Data Badges: Making an Academic Profile through a DIY Wearable Physicalisation

Georgia Panagiotidou
Research[x]Design
KU Leuven, Belgium
georgia.panagiotidou@kuleuven.be

Sinem Görücü
Research[x]Design
KU Leuven, Belgium
gorucusinem@gmail.com

Andrew Vande Moere
Research[x]Design
KU Leuven, Belgium
andrew.vandemoere@kuleuven.be

Figure 1 Data Badges are customisable wearable physicalisations that express participant academic profiles in professional events. The canvas and encoded tokens are designed to be modular, interlocking and simple to attach so as to be assembled directly by participants on site.

ABSTRACT

In this pictorial we present the design and making process of Data Badges as they were deployed during a one-week academic seminar. Data Badges are customisable physical conference badges that invite participants to make their own independent and personalised expressions of their academic profile by choosing and assembling a collection of predefined physical tokens on a flat wearable canvas. As our modular and intuitive design approach allows the construction to occur as a shared, collective activity, Data Badges take advantage of the creative, affective and social values that underlie physicalisation and its construction to engage participants in reflecting on personal data. Among other unexpected phenomena, we noticed how the freedom of assembly and interpretation encouraged a variety of appropriations, which expanded its intended representational space from fully representative to more resistive and provocative forms of data expression.

Index Terms — *information visualisation, physicalisation, human-centred design*

INTRODUCTION

Professionals attend events such as academic conferences in order to link with like-minded people, get exposed to the state of the art and find future collaborations. In a large pool of people, however, discovering and establishing connections can be a daunting task. In an attempt to address this social experience, event organisers have been experimenting with various infrastructural tools, such as RFID badges, public displays, recommendation systems, apps and trackers[1]. Although promising, many technologically driven approaches still overlook the human dimensions of socialising. For instance, agency, privacy and self-representation are aspects that impact group dynamics and yet are often not taken into account in existing social connection systems.

Some events have attempted to connect participants more subtly through personalised and wearable visualisations of personal characteristics. For instance, large academic conferences such as IEEE VIS already use embedded visualisations[2] to indicate the different roles the participants have in the event. Accurat Studio's Data Portraits[3] forms a more imaginative and 'human' approach,

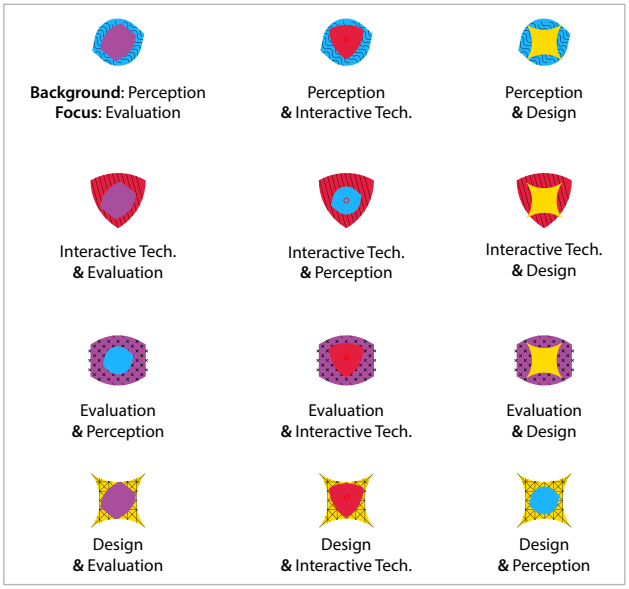

Figure 2 Interdisciplinary combinations of academic interests were made possible by combining multiple tokens on the badge. This assembly created a larger design space even with predefined research classifications.

as it is based on a highly aesthetic and abstract graphical algorithm that is able to generate a unique badge for each participant, based on a rich list of personal characteristics and interests. While informative in reflective in nature, these examples are based on pre-collected data that is visualised in predetermined ways.

At the same time, data physicalisation studies suggest that tangible tokens can actively engage and inform participants[4], [5]. Moreover, recent examples exemplify how physicalisation is able to visualise collective patterns towards building a collective identity[6], and how its assembly process is able to encourage reflection on the encoded data and context of use[7]. Given these largely unexplored potentials, we set out to design a system of physical customisable badges that conference participants can assemble in a DIY manner during the event itself. Moreover, inspired by Lupi's manifesto of data humanism[8], we aimed to also encode qualitative and 'soft' data that encourages ambiguity and personalisation beyond absolute numerical values. The opportunity arose during a Dagstuhl seminar on Data Physicalisation[9], which was a five day event with an expected attendance of 40 to 50 people. As the theme of the seminar focused on data physicalisation, it was only fitting to explore the possibility of personalised badges as social icebreakers.

Data Badges **(Figure 1)** are customisable physical conference badges that allow participants of a specialized event to express their academic characteristics by choosing and assembling physical tokens on a wearable canvas. Rather than collecting this personal data beforehand, a Data Badge is meant to be assembled on-site by the wearers themselves - potentially during a collective activity. The easy instructions explain how to physicalise aspects like past and future academic interests, the amount of theme-related publications, along with situational data such as the travel-time to the event, as well as the daily session attendance.

DESIGN

The Data Badges concept was formed as a result of an iterative prototyping process in which different iterations were discussed with the event co-ordinators. Overall, two design constraints emerged: the organizational issues that are required to elicit all the data dimensions and their physical representation on-site, and the concern to avoid probing or showing data dimensions that might be misinterpreted by onlookers. Both constraints impacted the type of data dimensions that were chosen, and how their abstract encodings and assemblies were meant to be used in open-ended and creative ways.

Data Dimensions

The four chosen data dimensions to be visualised were: current and future academic interests, number of physicalisation-related publications along with two situational data values: the participant travel time and daily session attendance. Qualitative and imperfect data was favoured over numerical absolute values. This meant however, that when combined with the in-situ assembly, the badges could only support qualitative data collected through categorical questions with limited number of response options. Regarding the core question on the participant background, four main academic research areas were predefined: (1) Interactive Technologies and Hardware forms, (2) Evaluation and Methodologies, (3) Arts, Design and Applications and (4) Perception and Cognition. Nevertheless, to not over-classify participants in silos, we opted for interdisciplinary combinations of academic interests and encouraged such variations in the representation options **(Figure 2).**

Data Encoding

The four data dimensions were encoded through the token's material, pattern, colour, relative size as well as location on the wearable canvas. Academic interests were encoded in the shape and colour of custom-made tokens **(Figure 3)**. The size of these tokens indicated the depth of experience or interest in the corresponding academic area. The material type separated the core background of the participants (folding-paper) versus additional interests (acrylic). The location of tokens on the badge frame (top-left or bottom-right), divided past research explorations from future ones accordingly. The number of physicalisation-related publications and the participant travel time were encoded in the length of a blue or white wire accordingly. The daily session attendance could be tracked by adding small markers on the lanyard.

Consequently, to illustrate, the badge shown in **Figure 1** belongs to a participant who travelled quite a few hours (length of white cable), whose core background is situated in the arts and design (yellow folding-paper token, top-left corner) yet has also worked in the fields of perception and cognition (blue acrylic token, top-

Figure 3 The final, foldable-paper (front) and acrylic tokens (behind) representing the academic interests.

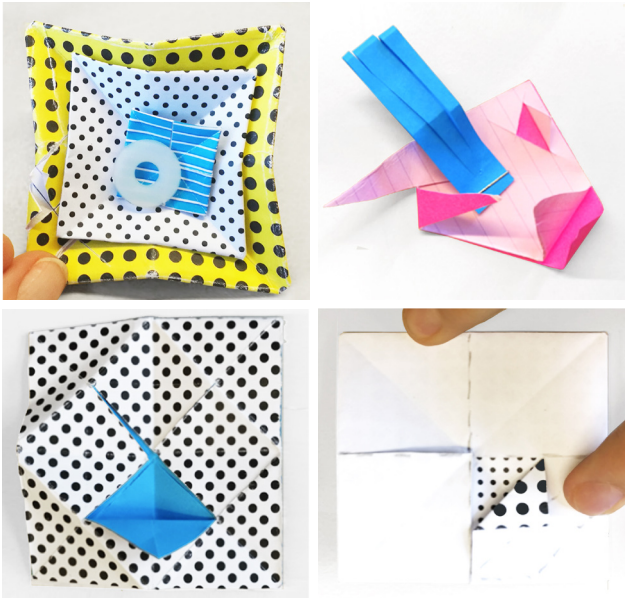

Figure 4 Initial prototypes of folding physicalisation in which a participant folds, tears, trims part of the badges until it represents their profile.

left area). That participant, has only a few publications on the topic physicalisation (length of blue cable). Their future interests lay in further exploring evaluation methods especially in the relation to interactive technologies (combination of red and purple acrylic tokens, bottom right corner) and to a lesser extent work further within the fields of perception and cognition (smaller acrylic token, bottom right corner).

Design Rationale

In our iterations, we designed two conceptual directions for encoding the data: folding and grid-like. A folded physicalisation allows for extra material properties such as texture to be encoded and emphasises the tactile aspects of a physicalisation (as in **Figure 4**). With a folding physicalisation a participant would fold, tear, paint, trim aspects of their badges until it represented their profile.

The grid-like approach on the other hand, was inspired by Cairn[6], LEGO and similar types of modular systems and physicalisations. Grid-like systems encourage flexibility in the types of data encoding since the tokens support modularity and interlocking, and could potentially also allow for more intuitive instructions for assembly **(Figure 5)**, as a participant could simply pick and attach tokens progressively to create a unique badge. Eventually the two conceptual techniques were combined to try and balance the craft-like flexibility of the folding (even if the folds did not encode data) and the intuitive standardisation offered by a grid system.

We chose affordable easy-to-find materials; the tokens were fabricated from either acrylic or patterned paper, engraved with dents to fold into 3D shapes. Using a sturdy material such as acrylic for the tokens allowed the badges to be reused throughout the five-day event. To facilitate interpretation, each parameter was encoded twice, i.e. by colour and shape. For acrylic tokens this meant that each transparent pattern-engraved acrylic token was additionally accompanied by a corresponding coloured paper. Inspired by cross-stitching kits, we used cheap, electrical coloured wires to encode the two quantitative data dimensions: the participant travel time (in hours) and the number of topic-related publications. All tokens were combinable to be assembled on the badge canvas through split pins.

Figure 5 Initial prototypes of grid-like physicalisation design in which a participant chooses between tokens to assemble on their grid.

Direct and In-Situ Encoding

A practical issue with the in-situ assembly is that the value ranges of the data are not known a priori. Without knowledge of these ranges, extreme data cases had to be assumed and tested beforehand. For example, an early iteration of the grid-like system visualised the years of experience by dividing the badge canvas accordingly into past and future (**Figure 6**). This meant however that participants with many years of experience would create badges that mistakenly communicated as having less 'future' space for academic interests. Since we considered this as a potentially unethical misrepresentation, this iteration was rejected and modified so as to allocate the same unchanging space to past and future regardless of actual experience years.

In-Situ Physicalisation Construction

One core design goal of Data Badges was to promote social interaction between the participants. Beyond wearing the badges, social interactions could also be encouraged during the assembly process itself. Therefore, we facilitated a process during which participants collectively are given an empty canvas badge as well as an instruction sheet that doubled as a visual assembly manual and a data legend. Beyond the individual instruction sheets, all the tokens were placed on a centrally located table that was in easy reach for multiple participants, hereby potentially encouraging various casual interactions throughout the assembly **(Figure 7)**.

Assembly Instructions

Initially, participants are meant to encode their core background using the foldable paper-tokens and placing the resulting combination at the top left corner of the canvas badge with split pins (**Figure 8**-1a). Next, all other tokens had to be chosen in their various sizes and combinations to represent either past endeavours – and therefore placed on the left side of the canvas badge - or their future academic interests - and therefore placed on the areas on the right side (1b & 2). The participants visualised their hours of travel (3) and the number of their physicalisation-related papers (4). The wires were measured and cut based on the appropriate scale found on the bottom right of the instruction sheet.

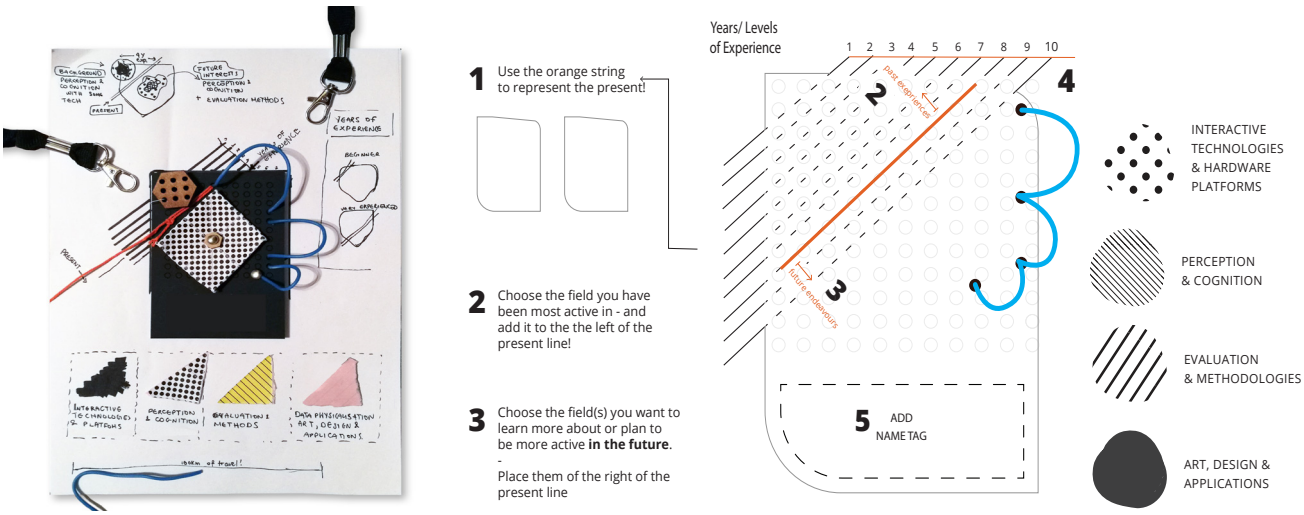

Figure 6 Previous iterations of the assembly instruction sheet. The instruction sheet defined the assembly process as well as acted as the data legend. Both these prototypes show the eventually rejected data dimension of 'years of experience' on the data canvas. This dimension was rejected because with extreme data it miscommunicated the potential future interests of the participants.

DEPLOYMENT

The data badges were deployed in the seminar as originally planned, to an audience of approximately 40 people. The badge making was planned directly after the first introduction as a collective activity that would take approx. 30 minutes.

All participants were invited to assembly a badge for themselves, to be worn throughout the conference duration. Throughout the making process we noticed participants enthusiastically giving each other tips and creatively influencing each other on how place the tokens or even wrap the wires. The focus was on the making process rather than the actual meaning of the physicalisations. People often added, removed and re-added tokens until they matched their expectations. Overall, the making process resulted in a range of physicalisations that although being visually consistent, still varied their adherence to the original encoding scheme **(Figure 9)**. Some badges fully adhered to our instructions, some partially adhered and some completely re-appropriated the tokens - hereby bypassing any meaningful decoding by others. The most appropriated tokens were the coloured wires, perhaps because of their relative abundance, their material flexibility to be swirled, shaped and woven into any custom pattern, or their lack of pre-designated area. Thus, the least restricted data encoding rule with the most flexible material was the most creatively used.

Figure 7 The physical tokens were placed centrally and participants interacted and influenced each other while choosing the tokens and assembling their Data Badge. Either held or in front of them are the instruction sheets, that participants used to as legends throughout the process.

PARTICIPANT FEEDBACK

We sent an anonymous survey to the participants, probing their experiences with making and using the Data Badges throughout the event. Specifically we asked how well the badge design could express their characteristics, how they experienced the co-located making, how they used the badges during the event and finally what they did with their badge afterwards. The survey was shared in the seminar mailing list. We received a total of 16 responses.

Expressiveness and precision. Participants were largely in agreement that the badges offered a creatively "*unique*" (p10) yet imprecise expression of their characteristics in comparison to conventional conference badges. In terms of representational possibilities, participants had diverging views with some stating that the design with modular tokens sufficiently allowed them to represent their professional selves (p6,9,11,14,16) while others described it as still not open enough (p5,10,12,15), or even found the labels too open and "*would have preferred more specific options*" (p7). Almost half of the responses (7, n=16) mention that the encoding was not obvious and that they needed to consult the legend multiple times and/or interpret the encoding in "*freeform ways*" (p8). Interestingly, while this imprecision introduced some difficulties, participants mentioned that the actual encoding or token meaning was secondary to the act of making it: "*in a way it didn't matter, because interpreting how to use them was half the fun*" (p5).

Assembly Process. Participants responded that the assembly activity functioned as a good icebreaker, many referring to it as a fun and good way to interact with others (12, n=16). "*Stumbling along together with other participants was enjoyable and was a good ice breaker*"(p1). Moreover, the co-located assembly process seemed to impact the results, as two participants additionally mention how they saw themselves "*self-regulating*" (p13) and "*negotiating*" (p11) their own representation and assembly decisions based on the designs of others.

Use. When asked about their use during the event there was a consistent response that beyond some occasions in which participants used the badges as a conversation starter, for the most part, the badges were not actively used during the seminar. Their purpose throughout the event was to give a feeling of "*belonging in a unique group of peers*" (p4) and communicate the participants name, with only the most "*creative ones leading to most conversations*" (p15).

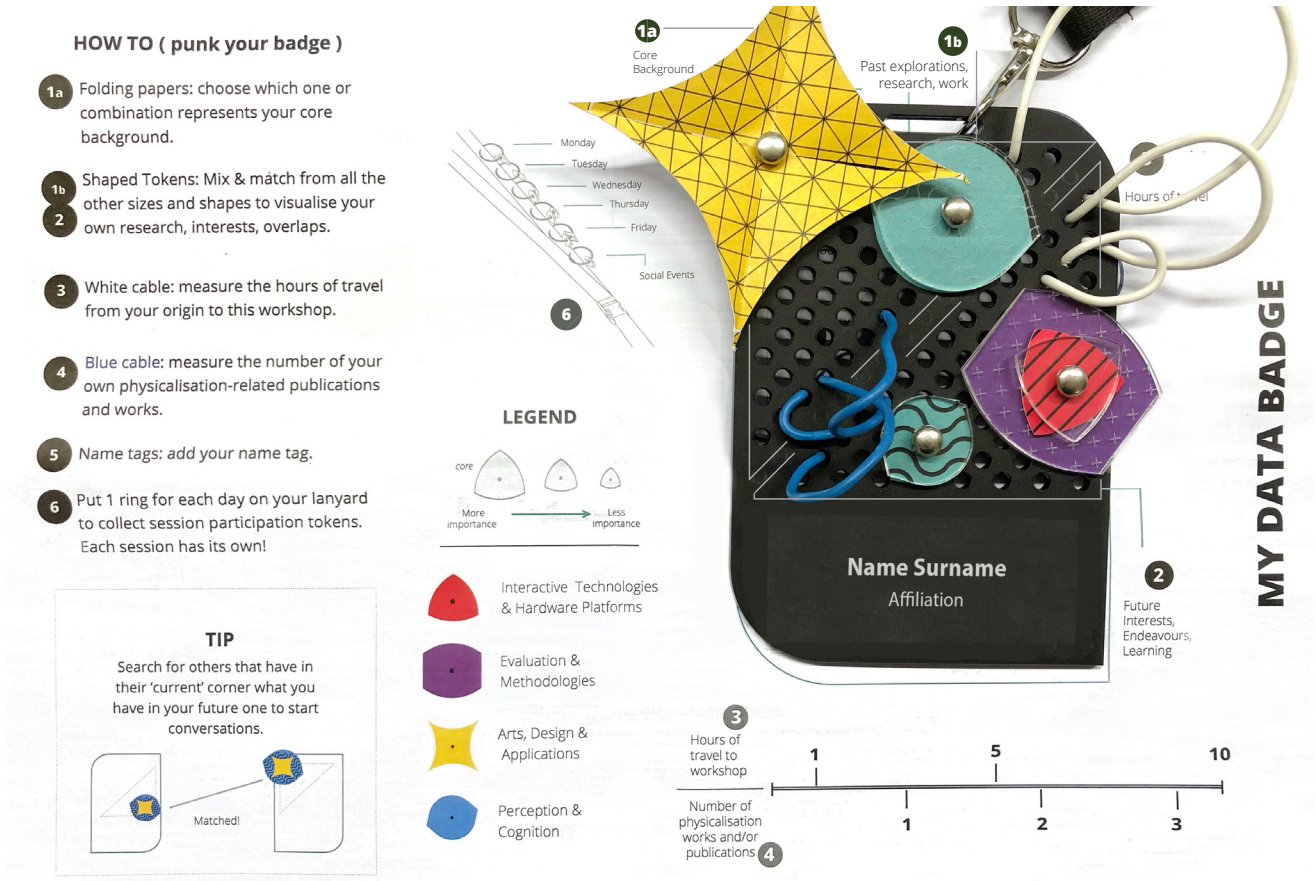

Figure 8 An assembled Data Badge on a backdrop of its instruction sheet. This badge belongs to a participant whose core background is in design (top left) and whose future interests lay in exploring evaluation methods for hardware platforms and to a lesser extent, perception studies (bottom right triangle).

Beyond the Activity. Interestingly, the badges seemed to outlive the event, with 11 of the 16 respondents saying that they have kept the badge visible in their office and still occasionally use it to stir conversation about the event or about physicalisation more broadly.

Lastly, participants also mentioned two practical shortcomings we had not anticipated when designing the badge. Firstly, the badges were quite "*bulky*" (p1, 7, 10) to wear throughout the event. While the sturdy materials chosen were appreciated since they made the assembly easy and durable (p9, p5), the finalised design was quite large to wear. Secondly, the placement of the badge might have inhibited some social interactions as a participant mentioned how the need to focus at another's chests in order to read and interpret a badge encoding was a socially uncomfortable position (p14).

DISCUSSION

While we cannot generalise on the use of the Data Badges from a single deployment with an arguably physicalisation-biased participant sample, we try to provide some insight on its overall impact, believing that our anecdotal data can still help inform future iterations of personalised physical data badges.

Wearability. Conference badges are made to be worn, looked at, touched and photographed, DIY physicalisation badges being no exception. Feedback on our design shows that the token materials must be durable, aesthetically pleasing and easy to assemble yet without becoming too impractical for participants to want to wear. We suggest future endeavours to take into account the real context of use, and especially consider the scale, weight and position of the badges on the participants. A good balance between sufficient token encodings, sturdiness and self-assembly can be challenging to achieve, and further studies are needed in this direction to understand the nuances of physicalisation 'wearability' more broadly.

Re-appropriation. We noticed how flexible assembly encourages for combining the tokens creatively and expanding its intended representational space, but also allowed participants to completely bypass our instructions, escape the predefined encoding and re-appropriate them freely and creatively. In and by itself, this deliberate re-appropriation encodes interpretable and meaningful data by itself, such as, but not limited to, one's personal attitude towards group norms and attitudes. The participants in our deployment for the most part were positively inclined to such re-appropriation. Depending on the intentions, designers might want to encourage or discourage such behaviours by adhering to more or less customisable assembly techniques, or by more explicitly facilitating for such tacit dimensions to be expressed. As a guide, future endeavours should reflect on the importance of precision of representation versus self-expression and compromise to find a balance. While stricter assemblies can be enforced through more restrictive locking mechanisms, they might negatively impact the attractiveness of the physicalisation[4].

Creativity, Order and Ethics. The process of personal physicalisation assembly without pre-logged data still involves some ethical responsibilities from the physicalisation designers. Firstly, without pre-logged data, many data characteristics are unpredictable, making it hard to account for extreme values or cases. Secondly, some data encodings could be misrepresented towards negative connotations. While these issues relate to how elaborate visualisations get modified with the advent of actual data[10], we find them especially relevant when the physicalisation is meant to represent personal characteristics. Unanticipated data or encodings

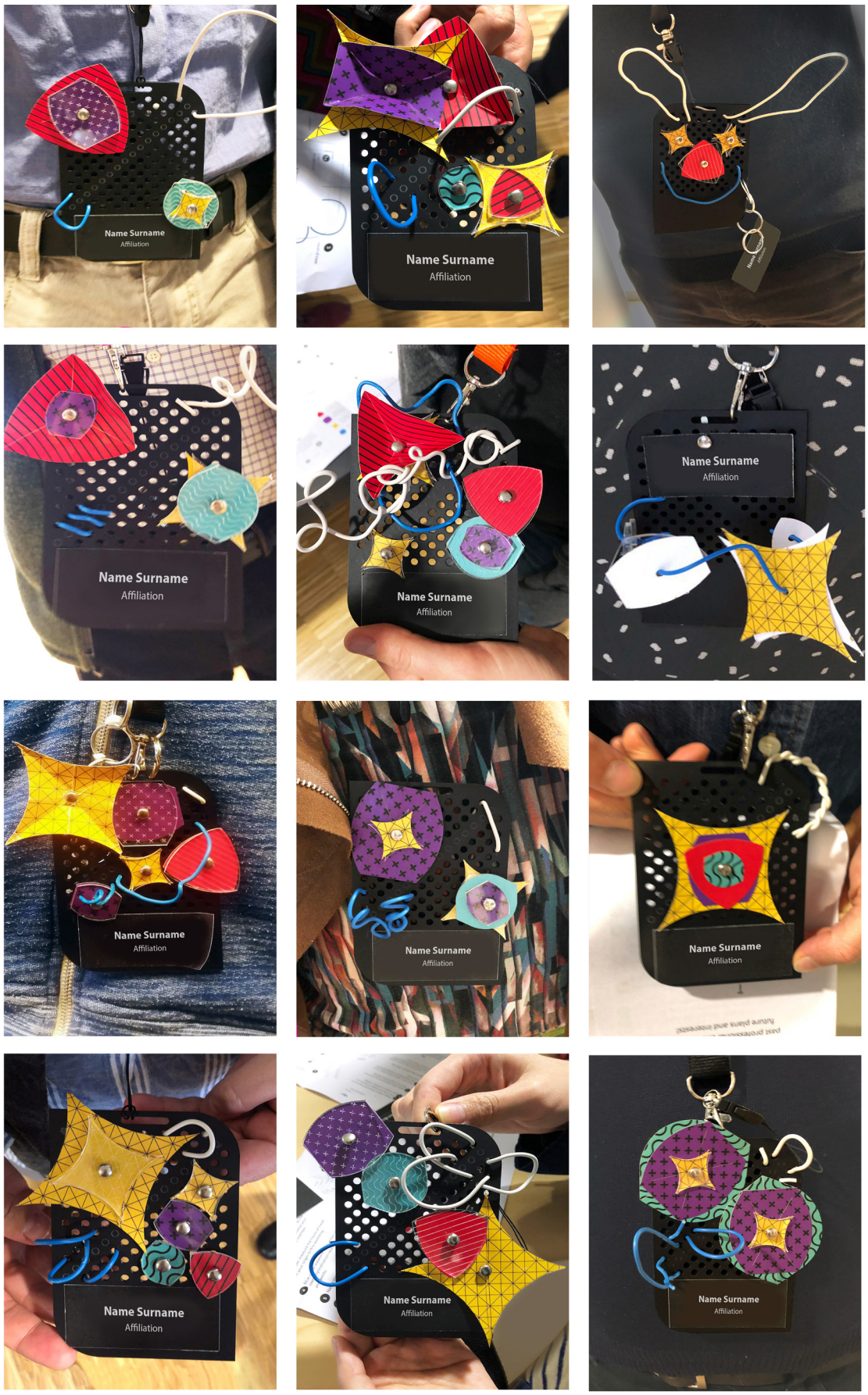

Figure 9 Diversity and creativity in the final Data Badges. Each column is organised so the badge adhering to the instructions are placed on the left, badges that have partially adopted the instructions are placed in the middle, and those with complete re-interpretation of the badge and tokens are placed on the right (with the exception of the bottom right). The name and institution of the participants, and have been removed for anonymity.

can leave badge wearers feel excluded or misrepresented. Physicalisation designers should consider such uncertainties, and account for them both practically (i.e. how the physicalisation will be assembled) and ethically (i.e. how, when assembled, it will transmit an accurate message). We found that the aspect of self-assembly at least partially mitigates some of these issues, since the participants have the power to only add and visualise what they feel comfortable with.

Critical Making. We argue that the making process of the data badges was more insightful and useful than wearing them. Participants agreed that the in-situ assembly helped break-the-ice and while many participants wore the badges throughout the seminar, they were rarely used as conversation starters, or applied in discussions about personal or professional matters. Data Badges could therefore be considered a form of critical making in that they act as a catalyst medium for reflection. Some participants mentioned that making the physicalisation evoked a conscious externalisation of their expectations from the upcoming seminar and even made them reflect on their choices in comparison to other participants. We believe that was the case because our relatively fixed encoding scheme implied a certain need for prioritisation and reflection from their part.

Finally, while it is generally challenging to pinpoint and then objectively measure the true value of physicalisation, we propose that the value of Data Badges, seen as one single example of co-located, shared physicalisation construction, lies at interpreting physicalisation as an open-ended organisation system that can be shared, co-located and appropriated by others rather than solely focusing on its isolated output.

ACKNOWLEDGEMENTS

The authors would like to thank the organizers and participants of the Dagstuhl. This research was supported by the the Research Foundation Flanders.

REFERENCES

1. P. Brusilovsky, J. S. Oh, C. López, D. Parra, and W. Jeng, "Linking Information and People in a Social System for Academic Conferences," New Rev. Hypermedia Multimed., vol. 23, no. 2, pp. 81–111, 2017.
2. W. Willett, Y. Jansen, and P. Dragicevic, "Embedded Data Representations," IEEE Trans. Vis. Comput. Graph., vol. 23, no. 1, pp. 461–470, 2017.
3. Accurat Studio, "Data Portraits at TED 2017," 2017. [Online]. Available: https://www.accurat.it/works/ted/. [Accessed: 07-Jan-2020].
4. Y. Wang et al., "An Emotional Response to the Value of Visualization," IEEE Comput. Graph. Appl., vol. 39, no. 5, pp. 8–17, 2019.
5. Y. Jansen et al., "Opportunities and Challenges for Data Physicalization," in Proceedings of the 2015 ACM Conference on Human Factors in Computing Systems (CHI), 2015, vol. 1, pp. 3227–3236.
6. P. Gourlet and T. Dassé, "Cairn: A Tangible Apparatus for Situated Data Collection, Visualization and Analysis," in Proceedings of the 2017 Conference on Designing Interactive Systems (DIS), 2017, pp. 247–258.
7. A. Thudt, U. Hinrichs, S. Huron, and S. Carpendale, "Self-Reflection and Personal Physicalization Construction," in Proceedings of the 2018 ACM Conference on Human Factors in Computing Systems (CHI), 2018, pp. 1–13.
8. G. Lupi, "Data Humanism: The Revolutionary Future of Data Visualization," PRINT, 2017. [Online]. Available: https://www.printmag.com/post/data-humanism-future-of-data-visualization. [Accessed: 27-Jun-2020].
9. J. Alexander et al., "Data Physicalization (Dagstuhl Seminar 18441)," Dagstuhl Reports, Schloss Dagstuhl–Leibniz-Zentrum fuer Inform., vol. 8, no. 10, pp. 127–147, 2019.
10. J. Walny et al., "Data Changes Everything: Challenges and Opportunities in Data Visualization Design Handoff," IEEE Trans. Vis. Comput. Graph., vol. 26, no. 1, pp. 1–1, 2019.