ideas, concepts, theories and plans; Reidemeister as the transformer, linking the ideas, concepts, etc., to sketches of pictorial statistics and Arntz as the designer. This creative synergy cannot easily be recaptured.

A combination of the third, fifth and sixth points seems to be the best explanation for the disappearance of ISOTYPE from statistics. Nowadays, there is no philosopher, mathematician and social scientist such as Neurath, who, together with a transformer such as Reidemeister and a creative designer such as Arntz, uses the possibilities of the digital era for educational goals. The social and cultural report of any country, in which the state of society and many different trends are depicted in descriptive statistics for a wide public audience, could benefit from such a group. Such a combination would provide an ideal opportunity for new pictorial statistics, but there has not been such a group of people for a long time. Certainly, there have been and still are statisticians who have brought new ideas into the field, but the ISOTYPE legacy has gone either unnoticed (e.g. Tukey) or unappreciated (e.g. Tufte). There have been and still are great designers who are interested in the history of their field, but they are familiar with Neurath's name only via Arntz's pictograms. Statistics and design: two worlds apart. What is needed is a programme that aims to bridge the gap.

In October 2007, the Department of Typography & Graphic Communication of the University of Reading launched their 'ISOTYPE revisited' project. One of their objectives is to challenge the monolithic view of ISOTYPE as concerned only with the design of symbols and charts and making known its much wider sphere of application, e.g. in education, in new media developments and in the visualization of information. One of the results from the project, which will become public in 2010 and 2011, could be that with the help of creative transformers and designers who possess an intuitive grasp of a maximum data : ink ratio, it should be possible to create new pictorial statistics and to re-use existing ones in a new way. In addition, 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.

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Notes

1 O. Neurath, 'From Vienna Method to ISOTYPE', in *Empiricism and Sociology*, M. Neurath & R. S. Cohen (eds.), Reidel, Dordrecht, 1973, p. 220.

2 Full title: *Orbis sensualium pictus. Hoc est, Omnium fundamentalium in Mundo Rerum, & Vita Actionum, Pictura & Nomenclatura* (The first English edition, translated by Charles Hoole, was published in London in 1659: *Visible World. Or, a Picture and Nomenclature of all the Chief Things that are in the World and of Mens Employments Therein).*

3 W. Playfair, H. Wainer & I. Spence, *Playfair's Commercial and Political Atlas and Statistical Breviary*, Cambridge University Press, Cambridge, 2005.

4 M. G. Mulhall, *Dictionary of Statistics*, G. Routledge & Sons, London, 1883.

5 W. C. Brinton, *Graphic Methods for Presenting Facts*, The Engeneering Magazine Company, New York, 1919.

6 M. Dalbello & A. Spoerri, 'Statistical Representations from Popular Texts for the Ordinary Citizen, 1889–1914', *Library & Information Science Research*, vol. 28, 2006, pp. 83–109.

7 A. Creisher & A. Siekmann, 'Bubbles and World Class Culture Districts', in *ISLANDS+GHETTOS*, J. Holten (Hg.) Heidelberger Kunstverein, Heidelberg, 2008, pp. 38–43.

8 N. Holmes, *Designer's Guide to Creating Diagrams and Charts*, Watson-Guptill Publications, New York, 1984; N. Holmes, *Designing Pictorial Symbols*, Watson-Guptill Publications, New York, 1985; N. Holmes, 'Pictograms: A View from the Drawing Board or, What I Have Learned from Otto Neurath and Gerd Arntz (and jazz)', *Information Design Journal*, vol. 10, 2001, pp. 133–43.

9 P. Wildbur, *Information Graphics: A Survey of Typographic, Diagrammatic, and Cartographic Communication*, Trefoil Publications, London, 1989.

10 P. Mijksenaar, *Visual Function: An Introduction to Information Design*, Princeton Architectural Press, New York, 1997, p. 30.

11 E. Lupton, 'Reading Isotype', *Design Issues*, vol. 3, 1986, pp. 47–58; F. Hartmann & E. K. Bauer, *Bildersprache: Otto Neurath Visualisierungen*, Wiener Universitätsverlag, Wien, 2000; F. Mertens, *An idealist in The Hague: Otto Neurath's years in exile*, Municipality of The Hague, The Hague, 2007; F. Mertens, *Otto Neurath en de maakbaarheid van betere samenleving: fragmenten uit de vorige eeuw*, Sociaal en Cultureel Planbureau/Centraal Bureau voor de Statistiek/Uitgeverij Aksant, Den Haag/Voorburg/Amsterdam, 2007; M. Ackermann (ed.), *Piktogramme—Die Einsamkeit der Zeichen*, Deutscher Kunstverlag, München, 2006; M. Krampen, M. Götte & M. Kneidl, *Die Welt der Zeichen: Kommunikation mit Piktogrammen/The World of Signs: Communication by Pictograms*, **av**edition GmbH, Ludwigsburg, 2007.

12 Brno, 2002 (*ISOTYPE—And the Development of Modern Global Signs. Catalogue of the Exhibition at the Moravian Gallery in Brno, 18.06 – 20.10.2002*, Edition Designrevue CZ, Praha, 2002); Cologne, 2004 (Ackermann, op. cit.); Stuttgart 2006/2007 (N. Vossoughian, *Otto Neurath: The Language of the Global Polis*, NAI Uitgevers, Rotterdam, 2008); The Hague, 2006/07 and 2008 (F. Mertens, *Otto Neurath in Den Haag: 1934–1940*, Introductory lecture given at the start of the project 'After Neurath, 10/06–04/07, Stroom, The Hague, 2006; <http://www.stroom.nl/media/MertensNeurathLezing.pdf> accessed 25 February 2008; Utrecht, 2008 (E. Annink & M. Bruinsma, *Lovely Language: Words Divide, Images Unite*, Veenman Publishers, Rotterdam, 2008).

13 H. Kraeutler, *Otto Neurath. Museum and Exhibition Work. Spaces (Designed) for Communication*, Frankfurt am Main, Peter Lang, 2008.

14 E. Chapel, 'Otto Neurath and the CIAM—The International Picture Language as a Notational System for Town Planning', in *Encyclopedia and Utopia. The Life and Work of Otto Neurath (1882-1945)*, E. Nemeth & F. Stadler (eds.), Kluwer Academic Publisher, Dordrecht, 1996, pp. 167–82; N. Vossoughian, 'Mapping the Modern City: Otto Neurath, The International Congress of Modern Architecture (CIAM), and the Politics of Information Design', *Design Issues*, vol. 22, 2006, pp. 48–65; Vossoughian, op. cit., 2008.

15 The Munich soviet republic was the short-lived attempt to establish a socialist state in the Free State of Bavaria, with Munich as its capital. On 7 November 1918, Kurt Eisner declared Bavaria a 'free state'; in April 1919 it was proclaimed a Soviet Republic, and on 3 May 1919, it ended when the German army entered Munich and defeated the Communists.

16 O. Neurath, *The ISOTYPE Work*, 1943. Letter in the Wiener Kreis Archive, Haarlem.

17 In 1941, Otto Neurath and Marie Reidemeister married. After Otto's death in 1946, Marie Neurath (1898–86) lived and worked in England.

18 Neurath, op. cit., 1973, p. 217.

19 Ibid, p. 221.

20 Taken from O. Neurath, *International Picture Language: The First Rules of ISOTYPE*, Kegan Paul, Trench, Trubner & Co. Ltd, London, 1936.

21 G. Dumbar & D. Dumbar, *Safe Place*, Utrecht Manifest, Utrecht, 2007, p. 14.

22 G. Arntz, *De tijd onder het mes: hout- en linoleumsneden 1920-1970*, SUN, Nijmegen, 1988.

23 In 1930, Alma edited the ninth issue of the famous journal 'Wendingen', titled 'Pictorial Statistics and Sociological Graphics', devoted to ISOTYPE and the GWM.

24 R. W. D. Oxenaar, *Bart van der Leck tot 1920. Een primitief van de nieuwe tijd*, PhD thesis, Utrecht University, 1976, p. 87. In fact, Van der Leck recommended that Peter Alma go to Vienna. Neurath and Arntz could have been familiar with the work of Van der Leck, who had an exhibition in the Kunsthalle Düsseldorf in 1927/1928. See T. van Kooten (ed.), *Bart van der Leck*, Kröller-Müller Museum, Otterlo, 1984. Van der Leck's work from 1910 to 1914 appears to have had an impact on the development of pictographs. Works from the period 1911–14, which could be termed 'pictographic', are *Twee huzaren*, 1911; *Oefeningen met geschut*, 1911; *Uittocht van de genie naar het kamp van Zeist*, 1911; *Vier soldaten*, 1912; *Huzaren met volk*, 1912; *De ordonans*, 1913; *De hondekar*, 1913; *Houtrijden*, 1913; *Rust bij de ploeg*, 1913; *Op de markt*, 1913; *Buurpraatje*, 1913; *Negociant*, 1913; *Bij de Gooise haard*, 1913; *De jager*, 1913; *Oogst*, 1914; *Naar het vliegveld*, 1913; *Buiten met de fiets*, 1913; *Het afscheid bij de auto*, 1913; *Op het perron*, 1913; *Voetballers*, 1913; *De opperman*, 1913; *De blinden*, 1912; *Ziekte*, 1912; *De nood*, 1913; *Brand*, 1913; *Het ongeval*, 1913 and *Bedelvolk*, 1914.

25 R. Modley & W. R. Myers, *Handbook of Pictorial Symbols: 3,250 Examples from International Sources*, Dover Publications, Inc.,

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Mineola, NY, 1976. Recently, a selection from this handbook has been made available royalty-free, on CD. See R. Modley (ed.), *1,100 Pictorial Symbols. CD-ROM and Book*, Dover Publications, Inc., Mineola, NY, 2007.

26 Full title: *Gesellschaft und Wirtschaft. Bildstatistisches Elementarwerk. Das Gesellschafts- und Wirtschaftsmuseum in Wien zeigt in 100 farbigen Bildtafeln Produktionsformen, Gesellschaftsordnungen, Kulturstufen, Lebenshaltungen*, Bibliographisches Institut AG, Leipzig, 1930. The Atlas is available at: <http://www.wirtschaftsmuseum.at/pdf/Atlas_Neurath_Gesellschaft_und_Wirtschaft.pdf> accessed 1 March 2009.

27 Neurath, op. cit., 1936, p. 27

28 A fairly complete overview of the Vienna Circle and its context is given by F. Stadler, *The Vienna Circle: Studies in the Origins, Development, and Influence of Logical Empiricism*, Springer-Verlag, Wien, 2001.

29 L. A. Coser, *Refugee Scholars in America: Their Impact and Their Experiences*, Yale University Press, New Haven, 1984. The Vienna Circle was certainly not a homogeneous group. Politically, there was a left wing and a right wing: Carnap, Hahn, Frank and Neurath represented the left wing (Marxists, socialists and social democrats); Schlick and Waismann the right wing (liberal conservative). Even within the left wing, factionalism emerged: 'Carnap deplored Neurath's involvement in Viennese politics, Neurath in turn rebuked Hahn for attending spiritualistic séances, where the latter aspired to introduce rigorous methods of experiment'. See W. M. Johnston, *The Austrian Mind: An Intellectual and Social History 1848–1938*, University of California Press, Berkeley, CA, 1972.

30 C. Chizlett, 'Damned Lies, and Statistics: Otto Neurath and the Soviet Propaganda in the 1930s', *Visible Language*, 26, 1992, pp. 298–321. The title of Chizlett's article refers to D. Huff, *How to Lie with Statistics*, Penguin Books Ltd, Harmondsworth, 1973. The book bears the Disraeli motto: 'There are three kind of lies: lies, damned lies, and statistics'. Clearly, Chizlett dislikes Neurath's pictorial statistics ('... something odd, bogus, tinny; of things that did not really make sense', p. 299). His argument for charging Neurath of producing misleading statistics is based on just one observation: 'Among many statistical charts published in support of the first Soviet Five Year Plan, in late 1933, or early 1934, is a particular ISOSTAT chart which claims to deal with statistics of insecticidal crop-spraying. .... It shows a fivefold increase in crop-spraying by aircraft across the SU [Soviet Union] over a span of four years from 1931 to 1934 inclusively, but with the exception of the year 1932. ... [W]hy is the year 1932 missing from the rest? Is that year missing because it was the year of the first and worst in a continual series of man-made famines?' (p. 307). Note that during Stalin's first five-year plan (1929–33), collectivized agriculture was imposed upon the whole of the Soviet Union. Note further that the statistical input for the ISOSTAT charts was collected and provided by GOSTAT, the central statistical office of the Soviet Union. Most probably, the figures for 1932 were not provided to ISOSTAT by GOSTAT for reasons not known to us or to Chizlett.

31 Neurath, op. cit., 1937, pp. 224–5.

32 Neurath, *Modern Man in the Making*, Alfred A. Knopf, New York, 1939.

33 Mertens, op. cit., 2006, 2007.

34 Vossoughian, op. cit., 2005, p. 60.

35 O. Neurath, 'Visual Aids and Arguing', *The New Era*, 25, 1944, pp. 51–61.

36 R. Kinross, 'Emigré Graphic Designers in Britain: Around the Second World War and Afterward', *Journal of Design History*, 3, 1990, pp. 35–57.

37 A more recent example is the six-minute ISOTYPE movie 'The Street', by Lars Arrhenius. The movie was released in 1994 and can be viewed on YouTube: <http://www.youtube.com/results?search_query=arrhenius&search_type=&;aq=f> accessed 23 April 2008.

38 C. A. Doxiadis, *Destruction of Towns and Villages in Greece* (in Greek), Ministry of Reconstruction, Athens, 1946; C. A. Doxiadis, *Ekistic Policies for the Reconstruction of the Country with a 20-Year Program* (in Greek), Ministry of Reconstruction, Athens, 1947.

39 Centraal Bureau voor de Statistiek, *Statistisch Zakboek (Statistical Pocket Yearbook)*, Drukkerij Albani C.V./Uitgeversmaatschappij W. de Haan N.V., 's-Gravenhage/Utrecht en Zeist, 1940–1966. Each yearbook contains about 25 ISOTYPE pictorial statistics.

40 The collection of pictograms is in the archives of the Municipal Museum in The Hague. Recently, digitalization has been started and the results can be viewed and downloaded at <http://www.gerdarntz.org> acessed 23 April 2008.

41 <http://www.nytimes.com/imagepages/2007/02/03/opinion/04opart.html> accessed 11 January 2009. An updated version, using various colours, shows type and location of each attack responsible for the 2,592 recorded deaths during the year 2007 among American and other coalition troops, Iraqi security forces and members of the peshmerga militias controlled by the Kurdish government: <http://www.nytimes.com/imagepages/2008/01/06/opinion/06opchart.ready.html> accessed 11 January 2009].

42 R. S. Wurman, *Understanding USA*, TED Conferences Inc., Newport, RI, 1999.

43 C. Behnke, D. Stoller, A. Schlosser & U. Wuggenig, *Atlas: Spaces in Subjunctive*, Verlag für Wissenschaft und zeitgenössische Kunst, Lüneburg, 2004.

44 S. J. Rose, *Social Stratification in the United States, The American Profile Poster. Revised and Updated*, The New Press, New York, 2007. Previous editions of the poster date back to the 1970s.

45 Some examples of these along with their redesign in ISOTYPE style can be found in A. Jansen, 'Isotype and Infographics', in *Encyclopedia and Utopia: The Life and Work of Otto Neurath (1882–1945)*, E. Nemeth & F. Stadler (eds.), Kluwer Academic Publishers, Dordrecht, 1996, pp. 143–156.

46 H. Koberstein, *"Wiener Methode der Bildstatistik" und "International System of Typographic Picture Education" (ISOTYPE): Informative Graphic und bildhafte Pädagogik*, PhD thesis, Universität Hamburg, 1969; H. Koberstein, *Statistik in Bildern: Eine graphisch-statistische Darstellungslehre*, C.E. Poeschel Verlag, Stuttgart, 1973; K. H. Müller, *Symbole, Statistik, Computer, Design: Otto Neuraths Bildpädagogik im Computerzeitalter*, Verlag Hölder-Pichler-Tempsky, Wien, 1991.

47 Johnston, op. cit., 1972, p. 195. An indication of the size and wealth of Neurath's interests can be found in the Wiener Kreis Archive at the Provincial Archives of North Holland in Haarlem, the Netherlands. The inventory of the Archive is given by R. Fabian, *The Vienna Circle Archive: Inventory of the Papers of the Vienna Circle Movement (1924–1938) in Particular of the Scientific Papers of the Philosophers Moritz Schlick (1882–1936) and Otto Neurath (1882–1945)*<http://viennacirclefoundation.nl/VCArchive.pdf> accessed 24 February 2008. An interesting part of the archive is Neurath's correspondence. He was an prolific writer of letters, using a typewriter and carbon copy. The inventory reads like a Who's-Who in science, art, literature, and architecture.

48 D. Skopec, 'The Changing Media of Visual Statistics', in *Encyclopedia and Utopia: The Life and Work of Otto Neurath (1882–1945)*, E. Nemeth & F. Stadler (eds.), Kluwer Academic Publishers, Dordrecht, 1996, pp. 157–165.

49 E. R. Tufte, *The Visual Display of Quantitative Information*, Graphics Press, Cheshire, CT, 1983; E. R. Tufte, *Envisioning Information*, Graphics Press, Cheshire, CT, 1990; E. R. Tufte, *Visual Explanations: Images and Quantities*, Graphics Press, Cheshire, CT, 1997.

50 J. W. Tukey, *Exploratory Data Analysis*, Addison-Wesley Publishing Company, Reading, MA, 1977.

51 Tufte, op. cit., 1997, p. 37.

52 Ibid, p. 22.

53 S. Lewandowsky & I. Spence, 'The Perception of Statistical Graphs', *Sociological Methods & Research*, 18, 1989, pp. 200–42; S. Lewandowsky & I. Spence, 'Discriminating Strata in Scatterplots', *Journal of the American Statistical Association*, 84, 1989, pp. 682–8.

54 Chizlett, op. cit., 1992, p. 299.

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55 P. B. Meggs & A. W. Purvis, *Meggs History of Graphic Design*, 4th edn., Wiley, Hoboken, NJ, 2006, pp. 326–7; Holmes, op. cit., 1984, pp. 20–21; Wildbur, op. cit., 1999, pp. 51–2.

56 Mijksenaar, op. cit., 1997, pp. 30–1; Krampen et al., op. cit., 2007, pp. 22–3.

57 Holmes, op. cit, 2001.

58 P. J. Lewi, *Neurath and the Vienna Method of Picture Statistics*, p. 31. <http://www.datascope.be/sog/SOG-Chapter6.pdf> accessed 25 February 2008.

59 Tufte, op. cit., 1983.

60 Behnke et al., op. cit., 2004, p. 32.

61 Neurath, op. cit., 1936, p. 27.

62 Behnke et al., 2004, op. Cit.

63 W. S. Cleveland, *The Elements of Graphing Data*, AT&T Bell Laboratories, Murray Hill, NJ, 1994.

64 Playfair et al., op. cit., 2005, p. 13.

65 R. Bijl, J. Boelhouwer & E. Pommer (eds.), *De sociale staat van Nederland 2007*, SCP, Den Haag, 2007. <http://www.scp.nl/publicaties/boeken/9789037703214/De_sociale_staat_van_Nederland_2007.pdf> accessed 26 February 2008.

66 Transparencies for teaching purposes can be downloaded from <http://www.wirtschaftsmuseum.at/wmdown.htm> accessed 1 March 2009.

67 The Austrian data archive is called WISDOM (Wiener Institut für Sozialwissenschaftliche DOkumentation und Methodik); <http://www.wisdom.at/> accessed 1 March 2009. A link to European social science data archives: <http://www.cessda.org/about/members/index.html> accessed 1 March 2009.

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