

Walker, K. and Craft, B. (2013) Data, representation and aesthetics. In Zhou, C. (Ed.) *Information in Style*. Beijing: ADPP.

Introduction: Data, representation and aesthetics

Every time the UK Prime Minister boils a kettle of water, the energy he uses is reflected in a giant prism atop a museum, across town. Citizens' sentiments about their home team's performance in the Olympics are preserved in a data sculpture of peaks and valleys. Invisible wireless signals are made into landscapes of light, text from Charles Darwin is transformed into encircling branches, emotions are mapped onto cities, and chairs created from sound. Within these pages are a range of works that started out as pure data and ended (or continue) as beautiful or useful things, from the informational (David McCandless), to the commercial (Max Gadney), to the artistic (Tim Knowles).

This book documents enquiries into a new domain of intellectual work and aesthetic expression, a crossroads where data and everyday life intersect. Data, of course, is nothing new. Humans have been collecting, analysing and representing information since there were humans. The cave paintings of Ice Age Europe are held up by both the art and design communities as a starting point for their respective fields; they could similarly be said to represent the early days of data visualisation and information aesthetics.¹

What is new is how digital technology now enables access to data. Networks and sensors are ubiquitous, enabling data to be collected (via drones and satellites) even in the remotest locations; and simple, inexpensive software and hardware make it easy to render data into new forms both digital and physical, static and dynamic. Today, we are all aware that data exists everywhere. We are bathed in rivers and flows of data – a flood, a sea, a surfeit. Shaping, simplifying, designing and moulding it into visible and tangible forms helps us comprehend and experience it.

The new ways of capturing data enable new ways of thinking about it meaningfully, as information that we can interpret and use for creative and contemplative purposes. And because information is fundamental to our existence, its generative possibilities are endless. Indeed, biologists now believe that life itself is an exchange of information², and physicists believe that information is more fundamental than matter³ – that the entire universe computes information.⁴

¹ There are many pre-historic examples. The Ishango Bone, a notched tally stick discovered in the Congo (Zaire) in 1960 by Jean de Heinzelin de Braucourt may represent a six-month lunar calendar. It is among the earliest known mathematical objects, dating to about 25,000 BCE. Other lunar calendars from about the same date have been discovered on other bones such as the Isturitz Baton, and possibly in cave paintings in Lascaux, France and elsewhere.

² Walker SI, Davies PCW. 2013 The algorithmic origins of life. *J R Soc Interface* 10: 20120869

³ Gleick, J. (2011) *The Information: A History, a Theory, a Flood*. New York: Pantheon

⁴ Lloyd, S. (2010) The computational universe. In Davies, P. and Gregersen, N. (Eds) *Information and the nature of reality: From physics to metaphysics*. Cambridge University Press

Couldn't rocks, plants and people be regarded as physical manifestations of data? How can we turn something so basic, so primordial, into meaningful expressions that tell us about ourselves and illuminate what it means to live in the world? Contemporary artists and designers who are engaging with information as a medium must grapple with questions like these.

What is information?

Let us make some distinctions and set some boundaries. We think of 'data' as quantities of qualities about the world that we sense and perceive. This is what enters our eyes, ears, hands and nerve endings, and it is the raw material for the work presented in this book. Our senses evolved to take in such data.

Some people use the words 'data' and 'information' interchangeably, but we prefer the more nuanced view that information is what happens when data is interpreted by the brain. Some neuroscientists believe that we see with our brains, not our eyes – information is not merely the cognitive result of what our eyes see and our brains interpret. Our brains construct it from our visual perception *as well as* from our past experiences and the social, physical and emotional context in which we perceive things.⁵ This begins a process of meaning making, resulting in comprehension and understanding. It is the result of us integrating new information with our long-term memories, both conscious and unconscious. Knowledge construction is not a passive transmission of information from one person or place to another, but an active process, whether internal or in communication with others; it involves both internalisation and externalisation.⁶ So data are facts about the world; information is our interpretation of data as artefacts, assertions, entities or kernels; and knowledge is built up from information and experience. So, informing can lead to knowing, but not always. What interests us is how representations of information can become knowledge through the ways they mediate the process of meaning making.

In our research, we work with both quantitative and qualitative data – put simply, numbers and stories. Claude Shannon famously constructed a theory of information by translating qualitative data (i.e., the English language) into quantitative data, to derive a mathematical means of communication – the basis for our sea of digital data today.⁷ This book represents a move in the opposite direction: translating all those numbers back into qualitative interpretations. And interpretations of interpretations – see, for example, Kate McLean's sensory maps comprised of people's perceptions arrayed across urban spaces, and Christian Nold's similar mapping of emotions in the social landscapes of cities.

⁵ e.g., Eagleman, D. (2012) *Incognito: The Secret Lives of the Brain*. London: Canongate.

⁶ See Piaget, Jean. (1950). *The Psychology of Intelligence*. New York: Routledge; and Kaptelinin, V. and Nardi, B. (2006) *Acting with Technology: Activity Theory and Interaction Design*. Cambridge, MA: MIT Press.

⁷ Shannon, Claude E. (July/October 1948). "A Mathematical Theory of Communication". *Bell System Technical Journal* 27 (3): 379–423.

Then there is 'Big Data,' which has become a popular term in the UK and elsewhere to describe the digital flood. But defining *how* big is, itself, a matter of perception: for example McLean found in her research that a mere 14 geographic locations could be navigated more than 87 trillion different ways. But while big data can come from small data, the design process is more often a simplification and reduction of Big Data into visual, tangible or experiential forms. That's what you'll find here.

Big Data gets even bigger when it flows in real time. Keiichi Matsuda's *Prism* utilised 50 live data streams. With such live data, liquid metaphors are apt – flows, streams, waves, and so on. It's up to artists and designers to capture, code and construct them into forms perceivable, understandable and beautiful to humans, whether ever-changing and dynamic like *Prism*, or fixed and physical like *Emoto* by Moritz Stefaner, Drew Hemment and Studio NAND.

The data-driven design process

Once an artist or designer decides which data to work with as a raw material, there begins a process of editing, reducing, shaping or chipping away like a sculptor working with stone. For example, raw data often needs to be formatted or 'cleaned' of spurious data points. In the course we run at the Royal College of Art, the design process often starts with sketching – whether sketching with pencil,⁸ sketching with code,⁹ sketching with hardware,¹⁰ or sketching with data.¹¹ Over the course of many iterations, a final design gradually emerges from the materials, constraints, and objectives of the designer. The final form might already be present in the designer's mind, or arise from some combination of the data, materials, or context, as in Knowles' work.

Since we usually work with digital data, sometimes the design process involves computational thinking. This is a structured methodology that begins with breaking down a problem or dataset into smaller pieces, then looking for patterns. Designers are generally good at spotting patterns; Gadney calls them 'difference finders.' Often, the data needs to be visualised in some form even before the designer can explore it, in order to help spot patterns and identify salient features. Shaping such differences or patterns into abstracted or recognisable forms is then done algorithmically or physically, depending on the final form; this is where aesthetic decisions are primarily made. It frequently involves a translation or transformation, from one medium to another; or a manifestation, from the digital to the physical. It is often a balance of simplicity and complexity, with randomness, uncertainty and variation adding interest.

Computation often connotes complexity, but it is actually often easier to work with data using software than to represent it physically. Rapidly evolving technologies, however, help: for example, microcontrollers and electronics are being made increasingly friendly to artists and

⁸ Buxton, B. (2007) *Sketching User Experiences*. Morgan Kaufmann.

⁹ <http://processing.org>

¹⁰ <http://arduino.cc>

¹¹ <http://nearfuturelaboratory.com/seventh-and-half/2012/03/06/at-oreilly-strata-conference/>

non-experts, making it simpler to interface the digital with the physical. For example, *Colony* by our students David Hedberg and Gabriele Dini uses a small, open-source microcontroller to match flows of honey to flows of data. Rapid manufacturing technologies make it possible to render complex data forms with material means – as in *Emoto*, which then superimposes projected digital data back onto the finished physical form. Data sculptures are a new art form, and turning data into experiences is even newer; this book represents the forefront of this new movement.

Finding stories in data is the most important, and difficult, part. Depending on the dataset, stories can emerge from the journalistic conventions of who, what, where, or when. Why and how are often more interesting, and involve interpretation, whether by the eye of the artist or the nose of the journalist. From a commercial perspective, Gadney says that a data visualisation is a hypothesis. From an artistic perspective, Knowles says, “You notice differences in the world, and not all artists notice the same thing.” And from a designer’s perspective, McCandless says, “I really see information visualisation as designing understanding.”

Telling those stories can be done over time (with motion and animation) or space (with mapping and experience). The ‘who’ applies not just to the source of data, but the reader, viewer, listener or user. Designers and artists must know their audiences, as well as the contexts in which their work will be presented and experienced. Generally speaking, designers are good at thinking about audiences, while artists are good at thinking about the form and context of a work. So the who, where and when determine the what – the final form of the work. And despite the importance of data integrity and interpretation, form is perhaps foremost. If a work is not well-designed, new or unusual, or simply beautiful to look at, it will not invite exploration and will not be attended to. The ‘style’ in this book’s title has equal weight with ‘information.’

The broader context

Flipping through the book, the images alone illustrate a wide range of forms that data can take. Taken together, they create a much bigger picture that illustrates fast-moving, global economic and political shifts.

It is now widely accepted that the masses of data made available by digital technologies and networks are changing just about every industry and every part of society, all around the world. Previously, scientists did research on small samples and extrapolated the results to the larger population; now they can access data on entire populations and extract very narrow results with laser precision. Previously, companies made a narrow range of products for specific target markets; now, they can easily customise for specific demographics or even individuals – indeed, individuals themselves can now use data to manufacture things at work and home to suit their personal needs. Previously, a few mass media outlets produced and served up the same narrow range of content to everyone; now, a wider range of media producers serves to narrowly-sliced audiences, and the audiences themselves can produce their own media. The

old models and ways of doing things are being redefined by the data revolution because new meanings, new information, and new *kinds of information*, can be created.

The economic effects extend even into the realm of art. Tate Modern in London – a disused power plant turned into a world-class art gallery – aptly signifies the shift from manufacturing to cultural production, having regenerated not only its local surroundings, but boosting the city’s tourist economy significantly. Now, data-driven art can talk back, reflect attitudes and phenomena, reflect and affect its surroundings. We are at the cusp of an age when data will be incorporated into artworks as well as galleries, companies, homes, shops, businesses and cabinet offices.

These circumstances have created inescapable political implications. Nold believes that data visualisations, whether artistic or informational, must be critically engaged, and not mere decoration. Data does not just tell stories and make statements; it asks questions. Through his work, Nold found that organisations and groups have agendas. For his part, Gadney works with organisations and government to form digital departments and formulate data strategies. The aggregation of data from diverse sources can be used for good or ill, and visualisations and manifestations of diverse datasets can influence economic and policy decisions either overtly or subtly, by design or through their design.

And so we return to the UK Prime Minister, using Gadney’s iPad app of aggregated data to inform his thinking and, perhaps, make policy decisions. Watching the polity while he boils his kettle, his energy use on view for all to see. Information designers help us to see more, and see more clearly. Information isn’t going out of style, but as this book shows, we can now experience it in style.

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