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Supplemental Material – Data to Physicalization

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1. Inclusion-Exclusion Criteria of the Corpus

In the methodology section of the paper, we discussed our approach to search and filter various works to be reviewed for this survey. Here, we discuss the process in greater detail so that it can be easily repeatable for future research purposes.

As discussed, our systematic literature search started by filtering papers, short papers, and posters, published between 2010 and 2020, from the following communities:

- Computer Graphics (Eurographics, SIGGRAPH, SIGGRAPH Asia, IEEE CG&A),
- Visualization (EuroVis, IEEE Vis, IEEE TVCG),
- Human-Computer Interaction (CHI Proceedings),
- Fabrication in Art and Architecture (SIGGRAPH Art, SMI FASE, CUMINCAD).

We used several websites to search for the work on these communities based on a list of keywords that we had prepared. The complete list of keywords that we use for our search is as follows (in alphabetical order): 3D Printing - Actuating - CAD - Computational Manufacturing - Data - Data Design - Data Materialization - Data Physicalization - Data Visualization - Data-driven Design - Data-enabled Design - Design - Digital Fabrication - DIY - Embodied Interaction - Fabrication - Information Visualization - Installation - Interaction - Interactive - Kinetic - Media Façade - Model - Modelling - Personal Data - Physical - Physical Material - Physical Visualization - Physicalization - Prototype - Prototyping - Rapid Prototyping - Shape Changing - Spatialization - Tactile - Tangible - Tangible Interaction - Tangible User Interface - Visualization - Wearable.

The websites we used to start collecting works were as follows:

- ACM Digital Library (`https://dl.acm.org/`) for the works mostly published in SIGGRAPH, SIGGRAPH Asia, SIGGRAPH Art, and the CHI Proceedings,
- IEEE Explore (`https://ieeexplore.ieee.org/Xplore/home.jsp`) for most of the works published in various IEEE conferences and journals,
- Wiley Online Library (`https://onlinelibrary.wiley.com/`) for EuroVis and Eurographics papers,
- CUMINCAD (`http://papers.cumincad.org/`) for the works published in Computer Aided Architectural Design, including ACADIA, CAADRIA, eCAADe, SIGraDi, ASCAAD and CAAD futures, and
- Hyperseeing magazine (`http://www.isama.org/hyperseeing/`) for SMI FASE publications.

We also used Google Scholar (`https://scholar.google.com/`) and Mendeley desktop application for further filtering the works. At this stage, we did an *initial* inclusion/exclusion filtering. Our two main categories for including works at this stage were aiming to visualize data and having a physical object as result. That said, if the paper was not related to the field of visualization, we excluded it from the corpus. We then checked to see if there is a physical object fabricated in the results section of the paper. In other words, papers only introducing design and/or modelling methods were excluded.

As mentioned in the paper, we wanted to also include examples from the broader art and design community whose physicalizations may not appear in academic literature. For this purpose, we chose *dataphys.org* as our main corpus to collect and analyze various physicalizations. To begin the process of analyzing entries on this website, we started using physical cards provided by Huron and Beignon for an IEEE Vis 2018 workshop called *You name it!* [HB18]. *You name it* is a deck of cards produced based on the entries of dataphys.org and is composed of approximately 280 cards from different artists and practitioners. Each card has a picture of a physicalization work on the front, a short description on the back, as well as the approximate creation date. We stacked these cards based on their fabrication method and then excluded work from before 1990 as CAD/CAM technologies were less common. We then checked the dataphys website for each initially included card (i.e., one entry in the website) and removed examples without proper documentation (e.g. entries that only had a photo and a paragraph of details on a website).

Another source for our initial paper collection process was a curated bibliography provided by dataphys.org (`http://dataphys.org/wiki/Bibliography`) that includes various academic work from different communities. The *initial* inclusion/exclusion filter for dataphys, i.e., publication date, was also applied to these entries.

At this point, we merged the initially included works collected through the academic communities and the dataphys.org website and started the main filtering process based on the following steps:

1. We first checked to see whether documentation was available that well addressed the research questions. To be more specific,

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the qualifying documentation should at least explain the data collection and processing, design methods, and fabrication process in acceptable details to be included.
2. We checked to see if the physicalization process used digital design (CAD) and digital fabrication (CAM). Here, we tried to be as inclusive as possible and accept any use of CAD and CAM for our inclusion criteria. For instance, if a physicalization process used LEGOs to make models, we excluded them. However, if a work designed and 3D printed customized LEGO bricks as part of the physicalization process, we included it.
3. Finally, if the physicalization was an active work, we made sure that the active system was designed solely for a physicalization purpose. There are many examples of active works that are kinetic objects or responsive architectural structures or installations with possible physicalization applications. We excluded such works in our paper.

As mentioned in the paper, a summary of the whole paper collection and corpus curating process is presented in Figure 1. The corpus and its analysis are available to readers both as static tables included in the paper and as an interactive online version under `https://yvonnejansen.github.io/physicalization-rendering/`.

References

[HB18] HURON S., BEIGNON A.: Encoding data through experiential material properties. In *Physlist: You Name it: Workshop at IEEE VIS 2018* (2018), IEEE.

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