

Data Visualization – How to ensure understandable and sustainable statistical products

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Abstract

Charts and other means of data visualization add to the comprehensibility of statistical data. Whereas the different types of visualization have undergone very deep academic treatment in recent years, the role of aesthetics and usability seem to be rather unexplored in this context. But user experience does affect the comprehensibility of visualizations and is an important factor in the perception of quality thus has to be considered in the planning and maintenance of sustainable data visualizations.

Keywords: accessibility, sustainable products, visualization, skills, resources, communication.

1. Data Visualization

Data only can be useful, if we understand its meaning. Especially complex data needs explanation – or visualisation – in order to be presented in a comprehensive way. For example the adoption of the 2030 Agenda and the Sustainable Development Goals (SDGs) introduced 17 development goals, containing 169 specific targets. To monitor the process, about 230 indicators were proposed by the Inter-Agency and Expert Group (United Nations, 2016).

For evaluation purposes, such a big amount of data has to be organized and displayed in a simplified and comprehensive way. Not surprisingly, first visualization projects, e.g. 2030-watch.de have already been published.

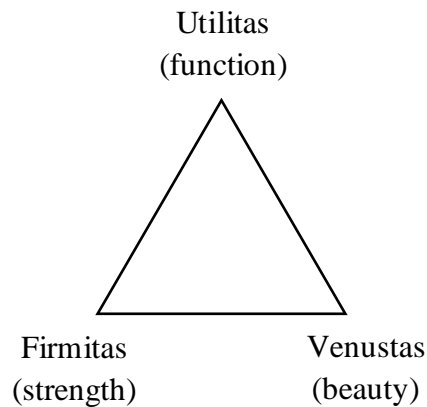
In contrast to tables, the purpose of data visualization is not to display data as accurately as possible. "The power of a graph is its ability to enable one to take in the quantitative information, organize it, and see patterns and structure not readily revealed by other means of studying the data" (Cleveland/McGill 1984, p.535).

2. Sustainability

2.1. Requirements for data visualization

In order to understand the notion of sustainability, we first have to define the requirements for good data visualization. Following Moere and Purchase (2011) the Vitruvius triangle, first formulated in 25 BC by the Roman architect Vitruvius, can serve as a starting point for this approach. In many modern disciplines it is still considered the basis of good design. The triangle consists of *Firmitas* (strength), *Utilitas* (function) and *Venustas* (beauty).

Fig. 1: Vitruvius triangle



“Strength” is used in a figurative sense here and means the reliability and robustness of the application. That is especially important for interactive data visualizations as it addresses the technical performance in combination with different types of data sets and targeting a variety of output media.

“Function” means first of all effectiveness and efficiency. Considering data visualization, it is probably the best explored part of the triangle, as it deals with the question, which specific visualization type is most suitable for a given data set. Function also refers to the aspect of usability.

“Beauty” - or better attractiveness - is often considered a less important factor during the planning and development phase of data visualization. Referred to as "eye-candy", it is seen as an add-on, competing with functionality.

Except for the choice of visualization types, which is a rather static decision, our attitude towards other aspects or their environment can change over time. That is especially true for everything depending on technical specifications. With Adobe (former Macromedia) Flash being completely replaced by HTML 5 and JavaScript as the tool of choice for cross-platform media projection, we witnessed the enormous speed of technological evolution.

With new technology now available for web designers and new consumption devices there also arose a new way of experiencing the internet. Consequently the aspect of usability also needs to be readdressed.

Accompanying the technological development, there have also been some major changes in the way we perceive design in terms of graphics or aesthetics. The semi-realistic and playful 3D style of the last decade has been replaced by the much more down-to-earth flat design in recent years.

2.2. Consequences

As we can see, there are a lot of elements beyond updating the underlying data set that have to be maintained. The most striking is of course technology. It has to be adapted to the users' devices and preferred way of consumption. The usability has to follow changing habits and – if we consider aesthetics as a relevant part of visualization – the graphic design also has to be revised from time to time in order to keep up with current styles. The following section will show what has to be considered in terms of aesthetics when visualizations get updated.

3. Aesthetics in data visualization

3.1. Information Visualization vs. Visualization Art

The way data is visualized may vary from direct mapping with a very tight connection between source and image to interpretive mapping, where the underlying data can hardly be identified and the focus is not primarily on comprehensibility (Lau/Vande Moere 2007). The latter has a more artistic motivation whereas direct mapping has clear communication of data as its purpose.

As artistic freedom is not part of the dissemination strategies of official statistics, the following sections will concentrate on the role of aesthetics in visualization types that can be considered rather close to direct mapping.

3.2. MAYA Stage

In the early 1950s, Raymond Loewy, one of the most famous industrial designers, formulated the so called MAYA principle. It describes the "tug of war between attraction to the new and fear of the unfamiliar" (1951, p. 326). His conclusion is that smart design strives for the Most Advanced, Yet Acceptable stage. Half a century later, Hekkert et al. found empiric proof for that theory. "In order to create a successful design, the designer should strike a balance between novelty and typicality in trying to be as innovative as possible while preserving, as much as possible, the typicality of the design" (2003, p. 122).

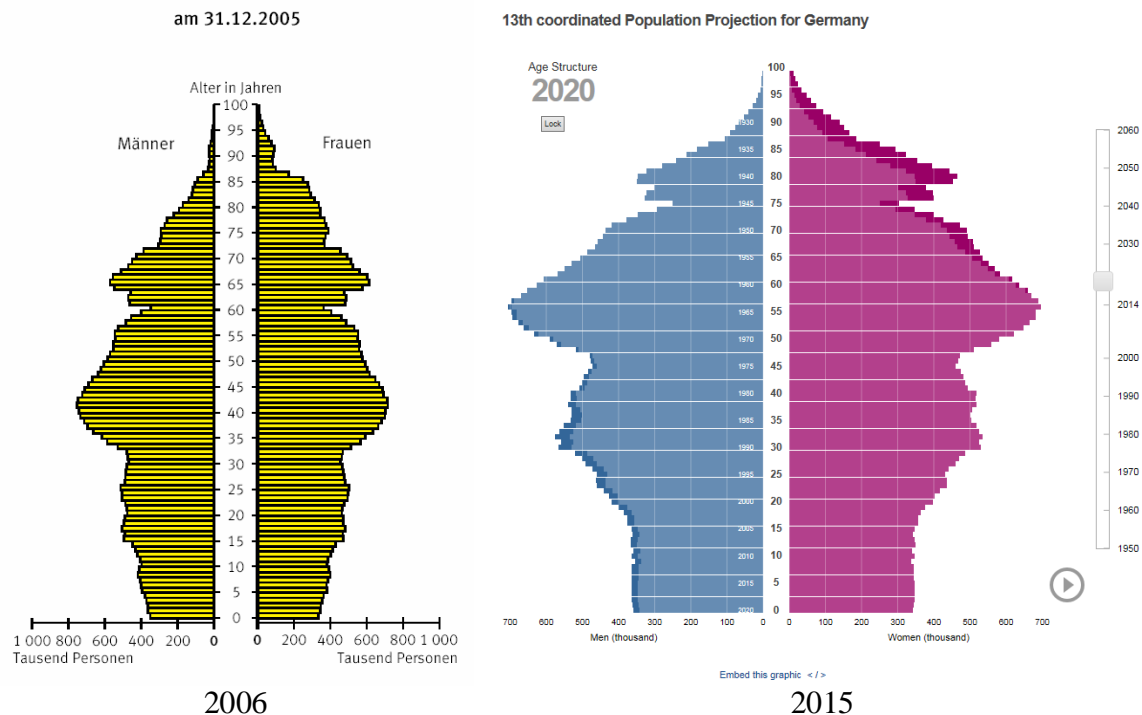
Keeping in mind that the MAYA stage varies with respect to the given context (Anderson, 2011, p. 47), we can adapt this concept to the design of data visualizations.

3.3. Most Advanced

An elaborate design is an indication of the level of effort a creator has invested in his or her product. If the design follows latest trends in style, it is an indicator for frequent data updating processes. If, on the other hand, the design is perceived as old fashioned or simply not good, it

will transport an image of unprofessionalism. So in order to achieve a professional impression at first glance, design in terms of aesthetics is the most important element.

Fig. 2: Population Pyramid: Different aesthetics in 2006 and 2015



Graphic design should never negatively influence the function of visualizations. But it can – and should – support it. The aesthetic perception of a user interface (or interactive visualization) does not only influence the initial perception of usability, it also adds to the satisfaction after using the system (Tractinsky, 2000).

Another finding is that users will more likely spend a longer time period with the visualization, if it is aesthetically appealing (Cawthon/Vande Moere, 2007, Norman, 2004).

3.4. Yet Acceptable

But as the MAYA principle indicates, there are limits to novelty. In the sense of Loewy, typicality still has to be maintained in order to achieve good design. Graphic extravagances

have to be considered very carefully in the realm of official data dissemination. The reputation as an official source may set very tight limits to artistic freedom.

Expanding the original concept, we also have to consider other limitations to aesthetics when we deal with data visualization.

The purpose of information visualization - in contrast to visualization art - is to simplify the understanding and the access to data in general. One of the most important limitations for designers is the function of the visualization: "The data define the shape of the graph. The designer cannot arbitrarily decide to change its shape, as doing so would change the content and meaning" (Richli, 2008).

Having examined the connections between function and aesthetics, it should also be noted, that there are implications for "Firmitas" in terms of reliability as well. Some of the recent visualizations need very powerful computer hardware on the side of the end user. For good user experience, such applications are to be avoided as they often result in frustration. The cost of aesthetically appealing design must not be bad performance.

4. Competencies for sustainable information visualization

The visualization of long term indicator systems is a periodical task that starts with the design of the product and that continues not only with the supply of current data but also with the maintenance of the application in terms of technology and graphic design. In order to provide successful sustainable visualizations, beyond statistical expertise, a variety of competencies is needed.

Depending on the visualization form, special technical knowledge is necessary. That might be programming skills, experience in web technologies and UX-design in the case of interactive visualizations. For animated videos, motion graphics and editing is indispensable. In each case, graphic design is important, as visualization always has a graphical aspect to it.

These competencies should be available in order to ensure visualization projects remain up-to-date. As the evaluation is a permanent process, it is advisable not to rely completely on external service providers but to have these competencies available in-house.

5. Conclusion

Aesthetics should be part of the planning process of successful data visualization projects. They add not only to a better understanding and improve the usability but they also communicate the professionalism and reputation of the creator. Thus they support the impression of a trustworthy and reliable high quality product. In order to guarantee a periodic modernization circle for long term products, the relevant competencies should be available permanently.

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