Chapter 13
Post-script: Visualising Safety

Teemu Reiman and Jean-Christophe Le Coze

Abstract This concluding chapter on visualisation for, and of, safety, weaves together ideas put forward by the volume's contributors. It analyses how visualisations and their role have changed over time, their co-evolution with key concepts in safety science and impact on cognitive representations built by practitioners, whether success should be assessed by level of adoption or by impacts on safety outcomes. A number of open questions for future research are outlined.

Keywords Visualisation · Usability · Evaluation · Safety science · Communication

13.1 Introduction

The workshop was a success in terms of the quality of the original contributions and the debates ranging from the usability of different types of visualisation to the status of safety science in general. An interrogation on visualisation can trigger fundamental questions about our relationship with the world. It is far from trivial, and investigating visualisation has multiple implications.

In this respect, we included a wide variety of potential questions and topics to explore into the original call for papers reproduced in the introduction of this book. This was done on purpose. The workshop was to be an exploration of a previously under-researched topic. We did not expect an answer to all, or even most, of the questions. We did expect vivid discussions about the topic of visualising, together with some tentative answers to our questions combined with ideas and directions for future research. In this we succeeded. Next, we provide a brief summary of answers received to the questions we posed in the Call.

T. Reiman
Lilikoi, Lohja, Finland
e-mail: teemu.reiman@lilikoi.fi

J.-C. Le Coze (✉)
Ineris, Verneuil-en-Halatte, France
e-mail: jean-christophe.lecoze@ineris.fr

J.-C. Le Coze and T. Reiman (eds.), *Visualising Safety, an Exploration*,
SpringerBriefs in Safety Management, https://doi.org/10.1007/978-3-031-33786-4_13

13.2 Visualisations of the Past, Evolution and Successful Examples

First questions we asked concerned issues such as examples of successful visualisations in safety, the evolution of visualisations over time and ways of classifying the diversity of existing visual artefacts.

Many contributions touched this topic. It became clear that whether a visualisation can be judged to be successful depends on how success is defined. If "successful" refers to effectiveness in terms of contributing to safety, there is little empirical research to make any conclusions although presentation of empirical case studies of a design project by Stoessel and Racuna (Chap. 9) or of daily operations in the construction phase of an underground by Gisquet and Rot (Chap. 11) make it clear how visuals matter in practice (one could also refer to Flach's contribution on ecological design, Chap. 8).

Many contributions showed how visualisations of concepts such as Swiss cheese and the Sharp-End Blunt-End (see especially Chaps. 4 and 5) have been influential among researchers and practitioners. This is the second challenge in answering the question: Some visualisations are accepted and shared among the safety community much more than others, making these "successful" in terms of their spread and utilisation. If we measure success by prevalence of use, posters in general can be considered among the very successful safety visualisations. However, modern safety posters differ from the safety posters of the past. As Swuste et al. (Chap. 2) illustrated in their contribution, the underlying ideas presented in posters have changed during the years. Yet there is little empirical research on whether effectiveness of posters in safety prevention has improved.

The same challenge of defining a successful visualisation exists when we look at some of the widely used models or methods. It has been noted that the usability of the method is more important than scientific concerns ([6], see also Chap. 4) in facilitating its acceptance among the practitioners. Again, how useful the widely accepted methods and models are in accident prevention, when compared to other less widely used methods and models, remains an unanswered question.

Visualisations, especially those that become widely accepted, also change through time. The evolution of visualisations question was addressed by Swuste et al. (Chap. 2), Waterson (Chap. 4) and Haavik (Chap. 5), especially in relation to posters, metaphors and concepts. However, further characterisation of the evolution of visualisation in safety is a potential future research topic. This would include the question of how the underlying representations of safety and accidents contribute to different types of visualisations and how visualisations in turn can have an effect on these representations (a co-evolution of representations).

13.3 Participants' Own Experiences in Visualisation

The second set of questions in the Call concerned practical experience of using visualisations in research and practice. We asked the participants to either reflect on their own research and the role of visualisation in it, or to take a look at how practitioners and/or researchers produce, use and disseminate diverse visualisations in their daily activity. These topics are clear future research areas as none of the contributions directly addressed them. However, there were many indirect implications and ideas in the many of the contributions. The topic was also discussed at length during the workshop, as all participants had practical experience in using visualisations in either research or practice of safety.

Even if personal experience of using visualisations was somewhat lacking in the contributions, some examples based on past studies were presented. For example, some contributions of the workshop showed how researchers have produced and reproduced visualisations, and how this process gradually changed both the visuals and the underlying representations (see also Waterson's work on the development of Accimaps e.g., [7]).

There are many interesting research avenues to pursue in relation to this topic. For example, what can the use of visualisations by practitioners reveal about safety as a practice? Can we learn something about safety practice by studying visualisations that are used by practitioners, and how practitioners use and re-use safety visualisations, whether of their own making or borrowed from safety literature?

13.4 Visualisations and the Science of Safety

The third set of questions in the Call focused on the role of visualising in conceptualising safety as a scientific concept. The questions concerned the contribution of visualisations to the framing of safety as a scientific object and how visualising a concept can change the concept.

These questions were again highlighted in many of the contributions and further discussed during the workshop. When discussing the evolution of visualisations over time (see above), it was noted that the underlying representation may also change. This co-evolution of the concept itself and the visualisation of the concept is an interesting future research topic.

The role of visualisations in the creative process of safety science is interesting. Looking at history (see especially Chaps. 2, 4 and 5), visualisations seem to play a major part in theory development in safety science, and maybe in science in general. However, some interesting questions warrant further attention: How much do visualisations merely communicate what the researcher is trying to convey, and how much do they also help the researcher to conceptualise his/her ideas? Are visualisations used only after the theory or model has been conceptualised, or in parallel? And

how about the influence that the visualisation has on further development of the underlying representation?

James Reason's model of organisational accidents (the so-called Swiss cheese model) is an interesting example in illustrating the role of visualisation in model development, since Reason did not himself use the metaphor of a Swiss cheese. He developed a model together with John Wreathall of defence in depth applied to organisations and accidents, and represented this with slices with holes in his 1990 book Human Error. It is only later that an acquaintance, Rob Lee, came up with the cheese metaphor [4]. This invention by a colleague clearly influenced Reason, since his later visualisations resembled Swiss cheese much more than the earlier ones. In fact, to go one step back in history, Reason's original model was based on the metaphor of a human body and its resident pathogens combining with external factors to bring about disease. Reason was inspired by the human body analogy while using another analogy from the nuclear industry brought by John Wreathall. It is interesting to consider how much the underlying model was changed when the metaphor of Swiss cheese was invented, or when the metaphor was communicated to researchers and practitioners who all adapted the metaphor to their particular context of use. Certainly, the model can be considered among (the most) successful visualisations in safety science, and the strong debates following the validity of the model demonstrate its influence on science and practice of safety. Whether the influence has been bigger than warranted by the merits of the underlying model itself brings us to the final topic of possibilities and limits of visualising.

13.5 Possibilities and Limits of Visualising

The fourth set of questions in the Call asked about the possibilities and the limits of visualisation. The specific questions concerned issues such as the dangers of visualising complex phenomenon such as safety, what kind of opportunities new technology offers, the role of big data, and how videos or movies portray safety. We were also interested in the possible biases created by visualisations as well as how visualisations guide the attention of public and experts.

The contribution by Dixon and Gawley (Chap. 12) provided insight into the question concerning movies. What storylines emphasise and what they leave in the background characterise the situated perspective of the movie director. The pros and cons of a narrative approach to visualisation was also discussed at length during the workshop. This is connected to the issue of "selling" the visualisation to its intended audience. This selling can be done by different means, one of which is dramatisation. Another selling tactic can be simplification of complex phenomena. Further tactics could be humour, or otherwise clear and distinguishing visualisation. One could argue that Swiss cheese was successful also in this regard. We return to this topic in the concluding section of this chapter.

The possibilities and limits of visualising were discussed at length during the entire workshop, with the insight from John Flach's extensive experience with the

design of ecological interfaces which guide their users in operational contexts [1, 2]. It was noted that visualising is always situated in a historical context. Visualisations have been created for a certain purpose in a certain context. Sometimes the purpose has not been clear even for the visualiser, and sometimes the purpose cannot be met (sometimes there are multiple, partly conflicting purposes). All visualisations, no matter when (or how, or why) they have been created, are always interpreted in the context of their current use. Visualisations are thus always (more or less) fit for purpose, and knowing what this purpose was is important for subsequent use of the visualisation.

The visualisation will emphasise some aspects of the phenomenon of interest, while obfuscating other aspects. However, it never dictates how the user eventually perceives the representation underlying the visualisation. Thus, instead of asking how a certain visualisation contributes to safety, we can ask what lines of reasoning different visualisations support. Then our focus is on the possibilities and constraints that a certain visualisation imposes on the user, including what aspects of the visualised phenomenon are emphasised and what aspects are de-emphasised.

The choice of what to leave out in visualisation is as crucial as is the choice of what to include. This can be studied from the perspective of the one doing the visualisation: how visualisations are created, and how conscious is the process of selecting the issues to include or emphasise and issues to leave out or de-emphasise? Are there some typical issues that safety visualisations under-represent?

13.6 The Way Forward and New Questions

Another future research topic could be the dark side of visualisation: misrepresentation, misuse and dramatisation in visualisation. Visualisation offers a way of highlighting issues of interest in a way that captures the attention of the perceiver. This added freedom of imaging also creates possibilities to misrepresent issues differently from text, for example. Misrepresentation can be accidental (e.g., due to lack of safety knowledge) or intentional (e.g., part of an organisational attitude change campaign or propaganda by interest groups). However, one should not underestimate the perceiver and his or her ability to see behind the surface of the visualisation: what have been the motives of the designer of the visualisation. A bad visualisation can in fact reinforce the opposing message.

The above issues bring forth an interesting question: Who is making the visualisations and what do they know (or should know) about safety (managers, designers, human factors experts, communications specialists, movie directors)? Future research could aim at clarifying the limits and possibilities of co-creation between safety experts (whether scientists or practitioners) and other interested parties such as designers, safety managers or communications specialists.

Another potential future research area is the role of trade-offs in visualising. As highlighted many times during the workshop, visualisations always emphasise some aspects to the detriment of other aspects. In addition to the question of what to

visualise, the designer of the visualisation needs to balance between various other tensions; how much to simplify a complex phenomenon without oversimplifying it, how much to highlight (or dramatise) some aspects without distracting other important aspects, how much to explain (e.g., by text) and how much to leave for the perceiver to make sense.

One interesting research topic is the role of text in safety visualisations. During the workshop, it was noted that many of the posters presented by Swuste et al. (Chap. 2) were mostly composed of stylised text, whereas Castan's posters, as shown by Portelli et al. (Chap. 3), had pictures with little or no text. Humans process text differently from images, and this may affect how visualisations with or without text are understood. In many visualisations of safety models, text is typically used to explain signals or signs that can have multiple meanings, e.g., arrows. However, more "simple" or "information poor" visualisations, such as posters, often lack this explanatory imagery, making them more subject to multiple interpretations.

Finally, another topic is the relationship between visualisation and art. Have the heuristic, cognitive and enduring influences of some visualisations discussed in the workshop anything to do with their aesthetic dimensions? Posters, movies but also drawings clearly exhibit artistic features. Drawing is about selecting, ordering and combining shapes, lines, colours and sometimes texts to follow one's imagination when trying to make sense of something.

Painting is the same, whereas directing a movie is about composing with images, movement, lights, landscapes, sound and characters into stories something which is obviously deeply artistic. This connection is therefore another research area. Finally, art is deeply connected with imagination, as is visualising. What is the role of creativity and imagination in safety visualisation?

Many of the issues raised in the chapter deal with the wider issues of the place and use of safety visualisations in the context of development of safety science and practices. We hope this brief exploration of the topic of visualisation stimulates further studies, and also further visualisations for, and of, safety.

References

1. K.B. Bennett, J.M. Flach, *Display and Interface Design* (CRC Press, 2011)
2. J.M. Flach, The ecology of human-machine systems I: introduction. Ecol. Psychol. **2**, 191–205 (1990)
3. T. Haavik, Remoteness and sensework in harsh environments. Saf. Sci. **95**, 150–158 (2017)
4. J. Larouzée, J.-C. Le Coze, Good and bad reasons: the Swiss cheese model and its critics. Saf. Sci. **126**, 104660 (2020)
5. J. Reason, *A Life in Error: From Little Slips to Big Disasters* (Routledge, 2013)
6. P. Underwood, P.E. Waterson, Systemic accident analysis: examining the gap between research and practice. Accid. Anal. Prev. **55**, 154–164 (2013)
7. P.E. Waterson, D.P. Jenkins, P.M. Salmon, P. Underwood, 'Remixing Rasmussen': the evolution of Accimaps within systemic accident analysis. Appl. Ergon. **59**, Part B, 483–503 (2017)