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DIGITAL PRODUCTION

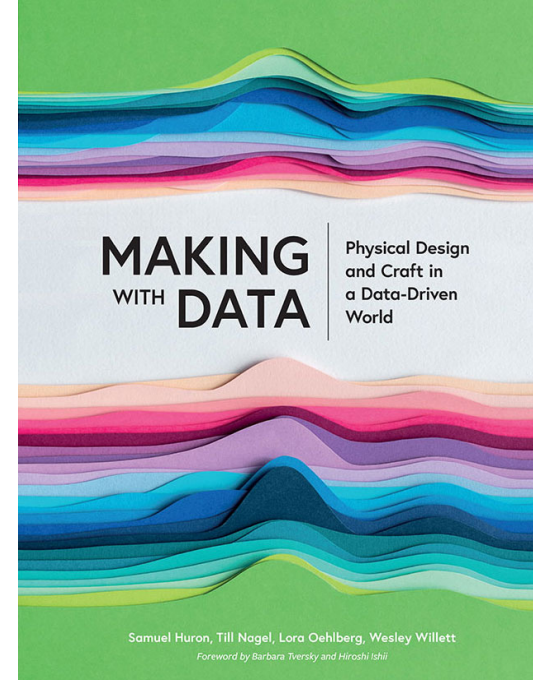
Section introduction

Yvonne Jansen

is a permanent research scientist with the French National Center for Scientific Research. Her Ph.D. thesis focused on physical data representations, and her research interests now center more broadly around how visualizations may help people make better decisions and generally improve their lives.

Digital production changed the practice of physical data representations tremendously. The first section of [this book](#) includes works which relied on manual crafting which requires mastery of "traditional" tools, such as chisels to do woodcarving (like Adrien Segal's *Snow Water Equivalent*), or machines such as pipe benders or various saws, to bend and cut materials into the needed shape (like Loren Madsen's *Endings*). This section shows how the emergence of *digital production* shifted mastery from tools to the *software* controlling the machines. Included is a selection of five works which relied to different degrees on digital production mechanisms to produce the desired physical artifacts.

While one may be tempted to think that not much mastery is required when machines do all the work, creating physical data representations using digital production is not as straightforward as it may seem. Yes, machines do the actual carving, bending, or cutting, and in many cases probably more accurately than a human would be able to, but telling a machine what to do requires a different kind of ingenuity: one has to generate the unique code that can tell a machine how to make the specific data physicalization one has in mind. And in most cases there is not an app for that. Sometimes, even the machine is not something one can just buy in a store. For example, Figure 1 shows a printed 3D model of a mathematical object (a D2 dihedral symmetry group) created with a home-built custom 3D printer which uses sugar as printing material and was dubbed CandyFab4000 by its inventors. Finally, there is more than one way to go about physicalizing particular data and often many paths

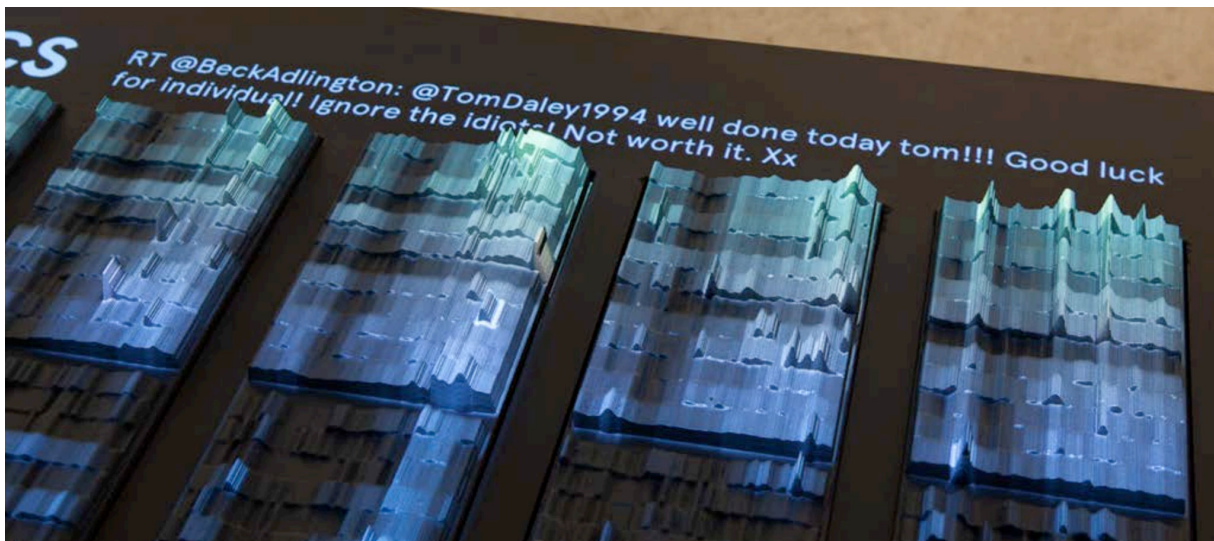


need to be explored and many decisions made until finally an object emerges. Due to the intrinsic physics of a desired geometry and a chosen fabrication process, the resulting artifact does not necessarily come out as one expected (as Stephen Barrass discusses in his chapter on the *Chemo Singing Bowl*). In most cases, some additional manual intervention is needed, most commonly to assemble or paint what comes out of a machine. The five chapters in this section all rely on digital production, and each one tells a different story combining different levels of manual and digital craft.



◀ Figure 1
A 3D model called Sugar Soliton created by Windell Oskay after the original model by Batsheba Grossman printed using sugar which turned partially into caramel giving it an appearance of a coral | Credit: CC-BY 2.0 Windell H. Oskay, www.evilmadscientist.com.

▼ Figure 2
Emoto data sculpture showing timelines of Twitter sentiments during the Olympic games in 2012. It consisted of 17 plates milled with a CNC machine. | Credit: Moritz Stefaner, Drew Hemment, and Studio NAND. www.emoto2012.org



A high level of manual craft is involved in pieces where machines cut from dozens to hundreds or sometimes even thousands of components into a particular shape which then need to be (often manually) assembled. Machines can produce very accurately an abundant number of pieces which then need to be put together to make sense and show the actual data, which can be a very painstaking process. Ekene Ijeona's chapter introducing his *Wage Islands* sculpture is an example of such an approach, and the artist details the minutious effort that went into it. Volker Schweisfurth also describes how he cut, assembled, and glued 3D printed elements to create *Data That Feels Gravity*. Another example is the Emoto data sculpture created by Moritz Stefaner (whose *Perpetual Plastic* project appears later in the book), Drew Hemment and Studio NAND which shows timelines of Twitter sentiments captured during the Olympic summer games in 2012. Figure 2 shows a closeup of the sculpture and the detailed peaks which represent the volume of tweets about the 2014 Olympics grouped into columns for each day and separated into rows by the level of positivity of the sentiment expressed in a Tweet (positive to negative). A CNC machine made sure that the sculpture accurately showed the data, but much preparatory work went into the collection and processing of the data, the editing of the 3D design files, and the final assembly of the different pieces. A differently laborious process involving many different steps and combinations of support structures and data-encoding parts is described in detail in the MINN_LAB Design Collective's chapter detailing their *Orbacles* project.

The above are very specific examples, where a particular type of physicalization was thought up explicitly for a specific dataset. On the other extreme, one can find examples where the digital production process is almost entirely automated such that anyone, without prior experience in digital design or fabrication, could insert their data, for example, from their personal activity tracker, and get a 3D printed artifact at the end, whose shape is entirely defined by their own data. Figure 3 shows multiple examples of pre-defined designs, which are parameterized such that someone's data determines specific features, like the length or width of spikes. The motivation behind these is to make physicalizations accessible to anyone who would like to see their data in physical form, for instance, as a memento.

► Figure 3
3D printed data sculptures encoding data about an individual's physical activity. | Credit: Rohit Khot.

▼ Figure 4
Idem. | Credit: Simon Stusak.



Physicalizations can also simply serve personal curiosity, such as the ones shown in Figure 4, made by Nathan Yau, who generated physical charts from shot position data of key players of the NBA in 2018. He wrote code to transform NBA data from a player into a physical shape and—similar to the physicalizations of personal data above—ran the same code for different players to generate different physicalizations that can be physically organized and compared.



▲ Figure 5
Nathan Yau's physical charts showing per-player NBA shot selection data. | Credit: Nathan Yau.

While many physicalizations primarily encode data solely in their geometrical shape, as shown in the above figures, some take on the additional aim to encode data in non-visual properties of the final physical object. For instance, Stephen Barrass' chapter describing his *Chemo Singing Bowl* sculpture examines how objects can sonify data. The result is meant to be played like an instrument so that it makes the encoded data perceivable. Many different kinds of physical properties can be adjusted based on the data used to generate the object, including properties such as mass, floatability and even taste. For instance, in their chapter *Data Seeds*, Nick Dulake and Ian Gwilt detail how adjusting the shape and mass of artificial seeds results in objects falling down at different speeds. The relationship between shape and speed to fall is complex and being able to encode data in such ways depends very much on the availability of mathematical models to transform the data. Realizing such data physicalizations would not be possible without the support of digital production.