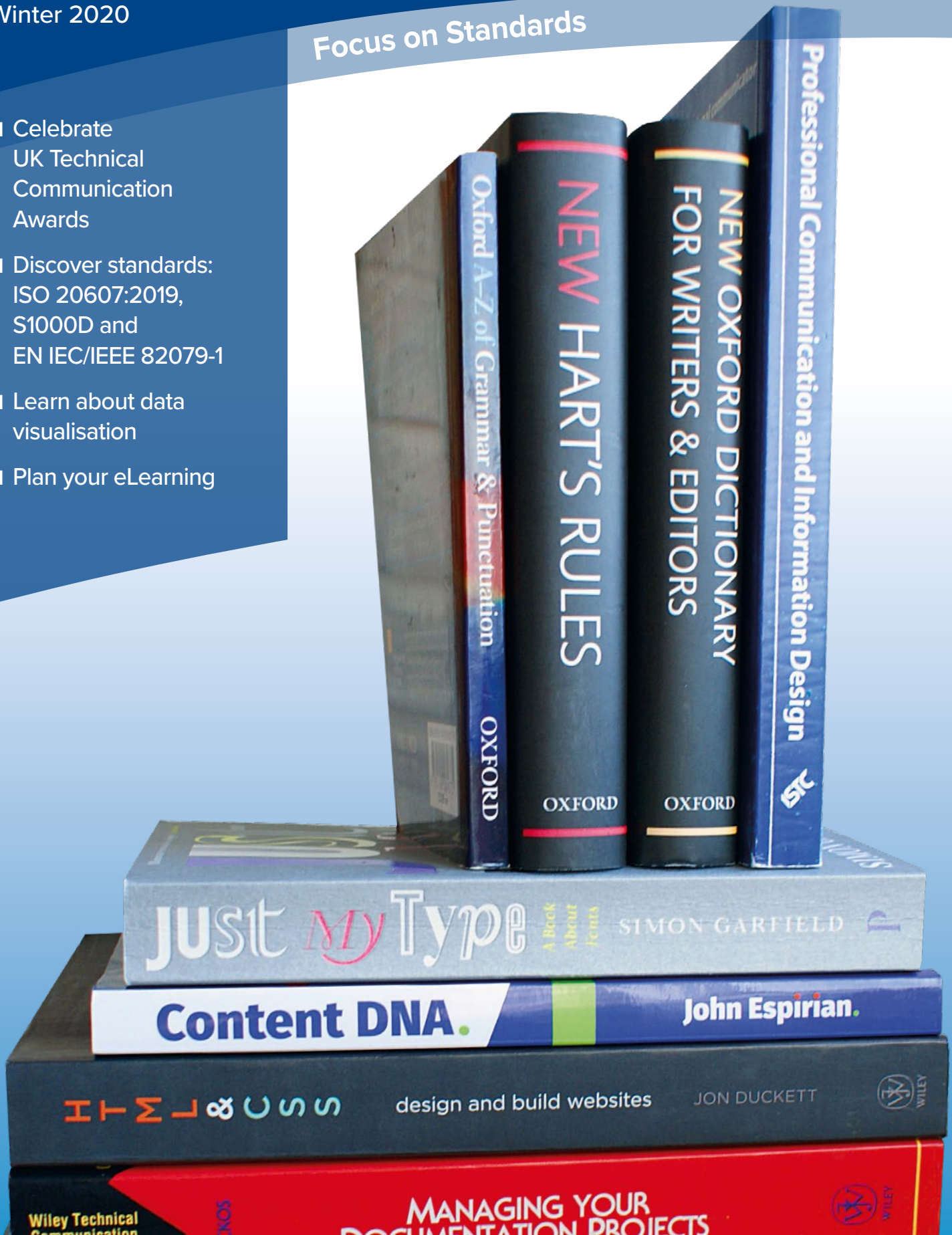# Communicator

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Understanding data visualisation

Sawsan Khuri explores how data visualisation can change perception and cognition.

Are we critical enough when we see a chart or graph? The world has finally recognised the power of data, and the ability to influence using data graphics. We are taught to trust charts: lines show growth or decline, bars show quantity, pies show segments or market shares. Then we get some people who superimpose design and optical illusions onto straightforward data visualisation, and the story becomes distorted. So how does this work?

We perceive the world around us through our senses, and these observations become cognitive knowledge once they are processed and analysed against our existing knowledge base. Recent psychology, summarised by Alexandra Michel (2020), shows that there is a very fuzzy area in between perception and cognition, and that there is room for bias causing misinterpretation at every step.

What you perceive is what you see or hear, new information that you take in. How you understand what you perceive is your cognition, it is about matching the new information to pre-existing knowledge that you already have. If your existing knowledge is already biased towards something, whether consciously or unconsciously, then your cognition of the new information is bound to be influenced by it.

When we look at something, the image is processed by our visual cortex at the back of the brain, and the signal between the eyes and the visual cortex is really fast. Cognition, that is, thinking about and understanding what you have seen, is handled by the cerebral cortex and takes a lot longer. When you look at a graph, you want to quickly get the message and you don't actually expect to spend too long figuring out what it is trying to tell you. This sort of mirrors David Kahneman's explanations of the two systems of thinking, where System 1 is fast and based on emotions, with the other being slower and based on rational analytical thought. Data visualisations, dataviz for short, make the process of understanding data simpler by giving our brains a little visual help to try and think about the data more quickly. Things like line graphs and bar charts are simple, easy, almost intuitive to understand.

The following example from Alberto Cairo highlights how optical illusions can be used to misrepresent data. In Figure 1, the top row shows a bar chart, a pie and a line chart of company trends and implies a thriving company with record sales. However, there are no scales on the bar graph, and a closer look at that pie chart brings doubt about the relative size of those slices. Below that is the same data visualised correctly. This company is not doing very well! It is doing worse than its main competitor in terms of dollar sales, it does not have a major slice of the market share pie, and its sales since 2011 have not exactly soared. Cairo's book 'How Charts Lie' is full of examples like this, his charts are available through his website from www.thefunctionalart.com.

Where does this begin? Let's take a step back for a minute and talk about data. Data points are basically measurements, evidence, things you can tangibly assess such as words in books, names and addresses, prices of stocks being traded, or the amount of a substance in a cell. Working with data has cognitive biases at every single step. It begins with where you choose to collect your data, all the way through to the methods you use for collecting and analysing that data. Quite often you have to make assumptions along the way, and in scientific experiments and investigative journalism, you have to declare all these assumptions and methods, so that the reader is clear what they are looking at. You also have to declare and justify all the algorithms you used for statistical analysis. But this is not necessary across the board in business or in journalism. With social media as it is today, we can all stick any data on any axes and call it evidence... who's to know?

The thing about real data is it doesn't lie. Once collected, as you are analysing it, it tells you the story. It provides the evidence. The responsibility then rests on the data visualisation designer to represent that data accurately. Accurately means without political agenda, personal gain, or greed. Accurately means telling it as it is, even if the results don't match what you wanted to hear.

There is more to it, dataviz is a method of communication. So, it is not only our responsibility to represent the data accurately, but we also need to do this in a way that informs and relays the message unambiguously. Dataviz reception, as Martin Engebretsen (2020) posits, requires a deeper investigation

Alberto Cairo has put forward the five qualities of a great data visualisation (Figure 2). First, they have to be truthful,
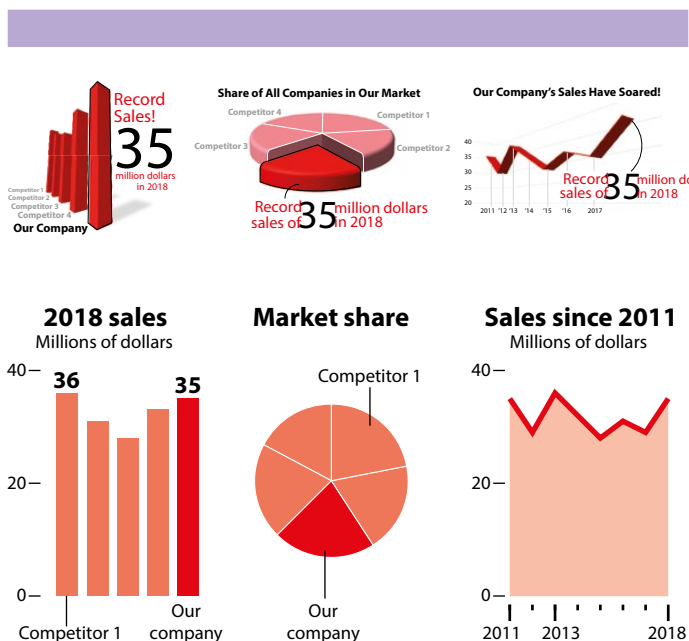

Figure 1. The top row shows three graphs using optical illusions to distort true company data. Underneath is the same data visualised using appropriate scales. From Alberto Cairo, How Charts Lie, charts available from www.thefunctionalart.com

1.	2.	3.	4.	5.
TRUTHFUL	**FUNCTIONAL**	**BEAUTIFUL**	**INSIGHTFUL**	**ENLIGHTENING**
Based on real and solid research.	Accurately represents the data and allows interpretation.	Well designed, catches the eye, aesthetically pleasing.	Reveals evidence that is otherwise hard to see	Able to inform, educate and possibly change minds

Figure 2. The five qualities of great data visualisations. Adapted from Alberto Cairo, 2016, The Truthful Art, published by New Riders, Pearson Education.

based on real and solid research, the data has to have provenance. Tell people where you got the data, and how it was collected and analysed. Second, the dataviz has to be functional. By that he meant that it has to accurately represent the data and allow the viewer to interpret the information correctly. It has to fulfil the function that a visual image is meant to convey.

The third rule is that the visualisation has to be beautiful. This is vital for viewer engagement with the data and how they will react to the message it is trying to deliver. A well designed, attractive graphic that a person enjoys looking at will relay the message so much more effectively than one that has been slapped together quickly and without attention to design detail. You can have a line graph, or you can use some creativity to make that story come alive. You do not have to be an artist to design a clear and beautiful graph – you need some sense of shape and colour, and the scope to make the dataviz relay the message.

For it to be part of the message, dataviz has to be insightful and enlightening, revealing its truths, adding to knowledge, useful and informative to people. Your graph is not just an add on to make the report look pretty, in and of itself it is also the message.

When we consider these five qualities of a great data visualisation together we see that, even though Cairo does not explicitly talk about perception and cognition, all these guidelines are to do with using perception and cognition principles to help people better understand the data they are looking at. In most cases, once people see an image, they try to understand it, their perception-cognition wheels are turning and they may not actually listen to most of the words that are being said to explain the graph. If the graph is confusing, so will the message be. If the graph is only able to be understood by a few specialists, then the message will be completely lost on the majority of viewers. Hence dataviz needs to be more than a line on a graph, it needs to be a truthful, functional, beautiful, insightful, and enlightening visualisation of your data.

In a world where there is misinformation around every corner, it is our responsibility as people who work with data, every sort of data, be it big or small or in between, to relay the information that the data provides clearly and accurately. It is our responsibility as dataviz producers, enablers and/or consumers to demand that the graphics communicate the truth. ■

References

Cairo, Alberto (2019) How Charts Lie, Getting Smarter about Visual Information, W.W. Norton and Company.

Cairo, Alberto (2016) The Truthful Art, New Rider, Pearson Education.

Cairo, Alberto website: www.thefunctionalart.com (accessed 19 November 2020).

Engebretsen, Martin (2020) From Decoding a Graph to Processing a Multimodal Message. Nordicom review 41. DOI: https://doi.org/10.2478/nor-2020-0004 (accessed 24 November 2020).

Kahneman, David (2011) Thinking, Fast and Slow, Penguin Books.

Michel, Alexandra (2020) Cognition and perception: Is there really a distinction? Observer, Association of Psychological Science. Available at: www.psychologicalscience.org/observer/cognition-and-perception-is-there-really-a-distinction (accessed 24 November 2020).

Further reading

Examples of dataviz that are enlightening, insightful, seriously beautiful, functional, and unwaveringly truthful can be found by going to:

David MacCandless and his team at Information is Beautiful https://informationisbeautiful.net (accessed 19 November 2020).

Andy Kirk at Visualising Data. www.visualisingdata.com (accessed 19 November 2020).

Max Roser at Our World In Data. https://ourworldindata.org (accessed 19 November 2020).

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