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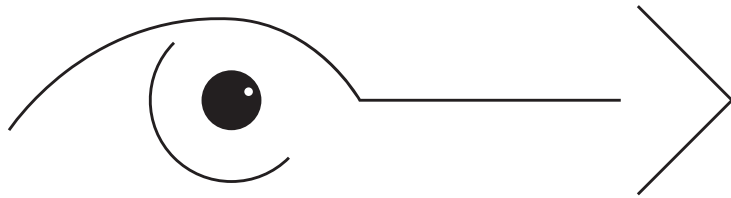
august 2018

52 . 2 Visible Language

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the theory

august 2018



Before there was reading there was seeing. *Visible Language* has been concerned with ideas that help define the unique role and properties of visual communication. A basic premise of the journal has been that created visual form is an autonomous system of expression that must be defined and explored on its own terms. Today more than ever people navigate the world and probe life's meaning through visual language. This journal is devoted to enhancing people's experience through the advancement of research and practice of visual communication.

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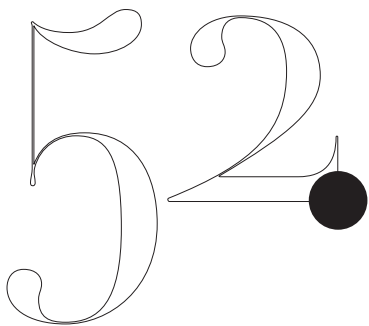
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BOOK REVIEW:

Design Theory To Go by *Sharon Helmer Poggenpohl*

Mike Zender

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Sometimes research creates breakthroughs that shatter paradigms. Sometimes research supports and affirms what's already known. Every journal hopes to publish a constant stream of breakthrough articles perhaps to the neglect of the necessary but less hair-raising articles that confirm, affirm, and probe what's thought to be known.

_____ This issue presents three important articles that are closer to the latter than the former. Brian Switzer's nice study confirms the ways and means that design research contributes to complex problems in the mundane context of caring for the aging and dying. Hospice care called for help and Brian's designers brought their naive eyes and design research methods to bear and identified numerous possible interventions.

_____ Rodrigo Ramírez's work affirms the usefulness of established comprehension testing protocols in the development of open-source icons for use in emergency situations. The nature of a crisis reinforces the need for designers to employ performance measures for supposedly "universal" icons.

_____ Emma Fisher, Nicolette Lee, and Scott Thompson-Whiteside's study tests the assumption that design practitioners and design academics see research differently. Their conclusions confirm the original assumption in many ways while adding important nuance leading to proposals to advance collaborations between practicing designers and academic researchers.

_____ Pino Torgu's challenge to conventional wisdom, that representational pictures of data enhance comprehension, probes Otto Neurath's Isotype and concludes that counting rows of pictograms is not as effective for reaching a total as reading an arabic number.

_____ These studies confirm the usefulness of design research to practice and support their integration. The articles are another step away from glory in beautiful graphics alone to pleasure in the demonstrable integration of beautiful and useful work Paul Rand envisioned in his 1970 breakthrough *Thoughts on Design*.

_____ One step, one study at a time, Design is passing from adolescence to adulthood.

_____ Mike Zender

research complex



Using Design Research for a Better Understanding of Complex Problems:

a study of two homes for the elderly

Brian Switzer

Although the Hospice Foundation in Constance knew they had a personnel problem, they were unsure how to begin to fix it. In addition to difficulties in finding and keeping employees, the Hospice Foundation's employees were often on sick leave, adding pressure on remaining staff. Twelve communication design students in the masters program at the University of Applied Sciences in Constance (HTWG Konstanz) conducted a study aimed at identifying the causes for these problems and, more generally, understanding how the employees work and feel. Even though the methods in this study are well known, it presents an important prototype for designers and design researchers because of its success in finding useful insights. It also serves as a pre-design project briefing for both management and designers. It demonstrates the usefulness of qualitative methods in providing a deeper understanding of a complex situation and its usefulness as a strategic tool and for defining a project's focus and scope. Ideally, it also provides insights into health care for the elderly.

Keywords

*design research
complex problems
healthcare*

Introduction

A common problem in design is to define the problem to be solved as precisely as possible. This is particularly the case when dealing with complex problems. Using the student project undertaken during a master's class on Design Research at the University of Applied Sciences in Constance, Germany as an example, I will show how projects similar to the one described here can be essential in understanding and defining a difficult problem. The Hospice Foundation¹ approached me with problems they were having with employees leaving and with finding (and keeping) new employees. The hiring of expensive temporary help had cost the foundation a substantial sum of money, and the management was under pressure to remedy this situation. They initially planned to give their personnel a questionnaire and wanted my help with preparing it. I proposed a more in-depth study of how the employees work and their day-to-day work situation to better understand what the problem(s) might be. Fortunately, they agreed to work with the university on this semester-long project. Two retirement homes in the foundation agreed to be a part of the study.

The project was conducted with twelve beginning Master's Degree communication design students, who had no training in design research methods. I have practiced this type of research in the past² because it gives students an excellent hands-on way to understand the theory behind the research. Furthermore, design research needs to be practiced to be understood and truly learned. In initial meetings with the Hospice Foundation, it became clear that many of the staff were mistrustful of outsiders. In order to help win the trust of the employees we organized introductory meetings; all employees were invited, and we (the students and myself) introduced ourselves.³ We explained that the purpose of the study was to better understand the daily lives of the employees as well as their needs and problems. We also repeatedly stressed that participation was voluntary and that employees could break off at any time they wished. After an open question and answer session, we were given a tour of the facilities. This particular study presented us with a unique problem, namely, how would we deal with the patients? They were not the focus of our study, and their privacy and dignity needed to be protected at all costs, yet they were an integral part of the employees' day-to-day activities. We agreed on the following

1. in German: Spitalstiftung Konstanz

2. Two projects in particular: in 2012 for a local grade school, and in 2011 for a local shopping center had each been successful in understanding the problem and in teaching Master's Degree students in research methodology.)

3. Although this meeting was paid time, only roughly one half to one-third of the employees attended.

ground rules: patients would not be photographed (in general we avoided photographing people), as they were not the focus of our study; and we would only speak to them if they actively spoke to us in the common areas. Furthermore, we also agreed to be careful to protect the employees and their privacy and discussed various methods to achieve this goal. Parallel to this introduction process, the students were being trained in the methods and ethics surrounding a qualitative research study with human subjects.

Methods and Scope

The study used a variety of methods to gain a greater understanding of the employees' daily lives. These included active participation methods such as shadowing, guided tours and interviews, as well as passive observation methods such as mapping activities and people to places and times, or document inventories, photographing workplaces.⁴ Finally, general background research – such as news and basic background information on the profession – provided some context to the research focused on the specific situation. Getting students to engage with people directly was a challenge. Obviously some students are more outgoing; however, it is often the shy quiet ones that make more detailed observations, and who need special encouragement. Encouragement and feedback were organized around weekly group meetings. Here students were encouraged to share in a detailed way what happened, and particularly what was not so successful so that all could learn from it. I use Clifford Geertz's term "thick description"⁵ to describe what is expected in terms of describing what happened and how detailed notes need to be. From week to week the students became more secure and practiced in their methods, and the observations became more interesting.

It is my observation (and the success of IDEO and their qualitative Method Cards⁶ supports this theory) that qualitative research methods comes naturally to designers and design students. Qualitative methods are more open than quantitative methods; they start without a specific theory;

4. Shadowing is following someone around during their work day and observing what happens; guided tours are asking someone to show you around their place of work or home and explain objects or situations. In the case of this study, we used unstructured interviews, where a rough set of questions is used to guide a conversation. Behavioral mapping documents where activities happen or where people are. A document inventory collects all documents related to a particular process or profession and analyzes these. Photographing workplaces captures the work environment in a very detailed way.

5. see Clifford Geertz (1973) *The Interpretation of Cultures*, paperback edition pages 3-10.

6. See the IDEO website www.ideo.com and their publications especially: IDEO Method Cards (2003) and Kelley, Littmann (2006) *Ten faces of Innovation*.)

FIGURE 1

The five topics and their relationships to each other.



rather, they develop the theory out of the observed situation (Grounded Theory, Anselm L. Strauss, *Qualitative Analysis for Social Scientists*, Cambridge, University Press, 1987.), and tend to be more problem-oriented.⁷

Although the Hospice Foundation runs many retirement homes, and other services, we agreed to limit our study to only two homes for the elderly. This was primarily because the managers of these homes agreed to be a part of the study, but also simply due to the limited resources available to the team. The students prearranged their visits and made observations during all three work shifts. In addition to the research specific to the homes for the elderly, we also met with the employee coach, the union, and sat in on one of the monthly management meetings.

The students collected a large amount of material: photographs, quotes, notes of observed activities and situations, documents, and notes from interviews. This material was condensed into concisely noted quotes and observations and then sorted into categories. Originally we sorted the information physically using cards and post-it notes (see figure 1) and then transferred this to a spreadsheet for practical reasons such as transport, precision and sharing. As we worked with the information categories and subtopics slowly started to emerge.

Results

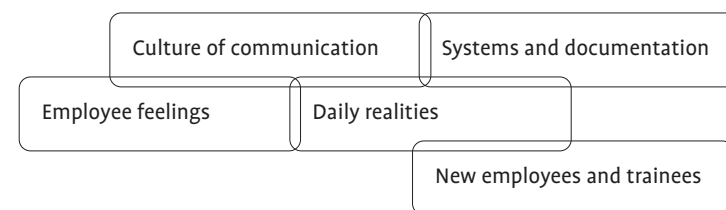
One of the first things that happened is that the students gained a great deal of respect for the employees. This solidarity with the employees was good in one sense because it allowed the students to gain many personal insights from the employees, but it also contains a risk of skewing the evidence in favor of the employees. The other difficulty the students faced was unexpected; after the initial mistrust, the students were so accepted that they had no time to take notes. Furthermore, they noticed that their presence was taking time away from the patients. We discussed different ways to deal with this problem in the weekly meetings and finally agreed on two possible tactics. First, the students could go in teams of two and take turns, one asking the questions and the other observing and taking notes. Second, the students could use their notes as an excuse for extracting themselves from a prolonged interview, saying "I just need to make some notes."

7. see Peter Atteslander (2008), on the uses of qualitative research methods, pages 71-72.)

FIGURE 2

The five topics and their relationships to each other.

Observation clusters



"I'll be right back."

The results of this study can be grouped into five categories: culture of communication, systems and documentation, daily realities, new employees and trainees, and employee feelings. Each of these will be briefly covered in the following section. It should be noted that all of these observations are taken from the time of the study. How these different aspects (or categories) combine to influence employee well being is then addressed in the analysis section. The analysis and subsequent recommendations are based on our observations and are detailed at end of this section and in the "Proposals" section of this paper.

1. Culture of communication

Fundamentally the Hospice Foundation's internal communication needs work. The study also touched on the Hospice Foundation's external communications; this will be discussed in the conclusion. We focused more on the internal communication because we had access to all parties involved. Through our observation we discovered multiple barriers in internal communication each with a different root cause.

The first of these is physical separation; the two different homes for the elderly were located in different sections of the city. This is true for all of the homes in the Hospice Foundation network although the distances vary. Each of the homes is managed by a different person with a great deal of autonomy. These managers meet once a month with the managers of the Hospice Foundation, and it quickly became obvious that they cannot be forced to make changes unless these are legally binding. This could be seen, for example, with the way the employee coach was dealt with: in three homes she was a welcome support whereas in one she was not welcome at all. In general, the managers had a cautious alliance among each other, as the result of past battles with the previous Hospice Foundation director. At the employee level there is little to no exchange between homes. At the time of the study, employees moved very rarely from home to home and almost never saw or spoke to workers from other homes. This is often due to the time pressures of the job itself, and we observed no informal organization beyond the workplace. The second aspect of physical separation was within the workplace itself. Each home was organized into functional units (stations) of one story (level or floor) each. Employees were usually assigned

FIGURE 3

An overview of the different kinds of communication barriers between the employees.

Types of separation

Physical separation 1: homes

Physical separation 2: levels

Hierarchical separation

Linguistic separation

Socio-cultural separation

to a specific station, and although some movement occurred, most of the employees were most familiar with their home station and preferred to be assigned there. However, the workload varied from unit to unit, causing an imbalance that affected the employees' workload. This imbalance was often resented. Furthermore, there was very little exchange between the employees assigned to different units.

The next type of communication barrier is the result of hierarchy. The hospice and health care system in Germany, in general, is highly stratified, and within the context of the Hospice Foundation particularly so. Not only is there a higher level of overall hospice management (which in turn answers to a board of overseers made up of local politicians), each home has its own manager, nursing director, unit manager, nurses, and various levels of caregivers, volunteers, and trainees. There was a clear barrier between management and nursing and caregiving staff, either due to physical separation or simply because their duties were so different. This barrier often caused tensions that were visible right from the start of the study.

The final barrier is a linguistic/socio-cultural barrier. This last barrier was often more subtle than the other two, which were often directly addressed by employees. The Hospice Foundation employs people from many different nations, who are often recent immigrants. Over the course of the study, we discovered that how well employees spoke German led to the formation of subgroups and isolation/problems due to a lack of understanding. For example, the management often complained that the employees didn't understand the latest memos. These memos were printed and posted in the units for all to see and read. However, the German used was often full of bureaucratic terms and complex language, making it difficult to impossible to understand for non-native speakers. This misunderstanding fueled the discord between management and nursing staff. The socio-cultural aspects were often either cultural: husbands dragging their wives away from the workplace, or social: employees that lived so close to the poverty line that they sometimes simply failed to show up. Both of these factors are more personal and were not readily addressed, because they were too private or too embarrassing, but their effects could be observed or were related to us.

2. Daily realities

The daily routines of the hospice foundation staff are influenced by four given factors; the pressure of working in shifts, division of duties, illness and

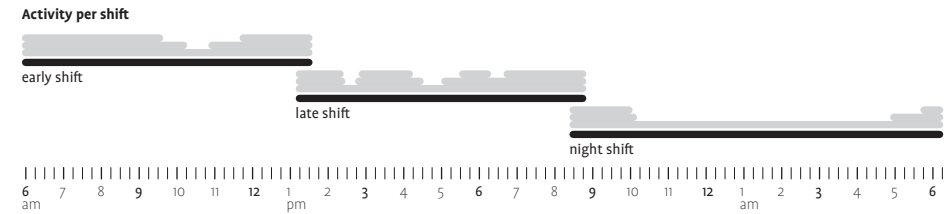


FIGURE 4

A diagram of the observed activity per shift, where more gray indicates more activity.

understaffing, mental pressure and exhaustion. Each of these factors affect how the employees feel in differing degrees at different times.

Working in shifts is the only way to guarantee that the residents of the homes have the 24 hour care that they require. These shifts are the early shift from 6:00 am until 1:35 pm, the late shift from 1:15 pm until 8:45 pm and the night shift from 8:30 pm until 6:15 am. The overlapping times (15 or 20 minutes) are used for short meetings in each unit or station to relay important information from one shift to the next. Each shift has its own challenges, whether distributing medicine, organizing meals, getting residents dressed, all of these activities have to be planned and executed for a unit of up to 24 residents. Each nurse⁸ for elderly patients) ideally cares for 6 to 8 patients during the day shifts. Night shifts care for all units together as long as they have no more than 70 patients in total. The rhythms of these shifts and the desire and/or pressure to hand off well to the next shift is central to the job.

The German medical caregiving environment is highly stratified. There are several different levels of nurses; those with a general nursing care background, those who have three years of training in care (for the elderly), and multiple certificates that qualify one for management positions. Higher management usually requires a degree in nursing care. Below the trained nurses there are caring staff (*Pflegehilfskraft*) who need only one year of training, as well as trainees and volunteers⁹. There are also new additional care staff with short specialized training for the elderly. Housekeeping staff are also part of the mix. These employees and trainees are not allowed to perform the same duties as the more qualified nursing staff but can be used for many of the more menial duties in the home for the elderly. All of these activities and people need to be coordinated. Although many employees know their duties well, this coordination is complicated by the two factors: teams that are constantly changing and employees calling in sick. Improvisation and gaps in planning for either eventuality lead to the blurring of the boundaries of activities (e.g., under-qualified staff distributing medication, or nursing staff making sandwiches) or that the residents do not receive the care that they need. The study revealed that these things occur more often than they should.

Most of the employees work in this sector because they enjoy

8. I use the term nurse to refer to male and female trained caretakers (*Pflegefachkraft, Altenpfleger*)

9. The German system has many social programs that offer support in the care for the elderly, young people can volunteer for a year of social work (FSJ = *Freiwilliges Soziales Jahr*) and there is a government organization for volunteers that also support social causes (BFD = *BundesFreiwilligenDienst*)

taking care of people. Our study found that the vast majority of employees find the caring aspect of the job enjoyable. Furthermore, in the interest of the good of the residents, many employees went the extra mile to help each other, fill gaps, etc. to make sure that the residents received care. This desire to do a good job in caring for people is fundamental to many employees. This same desire also creates mental pressure especially when the job and its circumstances (not enough time or too many residents), leave many employees with a guilty conscience. This state was mentioned to us repeatedly during the study. This, combined with the time-pressure and responsibility associated with the job, as well as the long shifts caused by colleagues being sick, often leads to illness, exhaustion or low-level burnout. Employees repeatedly spoke quite frankly about this state or diagnosed it with others ("He or she is working two shifts back-to-back. Don't bother trying to talk to them now.")¹⁰ It is a vicious cycle, the more the employees are under pressure, the more often they get sick. This increases the pressure on the others who have to fill in or take extra shifts, which in turn causes more illness. This situation, combined with the reluctance of both the staff and the management to move employees from unit to unit, can cause whole units and their residents to have poorer care, or force the hospice to hire outside care at a premium. The costs of these external employees ran so high that the board of overseers made it a major issue of concern, which in turn led to our study.

3. Systems and documentation

The care for the elderly and the medical profession in general bring a great responsibility for the patients, and it is accompanied by legal requirements that often require documentation. In Germany at the time of the study, for example, the staff were required to document any changes in the behavior or health of the residents. This is logical and helpful for diagnosing problems. It is also essential that this information be transferred from one shift to the next. Organizing the highly stratified staff in shifts also required systems and documents, not only to plan but also to document who actually worked. Our study examined the meetings at shift changing times, the use of the duty roster, the use of the computer and management software, and how information was transferred from one employee to the next.

The short (15 to 20 minute) meetings at the change of shifts are essential in running each nursing unit smoothly. However, the meetings have several problems. First, the meeting times are too short. We discovered that many employees began discussing the job prior to the shift change in the dressing rooms or simply came early to work in order to have enough time to prepare. The demands of the shift leave little to no time for document-

10. The quotes in this article are paraphrased out of German quotes taken from the students' notes.

ing things carefully, so some employees also stayed longer or documented things from the last shift from memory in the extra time they had from coming to work too early. The second problem is that there is no official or recommended way of documenting each shift. Each home, station or unit and person makes it up as they go. Without systems or even key points to cover, the different records often have gaps or fail to document key information. Also, due to the time pressure on the nursing staff, notes were often taken on small improvised notepads and either shared at the meetings or ideally typed up in the office. Finally, a particular type of employee, i.e., the so-called additional care staff,¹¹ is also required to keep (written) records of patient development, but these are no longer shared during meetings.

The duty roster¹² is an important document in the Hospice Foundation. Every month is planned in advance and includes elements such as vacations or time off are requested ahead of time. The roster schedules all three shifts for the available employees, and a printed copy is kept on display in each unit's office. The plan represents an ideal state. The reality of illnesses that were not planned for means that employees are often called in spontaneously to fill gaps. The employees were all familiar with the roster because it regulated their work times. However, it was also a source of trouble. For example, because days off were simply listed and it was unclear why one employee would suddenly have more than the others – for example by having accumulated overtime in the previous months – was not visible on the plan, which led to misunderstandings and jealousy. Although

FIGURE 5

A typical roster with handwritten additions.

11. In German zusätzliche Betreuungskräfte, are staff who spend time with more active residents doing activities like art, singing, games, reading or just talking to them.)

12. In German this is referred to as the Dienstplan.

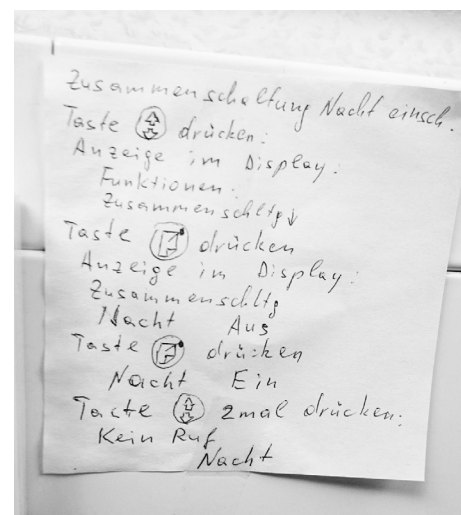
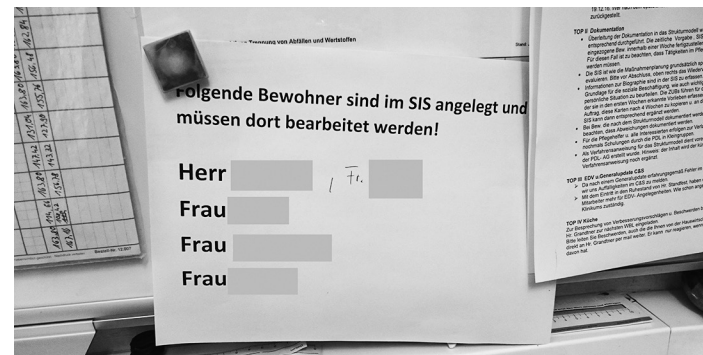
FIGURES 6/7

Examples of the office computers and corresponding instructions.



FIGURES 8/9

Examples of the office computers and corresponding instructions.



there are templates for these plans, we found them to differ from home to home. The duty rosters were often a mix of digital and hand-written forms and processes. Indeed, the plans often didn't deal well with the realities that we observed

All units had a computer in the office, but the use of these by the caregiving staff was minimal at best. In our observations and interviews, we uncovered a variety of reasons for this lack of use. Although most employees had been given a training course in the software, this course was given in lecture format and they had no hands-on experience in using the software. In a profession that is largely hands-on, this teaching strategy was totally inappropriate. All the people whom we found using the computer had been shown how it worked by another employee. Language was often a problem: many employees were from foreign countries, which made them more reluctant to work on the computer. The nursing and other staff do not interact with the residents in the office, which means that, if they made observations, they had to either write them on a notepad or run to the office and write them down there. Both of these solutions were impractical. Finally, the software was not designed to be user-friendly, as was clear from many handwritten instructions kept near the computer, and from its general lack of use (see figures 6-9).

FIGURES 10/11

Examples of notes and signs in use by staff.

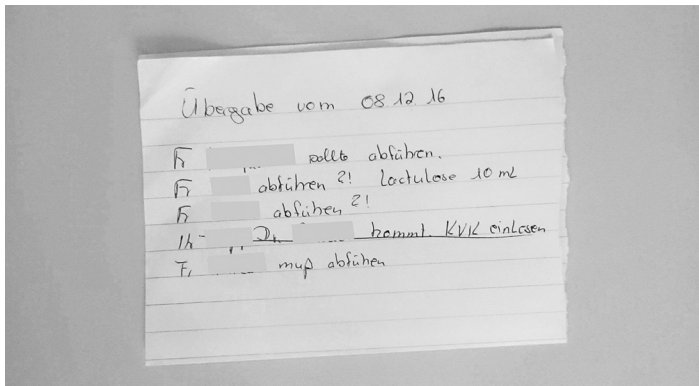
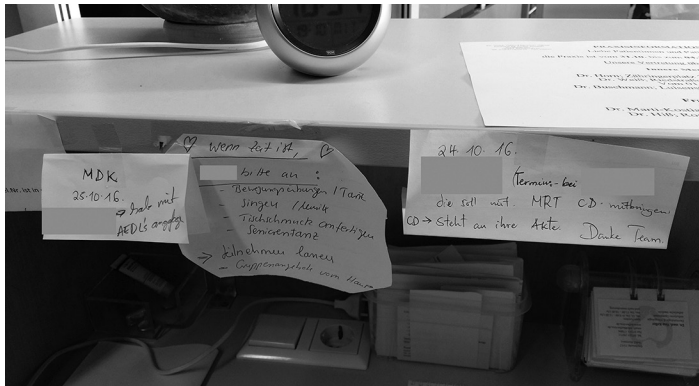


FIGURE 12

Examples of notes and signs in use by staff.

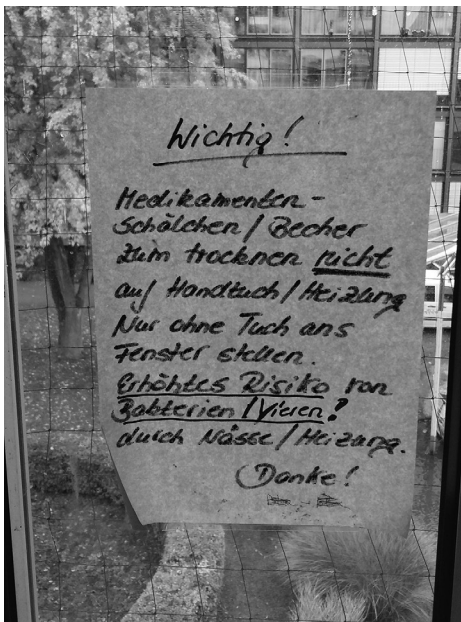


FIGURE 13

Examples of how messages were displayed.



FIGURE 14

Examples of how messages were displayed.

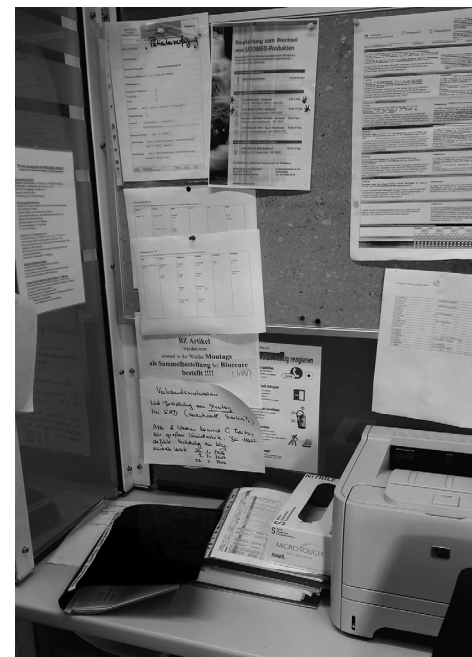


FIGURE 15

Examples of how messages were displayed.



_____ New signs/notes received attention; older ones less so, leading us to question how effective they really were after a few days. In addition to the ad-hoc signs, official records, regulations, and charts were kept in folders and organized by the head of the unit. Although the nursing staff knew of them and worked with these documents, most of the time they were kept in cupboards or shelves and had little bearing on day-to-day activities. ("The quality management handbooks are in the cupboard and that's where they should be." „Die [Qualitätsmanagement Handbücher] stehen im Schrank und da stehen sie gut.")

4. New employees and trainees

From the very first meetings before our study began, the Hospice Foundation told us that in the last five to ten years the number of trainees and applications had dropped sharply in both number and quality. The new policy, according to the personnel department was: "We hire anyone who applies." The challenge is not only to find and recruit new employees, but also to train and improve those that do apply. Up until 2011 when the military service draft was suspended, many civil service volunteers¹³ provided a valuable resource. This and the general demographic shift, and more and more young people pursuing higher education in Germany combine to make finding new employees difficult.¹⁴

13. In Germany it was possible to avoid military training and service, by volunteering for civil service (Zivildienst) for a longer period instead.)

14. The German school system divides the children in the fourth grade into two groups, those destined for higher education are sent to the Gymnasium, and those who will either pursue a trade or other professions are sent to the Realschule. Furthermore recently (roughly 2012 depending on the state) the formerly binding school certificate was changed to a recommendation, leaving the decision of attending Gymnasium versus Realschule up to the children and the parents.)

_____ Our interviews with the Hospice Foundation revealed that the foundation recruits in a variety of ways. They are present during career fairs for young people; they work with schools to provide practical training; and they recently implemented an "employee recruits employees" program with rewards for recruiting friends and acquaintances. In general, the type of person who pursues a nursing or caring career has a helper mentality. This is important especially in the care for the elderly because the pay is low, and the work is demanding. There are unfortunately many misconceptions about this type of work, and many people think no training at all is needed. This leads to many young people dropping out of training programs. Furthermore, many applicants are not originally from Germany, and they often have trouble with the application or fail to fill it out properly. Additionally, cultural biases create conflicts. For example, some cultures won't accept women as superiors, which is a problem as women are often in management positions. Finally, the importance of being a team player is often underestimated or not appreciated by young people or new employees.

_____ In one of the two homes, training is often very brief since the time veteran employees have is so short, or isn't officially planned. The lack of established systems for training new employees also created gaps in knowledge and quality. A quality handbook exists, but it is buried in folders and rarely consulted, as many found the information too complex, too long or not readily understandable. Many employees were grateful for a new coach that the foundation hired. This person had many years of experience and was very good at gently showing people more effective ways of working, even if they had already worked for a while. This helped free up the more experienced employees who otherwise needed to train new people in addition to their normal responsibilities. The second home we studied reserved four weeks for each trainee and these trainees came in coordinated batches. This time period was long but viewed as valuable by the employees. At the time of the study, the employee coach was not welcome in this home, due to the home management boycotting the concept.

_____ Additional training for existing employees is often under-used. Employees felt no incentive to participate (although the training could lead to a better position and higher pay), and some older ones were just biding time until their retirement. Furthermore, even if the employees wanted to participate they had to get permission from their unit manager, which given the current situation of insufficient staffing made getting permission more difficult. Some employees watched YouTube training videos, which was simpler and not tied to a specific date or time. Learning new software was also viewed by the management as the employees' responsibility, saying "They [nursing staff] just need to practice during their shift." The few times that software training was offered, the employees found the groups too large, and the classes too theoretical. In general, the practicality of the offers of additional training and their usefulness need to be optimized.

5. Employee feelings/well-being

During the course of our study, we were also very interested in how the employees felt, what might motivate them to leave for another employer – this behavior was described to us by the personnel department – or other more subjective influences on their work. We discovered fears and uncertainty, pressure from multiple sources, support and solidarity for each other, and distrust between management and nursing staff.

A common problem for employees at the time of the study was the feeling of uselessness, apathy, and helplessness, one longtime employee said: "You always go home feeling guilty." Another told us: "I wish I had more time with the residents, that is what I miss most here." Employees want to help and do a good job, but due to the number of residents to be cared for in a short time, they are constantly running, doing only the most necessary tasks. Language problems make it difficult for foreign employees to help more or to be more effective in the team. Older employees fear changes since they are often unsure if they will be up to the new way of doing things. Also many live in fear of making mistakes because the consequences of mistakes are often severe for both resident and employee.

Hospice Foundation employees feel many different types of emotional pressure: financial worries, lack of alternatives due to limited education, illness due to overtime, cultural pressure, lack of predictable daily routine, living by the duty roster and working in shifts, responsibilities of the job, colleagues being sick, the constant deaths of residents. All of these pressures are a very real part of an employee's emotional life. We also observed external pressures, from relatives of the residents who were often very unkind or arrogant to the employees, as well as from doctors at the nearby hospital who were often very rude. Often employees needed a sounding board to unload their troubles, not only did the members of the study team serve this purpose, but an interview with the union leadership also confirmed this. Management often had trouble connecting emotionally with the nursing staff, simply because they had very different work responsibilities and realities (or were not often present).

An atmosphere of mistrust between nursing staff and management was repeatedly visible during the study. Management was impatient with immature employees who overslept or didn't come to work, or who made mistakes. Employees felt left alone by management when they presented their problems. We found that unclear communication and misunderstandings fed these feelings. For example, although our visit was communicated to the staff, we often had to explain what we were doing. Many students were asked to explain what the "real" purpose of the study was. Overall employees and management were suspicious of new things, preferring to wait and see, rather than embracing the new ideas.

We observed Hospice Foundation employees helping each other on multiple occasions. Knowing that the early shift is very stressful, night shift employees would prepare things for breakfast if they were having a slow night. Or that management would spontaneously work in units that

FIGURES 16/17

Examples of appreciation for fellow employees



FIGURE 18

Examples of appreciation for fellow employees

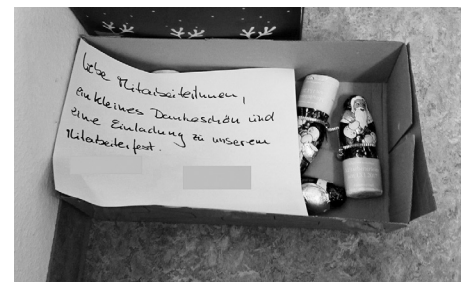
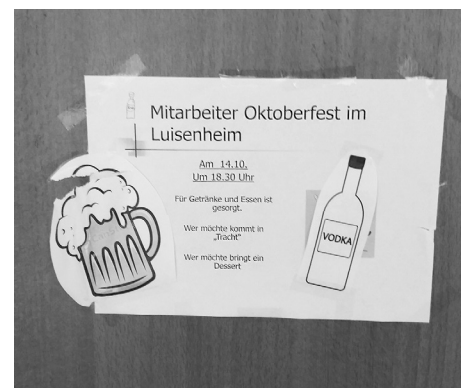


FIGURE 19

Sign promoting an upcoming employee party.



were understaffed to help them get through the shift. These things were appreciated and mentioned by the employees in interviews. We also observed many small signs of appreciation such as a chocolate Santa Claus for every employee around Christmas; birthday cakes were baked for employees to celebrate their birthday. The Hospice Foundation management also offered programs like "good health at work", or bonus pay for those who spontaneously worked shifts for others. Homes also organized employee celebrations such as the traditional 'Oktoberfest'.

Summary

A number of factors led to the problems that employees were having. Poor communication whether due to pragmatic problems (how were things communicated) or to physical, linguistic or other barriers bred suspicion in employees (and management) and led to a culture of distrust that was prevalent and easily observed. Impractical tools for documentation and learning led to both the loss of time and either frustration or fear in employees. Although employees worked well together in teams, these teams and this solidarity didn't apply to all of the employees in the home or in the Hospice Foundation. Nor was this team spirit enough to counteract all of the other negative forces. Finally and certainly the most difficult and fundamental, we found inherent problems in nursing care. These were caused by a clash between the type of person drawn to the caring profession (helper mentality) and the bean-counting mentality currently propagated by the government, meaning that a patient generally doesn't get enough attention, and leaves the employee with a guilty conscience. Another factor was a social one, nursing is in general not well paid and requires a lower investment in education. This type of work is often done by the lower class, and as such is looked down upon by society, although it plays an increasingly valuable role in an aging society. Starting with the fundamental social factors (poor pay, poor status) and systemic factors (people wanting to help but not able to do so) and then adding the more specific factors of problems in communication and intuitive resources, clearly leads to emotional stress, which often results in illness or changing jobs.

Proposals

This study differs from a classic sociological study in that it suggests specific responses and means for improving employee well being in this specific context. This is one key difference (and in my mind advantage) of research with designers who are trained to propose solutions. Designers, however, often lack the patience, training or resources to undertake such a study of the kind described here which aimed to better define the problem. At the end of the analysis, we proposed a number of activities and measures to specifically improve on the situation for employees. These proposals are described in the following section. The proposals are intended to work together in order to provide a better result overall.

1. Proposals for improving communication

We made a wide range of proposals to improve internal communication.

— The first was to use the employee coach as a confidential communication channel. By implementing email accounts for all employees, the Hospice Foundation would have a direct way to reach employees. Social media platforms (e.g. Facebook groups) could also be used to foster exchange between employees at all levels in the hierarchy. Based on comments that salary information is the only printed communication that all employees read, we suggested sending crucial information along with the employees' pay slip. Monthly "share and support" meetings for each home would help break down barriers between floors. We also suggested using practical means to get people together. For instance, a local bakery could come once a day and sell their goods in one place, so that all employees would come together. Having the break room and corresponding coffee automat and snack machines all together would also provide incentive and opportunity for informal communication. Sorting the pin boards into clearly labeled sections would make it easier for employees to see the latest news items.

— Finally, we proposed that the Hospice Foundation organize an open house event to involve the local community and get people in touch with the profession. We also suggested forming an alliance with other hospices/homes for the elderly and launching a local or national campaign to raise awareness of the care for the elderly. This same alliance can also lobby politicians to improve the profession's circumstances by providing better financing.

2. Proposals for improving the day-to-day

— work environment

Since it is legally and financially difficult to lighten the workload for the employees substantially, we suggested designating specific employees to work as "jumpers" who would fill in gaps for people who called in sick. The proposal was that each designated person would be on call for one week, so the load could be shared by many rather than a few. It would also likely prove attractive to offer incentives for being more flexible in where one worked (different homes, different floors/units). We also suggested that hiring a person to help the nursing staff with office and filing work would free up time for the care of residents. In the longer term, the Hospice Foundation has to take a hard look at its employee structure and attempt to shift positions from management to nursing care. Clearly longer overlap times between shifts allow for more information sharing, record keeping, etc.

3. Proposals for systems and documentation

Improving systems and documentation requires a wide range of actions and activities. Establishing a digital filing system, modeled after ones used

in large creative agencies would give types of documents specific abbreviations, dates, and version numbers so that the sorting is semi-automatic and easily searchable. Since many problems were rooted in language weaknesses, we suggested a handbook of special nursing and health care jargon and terms, improved explanation and documentation of the in-house software, and German classes for employees with language deficits.

A longer-term proposal advocated the purchase of handheld tablets similar to those used by waiters in large restaurants and developing a custom app that integrates calendar, resident notes, duty roster, and other useful functions in one handy device. Clearly the study's observations would directly feed into the app's development and design.

Including the additional care staff in one of the daily meetings would also improve resident care. Obviously, this brings challenges because we often observed an inherent conflict between departing staff wanting to catch their bus and the next shift wanting as much information as possible to do their job well. The additional care staff had a different focus (emotional well-being of the residents) from the nursing staff (physical and medical care of the residents); this mismatch also needs to be addressed.

4. Proposals for recruiting and training

During the study, the Hospice Foundation began to work on how it communicates with the community. They launched an attractive new website and increased activity (weekly posts) on their Facebook page. Our proposal to start an image campaign has been actively pursued and was realized in 2017 with Facebook posts, local ads, and advertising on the Hospice Foundation livery. We suggested a "trainee day" to welcome young people and give them a chance to see the workplace. Simpler (and digital) application forms (written in simple language) would increase the number of applicants. We also proposed a series of improvements and incentives such as a regular trainee roundtable, a Foundation trainee intranet – with specific information and support, a smartphone for new employees, or bonuses for especially good grades, or free tickets to local events and cultural venues. We also suggested offering these incentives for those who decide to work for the Hospice Foundation after being a trainee.

To improve training we suggested additional hands-on training for employees who wanted or needed help and making short demo-films and text explanations in pop-up windows. In the long term, we proposed a specially developed app for the employees that could be used to help with training. In addition to supporting the successes of the employee coach, we suggested making an introductory film that explains internal procedures and duties. We proposed that every employee be given a personal handbook – a compact, understandable version of the quality-management

handbook. Finally, we supported the union's new efforts to care for the young volunteers and interns rights and requests.

5. Proposals for improving employee well-being

Fears and other feelings are highly personal, which makes it difficult to address them in a general way. Instead, we propose a series of activities that, taken together, improve the general mood. The employee coach can act as an ombudsman to listen to concerns and feelings since she has worked in nursing for a number of years and can offer not only a sympathetic ear but also provide support. Regular meetings with the staff to reassure them that they are doing a good job can be very useful. Regular meetings with the unit's entire team are useful to the group dynamic and mutual support. Combining these meetings with snacks would also give the opportunity for staff to share aspects of their culture, and provide an opportunity to share important information in a relaxed atmosphere. Commonly implementing small, rather than large changes – for example in the schedule – should help break down resistance to new things. Support for the employees' daily lives is also essential, and we recommended augmenting the "good health at work" and the "children's daycare" programs that were just started or in planning at the time of the study. Simple measures such as providing each unit with a suggestion and complaint box were also suggested. We also remarked that the financial reward for spontaneous filling in for colleagues was too low, especially after taxes.

Showing appreciation is also essential for improving the overall work atmosphere. We suggested a series of small activities and gestures, such as sweets or small meals that are organized for each shift (for example by another unit or shift). In general, we suggested looking for activities that built a sense of community, offered a chance for communication and break down barriers. The sum of all improvements should have an effect on employee well being.

Conclusion and Outlook

The study and its proposals were published at the end of the semester in a 280 page document that was given to the Hospice Foundation management and was made available to all employees. Within a matter of weeks, the management was implementing recommendations made by the study and was interested in follow-up projects such as the development of a custom nursing care app. We were requested to reprint 20 copies of the publication and to present the project to the board of overseers about one year after the project was completed. This presentation was very well received. All in

all the project was a success, as measured in terms of the positive response to the study.

Although our study of the Hospice Foundation is unique to this specific case, there are ideas that can be transferred to other types of projects. Nursing work often carries many of the same stresses and problems identified here. The topic of elderly care is increasingly important in western society because of its rapidly growing population. These problems will have to be dealt with; the better we understand them, the better we will be able to propose solutions.

In a larger sense, this study shows the power of qualitative research methods for analyzing a complex social situation. Obviously, the methods used in this study are not exhaustive. Further methods or variations on the methods used are possible and depend on the social situation under study. The methods used here fit the scope of the project and the abilities of the students. It is my hope that this study will serve as an inspiration for designers wanting to extend the range of their work beyond the limited range defined by stereotypes of typical design approaches. This requires two things: an open-minded client and the willingness of designers to learn qualitative research methods. If designers can adopt these methods and this way of thinking, they will have the tools to work more effectively with clients on understanding a problem before thinking about solutions.

One key weakness of the study is its lack of rigor. Students were unfamiliar with the methods and often made mistakes. They were learning by doing. Over time they improved and the final results seem to point in the right direction. Certainly, our very presence created some bias, as the effects of scrutiny on behavior are well-documented. A bias in favor of nursing employees is apparent, largely because the observers spent more time with them than with management. Finally, the students had to rely on handwritten notes, rather than recording and filming. This was done primarily to protect the employees' (and residents') privacy. Despite these weaknesses, I feel that the study was invaluable for teaching practical lessons connected with qualitative research methods. The students had a specific example and learned directly from it.

Originally I had suspected that the employees from Constance were taking jobs in Switzerland simply because they were better paid. Over the course of the study, I was proven wrong. Some employees did indeed leave the Hospice Foundation for Switzerland, but not because of the money, but because the Swiss health care system allots fewer residents per employee, meaning the employee can spend more time with each resident and really focus on the person rather than focusing on just getting the job done. Governments need to consider such factors when financing care for the elderly. Numbers are not irrelevant; the investment in care for the elderly needs to be in proportion to the current demographic situation of the coun-

try in question. Certainly, this study alone will not reform health care, but it can contribute to the discussion in a relevant way.

Finally, the Hospice Foundation and other organizations like it are affected by public opinion and trends in society over which they have very little or no influence¹⁵. When politicians make the job of nursing or care for the elderly sound comparatively easy, the public is given a false image. Cultural or national stereotypes are an important context and are very difficult to change. However, it is our hope that policymakers will read this article and change the way they think.

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(15. In 2012 the labor minister Ursula von der Leyen suggested that the 25,000 predominately women employees from the Schlecker drugstore chain who had just lost their jobs due to the company's bankruptcy, go into nursing.)

Author

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research proof

Reviewing Open-access Icons for Emergency:

*a case study testing meaning
performance in Guemil*

Rodrigo Ramírez

Commonly called pictograms, symbols or icons, it is convened that these are normalized images designed to display a concrete meaning. As a system, icons function as a codified language to facilitate communication. These can also be efficient to manage messages on different media or information technologies. In the specific context of an emergency, different initiatives of icons have been developed, mainly considering context (i.e., a crisis) or specific actions (i.e., warning). Today, it is possible to find different icon collections, some presenting styling novelty, and open-access. However, usually, these are delivered as is, without any proof of their effectiveness. If these are designed for critical contexts such as emergency, evidence of performance might be provided. Evidence can be collected from testing, contributing to developing better tools for communication in crisis from local to global scale. This article presents definitions and a review of cases on icons for different types of emergency, selected by their open availability. Based in the literature review, a fundamental indicator to assess icons performance is Comprehension. As a case study, testing process and results conducted in the Guemil Project are explained. This is centered on 'Meaning' as a specific variable to measure performance. Finally, some reflections emphasize both open-access orientation and the importance of performance tests to establish effectiveness.

Keywords

*emergency
open-access
icons
performance
meaning*

Highlights

1. An emergency can be a complicated scenario with massive demands of information. Communities need accessible tools to manage.
2. Icon systems emerge as optimal graphic tools for multicultural communication in emergency = Open-access and implementable.
3. A visual language statement is not enough: Evidence about performance is needed to validate design effectiveness.
4. According to international practice, evidence of performance in icons is constructed mainly by asking about Comprehension.
5. Guemil Project includes a testing process on Meaning and Differences, a selection of results are presented.
6. New insights appear to be necessary, to collect interpretations from specific groups.
7. A collaborative approach is fundamental to transfer information into actions > safe decisions.

Introduction

Information design is a multidisciplinary practice oriented to develop information that is visible, understandable and usable for people, combining both art and science (Horn, 1999; idX, 2007). As a research area, Information Design contributes to articulate information needs, optimize communication, and measure the performance of messages. Figure [1] based on the framework presented in Allard, Briones, et al. (2014) shows, a fundamental virtuous cycle in Information Design is See > Understand > Use the content.

Information Design instruments such as graphic language, attempt to be natural ways to visualize, understand and perform in everyday life, constituting practical tools that can be eventually applied in different contexts. Fundamental tasks from communication design such as the presentation of information for action can be a different approach to construct reaction capabilities on emergency and facilitate resilience, and visual language can contribute to action (Frommberger & Waidynatha, 2017). Thus, graphic elements such as symbols and typography appear as ubiquitous, immediate solution to deliver vital information even for critical contexts. Dif-

FIGURE 1

See

Design to make visible



Understand

Design to make comprehensible



Use

Design to take action / decisions

ferent standards of symbols have been developed for diverse contexts such as transport, public spaces or safety at work, many of them aiming to reach universal interpretation.

In a broad context, this paper presents a review of icon systems that address emergency scenarios. It describes four cases selected by their open-source access, and opens a discussion from their visual statement but fundamentally from their performance as visual tools to accomplish communication objectives. A review of testing methods is presented, and performance measuring is exemplified taking five cases from the Guemil icons. Finally, reflections are delivered to remark the importance of visual information integrating risk management cycle with the user experience, using performance indicators and promoting collaboration.

1. Icons as normalized messages

Symbolic language persisted from ancient times, as a graphic instrument to represent actions and convene meanings (Aicher & Krampen, 1979). Today, Pictograms or Icons are part of normal processing of information by visual ways. Icons are normalized images that share a codified message, condensing a precise meaning, intending to present a common language. According to Jardí (2011), these are 'pictorial representations with an informative character that are generally part of wider systems, sharing attributes such as graphic style.' In theory, these are conceptualized as a universal language, and they would be functional to reduce linguistic barriers (2011, 23). Usually, iconic language pretends to be universal, applying to daily tasks, work and activities (Abdullah & Hubner, 2009; Frascara, 2011, Boersema & Adams, 2017).

Today, icons are part of systems that cover different functions and categorized according to their use (Abdullah & Hubner 2009). In recent history, different approaches had progressively become standards. Probably the best known are the AIGA/DOT (1979) for public information, ANSI z353 (2011) for safety, or the visual standardization for digital interfaces (Mijksenaar & Zwaga, 1990). Everyday contact with these particular elements of information should help to explain why icons are so ubiquitous, as Zender & Mejía (2013) demonstrate. From the interpreter side, Frascara (2011) defines two types of users for icons: (1) Professional and (2) General public: He considers that professional use of information must be clearly distinguishable and highly memorable. On the other hand, the general public needs an obvious meaning, ideally with no learning required. However, despite these statements, icons systems are not always being measured about their

System Name	Year	Context of application	Source	Open source	Promoted by
AIGA/DOT	1979	Public information	aiga.org	✓	AIGA
Health and Safety	1996	Safety signs /Health	hse.gov.uk	✓	UK Gov
ISO 7001:2003	2003	Safety signs / work	iso.org	x	ISO
ISO 7010:2011	2011	Public information		x	ISO
ANSIz545.3	2011	Safety signs / work	ansi.org	x	ANSI
ANSI - INCITS 415	2006	Safety signs / work		x	ANSI + INCITS
UN / OCHA	2012	Humanitarian Information	Reliefweb.net	✓	UN OCHA
Hablamos Juntos	2010	Emergency / Health	segd.org	✓	SEGD
ADA	2009	Public information	graphicartistsguild.org	✓	GAG
IIID Safety	2004	Safety signs / work	?	?	IIID (?)
SERNATUR	2012	Public information / Tourism	sernatur.cl	?	Sernatur, Chile (?)
First Aid	2015	Humanitarian Information	buerobauer.com	✓	Other
Guemil	2016	Risk & Emergency	guemil.info	✓	Other

TABLE 1

An –in-progress–
compilation of icon systems
for public information,
safety, and emergency

performance or effectiveness on communication. As Wogalter et al. (1999) explain, this can be critical in contexts such as safety and emergency. To illustrate, Table 1 shows different icons systems available worldwide.

Contextualizing risk and emergency

Due to human nature and global reach, risk and emergency management emerge as one of the most significant challenges for development (WEF, 2017). Aiming to complete emergency as a context, some concepts from the UNISDR 2015 document ‘Sendai Framework for Disaster Risk Reduction 2015 – 2030’ –commonly known as ‘The Sendai Framework’– are presented here. The idea of a framework is oriented to consider the ‘organization and management of resources and responsibilities for addressing [...] in particular preparedness, response and initial recovery steps’. Additionally, the Sendai Framework states definitions such as risk management or the need for communication, delivering relevant terminology for discussion. A potential role of information is part of every definition:

- Risk, defined as ‘the combination of the probability of an event and its negative consequences.’ Here information can be applied to identify, or used to facilitate learning about risk scenarios, and prioritize its reduction.
- Hazard, defined in the Hyogo Framework for Action (2005–2015) as a ‘potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental deg-

radation.’ Information here should help to identify and learn from identified hazards, facilitating preparation and eventual reaction.

- Emergency, a disruptive situation that affects both individuals and/or a whole community. Here information is a key to aware, to prepare, to react and to recover, among other stages.
- Disaster, defined as a ‘serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.’ Here also, information is relevant because such disruptive scenarios usually imply limited access to information, confusion, and lack of understanding, probably one of the most challenging contexts for safety or recovery.

In parallel, the discipline known as Emergency Management involves ‘all plans and arrangements to engage and guide multiple actors in their efforts coordinating responses to emergency needs.’ (UNISDR, 2015). They state that effective information ‘can avoid the escalation of an event into a disaster.’ Also, it is important to note that from a human-centered focus, this concept usually involves humanitarian crises.

In everyday life, visual tools can also play a fundamental role in experiencing an emergency. As Harries (2008) states ‘there is a growing realization that people’s understandings of hazards are the result of a process of social construction and not simply of perception and information.’ As a lingua franca of the information age, icon systems should be able to present and evoke precise meanings. As Kremer (2016) remarks, providing ‘unambiguous iconography can make a difference in communication for disaster.’ Oriented to perform indeed in critical situations, previously users need to learn information.

Therefore, presenting critical information through visual tools can help to understand risk and disaster scenarios, from identification and preparation –Before–, to reaction –During– towards active recovery –After– (Ramírez, 2017). Merging this with a user–experience approach, this framework constitutes another focus to deal with emergency centered on human needs. Starting from identifying hazards or understanding vulnerability, to action and reaction in a disruptive situation, towards a relief, assembly or procedures for recovery, in a continuum that resembles experience and it can be learned by users, articulating needs and actions by information.

Icons for emergency

Different types of graphics are recognizable resources of information for multiple contexts. In the unexpected and potentially dangerous scenario of emergency these are commonly deployed in applications such as signage or on multi-platforms, usually articulated by text (typography), images (icons)



Prohibition



Warning



Mandatory



Emergency escape

FIGURE 2

Free Safety Sign examples combining icons + colour + shapes, according to Safety signs and signals, HSE-UK (2015), see www.hse.gov.uk

and color (codes). Its correct application can provide meaning and certainty to facilitate decisions. The effectiveness for critical contexts such as warning messages and the use of clear signs are discussed in Wogalter et al. (1999), Zender & Mejía (2013) and Frommberger & Waidyanatha, (2017).

Beyond the widely recognized public symbols evidenced in everyday use, there are others explicitly oriented to safety or emergency. International organizations such as ISO (7010:2011), define a safety sign as graphic support, that delivers a general safety message, obtained by a combination of a color and geometric shape and which, by the addition of a graphical symbol, evokes a particular safety message. These are conditions that require action and visual information can constitute a difference, as Figure 2 exemplifies. ISO norm such as 7010:2011 prescribes safety signs oriented to industrial safety in a general context, for accident prevention, fire protection, health hazard information and emergency evacuation.

ISO (2011) states that 'There is a need to standardize a system of giving safety information that relies as little as possible on the use of words to achieve understanding.' Marom-Tock & Goldschmidt (2011) remarked about the need for visual symbols in signs, especially where 'text cannot be trusted as a communication channel [...]'. As occur with everyday use of visual information on multiple devices (i.e., interfaces, signage or instructions), it is essential to consider the context as an experiential framework. A systematic application of such images would become progressively familiar in its recognition, but also ideally in comprehension and use.

A recognizable representation can make a difference in critical contexts, and this constant and implicit learning by visual tools can have a global projection. However, beyond their form proposal –usually assumed as universal– can graphic elements such as icons be tested from the interpretations that people construct? Can this visual language be pre-learned to perform better during or after an emergency?

2. Four open-access cases

Icons can be ubiquitous elements constituting a tool to enhance communication in critical contexts such as an emergency. Four cases are briefly described here to examine different applications. The focus is defined under two main variables: (1) A broad context of emergency (i.e., health, humanitarian crises, disaster) and (2) their open-access. References are showed in Table 2.

TABLE 2

Icon cases oriented to Emergency as international open-access references

Case	Application	Access
1 Hablamos Juntos, 2010	Humanitarian access to information in clinical context	Free (downloadable)
2 UN OCHA icons, 2012	Humanitarian crises, risk and emergency	Free (downloadable)
3 First Aid, 2015	Humanitarian crises, displaced population	By request
4 Guemil Project, 2016	Risk and Emergency	Free (downloadable)

1 Hablamos Juntos (2010)



FIGURE 3

Examples from Hablamos Juntos Icons

Hablamos Juntos (Spanish for 'We speak together') is a US-based project funded by the Robert Wood Johnson Foundation, administered by the UCSF School of Medicine, and promoted today to be adopted by different organizations. This symbol system was launched to contribute to reduce language barriers and improve the quality of health care for people in an eventual clinical emergency. Oriented to humanitarian focus on clinical situations in a context of migrants living in the US –non-familiarized with English as the first language, also known as Limited English Proficiency (LEP).

'Hablamos Juntos' is a remarkable case of a system combining aesthetic and practical issues, in an icon set developed by a collaborative approach. The symbols are the result of a process involving both design and testing, from different stakeholders who endorse the outcome. Among these organizations, the Society of Environmental Graphic Designers (SEGD) has published further documentation, such as 'Developing a Symbols-Based Wayfinding System: Implementation Guidebook.' Today, the project and their extensive testing program can be fully accessed at the SEG D website, see Note 1.

With extensive documentation such as the 'Symbol Design Research Report' (2009), it is possible to observe how the icons are not only proposed, but also tested and then promoted for adoption by health organizations. The collaborative process in this project shows how the final set of 50 symbols was not only constructed but also validated by evidence. Briefly explained, this involved first a research and design task inside 4 Design Schools. Secondly, a testing and evaluation stage, and finally a refinement conducted by professional consultants. Figure 3 illustrates the outcome.

Note 1, icons and documentation are accessible at: <https://segd.org/hablamos-juntos-0>



FIGURE 4

Examples from the UN OCHA Icons

The Humanitarian and Country Icons is a symbol initiative to present emergency and crisis-related mainly for humanitarian information, originated in 2012 by the United Nations (UN) Office for the Coordination of Humanitarian Affairs (OCHA). This collection includes a massive set with near 500 icons covering different aspects of humanitarian representations such as food, shelter, or medical assistance. It is oriented to relief workers and has been optimized and hosted for use mainly on maps. These are available in a pixel format (.png), applicable on screen-based and digital platforms, in open and well-known platforms such as Google Maps.

Original icons provided can be accessed at their website, see note 2. Here they state: 'Anyone making maps for disaster response or other humanitarian purposes is encouraged to use these icons for their digital maps and is welcome to link to them directly on this server.' Therefore, this is an effort to visually embrace everything originated by collaboration that includes website platforms such as The Noun Project. Some icons are shown in Figure 4.

UN OCHA icons constitute an interesting humanitarian initiative from a global-scope organization, with a massive outcome set. However, despite being a collaborative initiative, some professional icon design principles (i.e., visual consistency and recognition in small sizes) appear to have been neglected and could limit its application as an effective tool for communication. In this case, a testing process is not known to have conducted.

3 First Aid, Icon Based Communication Kit (2015)



FIGURE 5

Example of First Aid Icons and kit samples

The First Aid Kit is originated in Austria, and it is oriented to refugees moving from West Asia to Central and North Europe, representing a context of

Note 2, icons are accessible at <http://reliefweb.int/map/world/world-humanitarian-and-country-icons-2012>

different cultures and their future communication needs with an emphasis on ethnic differences, packed in a visual outcome. More than being solely an icon set for an emergency such as forced displacement, First Aid is a set of visual tools to display multiple information using normalized components such as A4 format, designed to facilitate its B/W printing and distribution in various supports such as instructional material, boards, maps or implementation in further developments such as campaigns.

Collaborating with different organizations such as the Red Cross, First Aid is an open source information case, available on their website as a kit oriented to action, see note 3. Moreover, following the apparent clarity of graphic style and simplicity of its implementation, this initiative is continuously incorporating improvements after feedback provided by users and organizations. The current kit is 2.0, expanded to facilitate health interaction. The team states that they are open to help and advice 'considering comprehensibility and diversification' and hereafter they are constantly 'evaluating, improving and expanding' the icons and applications after suggestions, to produce visual tools to assist in a current humanitarian crisis, such as the displaced population. However, the project does not disclose any formal testing procedure to examine. Figure 5 illustrates examples from the kit.

4. Guemil icons for emergency (2016)



FIGURE 6

Example of icons from Guemil Project

This is an initiative of icons to represent risk and emergency contexts associated mainly to natural disasters. It is conducted as a design + research project by the author of this article. Guemil makes available an icon set to represent information in a stage-based concept: Before, During and After an emergency, constituting a resource for the deployment of graphic information for critical contexts. A key visual characteristic of Guemil icons is its simplicity and boldness.

As a collaborative project in development, icons are packed into an open source typeface. This can be installed as a multiple format font for computers, web servers or mobile apps. A pre-release version is available, its accessibility in a web platform and adaptability of such symbols make them easy to use for diverse contexts: Guemil icons can be implemented in multicultural communication using physical-analogic and/or digital supports. In parallel to design, the project includes a testing process to collect informa-

Note 3, icons are accessible at <http://buerobauer.com/first-aid-download/en.php>

Note 4, icons are accessible at www.guemil.info

tion about the performance of icons, specifically in Meaning and Differences. This is detailed in the next section.

Discussion from cases

For the human experience, an emergency can represent a complex context with massive needs of information. Here, concrete visual elements such as icons are usually presented to optimize communication. However, as the team from Hablamos Juntos (2009) project states 'Symbols are not the panacea for a poor signage system, nor will they solve wayfinding issues. But they can be part of a viable and dynamic system that can assist all people, regardless of their reading skill level, to feel more comfortable and confident [...]':

Platforms such as those on the web can facilitate their accessibility and public sharing. Thus, downloading and adopting open-access icons systems contribute to expanding their application as a normalized instrument to recognize, prepare or react in a disruptive situation. This can facilitate information demands from individual users, organizations or even communities, promoting its eventual adoption as a graphic language to commonly refer to emergency contexts.

However, such direct accessibility would also require to provide evidence about performance. As Frascara (2011) states, a pictogram development project involves a cycle with Interviews + meetings + tests, with a considerable amount of time spent on consultation, and refining its visual design. Being open source initiatives, it seems to be important to make available ways to validate if this graphic language is effective for the intended purpose. In some of the cases presented, graphic principles such as visual style, consistency, or small-scale reproduction raise questions about their feasibility as tools for communication. If these are designed for critical contexts such as risk or humanitarian crises, a responsibility to provide evidence of effectiveness emerges.

If icons are designed to present information to be visible and understandable in a critical context, ideally this requires collecting the most of data about their functioning. Therefore, asking what they can interpret is fundamental to observe what is objectively comprehended, and what could be misinterpreted. As noted, although they claim to be collaborative not all initiatives presented have been confronted with feedback, and beyond an originators' statement, this appears to be a key part of the process. In parallel, other challenges appear here, related to processing information in a real scenario of emergency and opportunities related to creative commons practice. Analyzing such topics need a more direct discussion and exceed the focus of the research presented.

All in all, as it occurs with Design methods iteration can be made by testing in different scales or contexts being used to improve tools

for communication in an emergency. This constitutes an opportunity to explore if the so-called 'universal' visual language can facilitate recognition. Even more, systematically applied this iterative process can be an efficient approach to integrate the risk cycle with the user experience (before-during-after an emergency). Thus, beyond statements on style, concepts and form, can be considered 'Meaning' from users as a critical response for effectiveness using icons to represent emergency? Such a hypothetical idea is developed in the next section.

3. Testing Icons:

What is considered

Icons are visual resources to deliver information on multiple scenarios and even in disruptive contexts, being appropriate for multicultural communication and across supports. However, as Foster (2001) states 'Verbal description is not equal to graphical implementation (and then to comprehension)'. A graphic style proposal might suggest multiple interpretations from users, becoming necessary to collect functional evidence: This is specifically what is the icon depicting. In specific, what does an icon represent?

After the design process, an aim from the testing procedure is to collect what a specific icon does mean to a specific user inside the topic of emergency. Then from results, it should be possible to evaluate and/or compare different options. Here is provided general background on icons testing and then a specific development from the case of Guemil.

In order to test the so-called 'Public Symbols', different testing procedures have been developed, pursuing a common aim to collect responses from the public, asking them to provide an open answer or choose among options (Brugger, 1999; Olygay, 2003; Frascara, 2011; Boersema & Adams, 2017). Concepts usually mentioned in international standardized protocols (ISO 9186:2011, ISO 9186-1:2014, ANSI z535) are Appropriateness, referring to recognition, and specifically Comprehension (Hablamos Juntos, 2009), as a merging concept on understandability.

For an emergency application, asking users what they suppose each icon represents is probably one of the most simple but important actions to define if this is effective or not. Then, evaluation scales and grades weighs are developed to quantify the effectiveness of each icon. Two main topics asked for evaluation are (1) Meaning and (2) Differences:

- (1) **Meaning:** Interpreting a defined image (significance): what does an icon represent (depict),
- (2) **Differences:** Recognizing particular elements from the icon, or among its components to distinguish characteristics.

International standards usually define a rate of 67% minimal comprehension to define an acceptance index on when an icon is effective or not (i.e., AIGA/DOT). Even more, in safety, emergency or risk related fields a rate of 83 to 85% is required to accept every icon (i.e., ISO, ANSI).

About the number of answers, some testing procedures recommend a relatively low number of responses (ANSI: 50 responses). Others such as *Hablamos Juntos* (2009) mentions 231 respondents from their comprehensibility survey, distributed in three US locations. Finally, ISO supports extensive testing, ideally covering at least five countries, with 400 responses each, in a total coverage of 2000 participants. In this scale, some additional material is also required (i.e., approved references, context symbols).

Additionally, some testing protocols define to provide a concept or name to recognize meaning, or just ask for open answers (Frascara, 2011). This is defined in procedures such as Comprehensibility Judgment Test (also known as 'Judgment test'), where users are shown the variants for a particular referent (meaning given). (2) Comprehension test, where users are asked to interpret a specific icon (depiction), sometimes with clues or alternatives to their meaning and/or context of application, sometimes without any information.

For the analysis of data, it can be important to consider how testing groups are segmented: Age range, Location, Education or any specific group for relevance. For example, with coverage inside the US, *Hablamos Juntos* (2009), established four language groups: English, Spanish, any Asian language, and other Indo-European languages. In the case of Guemil with an international coverage intended, tests are provided in English and Spanish, then users can define their segmentation marking age-range, location and even their familiarity with an emergency.

Tests can present variations, being adapted to different requirements. However, a primary objective in testing is to determine how effectively icons communicate an intended meaning. Basically, this can be collected from open answers to choosing options from a given meaning. Then, identify or analyze differences from responses or chosen options. In the case of Guemil that is detailed in next section, more than following a provided systematic methodology, the process has been an adaptive process with different practices, mainly learning by doing.

Study case: Testing 'Meaning' on Guemil icons

Methods for testing icons mainly involve measures of their Comprehension. Therefore, dimensions such as Meaning and Differences can be considered as key variables to establish a functional performance index. This is the case of the process followed to measure Guemil, where icons are being tested in a global scope.

Methodology guidelines applied are explained here according to considerations presented, and this is considered as a task to validate the effectiveness of the project. However, the purpose of testing icons was not to develop a methodology but to provide a feasible means of design by adopting diverse international practices available.

As mentioned, Guemil tests results shown here are centered on 'Meaning' as a specific variable. Thus, a first objective was to collect 200 answers per icon. An iterative method involving prototypes and evaluation was applied for the forms, designed to present icons and get open answers. For the procedure three main tasks were included:

(1) Define the Test: Five forms with questions were packed in interactive PDF (English and Spanish), considering a response timing of 10 min per form. The number of icons included in the test was 72 (for comparison ISO 7001: 78 symbols). These were randomly distributed in five forms. In a typical test page, this displayed three icons with the question: What does mean each icon? Every answer corresponds to an open interpretation from a specific user, considering even an empty or no response (see figure 7).

FIGURE 7

A Guemil test form sample

TABLE 3

Answer categories for the evaluation of the comprehension test; based on Brugger (1999), Olygay (2003) and Frascara (2011)

1 Correct	2 Almost correct	3 Doubtful	4 Incorrect	5 Opposite meaning	6 No answer
Correct understanding of the icon is certain	Correct understanding of the icon is likely	Correct understanding of the icon is marginally likely	The response is wrong to the intended meaning	Meaning is opposite as is intended	Any answer is given

(2) Collection and weigh of responses: Open answers are collected into a database and marked using a 6-grades scale, adapted from work developed for public symbols such as ISO and IIID, and published by Brugger (1999), Olygay (2003) and Frascara (2011). All responses have been collected and processed anonymously (see Table 3).

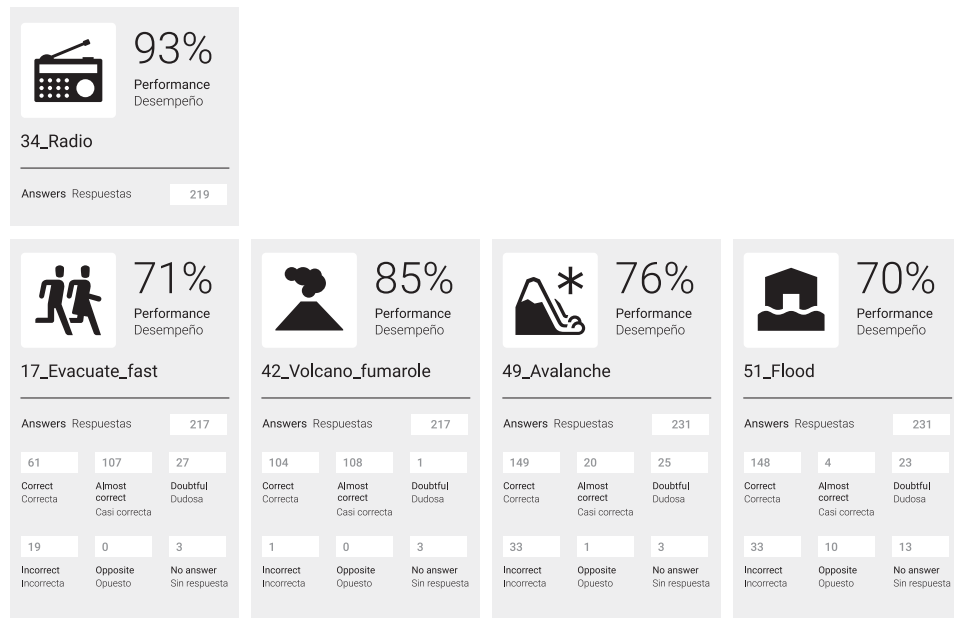


FIGURE 8

An example of visualization from Guemil tests web platform, with their performance index after testing.

(3) Establish performance: A quantitative index is calculated from weighed responses, to present the performance for each icon by percentage (+83%: Accepted). Taken from international practice for emergency or safety context, it has been adopted than up to 5% in 'Opposite meaning' (5) answers requires one to discard the icon from the system. Examples of this index are shown in Figure 8.

Additionally, other questions with multiple choice answers were included to test differences (i.e., options from given alternatives), associative meanings (i.e., colors), or performance (i.e., these icons can be applied...), to collect further information from visual language used for emergency. Although 'Differences' is the second important variable in tests, this is not presented here. Informed consent is presented on the first page noticing responders about the purpose of tests, informing them that is not a test about their skills or knowledge. In the last page or each form, users had the option to include a short comment or reflection.

Considering the international scope intended and as a pattern in construction, tests responses reveal a bias in age range: mainly 19–35 years, and from geographical location: Mainly Chile, Colombia and other South American countries. Then the West coast of the US, mainly from California. In Europe, answers come mainly from the UK. In Asia, from Hong Kong and Mainland China. This is explainable because these are specific locations where participants were asked to participate.

FIGURE 9

Optimal Performance

200 Responses Map > Mobile Message

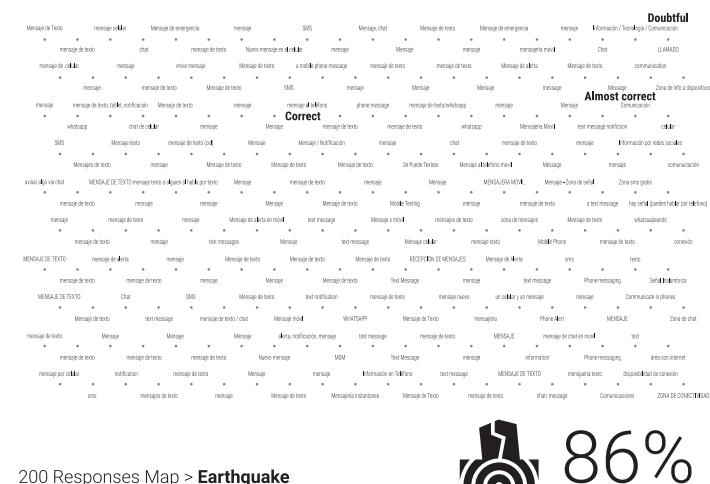
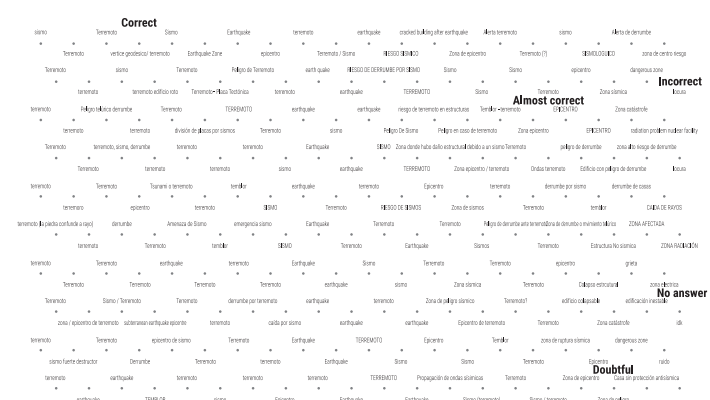


FIGURE 10

Accepted Performance

200 Responses Map > Earthquake



Visualizing Meaning performance

Specific results from Meaning part in Guemil tests are presented here in figures 9 to 13. For all cases, the question was: What does represent each icon? Responses correspond to Open Answers. In a wide spectrum to see and compare, a diagram allows to map 200 responses according to evaluation scale (see Table 3). These have been arranged from optimal to poor performance.

Figure 9 Mobile message [96%]:

This is a case of an icon presenting a direct interpretation, with precise recognition. It can be observed that is a combination of an analogical image (more descriptive than symbolic), with a relatively familiar action (usually

seen in everyday communication media). No single response was considered as Incorrect because all are close to depiction (Mobile + Messaging + sms). Of 72 icons tested, 15 can be included in this group (over 90%).

Figure 10 Earthquake [86%]:

A precise meaning provided, in this case with a more symbolic representation. It is interesting to observe that is possible to recognize a consistent pattern of answers using different words ('Terremoto', 'Sismo' or 'Temblor' are Spanish for 'Earthquake'). Of 72 icons tested, 20 can be included in this group (between 83% and 89%).

Consistent with statements made by Hablamos Juntos (2009) in their analysis after testing, most of icons that are in categories such as iconic or narrative are observed to perform better (83 to 96%), supporting their observation about form simplicity and boldness.

Figure 11 Authority Instruction [78%]:

In this case it is possible to observe that most of the responses fall into 'almost correct' category. This means that many responses are describing the literal icon and pointing to 'Police Officer' ('Policía' or 'Carabinero' in Spanish) although not delivering a precise description or emphasis in the action of 'Instruction.' Linking this with analysis from Hablamos Juntos (2009) although the icon part is recognized (Police), what appears to lack is the narrative component. Also, this could be explained because there was no context when the tests were conducted. Of 72 icons tested, 25 can be included in this group (between 66% and 82%).

Figure 12 Network [43%]:

This is case where abstraction (a representation relying on a symbol), can create different interpretations from users. Although some responses can be related with the intended depiction ('Break of Connection' or 'Support network') suggesting almost correct meanings, some others are revealing a confusing ambiguity: 'Electrical circuit' 'Connectivity' 'Broken route.' Providing more visual clues and detail eventually with elements that link clearly to objects, people or context could help to improve recognition. This icon is considered to be reviewed, focusing on a more explicit action (loss of connection) than a generic concept (network). Of 72 icons tested, 11 can be included in this group after tests (between 20% and 65%).

Figure 13 Girl [7%]:

The specific case of this icon evidences a complete failure of meaning. However, it also offers a great lesson about precision for visual communication. It is a case about how wrong emphasis in representation (hair bun + dress intended) can create disparate interpretations, making it difficult even to identify a pattern in responses (probably most repeated is 'Elder,' that actually can be considered as Opposite meaning). Another reflection from this case –and others related with human depictions is about the number of icons necessary to precisely represent actions (it can be observed for example that a 'couple walking' representation creates interpretative emphasis on couple behavior more than evacuation). Of 72 icons tested, just this icon can be included in this group (below 20%).

All 72 icons responses on Meaning can be visualized in detail in the project website: www.test.guemil.info.

FIGURE 11

Below Acceptance

200 Responses Map > Authority Instruction

78%

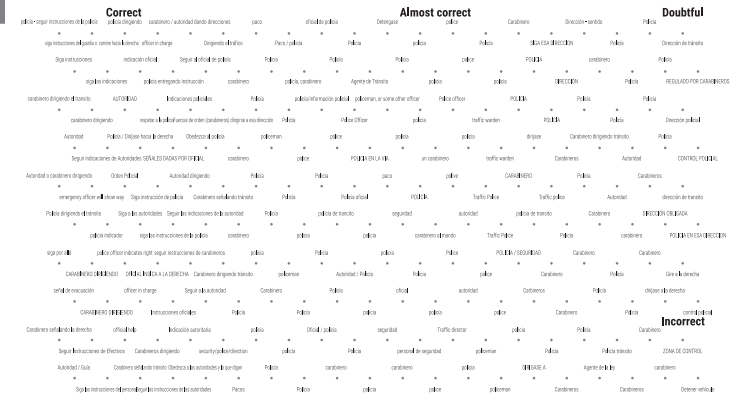


FIGURE 12

Below Acceptance

200 Responses Map > Network

43%

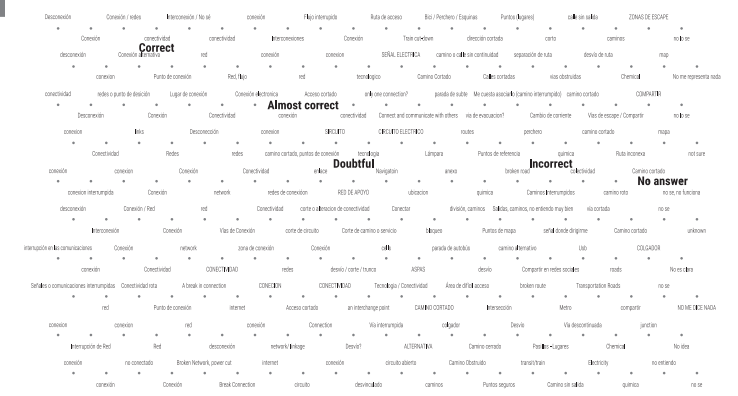
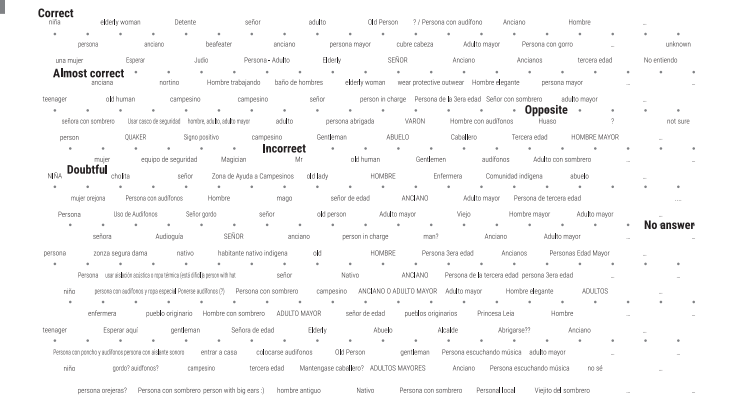


FIGURE 13

Poor Performance

200 Responses Map > Girl

7%



Next steps

The dataset collected should allow constructing different analyses. Although the task of collecting 200 answers per icon is finished (2017), further actions for the project suggests a continuous process to improve performance. Three steps are here suggested for further development and as open possibilities to collaborate.

1. Conduct further local testing: This could be linked to data collected such as geographical locations, age range or education level, allowing specific comparisons or evidencing patterns. Local research contributes to observe particular depictions or cultural interpretation, or what is already learned as meaning from media. This point is stressed after insights obtained by Frommberger & Waidyanatha (2017) working with linguistically challenged communities in Asia.
2. A research challenge that emerges is understand meaning problems on misinterpretation crossed with language aspects (verbal–visual) or familiarity with specific scenarios.
3. For next iterations, it is considered to construct additional ways to visualize performance in visual language for emergency, testing other variables: Associations (e.g., Color), Differences or Performance tasks (e.g., Decisions).

Other questions about the real experience of emergency or the effective role of graphic tools are open to further research. The following section will conclude with reflections to promote open-access, performance and collaboration.

4. Conclusion

Emergency is a complex human experience with global implications. Visualizing and understanding emergency appears as a challenging field for communication design. Being a context with significant needs, different initiatives to optimize information are available. To develop effective messages seems to be necessary to combine both User Experience and Risk Management approaches. It is recommendable to integrate risk, safety, and emergency from a user experience scope, promoting collaborative practices. An open–access approach is a contribution to share meanings.

From a design perspective, visual tools such as icons are ubiquitous units of information, efficient to manage and flexible to implement on different supports. Icons are simple resources for public adoption and contribute to optimizing messages. These can enhance learning and decisively

impact in all stages of risk cycle: covering from vulnerability identification and preparedness Before, to action and reaction During, towards recovery and resilience After, in a continuum covering different aspects of experience. However, beyond a formal statement assuming that an icon system would be universal just because their visual style, it is important to provide functional evidence.

From a research perspective, testing is necessary to validate design and transcend to a dimension of understandable and usable communication. It is necessary to observe how the recognition and interpretation of graphic tools complete communication. Reliable information presenting performance indicators and based on creative commons practice could help to reveal comprehension problems to tackle and focus on meanings. Tracking interpretation by people, the Guemil project is a platform for constructing visual knowledge on emergency, demonstrating how if the design outcome assesses meaningful factors, it reveals performance. The experience is useful to provide direct insights by people and preview patterns.

The case is also an invitation to collaborate, exploring other needs. If the community can adopt open initiatives, is more feasible to build a common language for the cycle of risk, aiming to preparedness, reaction or resilience supported by consistent information. Therefore, such initiatives are just a starting point. Hopefully, these can articulate the design of information for optimal, ideally safe decisions. Communication based on icons is a contribution, but also an opportunity to understand constraints and problems emerging on emergency scenarios. Thus, a definitive conclusion cannot be established here, because it will continue transforming.

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Awards

Guemil Project has been awarded as 'Shortlist' in IIIDawards 2017, in Emergency Category (iiidaward.net).

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practice research

Same But Different:

*A framework for understanding
conceptions of research in
communication design practice
and academia*

Emma Fisher

Nicolette Lee

Scott Thompson-Whiteside

Situation: There has been a growing emphasis on the importance of collaboration between the design academy and design practice, as well as research engagement by design practitioners in recent years. However, there is a lack of consensus about what constitutes research to support and inform these activities, particularly within communication design contexts.

Aim: This paper explores conceptions of research held within academia and practice in the communication design field in Australia, and aims to propose a speculative framework for understanding different conceptions of research that can be applied to enhance collaboration between the two sectors and engagement by practitioners.

Background: First, the background of this issue is summarized with a description of the growing value of research engagement and research collaboration, both in broad terms and specifically within the Australian communication design field.

Literature review: Second, the literature review discusses how research has been defined in the past including in general academic publications, literature from the design discipline, and mass-market media. An overview of past relevant studies that have explored conceptions of research by design practitioners is also presented.

The Australian Study: Following the literature review, key findings are presented from a study of how research is characterized in the Australian communication design field. Data collected via questionnaires and focus groups are reported, and differences and similarities between practitioners and academics' characterizations of research are discussed and compared with criteria for research found within the literature. Notable findings include that academics and practitioners characterized research similarly in some ways, yet differently in relation to underlying purpose and expectations for systematicity and empirical evidence.

Discussion: Finally, a speculative framework for understanding the differences between design practitioner and academics' conceptualizations

is presented including a proposal for how these conceptualizations may be managed during collaboration. Implications and recommendations for design academics and practitioners are outlined. Barriers and opportunities for collaboration are discussed in the interests of fostering long-term benefits and impact.

Conclusion: Recognizing that design practitioners and academics are likely to hold differing conceptions of research, particularly with respect to systematicity, appropriate types of data and expected outcomes, equips designers and researchers to enter collaborations with a greater awareness of aspects of the project that may require clarification, negotiation, and confirmation.

Keywords

*design research
practice*

Background:

The broader context for research collaboration and engagement

Collaboration between publicly funded research and private industry has been recognized as being of key importance to translating research into commercial outcomes (Australian Department of Education & Australian Department of Industry, 2014) and fostering innovation that supports national, international and global prosperity (OECD, 2013).

However, reports on the levels of co-operation between the public research sector and private industry in Australia vary significantly. While reported as particularly low by some OECD measures (Australian Department of Education & Australian Department of Industry, 2014; Department of Industry Innovation and Science, 2015)¹, a recent report concluded that research collaboration between Australian universities and industry is strong (IP Australia, 2017), and Australia has been found to perform well on other measures such as research productivity and research excellence (Australian Department of Education & Australian Department of Industry, 2014).

In an effort to increase translation of research into commercial outcomes in Australia, a range of government initiatives have been put into place. Research funding has been strategically adjusted to incentivize cooperation between academia and industry (Australian Department of Education & Australian Department of Industry, 2014), and the 2017/18 Excellence in Research for Australia (ERA) ratings will include an assessment of impact and external engagement via assessment methodologies that are currently being pilot tested (Howard, 2017). While there is variation in emphasis between collaboration and impact, these financial and academic incentives consistently aim to foster translation of research findings into commercial outcomes and thereby facilitate greater impact on economic, social and cultural domains.

Encouragement to publish impactful research across all sectors is also evident outside Australia. In the British *Research Assessment Framework 2014* (REF2014), 20 percent of the assessment was dedicated to research impact – research that benefits industries, policies and society, outside of higher education (Higher Education Funding Council for England, Scottish Funding Council, Higher Education Funding Council for Wales, & Department for Employment and Learning, 2014a). Many of the submitted impact statements involved collaboration with external stakeholders such as industry, government, and communities.

1. in 2013 the OECD ranked Australia 29th out of 32 countries in terms of the percentage of firms that engage in collaboration on innovation (OECD, 2013), and ranked Australia last of 33 countries in terms of the percentage of firms collaborating on innovation with higher education or public research institutions (OECD, 2013).

It is worth noting, however, of 6,975 case studies submitted by UK universities to the REF2014, only 44 were related to *Design Practice and Management* (Higher Education Funding Council for England, Scottish Funding Council, Higher Education Funding Council for Wales, & Department for Employment and Learning, 2014b). This suggests that despite academic and financial incentives, current levels of research collaboration within design fields are low.

Research collaboration and engagement in communication design

While the boundaries of the field are contested, communication design is generally held to have evolved from and to include, commercial art, graphic art, visual communication design, and graphic design. Increasingly strategy, branding, experience design and consultancy service have also become the domain of the communication designer (Buchanan, 2001; Frascara, 2004).

The perspective of design academics

As practical, industry-related research collaboration is being encouraged in both international and Australian universities, design faculty find themselves under increasing pressure to produce research that is relevant to two cohorts: industry (being commercial clients) and design practitioners (Robertson, 2011, 2014).

The expectation for academics to produce impactful research that is relevant to clients from industry as well as design practitioners is particularly challenging in Australia for two reasons. First, the population of Australia is relatively small (around 25 million people (Australian Bureau of Statistics, 2017)) and consequently the potential audience of commercial clients and design practitioners² is also small. Second, communication design has only entered higher education in Australia relatively recently, in the early 1990's when technical colleges and institutions that trained designers first moved to university status (Young, 2005) as part of major national education reforms (Croucher, Marginson, Norton, & Wells, 2013). Varying levels of research literacy exist within the academy and design profession, presenting additional challenges to research collaboration and dissemination (Barron, Zeegers, Jackson, Barnes, & Taffe, 2010).

The perspective of design practitioners

While there are many financial and professional incentives for academics to initiate and participate in collaborative projects with industry, there are also

2. The Australian communication design industry is relatively small compared with other countries, generating less than 2.5 per cent of global revenue for the communication design sector (IBISWorld, 2011)

some emerging arguments for practitioners to collaborate with researchers, and to engage with research more broadly.

Two forms of research engagement are typically discussed in the literature as important for designers: conducting research and reading research. Collaborating with academic researchers could possibly involve either form of engagement. It is also possible for a designer to conduct or read research independently – that is, without collaborating with academic researchers – although this is arguably less likely due to limited historical research training and literacy in design education (Barron et al., 2010).

Many authors have also discussed the importance of designers working with research experts or personally conducting their own investigations to inform their design decisions (Bennett, 2006; Boulton, 2014; Frascara, 1995; Hanington, 2003; Heller, 2006; Nini, 2006; Sanders, 2006; Throop, 2006). Some authors have argued that it is important for designers to use research without specifying exactly how (Davis, 2010; Lunenfeld, 2003). Others have argued for the importance of design practitioners reading published research findings to draw on knowledge beyond their own experience (Friedman, 2000; Robertson, 2014).

Supporters of research engagement by designers argue that reading research, conducting research, or collaborating with researchers offers many benefits, including increasing the efficiency of processes (Wong, Lam, & Chan, 2009); gaining a deep understanding of the end user, client, or problem (Hanington, 2010; Jönsson et al., 2004; Nini, 2006); improving the effectiveness of design outcomes (Chu, Paul, & Ruel, 2009; Cooke, 2006); providing a base of knowledge not possible for an individual to gain through personal experience alone (Friedman, 2003); fostering creativity (Storkerson, 2006); meeting the complex challenges of the knowledge economy (Friedman, 2003); and raising the professional standing of the communication design specialism (Bennett, 2006). Some authors have been particularly critical of design practitioners' engagement in research as they perceive it. For example, Poggenpohl has maintained that

Looking through trade magazines for inspiration is not research. Asking one or two people for their opinion about what you are designing is not research. Fooling around with some design element in order to get a better idea or result is not research. (Poggenpohl, 2010, 3:30).

Nonetheless, consensus on the importance of research for design practitioners is far from evident. Several authors have argued that using research findings (derived from literature or developed from original inquiry) to inform design practice can be ineffective (Zaccai, 2013), restrictive (Heller, 2006; Raisanen, 2012a, 2012b; Throop, 2006), impractical or unnecessary (Norman, 2011).

Despite these arguments about research collaboration and engagement in design, the nature of research activity in the communication

design field is largely assumed and what distinguishes research from other investigative activities remains unclear. As a result, arguments for increased research activity in either the academy or design profession are stalled, and research conducted by both design academics and practitioners remain vulnerable to claims of superficiality. When we examined the arguments for and against research engagement, we found that nearly all were based on opinion, practitioners' personal experiences, or individual case studies of design projects (Fisher, 2015). This pointed to a lack of substantial evidence (scientific empirical or otherwise) to support either side of the debate of the efficacy of research for improving design practice and aligns with other authors' findings (for example, So and Joo (2017)).

Common criteria for research in the literature

To seek a clearer understanding of which criteria are used to recognize different types of research, we conducted a systematic literature review based on the approach employed by Hemsley-Brown and Sharp (Hemsley-Brown & Sharp, 2003). Scholarly literature, reference dictionaries, qualitative and quantitative research design texts, and design research publications were searched (Fisher, 2015). A range of definitions, discussions, and criteria for research were collected and reviewed. The most common criteria in the general literature on research methods were also reviewed (for example those discussed by Patton (2002), Lincoln and Guba (1985) and Denzin and Lincoln (2011)). These criteria were then compared with criteria discussed in design contexts specifically.

Most definitions state that research is systematic in nature, from the *Oxford English Dictionary* (OED) (Research, 2011) to Archer's famous declaration that "research is systematic enquiry whose goal is communicable knowledge" (Archer, 2012, p. 6). To be systematic, research must be conducted following a methodical, thorough and careful process in the interests of ensuring the validity and reliability of findings. Systematicity is a key distinction that is commonly drawn between research and less formal or rigorous forms of investigation. In academic contexts, this expectation is clearly universal. In design practice, however, systematicity may not be essential. For example, Gaver, Boucher, Pennington, and Walker (2004) have argued that conducting research methods in an intentionally unsystematic way can generate new ideas and foster empathy.

To qualify as research, it is widely accepted that investigations must also produce knowledge that is valid, meaning "well founded and fully applicable to the particular matter or circumstances; ... against which no objection can fairly be brought" (Valid, 2013). Or, in Krippendorff's words, "in short, validity concerns truth" (Krippendorff, 2009, p. 356).

Research is also widely expected to produce knowledge that is reliable. That is, the data and findings are stable over time and are thus trust-

worthy. In Krippendorff's terms; "In short, validity concerns truth; reliability concerns trust" (Krippendorff, 2009, p. 356). This requirement is also logical considering it's difficult to think of a situation in which untrustworthy knowledge would be useful.

The requirement for findings to be transferable (that is, generalizable in quantitative inquiry or suitable for informing other situations in qualitative inquiry (Guba & Lincoln, 1989)) is a common criterion for research in academic contexts yet is required far less in design practice.

To be confirmable, knowledge produced by an inquiry must be clearly grounded in evidence outside the researcher as opposed to being based purely on the researcher's own opinion (Guba & Lincoln, 1989) or individual experience (Poggenpohl, 2010). This requirement has been attributed to the Enlightenment model of positivism (Denzin & Lincoln, 2011) that aspired to unbiased knowledge in the interests of achieving validity and reliability.

Some definitions of research found within the literature imply or specify that research requires a search for fundamental new knowledge, as distinct from knowledge that is related to one specific case. For example, the OECD's *Frascati Manual* explicitly disqualifies activities of investigation that test for diagnostic purposes within routine professional practice from qualifying as research, stating that "general purpose data collection... [including] market surveys" (OECD, 2002, p. 31), and "feasibility studies" (OECD, 2002, p. 31) should be excluded from qualifying as R&D. The requirement for research to generate original, novel or new knowledge (as distinct from identifying or discovering existing knowledge) is a common prerequisite for academic research.

Types of research discussed in design contexts

A variety of different types of, and criteria for, research have been discussed since the emergence of research within the design field around the 1960s (Cross, 2001). The diversity of understandings of what constitutes research in design practice was acknowledged by Fulton Suri when she wrote that "for some people it connotes 'data collection' – looking to the past and present but not to the future; for others it's simply a required step before coming up with ideas; for yet others it's a filter that rejects promising ideas before they've had a chance to evolve" (Fulton Suri, 2008).

In the context of design fields, Buchanan and Friedman discuss the appropriate contexts and applications of three types of research: basic, applied, and clinical research (Buchanan, 2001; Friedman, 2000, 2003).

Both authors describe basic research as an activity conducted by academics or other researchers to seek new fundamental knowledge and develop theory and first principles without necessarily having any particular application in mind (Buchanan, 2001; Friedman, 2003; OECD, 2002).

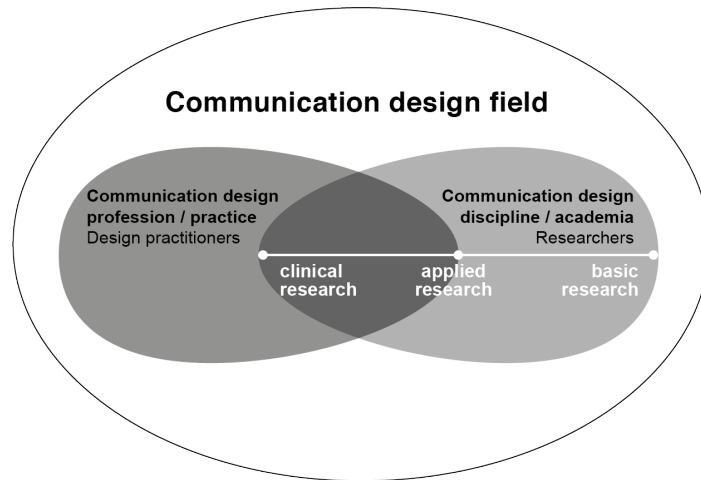


FIGURE 1

Types of research in the communication design field

Buchanan and Friedman discuss applied research as being most relevant to academics and researchers and somewhat relevant to practitioners, as it deals with broad categories or classes of problems to also seek fundamental new knowledge, yet with a specific purpose or application in mind (Buchanan, 2001; Friedman, 2003). And finally, clinical research is described as typically an investigation conducted by practitioners about or for individual projects. (Buchanan, 2001; Friedman, 2003)³.

Buchanan and Friedman's descriptions of how basic, applied and clinical types of research relate to different cohorts within design fields can be mapped onto a diagram to illustrate the types of research that are typically expected to be conducted by design practitioners and researchers (see figure 1).

While academics may need to engage with any of the three types of research described by Buchanan and Friedman, only clinical, and sometimes also applied research are considered relevant to design practitioners and useful for supporting design practice (Buchanan, 2001; Friedman, 2003). Aside from basic, applied and clinical types of research, a number of other useful categorizations have been discussed in relation to research in design fields.

Two of the most widely cited categorizations in design are Frayling's 1993 distinction between research *into design*, *through design*, and *for design* (Frayling, 2012), and Archer's very similar 1995 discussion of research *about practice*, *through practice*, and *for the purposes of practice* (Archer, 2012). While these categories come from a particularly arts-oriented perspective and have been interpreted in very diverse ways in the absence of clarification by the original authors, they remain popular in design literature. These categories distinguish types of research on the basis of their method or purpose, with *research for design* and *research for the purposes of practice* being discussed as most relevant for design practitioners to conduct, while the other four types are typically discussed as most relevant to academic researchers' work.

3. Both authors are credited with development of this concept within this paper because it is unclear from the publication dates and citations within these pieces of literature, whether Buchanan or Friedman was first to publish the distinction between basic, applied and clinical research within design.

Other types of research discussed within the design literature include Hanington's categorization of research methods as *traditional* (such as focus groups, surveys, market research and archival searches), *adapted* (such as variations on ethnographic and observational research), and *innovative* (such as design workshops, visual diaries, and card sorting) (Hanington, 2003).

The recognition of more unconventional methods included within Hanington's innovative category aligns with the emergence of practice-led approaches to academic research within design as well as other disciplines (Barrett & Bolt, 2007; Grocott, 2012; Smith & Dean, 2009). Conversely, there is growing evidence of research-led practice, which typically involves collaboration between academics and industry (Kuys, Thong, Kotlarewski, & Thompson-Whiteside, 2014). The growing credibility of these creative research methods is reflected in the Australian Research Council's recognition of creative outputs as Non-Traditional Research Outputs since 2009 (Australian Research Council, 2017).

The lack of evidence of designers and design

academics' opinions

Despite extensive discussions by individual authors about what research is in design, very little empirical evidence has been collected about what design practitioners and the broader population of design academics believe research is, particularly in communication design.

We identified only one study that sought to understand conceptions of design research by those involved. The investigation was conducted by *Metropolis Magazine* in the United States of America and surveyed 1,051 designers, educators, and academics from six design disciplines (Manfra, 2005). Within a range of questions about research activities, the survey asked respondents to give a definition of design research via an open response space. While only limited details of the methods and results were published, the authors concluded that understanding varies substantially within the design field of what constitutes research; ranging from highly formal, rigorous methods to everyday activities that are clearly contentious to claim as any type of investigation, such as travel or "selecting color swatches" (Davis, 2008, p. 74).

Overview of the Australian study

In light of the unclear nature of what research is understood to be in design contexts, in 2012, we carried out a study of the research engagement activities and attitudes of Australian Communication designers and academics (Fisher, 2015).

A mixed methods approach was adopted, using an explanatory sequential research design (Creswell & Plano Clark, 2011). This approach was chosen for its recognized ability to identify common behaviors and attitudes, then investigating the reasons behind them in more depth (Creswell & Plano Clark, 2011). In accordance with Creswell and Plano Clark's approach, first quantitative data were collected via online surveys with Australian communication design practitioners and academics to gain a broad understanding of common conceptions of research. Then, qualitative data were collected from members of the same cohorts via focus groups to explore the reasons behind their beliefs. The findings from the quantitative and qualitative data analyses were then compared to arrive at final conclusions.

Online surveys

Survey data collection methods and samples

We conducted two online surveys: one to collect responses from professional communication designers and another to collect responses from communication design academics in Australia. The surveys were open for 112 days and collected full responses from 218 communication design practitioners and 56 design academics.

While the number of responses was insufficient for broad generalization according to Krejcie and Morgan's guide (Krejcie & Morgan, 1970), the sample size compared favorably with other past surveys of research engagement attitudes in other disciplines such as those by Borg (2007, 2012). Responses were received from nearly half of the estimated population of communication design academics in Australia (Fisher, 2015) and overall, included a broad enough range of members from the Australian communication design profession and discipline to support useful insights. The sample of respondents included: a reasonable representation of gender (males: 34 percent, $N = 116$; females: 66 percent, $N = 222$); a range of age groups, (approximately normal distribution of data, ranging from participants in their twenties up to participants over 60 from both cohorts); a range of experience levels from less than five years of experience, up to those holding more than 26 years' experience in their field; participants holding qualifications from all levels of Australian tertiary education, including no formal qualifications, associate levels (diplomas, certificates, etc.), bachelor, masters and doctorate qualifications, and; design practitioners from varying sizes of organization ranging from individual self-employed designers (26 percent, $N = 55$), up to designers working in studios of more than 20 people (24 percent, $N = 51$).

Survey data analysis and key findings

Within the online surveys, communication design practitioners and academics were asked to respond to the question, "In your opinion, what is research?" via an open response space. The responses were thematically coded and tabulated to identify the most common qualities. The responses of practitioners and academics were then compared to identify similarities and differences.

The results of the data analysis suggest that conceptions of research are diverse in both cohorts, with practitioner and academic respondents referring to many different themes in their responses of (47 and 35 different themes respectively).

Within the themes mentioned, some key similarities and differences are evident between practitioners and academics.

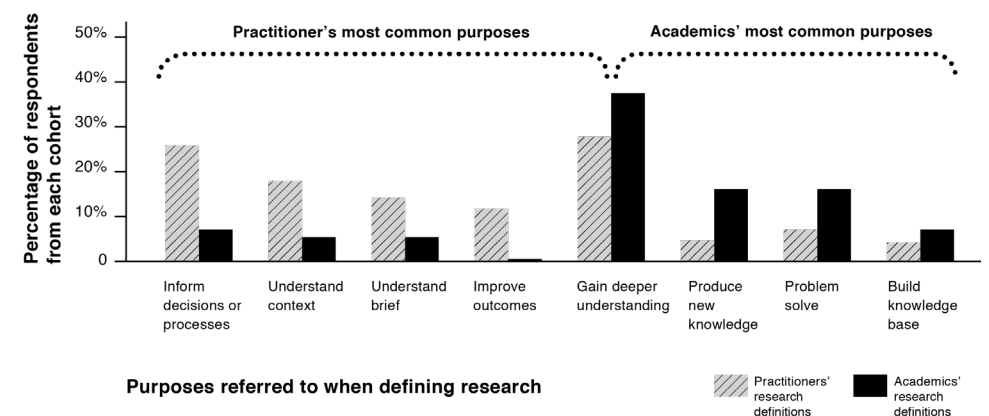
In terms of similarities, most respondents from both cohorts referred to research as an activity; that is a verb (83 percent of practitioners, $N = 176$, and 94.6 percent of academics, $N = 53$), rather than a noun such as a product or output.

Research purposes

Differences were evident between the purposes of research that academics and practitioners mentioned, with practitioners most frequently describing project-oriented outcomes, while academics referred to general knowledge-building or problem-solving. As shown in Figure 2, gaining deeper and more accurate understanding was the most common purpose of research referred to by both cohorts (27.8 percent of practitioners, $N = 59$, and 37.5 percent of academics, $N = 21$).

FIGURE 2

Comparison of academics and practitioners' references to purposes when defining research in online survey

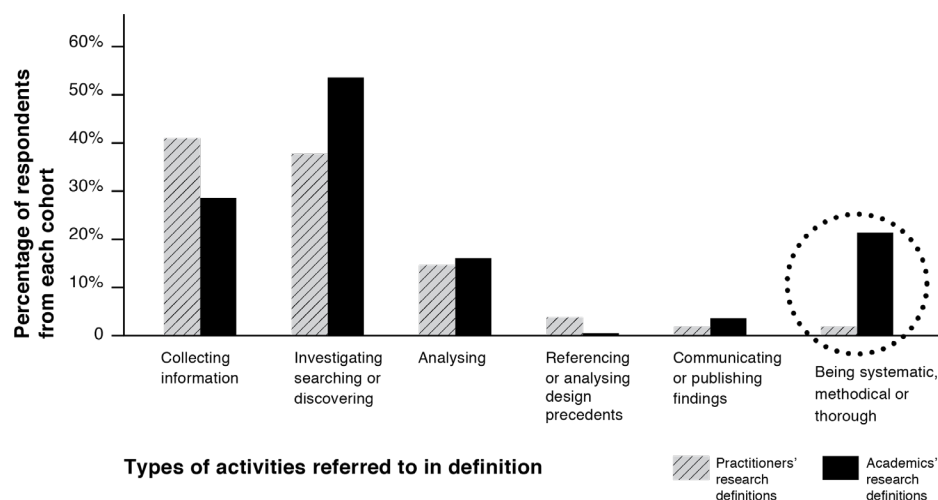


Research activities and criteria

FIGURE 3

Comparison of academics and practitioners' references to types of activity when defining research

Similar percentages of both cohorts described research as involving collecting information, investigating or analyzing. However, as shown in Figure 3, there was a much stronger emphasis on understanding and production of knowledge within the academics' responses. The biggest difference between the characterizations of research by the two cohorts was in relation to defining research as systematic, methodical or thorough. While very few practitioners mentioned being systematic (1.9 percent, $N = 4$), around a fifth of academics did (21.4 percent, $N = 12$), suggesting academics had a greater expectation for research to be systematically conducted.



Focus groups

Following the online surveys, five focus groups were conducted to explore and explain the survey findings further and gain a more in-depth understanding of the conceptions of research held by academics and practitioners.

Focus group data collection methods and samples

Two focus groups were conducted in Sydney and three in Melbourne, reflecting the largest populations of communication design businesses in Australia (Allday, 2016). These two cities also have the most concentrated university populations in the country, with ten institutions primarily located in New South Wales and eight in Victoria (Universities Australia, 2016). The focus groups involved a total of 11 communication design academics and 18 communication design practitioners.

Among a number of topics covered in the sessions, what consti-

tutes research was discussed to explore the diverse range of conceptions collected during the online survey. An activity was developed inspired by Borg's use of scenario ranking (Borg, 2007, 2009, 2012) to help participants reflect upon and articulate their opinions about what is and is not research. During the activity, each participant was given ten hypothetical scenarios that may or may not be regarded as constituting research, and was asked to decide whether each was: definitely not research; probably not research; probably research; or definitely research (*see Appendix A*). The scenarios were intentionally written to include or exclude the various criteria for research found within the literature (as discussed earlier in this paper) so that inferences could be drawn from the participants' rankings to deduce what they believed research to be.

Participants' responses were collated during the session and discussed as a group to further explore conceptions of research and reasons behind rankings. Data were collected via transcribed audio recordings of discussions as well as posters of the participants' collated scenario, and were analyzed quantitatively and qualitatively.

Focus group data analysis and key findings

The 29 individual participants' scenario rankings and the rankings of the two cohorts were compared in multiple ways. This included analysis on a two-category (positive and negative rankings) and a three-category (definitely positive, uncertain – consisting of both probably categories – and definitely negative) basis.

To complement this quantitative analysis, transcriptions of the conversations that took place were analyzed using Krueger and Casey's *classic analysis strategy* for qualitative data (Krueger & Casey, 2009). This identified important responses by the: frequency, extensiveness, specificity, and the level of emotion with which they were offered. The responses identified as important via this method were collated into a spreadsheet, themes were identified and the data sorted to seek patterns that revealed how participants within the sessions characterized research and how the perceptions of the two cohorts compared with each other.

As was the case in the online survey findings, a very diverse range of opinion about what qualifies as research was revealed. Seven out of the ten scenarios were rated across all four categories of research legitimacy within one or more of the sessions.

Research criteria

With regard to what research is, the question of how important it is for research to be systematic within design practice was discussed at length by a number of practitioners. Overall it was evident that practitioners did not consider being explicitly systematic or formal to be a high priority for their own research, which aligned with the survey findings. A range of reasons

for this were raised during the focus groups, including: it is not necessary for designers' research to be systematic to be valid; designers are sufficiently systematic at an intuitive level already; and reading or conducting systematic research is only appropriate during a few stages of the design process such as strategy or pre-design market analysis.

Within academic groups, several participants voiced concerns that unsystematic investigations lacked the necessary rigor and depth of process to be reliable and useful, which also aligned with the survey analysis findings. While the academic groups clearly favored research as being systematic, there was also some acknowledgement that systematic investigations may not necessarily be useful for designers, with one academic arguing, "I'm yet to meet someone who works as a designer who can charge more because they do codified research than if they just did what they did."

Overall, reflection alone (conceived as thinking based on internal processes exclusively rather than thinking based on external evidence or testing) was not considered to constitute research by either academics or practitioners, with nearly three times as many comments arguing that research must go beyond personal reflection and include external data, compared with those that asserted opinion alone was sufficient. Surprisingly, though, quantitative and qualitative analyses led to the conclusion that practitioners often held a stronger belief that research requires external data, and cannot be based on internal data (such as pure reflection) alone. One practitioner participant explained, "anything outside of your brain is research".

In contrast with practitioners' high expectation for external data, a number of academics noted that if reflection were combined with other things such as "severe testing", an explicit investigation, articulation, or triangulation to improve rigor, analysis of internal data such as personal reflection could constitute research.

These comments appeared to suggest that the academics typically held more unconventional conceptions of research that are more inclusive of approaches that involved purely internal data, such as auto-ethnography (Patton, 2002) that are emerging in academia. Practitioners, in contrast, typically expressed a greater expectation for research to involve the collection of external data for confirmability, suggesting they held relatively conventional conceptions of research.

With regard to what research is for, focus group participants rarely—if ever—explicitly discussed the kinds of activities referred to by survey respondents (see figure 3). Instead, practitioners and academics frequently referred to three distinct types of research: academic, market and informal creative research, and thereby implied that research is for academic, marketing and creative purposes. Of the three types of research discussed, informal creative research was clearly regarded to be the most common kind conducted by

design practitioners. This type of research was described as usually less scientific, explicit or systematic, yet still valid and appropriate for the purposes of professional design practice.

Discussion

The conclusions from the Australian study identified that communication design practitioners and academics held some similar conceptions in terms of research:

- Being predominantly an activity (rather than an output or product);
- Mainly involving collecting, investigating and analyzing;
- Having the purpose of gaining deeper understanding; and
- That the context or purpose of an inquiry determines which kinds of investigation and criteria are appropriate to employ.

The consensus that context or purpose informs what constitutes research in different circumstances aligned with Buchanan and Friedman's discussion in the literature that certain types of inquiry (namely clinical and applied research) are most appropriate for design practitioners to conduct, while basic forms of research were relevant to academics alone.

The study findings also suggested several key aspects of research about which communication design academics and practitioners held different opinions. In particular:

- Expectations for systematicity differed, with academics having a higher expectation for research to be systematically conducted;
- Requirement for external data differed, with practitioners having a higher expectation for research to involve the collection of external data as opposed to academics who regarded internal data from personal reflection to be sufficient in some situations; and
- Aside from gaining a deeper understanding, the other purposes or outcomes of research referred to by the two cohorts differed, with practitioners commonly referring to project-based outcomes, and academics referring to knowledge building and general problem-solving.

The key differences found between academics and practitioners' conceptions of research further suggest that the context of an investigation is important for determining what criteria are most appropriate for achieving the desired outcomes of the investigation.

These differences can be diagrammatically mapped as a framework, with the type of data (external or internal) on the y-axis, systematicity

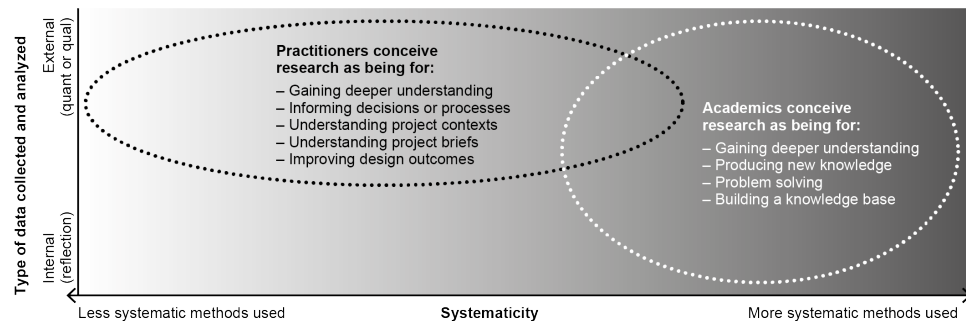


FIGURE 4

Speculative framework for understanding the differences between communication design practitioners and academics' concepts of research

on the x-axis, and the practitioners and academics' conceptions of research and outcomes or purposes overlaid (see figure 4).

The analysis indicates that the areas most likely to require clarification and deepening shared understanding prior to and during a collaboration are those of systematicity, location of data and expected scope of outcomes. While both groups are concerned with deeper understandings, practitioners are likely to have more direct concerns in relation to immediate sourcing of external data and particular project outcomes. These may well also be subject to the pressures of delivery in a commercial context. Exploratory and reflective research approaches intended to gather new but abstract knowledge are less likely to resonate, and more likely to lead to frustration.

Similarly, differing conceptions of the need for systematic methods are likely to be a cause for concern. Systematic research employing all the tools of validation do not clearly align with practitioner understandings. This difference in perspective suggests that the depth and length of preparation and formal management of research is likely to require negotiation. As the purpose or context informs what types of research are appropriate for a given situation, identifying the different research outcomes that academics and practitioners wish to achieve at the commencement of any collaborative project offers a logical starting point for establishing dialogue and planning investigations that can serve the purposes of all stakeholders. Once the desired research outcomes of all parties are clearly articulated, appropriate criteria, type of data, and level of systematicity can be more easily discussed and decided.

Conclusion

If, as discussed in the background section of this paper, collaboration between those undertaking research in academic and design practice contexts is to increase, and if design practitioners are to engage more with research to improve design outcomes, a shared language of research will be increasingly needed within the communication design field.

The nature of what research is in design contexts is unclear at present, as evidenced by the diversity of definitions of research identified during the literature review. Many common criteria for research have debatable

relevance to design contexts, indicating a limited and unstable foundation for research engagement and collaboration between design practitioners and academics.

As found in this study, concepts of research held by design practitioners and academics are similar in some ways (such as the activities involved, main purpose of research and that context determines what is appropriate), but significantly different in others. In particular, academics expected research to be more systematic than practitioners did and, surprisingly, practitioners had a greater expectation than academics for research to involve external empirical data, suggesting that practitioners held a generally more conservative view of research than academics.

Mapping the key differences between academics and practitioners' conceptions of research as a framework highlights the areas that could be useful to recognize, negotiate and accommodate for effective research engagement and collaborations to unfold. Designing an inquiry around achieving what may be disparate desired outcomes could avoid valuing any particular kind of research over another. Rather, it allows participants to respect the diverse concepts of research that exist within the communication design field, acknowledge the valid distinction between the academic and professional sectors in terms of their internal needs, recognize that different types of research are appropriate for different purposes, and capitalize on the variety of methodologies as a resource that can support more effective collaborations.

Armed with knowledge from the speculative framework presented in this paper, academics and design practitioners could initiate research collaborations with a clearer understanding of how their own conception of research may differ from other stakeholders, that is: most likely in terms of expected systematicity, requirement for external data and envisaged purposes or outcomes.

Further, by starting with clear identification of desired outcomes from the proposed inquiry, collaborators can plan investigations that effectively meet all stakeholders' needs. Individual design project objectives can be met while the wider impact of research can also be achieved to support the broader goals of national, international and global benefit.

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APPENDIX A

A

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

A designer noticed that a presentation method she used in a pitch meeting did not work well. She thought about this after the meeting and wrote down some thoughts. She tried something different in her next meeting. This time the pitch was more successful.

B

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

To develop concepts for a new packaging design, a designer experimented with a range of papers and polypropylene. He constructed 13 different options, from which he chose three that he refined and presented to the client.

C

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

A designer was studying a Masters of Design course. She read several books and articles about user-centered design methods then wrote an essay of 6000 words in which she discussed the main points in those readings.

D

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

A senior designer gave a questionnaire about how designers find inspiration to 500 designers. Statistics were used to analyse the questionnaires. The designer wrote an article about how to get the best ideas in AGDA's journal, visual design: scholarship.

E

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

To come up with concepts for a new online shop for sustainable produce from her local area, a designer spent a day searching the internet for examples of competitor sites, as well as imagery of fruit, vegetables and local landmarks. She used the collection of images for reference while developing concepts.

F

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

To find out if a new design for an online school newsletter was more effective, a designer first found out the online traffic figures for the school's existing e-newsletter. Then for four weeks she sent a new newsletter design home to families. She then collected the download and online traffic figures for the new newsletter design and compared them with the original figures. She presented the figures to the school to show that the new design was an improvement.

G

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

To learn about who purchased a brand of clothing, a designer sat outside a store of the brand and watched who went in and out for three hours one morning. She then returned to her studio and developed several concepts she thought would appeal to the people she saw.

H

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

Mid-way through a project a designer emailed a prototype signage design to 30 of their friends who they considered likely to be end users and asked them to complete a feedback form. Five people returned their completed forms. The designer read these and used the feedback to decide what to do in the second part of the project.

I

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

A designer asked every work experience student she supervised in one year to write a short essay about ways to engage teenagers via social media. After reading 10 essays the designer summarised the main points and presented them to a client to support a proposed design solution.

J

This is: ☐ definitely not research
☐ probably not research
☐ probably research
☐ definitely research

A designer gave disposable cameras to 20 staff at an organisation and asked them to photograph their day and return the camera. Once the images were received back, the designer reviewed them to seek inspiration for the organisations' new branding.

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Counting But Losing Count:

the legacy of Otto Neurath's Isotype charts

Pino Trogu

Since its invention by Otto Neurath in 1920s Vienna, the Isotype system of statistical visualization hasn't gone out of fashion. Isotype charts with their rows of aligned pictograms are common today but were a novelty one hundred years ago. Some praise Isotype charts for their accessible style of repeated pictorial symbols. Others correctly believe that this figurative characteristic often gets in the way of the data-message being presented. This paper questions the soundness of requiring the viewer to engage in such a cumbersome strategy to extract information from a typical Isotype chart: counting the symbols in each row and multiplying by the given scale to get the totals. Recent psychological findings on the limitations of working memory reveal why this strategy is inefficient, and renders Isotype ineffective for displaying data greater than the number seven plus or minus two – the famous finding of George A. Miller on the limitations of human working memory. The effectiveness of the Isotype method is therefore higher and its disadvantages less noticeable when small quantities are involved, and when other refinements can be added to the charts to aid the viewer. This paper notes that Isotype charts are subject not only to the limitation of working memory but also to the inherent ambiguity of words and images. Being culturally constituted, both words and images elude universality and are always in need of disambiguation. It suggests that Neurath was unaware of how deeply his pictograms are culturally constituted – not universal. The paper shows how these mental and cultural limitations can be mitigated or even eliminated by the use of means that are less ambiguous because more widely dispersed globally in almost every modern culture – namely by written arabic numerals showing absolute quantities and fractions. In many cases, written numbers are the best pictures. In today's world, they are pictures that are transcultural and psychologically immediate. By viewers throughout the world, they are so familiar that they require little mental processing time or effort. A picture is worth a thousand words. The picture of a number is worth almost any number of Isotype pictures.

Keywords

Isotype, Neurath, chunk, working memory, counting, arabic numerals, design history, information design, data visualization

1. Psychology

Chunking and the bottleneck of working memory

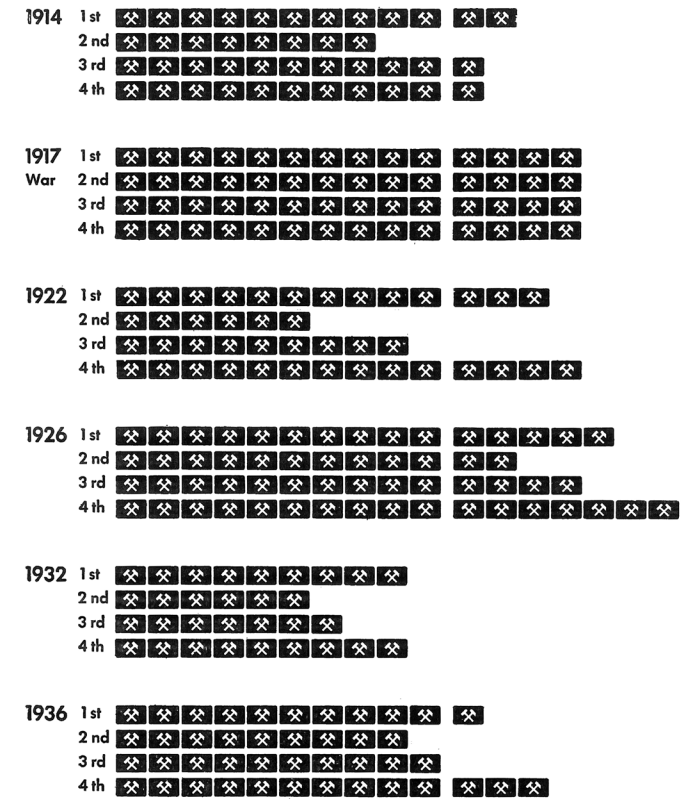
While the Isotype¹ system developed by Otto Neurath (1882–1945) and Marie (Reidemeister) Neurath (1898–1986) was highly innovative, its authors could not have anticipated the adverse effects on working memory by the breaking up of the solid bar – found in traditional bar charts – into repeated smaller parts. For these small parts go squarely against a basic coping mechanism the brain employs when dealing with large numbers of things. But it would be decades before this conflict could be tested empirically. That mechanism, one of the seminal findings of modern psychology, was termed “chunking” by its discoverer, a young Harvard professor named George Miller. His 1956 paper, titled “The magical number seven, plus or minus two: Some limits on our capacity for processing information” began with the memorable sentence: “My problem is that I have been persecuted by an integer (Miller, 1956).” Miller explained that although one can never keep more than about seven chunks of information in immediate memory, if one can chunk the items, then one is able to handle them more efficiently. For example, social security, telephone, and credit card numbers are chunked into groups to aid memorization. Thus the number 185–96–3217 has nine digits but only three chunks, making it much easier to handle and recall than 1-8-5-9-6-3-2-1-7. Many pictograms in a row, discrete items such as “iiiiiiiiii”, inadvertently un-chunk what could be represented by a single chunk, an item such as “_____” (Trogu, 2015a).

Isotype does sometimes chunk long strings of pictorial symbols into groups of five or ten elements – as shown in several charts from *Modern Man in the Making* (Neurath (1939), 79, 87). Yet it’s still difficult to read these charts because of the sheer number of total elements, which, according to Isotype’s model, could be handled by simply *counting* them. For example, a chart of coal production in the United States from 1914 to 1936 shows the symbols grouped in sets of ten; it helps, but there is still a lot of counting and multiplying left to do (figure 1).

Figure 1.

This chart of coal production in the US from 1914 to 1936 shows that seasonal fluctuations are a typical feature of the economy, only to disappear during what Neurath named a *war economy* (Neurath, P. (1973), 39, 81). In 1917 during World War I, “fluctuation was reduced to a minimum (Neurath (1939), 86).” But, except for that year, reading this chart still requires a lot of counting. Original chart from page 87 of *Modern Man in the Making*, 1939.

In War Seasonal Fluctuations Disappear Quarterly Coal-Production in the United States



Each symbol represents 10 million short tons of coal, produced quarterly



As in all typical Isotype charts, a scale or key indicates the value of each item; in this case “Each symbol represents 10 million short tons of coal, produced quarterly.” Thus, the viewer is required to count the pictograms and multiply them by the scale to get the totals.

It will be shown that if simple numerical labels were added to the horizontal axis in the chart, this process of counting would be much easier, maybe even unnecessary.

Geometric shapes or pictorial symbols?

Bar charts are often used to visualize data like population, money, and goods. Although height (or length) is the immediately perceived difference

¹ The word Isotype, usually set in all-caps, comes from “...the initials of I-nternational S-system O-f-TY-pographic P-icture E-ducation”; the word is based on Greek roots and may be translated ‘always using the same types’ (Neurath (2010), 102). “The acronym was suggested to Neurath by Marie Reidemeister in 1937 in The Hague, Netherlands, to describe the “picture-text style” they would use in his 1939 book *Modern Man in the Making* (Neurath, M. (1973), 63–64).

among the bars, a bar chart is actually an area graph like the pie chart² or the more granular tree-map (Shneiderman, 1992). To obtain the size and proportions of each area, the original data are “factorized”, so for example the quantity 125 can be depicted as a bar measuring 5 units at the base and 25 units tall, while the quantity 75 would be a bar 5 units wide but only 15 units tall (*figure 2A*). Dividing everything by 5 yields the proportional units of 5 and 3. Shown sideways, each new unit now stands for 25 of the original units; a 5 x 5 unit is now 1 x 1 (*figure 2B*). Since what matters is overall length, we can safely eliminate the divisions (*figure 2C*).

Figure 2.

In these three bar charts, the two bars all depict the relative quantities of 5 and 3 units.

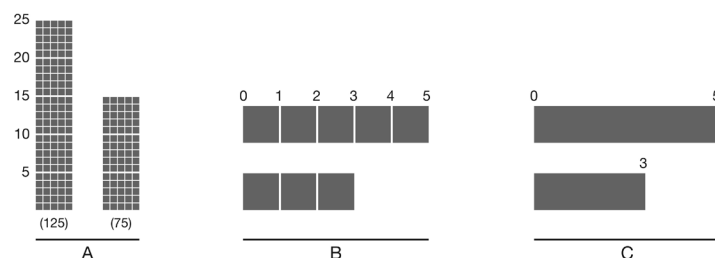
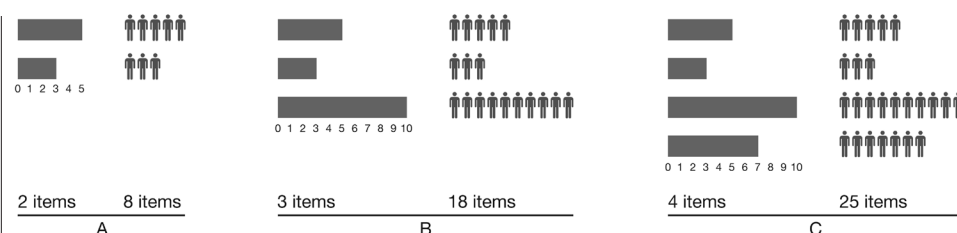


Figure 3.

In this comparison, the examples A, B, and C show the traditional bar chart (solid) on the left and the typical Isotype chart (pictograms) on the right. The continuous nature of the solid bars also allows for more precise data representation, while with pictograms “rounding off” is often necessary.

Now, if we substitute a pictogram for each unit we get the typical Isotype chart. In figure 3, to make the comparison easier, the solid bars have been shortened to match the length of the pictogram bars, but the relative lengths 5 and 3 are unchanged. Now compare the two solid bars with the rows of pictograms: we are comparing two items versus eight items (*figure 3A*). Eight items are still manageable, being within Miller’s seven-plus-or-minus-two span of human working memory, but if we add another row of 10 units, the new comparison becomes three items versus eighteen (*figure 3B*); adding a fourth row of 7 units pushes the comparison to four versus twenty-five (*figure 3C*); and so forth.



Subvocalization and labeling

The current view on working memory is that a limited span of time, lasting less than a handful of seconds, rather than the number of items, is the true measure of this strict bottleneck of the mind. Building on Miller’s findings, in 1974 Baddeley and Hitch proposed their multi-component model of

working memory, which remains the standard reference on the subject in cognitive psychology today (Baddeley & Hitch, 1974). One of its components is the articulatory or *phonological loop*, which provides temporary verbal storage, even in the case of visually presented materials. Baddeley found that we unconsciously name objects as they are presented to us, in a process called “subvocalization”, which is a kind of inner speech (Baddeley (2014), 49–66). Since the 1970s, it has been known that we subvocalize when viewing pictures (Noizet & Pynte, 1976).

Subvocalization helps the phonological loop with the temporary storage of verbal information, but the total span of this temporary storage, just a handful of seconds, cannot be directly modified. Thus subvocalization will be insufficient if the mental math required to read an Isotype chart exceeds this total span of time. In that case, to help the viewer move forward quickly, the designer should provide additional aids such as numerical labels, and also find a way to modify or organize the chart into more manageable visual chunks.

Typical Isotype charts could be improved by the simple insertion of a horizontal ruler with number labels, which would eliminate the work required to mentally add the pictograms and multiply them by the given scale. Why not read off a few labels instead of performing such cumbersome arithmetic? For the same reason that one stops counting with one’s fingers as soon as one learns the multiplication table by heart. Reading off labels takes little effort; it’s like automatically recalling number facts from one’s long-term memory storage. One does not perform mental math when recalling simple number facts like $2 + 2 = 4$.

Figure 4 is an adaptation of an early Isotype chart showing marriages in Germany in 1911–1926. This modified chart shows that inserting a horizontal axis with plain numerical labels provides fast and precise identification of the length of each row of pictograms, without the need to count and multiply the symbols. While the pictorial character is preserved, the statistical data are now precisely given and quickly grasped. The scale or key may be kept in Isotype charts, but if the numerical labels are missing, adding them will be a big improvement.

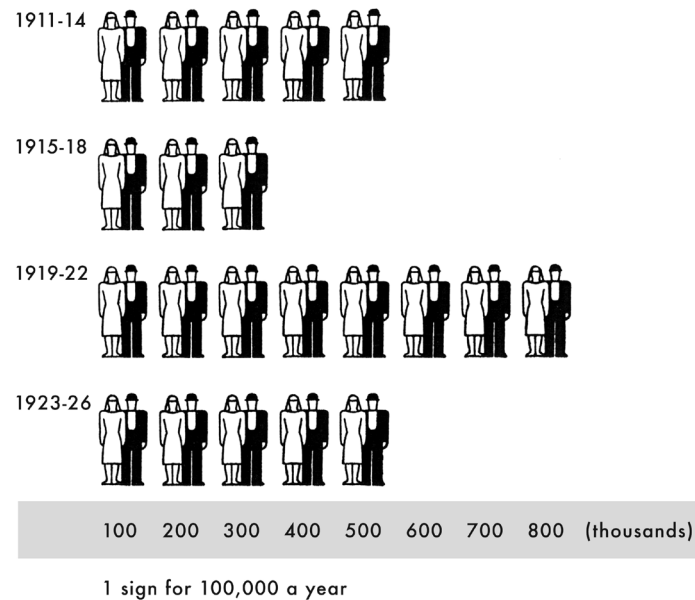
Labels on the horizontal axis add local detail to the overall display. While the notation “1 sign for 100,000 a year” gives the scale, the labels make the chart more complete. Labels have been a basic feature of data visualizations since William Playfair published the first bar chart in 1786, showing Scotland’s imports and exports for the year 1781 (Playfair, 1786).

As noted by Christopher Burke, Neurath was probably aware of Playfair’s work (Burke, Kindel & Walker (2013), 10–12), even though Neurath does not mention Playfair in his “visual autobiography” (Neurath, 2010). But Playfair’s original labels were soon omitted in Isotype charts: in a thorough analysis of successive versions – from 1925 to 1929 – of an Isotype chart on births and deaths, Kinross documents the progressive simplification of

Figure 4.

Men Getting Married in Germany in a Year

Author's adaptation of an Isotype chart of "Men Getting Married in Germany in a Year". The shaded area with the numerical labels on the x-axis has been added to the original, which included only the key: "1 sign for 100,000 a year." The lack of numerical labels on the quantitative axis, opting instead for a general key or scale, is a consistent feature of Isotype charts. The chart is Picture 27 in *International Picture Language* (Neurath (1936), 77).



the visual elements and the shifting of the verbal elements (the labels) to the "periphery" (Neurath, M. & Kinross (2009), 81–84). In the first version of that chart, each pictogram bar is labeled with an exact number, while the last version features only a typical Isotype scale: "one baby = 1 million." But the scale forces the viewer to perform mental math – an unnecessary task if labels are provided. The psychologist Daniel Willingham points out that in general, our brain prefers not to think at all, especially about something to which we already know the answer, like that $2 + 2 = 4$ (Willingham, 2009). Whenever possible, the brain skips thinking in favor of automatic behavior and recall: walking, driving a car, or adding two and two.

Closure

Breaking up the traditional solid bar into many smaller items is the opposite of chunking, and as Miller pointed out when more than 6–7 items are involved, our capacity for processing them diminishes quickly. Counting is time-consuming, and in real life we crave fast closure and are bound by working memory to "act fast", chunk, and move quickly to the next chunk. Only then we are able to keep up with the reading of a graphic, the reading of a text, or a conversation in progress.

While counting is possible, it's hard to keep lots of items in temporary memory storage, while also trying to understand the overall graphic. But since the overall comprehension depends on the prior successful "closure" of the smaller parts, these in turn must be grasped quickly or one's attention will shift to something else.

It's telling that this whole-and-parts conundrum applies not just to the visual, but to the verbal as well. In language, one also has to achieve

semantic closure all the time – quickly disambiguating between the many possible meanings of a word or phrase – and understand each "clause" at every stage of a sentence. And yet the overall meaning of the clause or the sentence might not be clear until the very end, when the whole comes into focus (Cassirer (1953), 304–305). Because individual words only become meaningful when closure occurs, it's the clause, rather than single words, that should be considered the "primary perceptual unit of all languages (Hirsch (1977), 108–109)." Because it saves time, chunking the elements in a chart is a good strategy to quickly achieve closure. Thus, whether one is looking at a graph, reading a text, or listening to speech, closure always has to occur quickly. Allowing more time would seem reasonable but, alas, the opposite is true: even a perfectly formed sentence, if spoken with extremely long pauses between words, will be difficult to follow and to understand. In such a scenario, chunking and closure become impossible within the few seconds allowed by working memory: by the time the next word is spoken, the previous word will have been forgotten.

Broad overview and detailed reading

Although the familiar look of pictograms greatly contributed to the success of Isotype graphics in exhibits, books, and films, the repeated symbols often feel monotonous and endless. A recent study by Benus and Jansen analyzes the efforts by Peter Alma – an associate of Neurath in Vienna who later worked in Holland – to provide visual variety and avoid monotony in Isotype charts (Benus & Jansen, 2016). Interestingly, Alma's variations on typical pictograms, people for example, add the benefit of a more compact, almost abstract, overall shape. This approximation, to brick-like elements that almost blend together, helps to make the shapes of the pictorial bars more easily comparable.

Sometimes the bricks composing the shapes can also reveal fine details even as one is reading the broader story. John Tukey challenged the principle "...that nothing should be given both graphically and in tabular form" and showed with his *semi-graphic displays* that properly arranged digits could be pictorial and tabular at the same time (Tukey, 1972). Today, using multiple small marks to fill traditional solid bars can yield a densely packed, "dappled" bar made up of little squares that look like a solid surface. The chart of US congressional votes shown in figure 5 illustrates how grouping small elements into simple geometric shapes exploit several positive psychological principles, including the gestalt principle of closure.³ Wolf-

3 In particular, see the gestalt principles of proximity (the spacing of the elements); similarity (the likeness of the elements); and closure (the meaningful whole), by which a field that is not continuous can appear solid because of a "...symmetrical brightness distribution [...] in which the 'homogeneity' consists in a uniform dappled effect (Wertheimer (1938), 74–75, 83–88)." However, the symmetrical brightness distribution is broken "...each time our eyes are confronted with a sufficiently sharp break in luminosity, [and] we tend to see the edge or boundary of a surface (Krampen, 1965)."

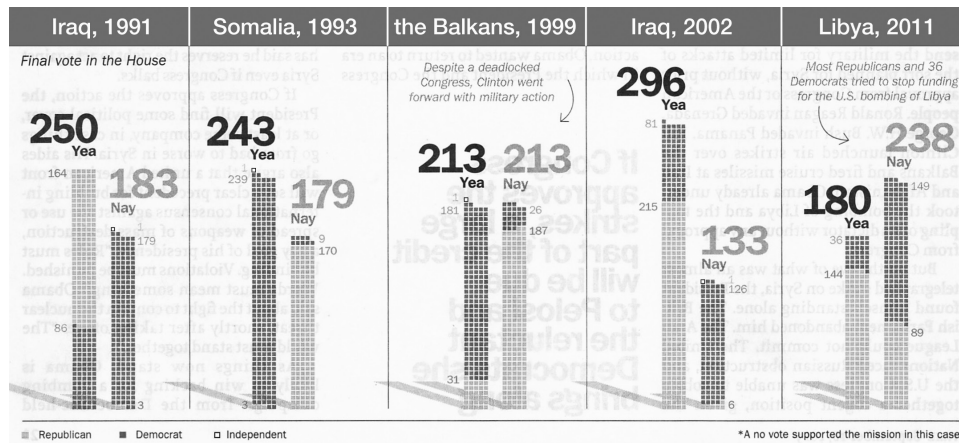


Figure 5.

"How congress voted on past military strikes" (detail). The five bar charts depict US congressional votes on striking foreign countries (Scherer & Altman (2013), 16). Original colors have been changed to: light gray dot = Republican (was red); dark gray dot = Democrat (was blue); outline dot = Independent (was green). Time magazine author's collection.

gang Köhler notes that "If the circumstances of a visual perception permit such a closure, the presented object is said to be a 'sinnvolle' [meaningful and suitable] figure, organization, design, etc. (Köhler (1938), 393)." In the stacked-bar variant of figure 5, the little squares are very effective, each original red or blue square precisely showing a vote by a Republican or Democratic member of the United States Congress (Scherer & Altman, 2013). Here both the overall shape – the coarse overview – as well as the details are easily readable (Tukey, 1972).

A similar approach was actually used in an early bar chart designed by Neurath's team at the Museum for Society and Economy in Vienna around 1925 (Neurath, 1927). In it, stacked bars are formed by rows of dots representing housing units (1 dot = 100 units) built by the city between 1919 and 1925. Although the bars were drawn to resemble buildings, and the little dots to resemble windows, the overall effect is abstract and geometric if compared to later Isotype charts. The chart includes a numerical table with the data used for the visualization, but in later charts this device was also abandoned.⁴

Within the Isotype system, with few exceptions, abstract shapes were soon replaced by recognizable pictures. Compared to abstract shapes, pictograms appealed to Neurath because of their potential to be understood in any language. So he adhered to this strict notion, but at the perils, unknown for him at the time, of fragmenting the data representation beyond the processing capacity of the human brain, whose working memory cannot be modified or improved directly. Although brilliant, Neurath's Isotype system is not always optimal. When used with discretion, for example when small quantities are involved, it need not crowd out working memory, and it may work well. If Neurath, who was highly alert to the trends of philosophy and psychology, had lived in the era of cognitive psychology, he would have surely accommodated his ideas to it.

2. Culture

The legacy of Isotype

Through Isotype,⁵ Otto and Marie Neurath attempted to create graphics that would be universally accessible and would educate citizens about the society they lived in. Their energetic, international attempt to foster social change through design ranks as a great and noble effort that has had lasting historical significance.

Otto Neurath was a polymath well known to philosophers as one of the founders of the Vienna Circle and its theory of logical empiricism (Neurath, 1973). But few philosophers know that his ideas about the graphical presentation of statistics, as applied in Isotype charts, are still very popular today. Interest in Neurath's work has continued in recent years with the publication of articles and books. Most notably, the volume *Isotype: Design and contexts 1925–1971* offers a broad overview covering biographical, historical, and cinematic topics (Burke, Kindel & Walker, 2013).

Though a fitting memorial to the vision of Otto and Marie Neurath, *Isotype: Design and contexts* leaves unanswered the question of whether the Isotype method was always the optimal solution to problems of statistical data display, especially if compared with other methods. Per Mollerup, in reviewing the book for *Visible Language*, laments this gap: "Isotype should itself be compared with competing data visualizing formats. How can we evaluate the virtues of airships without comparing airships with other airborne vessels (Mollerup (2014), 121)?"

The charts derived from Isotype endure and surround us with their aligned, repeated symbols. The method, like a great typeface such as Helvetica or Times, affects us whether we know it or not. But as with typeface variants, not all progeny of Isotype are as good as the original, especially in light of psychological findings that have come after Neurath's time.

Ambiguity in words and pictures

"Words make division, pictures make connection." These words, originally printed in all-caps in *International Picture Language*, are not as familiar as "a picture is worth a thousand words", but they can be just as dogmatic if not read in the proper context (Neurath (1936), 18). Although later in the text Neurath admits to the limitations of using pictures, the all-caps emphasis in

4 The reader will find this housing chart reprinted on page 28 of *Isotype: Design and contexts 1925–1971* (Burke, Kindel & Walker, 2013); also page 113 in reprint of original 1927 article (Neurath (1991), 99–117).

5 This article focuses on some limitations of Isotype when used as a statistical tool, mainly its variations of the traditional bar chart. Many other, very successful uses of Isotype, especially in museum exhibits, children's books and educational films, are well documented in *Isotype: Design and contexts 1925–1971* (Burke, Kindel & Walker, 2013). See also *Gesammelte bildpädagogische Schriften* (Collected writings on teaching by means of images). This 675-page volume also includes extensive photographic documentation (Neurath, 1991).

the original suggests a superiority and preference for pictures over words.⁶ Such emphasis assigns pictures a trans-cultural immediacy that words presumably do not possess. We now know that this is a grave oversimplification.

It's understandable why Neurath's optimism and his idea of a unified science would, until the end, be consistent with a belief in the universal value of a "visual education" (Neurath, 1945). This type of education would bring together people of different socio-economic backgrounds by means also of a common visual language. In the foreword to *Modern Man in the Making*, Neurath warns that "The reader may not understand the contents by reading the text only; he must 'read' the pictures as carefully as the text. An international picture language is combined with a word language (Neurath, 1939)." Neurath's emphasis on "reading the pictures" is another example of his faith in the power of images.

But in many, if not most instances, pictures and pictograms are just as conventional as words and may imply similar ambiguities. Not only words, but pictures as well, need a sense of culture behind them, a sense of convention, and intention, that helps to disambiguate them. For example, the three pictograms in figure 6 all come from the map symbol set of the U.S. National Park System. But before you read the caption or the next paragraph, try to guess what the left and middle symbols represent. Both represent the same thing: the first is an old discontinued version; the second is the one currently used (National Park System, 2018).

After having guessed wrong, one might be forgiven for thinking that they have something to do with the internet, especially the first one, and especially seeing them next to the third, similar symbol on the right. The third is the now familiar Wi-Fi symbol, indicating the presence of a wireless connection to the internet, but the first two actually stand for "amphitheater." The old symbol on the left is probably a better representation of amphitheater than the current one in the middle. However, one can understand the need to update the old symbol to avoid the similarity and possible confusion with the more recent symbol for Wi-Fi. Luckily, while the current symbol for amphitheater could use another facelift, words can be used to disambiguate its vague appearance. Thus, whenever that symbol is used on a map, the same symbol will be repeated in the legend, accompanied by its corresponding written word: "amphitheater."

Figure 6.

Various map symbols used by the U.S. National Park System. Left: old, discontinued symbol for "amphitheater", as reproduced in Rudolf Modley's *Handbook of Pictorial Symbols* (Modley (1976), 89). Middle: current symbol for "amphitheater." Right: current symbol for "Wi-Fi" or wireless internet hot spot. Current set updated as of May 11, 2018 (National Park System, 2018).



This example shows that pictures, and pictograms, are not as universal as we might think. Neurath himself was well aware of the limita-

tions of Isotype as a language.⁷ He wrote about it in his visual autobiography (Neurath (2010), 104):

There are many reasons why Isotype cannot be developed as a "complete language" without destroying its force and simplicity. Our daily language, even in primitive societies, is to some extent richer than our Isotype representations can be, and one needs words added to the pictures. Whereas the pictures may remain identical in different countries, the explanations may be spoken or written in different languages.

Just as words are often needed to disambiguate a particular image or pictogram, so additional words and sometimes images are needed to disambiguate a particular word or phrase. Universality would be a great thing, but images in themselves are no more or less universal than words are. Both always need context, and often they need each other to be correctly understood.

According to the most accurate models of human working memory, words and pictures are not separate in the human mind; they are complementary. For designers, who typically are trained in the visual tradition, the question: "How do I make data accessible, communicative, and engaging?" often involves some kind of translation from verbal or numerical content into some kind of visual representation with that semantic content. In information design, that visual translation often involves the use of pictorial symbols arranged in rows that recall a similar, familiar arrangement of bars in a traditional bar chart.

Pictograms and dots

In 2011, when I started teaching a new data visualization class at San Francisco State University, I decided to focus on good graph construction: pie, bar, line, scatterplot, etc. While a pie chart might seem quaint, such basic designs should not be hastily dismissed. Thus it seemed odd that when simple pie or bar charts would suffice, students would instead produce elaborate charts with repeated human figures, squares, or dots. Something was off and I made up the rule: "Do not use little dots for numbers." Urging them to reconsider such practice, I spelled out the rule in a small handbook (Trog (2012), 9):

Do not use little dots for percentages. Do not visualize quantities by the endless repetition of single units like little dots or little squares. We don't use pebbles to count anymore, and we have invented a tool called "place value." It's better to write out the number or to visualize it using a single solid area, not many tiny areas in little rows. Do not use little people as units to show quantities, even if the quantities represent people. Think of those poor little guys whose limbs get mutilated when you have to represent a fraction: arms, legs, even heads get cut off without mercy!

6 Despite his preference for pictures, Neurath was well aware of the limitations of the Isotype visual language, stating, after the all-caps salvo, that "The Isotype picture language is not a sign-for-sign parallel of a word language (Neurath (1936), 18)."

7 For a discussion on the use of the word language in the context of Isotype, see "The Graphic Formation of Isotype, 1925–40," in *Isotype: Design and contexts 1925–1971* (Burke, Kindel & Walker (2013), 107–77); in particular note 1 on page 107. See also: "The Linguistic Status of Isotype" (Burke, 2011).

But how sound is this advice? Why would population or currency data be better represented by single, contiguous surface areas, rather than by series of smaller, separate areas?

Although Isotype charts are typically used in lieu of more traditional pie charts and bar charts, all are based, as we saw earlier, on size or surface area difference. In a pie, this difference is the angle of each slice, while in a bar chart this difference is the height of each equal-width bar. “Size” is one of Bertin’s seven “retinal variables”, which include an object’s position on the plane: the underlying variable. Bertin’s own caption for the diagram illustrating the size variable captures these differences and includes the Isotype repetition variant: “– categories of SIZE: height of a column, area of a sign, number of equal signs (Bertin (2011), 60).”

“Number of equal signs” is key in Isotype, which prescribes using a larger number of the same symbol to represent a larger quantity. But usually what counts is the overall size, the total area covered by the smaller symbols arranged side by side. Neurath warned against the use of abstract geometric shapes: “...the square and the circle will have no place in the Isotype system (Neurath (1936), 92).” He reasoned, correctly, that unlike length differences, area differences would be harder to differentiate. In a 1974 article, Marie Neurath describes this difference (Neurath, M., 1974):

Otto Neurath found that the methods in use to represent statistics were of very different merit; some were all right, for example bars: the eye can compare lengths. But it is impossible to see whether a circle is twice the size of another circle, whatever care the draftsman has taken to be correct.

Neurath recognized that bars were an acceptable method to represent statistics – better than squares or circles – and included them, in somewhat veiled form, in a summary chart made for *International Picture Language* (figure7).

Equal areas of various geometric shapes are compared in this chart, with the goal to show that squares are inferior to sectioned circles; that both squares and circles are inferior to rectangles (another version of bars); and that all the above are inferior to groups of Isotype signs. This visual presentation is enhanced, with logical precision, by the captions explaining the uncertainty that the eye has already sensed. The last step, from rectangles to pictograms, adds the gender variable and reflects Neurath’s belief that familiar pictorial shapes would represent and communicate statistical facts much better than abstract geometric shapes. And he had a point: anyone being asked will agree that the simplified shape of a human figure – especially if the data are about people – is more communicative than a generic rectangle; or not? The answer depends on the aim of the “communication” in the statistical chart.

Since Isotype signs represent not only the quantity (number of symbols) but also the specific quality of who or what the symbols represent,

Figure 7.

A summary chart of various equal area comparisons by means of different geometric shapes and pictorial symbols. Designed by Neurath and included as Picture 35 in *International Picture Language* (Neurath (1936), 96–97). As in original, captions for each method and their relative merits are given on the side of the chart. The colors in the figure have been adapted: gray was red in original; black is unchanged.

Squares

One is only able to say:
2 is greater than 1.
B is greater than A.

Circles

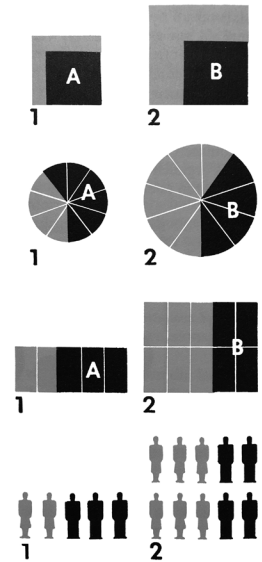
One is only able to say:
2 is greater than 1.
A is 6/10 of 1.
B is 4/10 of 2.

Four-sided forms put together from units

One is now able to say:
2 is twice as great as 1.
A is 3/5 of 1.
B is 2/5 of 2.
A is 3/4 of B.

Groups of signs

One is able to say:
Group 2 is twice as great as group 1.
In group 1 men are 3/5, women are 2/5.
In group 2 men are 2/5, women are 3/5.
Number of men in 1 is 3/4 of number of men in 2.
Number of women in 1 is 1/3 of number of women in 2.



two birds are killed with one stone: (1) Data are visualized by the quantity of symbols and: (2) Data are made “concrete” and thus accessible to the layperson, who can recognize in the symbols a race, gender, profession, crop, or industrial good.

The next section describes how the noble aim of making the subject matter, the “what”, more accessible by pictorial means, inadvertently resulted in making the data, the “how many”, more difficult to grasp and absorb by visual means alone. As mentioned, the strategy proposed by Isotype, “counting”, has proved to be inadequate.

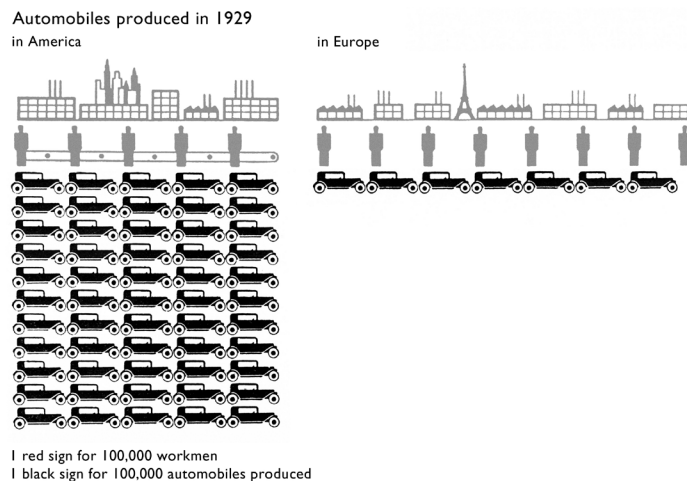
Counting

In the Isotype chart shown in figure 8, also published in *International Picture Language*, a block of automobiles on the left (production in the US in 1929, one car = 100 thousand) is compared to production in Europe on the right (Neurath (1936), 93). But how much larger is the amount represented on the left (US) compared with the amount represented on the right (Europe)? The obvious answer is of course: “A lot!” – but a more precise answer will take longer than expected.

Does knowing the precise answer really matter? After all, Neurath clearly stated that “Very often it is preferable to remember rough pictures than to forget exact data (Neurath (1945), 246).” But let’s try anyway: The group at left looks roughly ten times as large as the line at right. But can one check this assumption? Per Mollerup summarizes the counting technique: “In picture tables [Mollerup’s definition], the reader must count the pictograms in different groups and multiply with the scaling factor to get the total amounts (Mollerup (2014), 111).” Counting is the official technique offered by the creators of Isotype. When Marie Neurath described another

Figure 8.

Isotype chart showing car production in US and Europe in 1929. Picture 33 from *International Picture Language* (Neurath (1936), 93). The colors have been adapted: the buildings and the workmen, shown in gray, were red in original; the black cars are unchanged.



Isotype chart showing world population, she explicitly mentioned that counting provided a quick way to grasp the proportions of the various ethnic groups: "...how many they represent is stated alongside: [one figure =] 100 million. So each person can count how large the individual groups are, and do it faster than if they had a numerical table in front of them (Neurath (Reidemeister), M., 1928)."

While it's true that the relative proportions are grasped faster than if looking at a numerical table, the actual data – the magnitudes of the groups – are not grasped as quickly without some numerical notation. Counting is not very challenging per se, however, the span of time required to perform such counting is usually above the limits of our working memory.

In *Through the looking-glass* Lewis Carroll sets up Alice with this simple arithmetic problem: "Can you do Addition? the White Queen asked. "What's one and one and one and one and one and one and one and one and one and one?" "I don't know, said Alice. "I lost count." (Carroll (1872), 189). Try to solve the problem yourself. The answer would be easy if the question had been "What is five and five?", but then the tension in the text would disappear and with that the fun of the reader. But imagine yourself in Alice's place, with a similar, long line of identical widgets before you; imagine many such long lines of different lengths. In real life, if designers adhere strictly to the Isotype method, their visualizations all too often yield such serial presentations, with the result that the viewer is soon at a loss, much like Alice in front of the Queen. Thus, a concerned designer will not present the reader with "1+1+1+1+1+1+1+1+1+1" but will offer instead "5+5": one, at most two chunks, instead of ten units.

In Marie Neurath's example, *counting* sounds easy, but unless one gets out pencil and paper, it's a task that requires mental math: 100 million (in the world population chart described earlier) times the number of pictorial symbols presented. The visual comparison is indeed faster, but each total needs to be reckoned first.

So, let's count the signs shown in figure 8, where the scale reads: "1 black sign for 100,000 automobiles produced."

At left, 5 signs times 11 rows = 55 signs; 100,000 units times 55 = 5,500,000 automobile production in America in 1929. At right, 7 signs times 100,000 = 700,000 automobile production in Europe in 1929. Thus, in 1929 US automobile production was about eight times that of Europe. Most people, comparing two visual quantities side by side, will settle for an approximate rather than exact ratio between the two. And the aim of many data visualizations is just that, to give a general idea by a quick visual comparison which might be rounded off here and there if necessary. But psychologically, it's much easier to accept this approximation when we are physically prevented from checking the data by counting the visual units in the visualization. With many discrete units, we feel the need to "check" if all the units add up to our general estimation. Let's say you get a hundred dollars in a stack of one-dollar bills; do you trust, without counting, that such stack includes exactly one hundred notes? On the other hand, if five ten-dollar bills are placed side by side on a table before you, you can almost instantly see *fifty* dollars, without needing to count the bills. Why should this be the case?

A recent study by Haroz et al tested the memorability of Isotype charts versus traditional bar charts and it found Isotype charts to perform better (Haroz et al, 2015). But this may be true in a limited sense, as the study used test materials that displayed a 1:1 relationship between each unit in the data and each symbol representing that unit. In other words, one picture displayed in the chart – one parrot for example – represented exactly one parrot in the original data set; not ten or a hundred. This may be the biggest flaw of the study since Isotype charts typically assign a high value to each symbol: 1,000 or perhaps 100,000. Occasionally, Neurath's Isotype charts did display this 1:1 relationship, as in a chart of birth rates for married women in Paris and Vienna around 1900 (*figure 9*). Here, each newborn baby depicted in the chart directly represents a single newborn in real life, thus eliminating the need for a scale (Neurath (1939), 127). This chart can be read faster because of the direct correspondence between the quantity of symbols and the quantity in the data. Even if counting is involved, multiplication is not needed. Grouping the symbols in sets of ten is also quite helpful here.

Haroz et al also acknowledge another possible bias in their study: when the total number of items presented is small, such as five or less, the eye is able to quickly see the quantities without the need to count the individual items. In this process, termed *subitizing*, subjects are able to immediately and accurately identify the number of items if that number is 5–6 or less.⁸ In displays of more than six items, subjects' accuracy quickly degrades and the process is then termed *estimating* (Kaufman et al, 1949). This apparent threshold received renewed attention in Miller's magical number

8

"Subitizing is the rapid, accurate, and confident judgment of numbers performed for small numbers of items. The term [...] is derived from the Latin adjective *subitus* (meaning "sudden") and captures a feeling of immediately knowing how many items lie within the visual scene. . . . (Wikipedia, 2018):"

Figure 9.

This chart of birth rates in Paris and Vienna around 1900, included on page 128 of *Modern Man in the Making*, shows much higher birth rates for the lower classes, with Neurath pointing out in the accompanying text that "birth-control [had already] started in the higher social classes (Neurath (1939), 127)."

Births per 100 Married Women, between 15 and 50 Years of Age about 1900



seven article of 1956. It's no surprise that the earlier imaginary recipient of a hundred dollars was bound at first to *estimate* their loot, while the runner-up could *subitize*, and instantly see their fifty-dollar total.

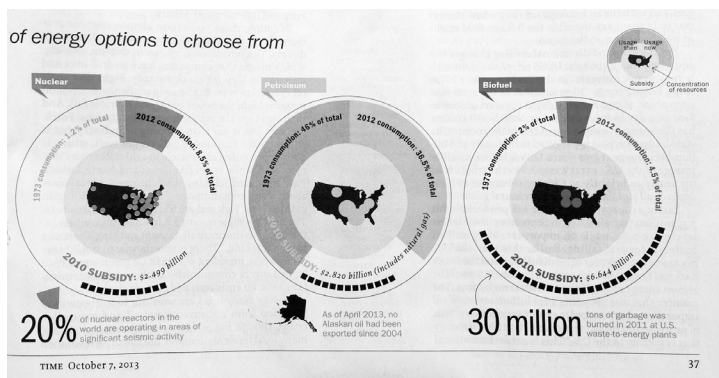
Thus, it appears to be the case that Isotype charts work best when the number of elements in the visualization is rather small and falls within the lower range of Miller's original limit: seven items; but five or fewer will even be better.

Pictures and dots or written numbers as pictures?

Today's infographics often use small, repeated geometric shapes derived from the repeated pictogram motif, but when the number of items passes seven or thereabouts, often confusion ensues, sometimes made worse by the arbitrary value assigned to each shape. To explain this confusion, let's take a look at an infographic titled "Power revolution", about energy consumption, from Time magazine (Walsch, 2013). The graphic on the right in figure 10 shows that in the US in 2010, the government subsidy for biofuel was about \$6.6 billion, which is visualized with 29 small, repeated squares aligned along the larger outer circle. Using a calculator reveals that each small square corresponds roughly to \$230 million. What kind of scale is that?

Figure 10.

"Power revolution" infographic, detail. The misleading large label "30 million" refers, despite the arrow, to the tons of garbage burned, mentioned next to it, and not to the \$6.6 billion biofuel subsidy visualized by the row of small squares. The confusion is compounded by mixing the consumption data with the subsidy data as if they were slices of the same pie. Original appeared in Time magazine on October 7, 2013 (Walsch (2013), 36–37). Author's collection.



While Neurath and his Isotype associates would be too skilled to design such a confusing graphic today, such representations are typical of current data visualizations. Magazines like Time continue to offer this type of

representation derived from Isotype, while discerning newspapers like the *New York Times* very rarely do so anymore. While the Neuraths should not be blamed for these distortions, the general historical source cannot, for better or for worse be denied.

Today, data visualization software offers the design student multiple data construction tools, but how does one distinguish good infographics from bad infographics such as the one published in Time magazine? For example, which of the two visual representations of quantity shown in figure 11 will be processed faster by the viewer?

Figure 11.

Which symbol better represents "two thirds"? A numerical fraction or a series of dots? (Trogu, 2015b). Author's illustration.

2/3

or



Are the three marks in the numerical notation "2/3" more universally recognized and understood than the twelve marks in the graphic notation "....."? Which will more quickly trigger in the mind of the viewer the concept of "two thirds"?

It's a mistake to assume that graphic elements, because they are visual, will be processed faster by the viewer. It's possible that sometimes, as Marie Neurath wrote, "...picture script is more rapidly readable than numerals and letters (Neurath (Reidemeister), M., 1928). But the opposite is probably more common. Cultural norm and psychology contradict the idea that pictures are faster to take in than numbers, and arabic numerals especially, have the advantage that their shape remains unchanged from one language to another. Thus in mathematics, the cultural emergence of the decimal system combined with the adoption of arabic numerals is a happy historical circumstance. While it took hundreds of years of convincing, when the use of arabic numerals and place value eventually took hold in Europe at the turn of the 14th century, their advantages became obvious when compared to other systems (Kaplan (2000), 106–115).

In figure 11, the symbol "2/3" will be processed faster because the verbal marks trigger two short words in the mind of the viewer: "two thirds", whether these are spoken or subvocalized. Thus, brevity is one advantage of the chunked "2/3" over the un-chunked ".....".

The other important advantage of such numerical notations is that their linguistic expression has already been established over many centuries.

Culturally, through literacy, number words have acquired very precise and unequivocal meanings. Unlike dots, written numerals are quickly named with their corresponding number words.

Arabic numerals are culturally constituted symbols that are the same in multiple modern cultures – making them more universal in many cases than pictures. Our minds are limited by working memory, and our symbols are inherently ambiguous and need a shared culture to disambiguate. Arabic numerals solve the problem of that double drawback: the time limitation of working memory and the ambiguities of language. Because culturally universal in the modern world, they are the pictures that in many cases are the most immediate, universal, fast and unambiguous.

Arabic numerals have found their way into many other languages and have become part of those other cultures. But, unlike general vocabulary, written numerals are truly international, so that in English one will read “2/3” as “two thirds” while in Italian one will read the same notation as “due terzi.” So, regardless of the written language in which they appear, the mark and the concept remain the same and nothing gets lost in translation.

Test your language when reading the numerals in the window sign shown in figure 12:

Figure 12.

A “sale” sign in a storefront in Chinatown, San Francisco. The sign 最后20天 reads “the last 20 days” (direct translation), so if there’s a sale, it means “20 days left.” The sign 结业 reads “close out” which means “store closing”, as in “out of business.” Translation by Judy Chu. Author’s photo.



Even without speaking Chinese, a tourist walking the streets of Chinatown in San Francisco will immediately recognize the price of many items for sale in the windows. Arabic numerals don’t need a dictionary.

Place value, by making numerical notation standard and generally shorter, is another reason why arabic numerals are often intermingled with Chinese characters: “[Most numbers above 20] up to 99 would require 3

characters [in Chinese] rather than 2 numbers and at 100 [above 110], you’re potentially dealing with 5 characters: 一百三十四 versus 134 (Edwards, 2014).” But the main reason Chinese people use arabic numerals may be that, as my neighborhood dry cleaner lady put it: “Everybody in the world uses them.” – and this simple fact makes them a truly universal language.

Every picture is a word

In a culture saturated with images, are pictures better than words for conveying concepts and visualizing data? Pictures and words are not opposites. If subvocalization is always at work, even in the context of visually presented items, then the aural/verbal “naming” is the first immediate linguistic step in any meaningful perception. An image triggers a word – its corresponding sound or “sound-image” – then the word is associated with the actual meaning of that word, and with any secondary or implicit meanings (Saussure (1959), 66). And as mentioned, words are often needed to disambiguate pictures. “A photograph always better have a caption under it!” was the stern admonition of my favorite art school teacher. While evaluating the “communication potential of pictorial illustrations” of a literacy program in Latin America in the early 1950s, Seth Spaulding made this observation (Spaulding (1956), 44):

Pictures help put meaning into the words used, but the illustrations can not take the place of the words. The words, being abstractions, have skimmed off something common from thousands of concrete experiences and are therefore much more efficient communication units, especially if illustrative material assists the reader to relate the word value to his own experiential background.

Neurath knew that the “pictures vs words and/or numbers” opposition is a rigid oversimplification. For example, he noted that while “...visualization may provide more impressive pictures than a formula [...], on the other hand, one is much more limited by visual representation than by algebraic (Neurath (2010), 95).” This observation gives another hint of Neurath’s effort to bridge the contrasts between his mathematical, his philosophical, and his visual education interests.

3. Conclusion

Memorable pictures; less memorable data

This paper has proposed that had Neurath been able to witness the advances of psycholinguistics and psychology in the decades after World War II, he

surely would have made adjustments to his own prescriptions. Based on his own experience with Isotype, he surely would have reviewed and fixed its shortcomings by whatever means available: "Like sailors are we, who have to rebuild their ship on the open sea, without its ever being able to be laid up in dry dock and be newly rebuilt from the best materials."⁹

In Neurath's original text this quote is preceded by "There is no *tabula rasa*." and followed by "Only metaphysics can disappear without trace (Neurath (1932), 206)." Like his philosophy, Neurath's Isotype project took into account historical precedent as well as changing cultural conditions. In "The Linguistic Status of Isotype", Burke points to separate letters by Neurath to a fellow philosopher, a visual educator, and a psychologist, documenting his interest to conduct psychological studies on Isotype, and publish the results in a book (Burke (2011), 45). Macdonald-Ross notes that "In the early days of the Isotype Institute charts were informally tested on groups of schoolchildren, but these trials were never reported in journals (Macdonald-Ross (1977), 65)." Neurath also describes these studies in his visual autobiography (Neurath, (2010), 114–117). Although these studies were never published, their record likely survives in the Otto and Marie Neurath Isotype Collection at the University of Reading in the UK (Isotype, 2018a).¹⁰

Neurath was first a mathematician and a philosopher, but also a practical person seeking results. If he could see today some of the distortions that his picture language involuntarily spawned, would he jettison or shift some of his ship's ballast to keep it steady? He certainly would, as his repeated questioning of Isotype orthodoxy shows. Burke again documents Neurath's observation that "picture scripts" were not in themselves superior to alphabetic scripts, especially in scientific notation, and his strong scepticism that a "visual language" would be richer and more "dimensional" than a verbal language (Burke (2011), 40–44). Neurath knew that words can encompass far more meanings than is possible with pictures alone.

Internationally, pictograms now live happily alone or coexist with written words. Thus, on an airport sign, a woman and a man might, in fact, be smiling at Neurath and his followers who saw the utility of such symbols in a connected world (AIGA, 1974, 1979). At the same time, perhaps just above their faceless heads, another set of pictograms – an airplane, a suitcase, a car – might be sighing with relief to be wearing their written name tags: *departures, baggage claim, taxi*.

But when similar pictograms get cloned endlessly for visualizations that chase a pictorial, iconographic look, the result is instead a numbing of the senses; the anaesthetic stronger with each additional pictogram.

⁹ Neurath's metaphor of the "ship on the open sea" was made famous by the American philosopher Willard Van Orman Quine, who reprinted the original German quote in the opening of his book *Word and Object* (Quine, 1960).

¹⁰ Various documents and texts from the Isotype Collection can be found on the *Isotype revisited* website: isotyperevisited.org (Isotype, 2018b)

In statistical visualizations, all quantitative representations are abstractions, even when they depict concrete events such as deaths. An abstract scatterplot might show death rates from lung cancer in various countries in 1950 (Tufte (2001), 47). A more pictorial, Isotype-inspired animation might show the 70 million fatalities of World War II (Halloran, 2015). But while these graphs, by themselves, cannot fully render the cruelty of disease and the horror of war, one should still discriminate them based on the knowledge they can transmit and deposit in our long-term memory.

More empirical research is needed to buttress or refute the soundness of Isotype charts. Neurath was a promoter of pluralism and he was against authoritarian thinking. Were he alive today, he would heartily embrace a debate about the longevity and merits of his theory. But are the information designers and historians of data visualization of today open to an alternative view of Neurath's legacy? Designers today cannot accept Isotype's axioms without reservations or questioning, simply because they originated in the teachings of a revered historical figure.

Questions and considerations

This paper has asked and considered the following:

Given the limitations of human working memory, *counting* is not an effective strategy for reading an Isotype chart. Is it not better to include and "read off" numerical labels placed along a quantitative axis instead?

Written words and written numerals such as "2/3" can be more universal than pictures. In particular, arabic numerals are now used even in non-alphabetic writing like Chinese or Japanese. By their fast comprehension in any language, these numerals help to get around the bottleneck of working memory and solve the need to disambiguate. Thus, a picture might be worth a thousand words, but the picture of a number is worth almost any number of Isotype pictures.

Is using a pictorial symbol to represent data, better than using a solid abstract shape? Which wins the tradeoff between accessible, memorable pictorial symbols, and more easily remembered data by means of less memorable shapes?

Isotype charts that depict small quantities can function well due to our capacity to "subitize", to quickly report quantities without counting the items, when the number of items is below seven.

Small repeated symbols can sometimes coalesce into a larger overall pattern by proximity and similar color or shape. Thus, the "dappled" area of a large abstract shape made of small individual items can provide both overview and detail in a single image.

These questions and considerations invite designers and historians to re-evaluate the popular but uneven Isotype system. More studies are needed to test the validity of Isotype charts. But two issues listed above and at the core of this paper take precedence: (1) The graphic construction must mitigate the limitations of human working memory, which unfortunately are not helped by the cumbersome strategy of *counting*, and provide the reader with a more chunkable image than is afforded by the long strings of Isotype pictograms; and (2) The graphic construction must disambiguate by using both verbal and visual elements – by using written words, such as labels and numerical notations, as well as pictures. For designers, taking stock of these two constraints of memory and ambiguity, and taking advantage of established universals like arabic numerals, is a good place to start.

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