Synthesizing Form And Data: Developing Practices For Student Engagement And Learning

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KEYWORDS *Visual communication, interpretation, novice, tangible, design process.*

DATE *2014*

ABSTRACT We explore the relationship between form and data as a design agenda and learning strategy for novice visual information designers. Our studentsw are university seniors in digital, visual design but novices to information design, manipulation, and interpretation. We describe design strategies developed to scaffold sophisticated aesthetic and conceptual engagement despite limited understanding of the domain of designing with information. These revolve around an open-ended design project where students created a physical design from data of their choosing and research. The accompanying learning strategies concern this relationship between data and form to investigate it materially, formally, and through ideation. Exemplary student works that cross media and design domains are described.

INTRODUCTION

The prevalence of data in everyday communication has created both need and opportunity to develop information design skills, but the necessary technical skills are outside the scope of typical visual communication students. We describe efforts to engage Visual and Interactive Design students in a meaningful way in this new space. These students are seniors in design but this subject, "Visual Information Design," is the first time that they encounter the data domain. The subject acknowledges a need for designers to utilize the increasingly available data, but to offer some unique contribution in doing so. We believe this to be the student's creative contribution, and our problem has been to facilitate this creation of conceptually and formally sophisticated outcomes with a high degree of critical thinking and synthesis, despite them having minimal understanding of the domain of information design and limited technical capability. The subject curriculum entails a series of formative technical exercises followed by one prescriptive and summative piece of assessment. At the mid-point

through the semester, this is then followed by a second and final piece of major assessment, which is the subject of this paper. This project is an open brief for a physically tangible information design outcome that synthesizes data with form. This design agenda necessitates that the formal outcome resonates with its data–that is, the data mapping should relate meaningfully to form. This is also our learning strategy; by creating physical representations of data, students are working with the data in an embodied way. In this way the process of information design has become a matter of exploring and comparing tangible forms and materials. We describe student work from this major project and their processes.

OPEN STUDENT PROJECT

In this assessment, students created a physical design outcome from their researched data on a topic of their choosing. The physical design outcome could draw upon forms of media and object design students were already familiar with in a conventional design context–cloth, lighting, sculpture etc.–or see them move into an entirely new, idiosyncratic design space. In students being free to select their own topic and datasets, they were asked to engage an area that resonated with them for some reason, which they could subsequently draw on for communication or composition in the final piece.

In terms of developing the project, the students already had an understanding of Tufte's notion of Chartjunk as distracting or affecting a viewer's accurate interpretation of data from earlier work in the semester.[1] The students were also familiar with a recent study showing the potential of decorative elements for improved audience understanding, recall, and appreciation of a data story.[2] An informed design response that considers these opposing viewpoints was encouraged. The student projects were required to emphasize a Gestalt of data and form, an integrated design response that synthesizes the formal outcome with the data that it is concerned with.

TEACHING APPROACH

Seevinck designed the subject curriculum and assessment, but both authors and educators worked towards an overarching agenda of provoking students to see data in new ways. We also share a philosophy of encouraging iterative and reflective design practices, and of mentoring students in this process. The students were required to make, think, and make again. It follows Donald Schön's articulation of Reflective Practice where, for example, practitioners "reframe" their understanding

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of a given design problem based on what they learned from making.[3] Peer critiquing and mentor feedback also worked to reframe the design problem and extend understanding of design possibilities. While we shared philosophies and design approaches, there were also differences: Kerr emphasizes creative exploration through visual communication strategies to inform data organization and visual outcome, and is discussed next. While Seevinck similarly emphasizes exploration, it is through engaging with data-form mapping possibilities. Our shared philosophy and these complementary design strategies have oriented students to question the role, impact and innovative potential of data for design and for society as a whole, thereby moving them towards a unique contribution to the information design domain.

BRAINSTORMING, MIND-MAPPING & CREATIVE THINKING

Brainstorming and mind-mapping constitute an integral learning strategy in this project. Both idea generation techniques were familiar to students due to their background in visual communication and both draw on visual mapping to facilitate creative thinking. While the prior information design assessment had largely precluded such approaches in order to focus on conventional and pragmatic design for a set information problem, this subsequent assessment item re-connected students with the design methods of their domain of expertise. In so doing, it could facilitate deeper creative engagement.

The first key method is brainstorming, considered to be the first idea generation technique ever invented.[4] In this case, the creative thinking concept and design development entailed distributing large pieces of paper to each student and then working on specific brainstorming sessions. Individual brainstorming was a key focus of this approach, the process representing one of the most common strategies for creative thinking for both students and designers.[5] It entails the designer generating a large amount of ideas in a limited timeframe, with the expectation that this will break his/her mental blocks and biases, and produce unexpected and potentially innovative concepts and designs. Essential in this process is withholding judgment of what emerges and often combining separate ideas to develop more viable ones. Incorporated within the process of brainstorming was not only writing or jotting down ideas on paper, but visualizing them through sketching. Sketching is widely seen as an integral activity for designers to develop ideas and creative solutions. As Buchanan observed, "The

sketch is exploratory, effectively a mini-hypothesis in a what-if scenario used to establish relevance."[6] A sketch can serve a pivotal role, extending the development of any initial possibility or idea generated by word-based brainstorming.

Utilized in combination with brainstorming and design sketching, was mind-mapping. Also drawn on paper, this method entails writing, noting, sketching, and creating diagrams in an intuitive way, anything that comes to mind in relation to a topic. This may include images, feelings, responses, key concepts, characteristics, issues, etc. Through using associations, mind-maps help to provide an overview and analysis of an area and create understanding. Like brainstorming they can benefit concept development at the beginning of the design process. Also, when used in later stages, they can help identify positive or negative characteristics of a developing concept.

The following works each reflect a successful application of the outlined teaching strategy. Each represents an unexpected and experimental approach to how data can be interpreted into form. They show how the combination of brainstorming, sketching, and mind-mapping methods could inform a novel design agenda which would drive the solution, layering data with a rich story to enhance its understanding and value.

CHARTING URBAN SUSTAINABILITY

Chloe Edwards's final work consisted of a series of information designs that provided an overview and insight into the topic of urban sustainability. Central to her series of visualizations was a physical information design artifact that displayed global urban growth from 1960 to 2010. The work consisted of a large world map (made of damp tissue paper) with cress plants, representing human population, positioned across it. These plants were systematically grown and maintained to display population changes (see FIGURES 1, 2). This use of plants to show data of urban population growth was to emphasize the fragility of human well-being and city sustainability, visually conveying her concerns as a designer.

Having developed the approach from extensive brainstorming and mind-mapping, Edwards researched and prototyped different plant types that would suit her conceptual needs. Her final "world garden" of cress plants was grown over the course of a week, with additional seeds added each day and some clipping of areas in order to maintain data accuracy. The data was drawn from the World Bank and the World Health Organization. Data growth was filmed using a stop-motion

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animation process. The outcome is an animated work depicting population changes over 50 years. Notably, the cress plants can be seen starting to wither at the end of the clip, foreshadowing the volatile state of our cities. Some photographs taken during the data "growth" are shown below.

Edwards' project demonstrates a strong response of thinking creatively about her data and how to communicate it. Initially, she was focused on the serious nature of the topic of urban sustainability, and overwhelmed by the nature and depth of data she was engaging with. This resulted in a level of creative stage fright and apprehension about the project, and a propensity to draw upon more conventional and straightforward visualization strategies that she ultimately rejected as "boring." Through a process of brainstorming and mind-mapping the project, however, she began to strongly identify the importance of communicating her broader environmental concerns within the data visualization. In outlining her emotional response to the data she had researched,

she began to understand exactly what the data made her feel about the topic. She also realized that this was likely to be just as important to communicate to viewers as what the data denoted. In order to communicate the feelings and significance of the data, she dismissed her initial, more emotionally impartial and less evocative design options. Through creative thinking about her project, she also identified a desire to develop a distinctly artistic aesthetic to display her information. She had no idea what this would be, but knew it was integral to expressing herself and making the data memorable to viewers. Further brainstorming was essential in then developing a focused approach from these vague inclinations. The uncensored and fast-paced nature of the exercise generated an important sense of play in the design process, which loosened her thought patterns and made her increasingly open for "off the wall" possibilities. Consequently, she became more inspired by the data and began to think not only about how the data visualization might look, but also feel, smell, and

FIGURE 1: *Photographic details from the growth cycle of CHARTING URBAN SUSTAINABILITY © Chloe Edwards 2014*

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FIGURE 2: *The world overview from CHARTING URBAN SUSTAINABILITY © Chloe Edwards 2014*

sound. This served to generate the creative leap whereby Edwards realized media for the 3D form could move beyond her perceived range of materials (and those suggested by tutors as options). Suddenly, materials could be unconventional, and even consist of natural elements like water and dirt. Further brainstorming provoked the realization that the material used could also be plant-based, alive and dying. This aligned completely with the sustainability message she had felt strongly about. Along with this, there was a poetic element to this concept data growth that directly conveys what the data was recording.

FOOD MILES BOWL

Another effective and unique way to present data was developed by Sarah Burnes in her Food Miles bowl. The bowl was developed as the key object in an information design series exploring where our food produce is sourced. Apparent in this research material was how little food we source is locally produced, and the significant impact this has on our carbon footprint. Rather than present this data in a heavy-handed and preachy way to make viewers see this bad news, Burnes developed a practical object—a food bowl—that was vibrantly decorated with a pattern based around her data. The attractive pattern consisted of looping bar graphs, which detailed the food miles for the fruits and food people

were likely to place on the bowl. This design allowed for an easy comparison between foods and showed the discrepancy between products we frequently eat. This represented an innovative outcome for the project, as the design artifact was not only focusing on educating people but provoking change in their behavior. It not only communicated data, but also forced the individual to contemplate the impact of their purchasing decisions each time they ate food.

This design evolved from consistent brainstorming, which saw the student continue to question how her work could affect people and their actions in relation to the issue. Burnes, like many students undertaking the Visual Information Design subject, questioned in what ways she could add value beyond merely telling, when working with data. As with a number of other students, she saw her data as disturbing and did not want to present a "negative" piece of design by simply documenting it. The idea of affecting change through design had been a core element of Burnes' design degree, and she saw it as integral in the role of a designer. As a visual design student she had utilized graphics and text in posters to communicate messages and encourage changes in people's behavior, and she realized she wanted to explore opportunities to do the same with data and form—areas in which she had never applied these skills.

The bowl represents an elegant solution as it relates

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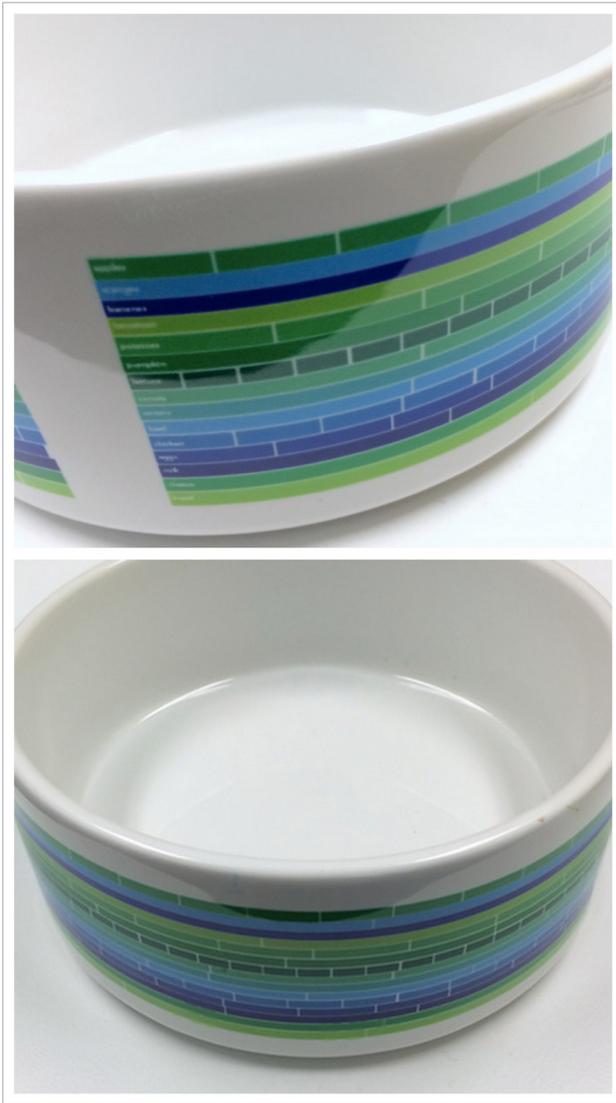
FIGURE 3: *Food miles © Sarah Burnes 2014*

directly to the data and is far more than a canvas for it. The form has its own separate purpose and use, though this is appropriate and completely entwined with the data it displays. The design on the bowl is pertinent also, as the data is not simply data, but an engaging design aesthetic. Its message is subtle, not overt. Importantly, the data does not become purely visual – as aesthetically attractive as it is – so it does not lose its meaning. It can be interpreted upon looking at the bowl. The simple application of text detailing each food represented is all that is needed and it is integrated seamlessly into the design.

TEACHING APPROACH: DATA & FORM

Another key design strategy involved physically exploring data and form, and through experimentation, developing ideas and approaches for concept and application. This was with the intention of getting the students to learn to see the data in different ways. An emphasis on synthesizing the formal outcome with the data that it embodies is consistent with Andrew Vande Moere's notion of "form follows data," an analogy to the architectural maxim of "form follows function."[7] Vande Moere's broader concept of information aesthetics similarly values the combination of art and utility as key to innovation in the information design domain.[8] This integration, as well as the considerations and explorations of data-mapping, are also key to the learning and design agenda described here.

Early on in this project, the students were required to create paper-based representations of a dataset in a quick, twenty to thirty minute workshop session. The students would explore the data as a material, reflecting on what the design elements are to play with and how these could display different variables or values. Thus, they would start to explore with material properties of the paper as well, such as transparency or texture as well as physical size, and look at how this might relate to aspects in the data. By having students think about the materiality of paper as though it was data, their understanding of the data was scaffolded, and they could also start to unpack the data in new and innovative ways. This approach became a core element in the subsequent work where the data and form were to be linked. It was, of course, also informed by continual mind-mapping and brainstorming as described above, to expand and question the understanding of possible design outcomes.

The exploration of data in terms of material, or formal outcome, was quite structured. Once a key interest area or topic and a sense of what the outcome might be

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had been identified (something which was informed by both the paper based workshop and above brainstorming and mind-mapping efforts), the students were guided to create two lists: one of formal variables and one of data variables. Formal variables were informed by what form the student thought the outcome might take–a clock, a bracelet, candy–and could include shapes/depth, position, and color. They are the interpretive, formal dimensions of what the student has come up with. Data variables are from the dataset being used–death rate, chakras, teeth decay rates, etc.

Students would then try to match up the two lists of variables and give the data variables "form." It would be mocked up in paper and brought to class to prompt further ideation and reframing. In the first (few) iterations it does not matter what is matched with what, the purpose is simply to engage because the student is thinking, exploring, and their understanding is improving. The design work would continue in terms of either exploration or in refinement, all the while reflecting on what was created in terms of the topic, story, and intention. When the outcome was an integrated Gestalt that met the designer's intentions, the iterative process stopped. Examples of successful outcomes, along with their data to form mappings are now reviewed.

BEANIE FOR THE NEEDY

Anna O'Reilly's Beanie for the Needy is a design activist project to "raise awareness and help the homeless through crochet data visualization." The project consists of crocheted beanies and packaging design for yarn. The designs reflect O'Reilly's interpretation of Australian census data and reports on population, housing, and homeless estimates. O'Reilly also provides a crochet pattern to map the data to the beanie form. Two crocheted beanies, for adult and youth sizes, have been created (FIGURE 4). These reflect the demographics' age range in the data.

O'Reilly's design outcomes are informed by learning, research, and experimentation. In class she was exposed to a range of information designs, and the crocheted visualization of the Lorenz Manifold chaotic equations intrigued her given the 'simplicity' of using crochet.[9] Through research into the topic of homelessness she learned about local community organizations that knit warm goods for the less fortunate. The exploration of alternatives with these activities led to creative connections and she came up with the idea of crocheting data visualizations for the "data subjects," (i.e. for the demographic represented in the data). Further

FIGURE 4: Beanie for the needy © *Anna O'Reilly 2014. From the top: Youth sized beanie, Adult sized beanie and the yarn packaging also designed by O'Reilly.*

exploration and experimentation occurred; crochet was unpacked into formal dimensions, which were translated into variables. Similarly, specific data variables were identified. Data-form mappings were developed and the forms were created. These mappings and the forms are below (TABLE 2, FIGURE 4). As shown, yarn color represents gender, thickness represents location (the state of Queensland versus Australia as a whole), and beanie size relates to the data demographic. In comparing the top two images of FIGURE 4 one can therefore see that there are more adult males "sleeping rough" than females.

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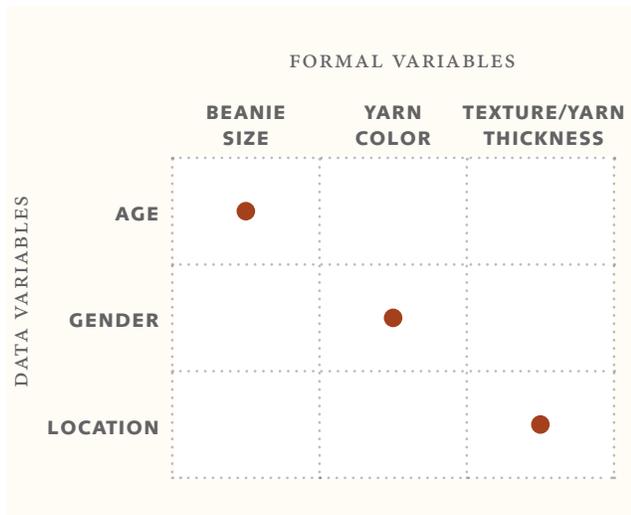
TABLE 1: *Data mapping in O'Reilly's Beanie for the needy.*

The data also communicates the fact that a significant number of homeless youth are located in the state of Queensland.

There is a particular focus on people sleeping in improvised dwellings, tents or sleeping out and the formal outcome is consistent with this data given that "This group is most likely to benefit from warm accessories such as beanies." This reflects a tight integration, or synthesis, of data with form. As her design process continued, this synthesis became the conceptual driver that pushed her project further. The concept of crocheted data visualizations to warm the data subjects was extended further as two additional design agendas emerged: raising awareness about homelessness, and facilitating social action through this formal outcome.

O'Reilly's beanies are everyday artifacts and as such, can raise awareness in everyday life–for all of us. However, subsequent design explorations pushed this further to also consider yarn packaging. As shown in FIGURE 5, this paper wrapper also includes an infographic with the homeless data. As the concept behind the work and the project gained momentum, she also realized the potential for facilitating community engagement through this packaging. A pattern for crocheting a beanie for the needy was also therefore included.

Here the integration of data and form is an effort at facilitating a design outcome, one where a given visual or formal element also serves a purpose such as the representation of data. In this sense the work aligns with Vande Moere's notion of form follows data. Form follows data informs the rationale behind the work and as such helps to shape a thoughtful compositional structure.
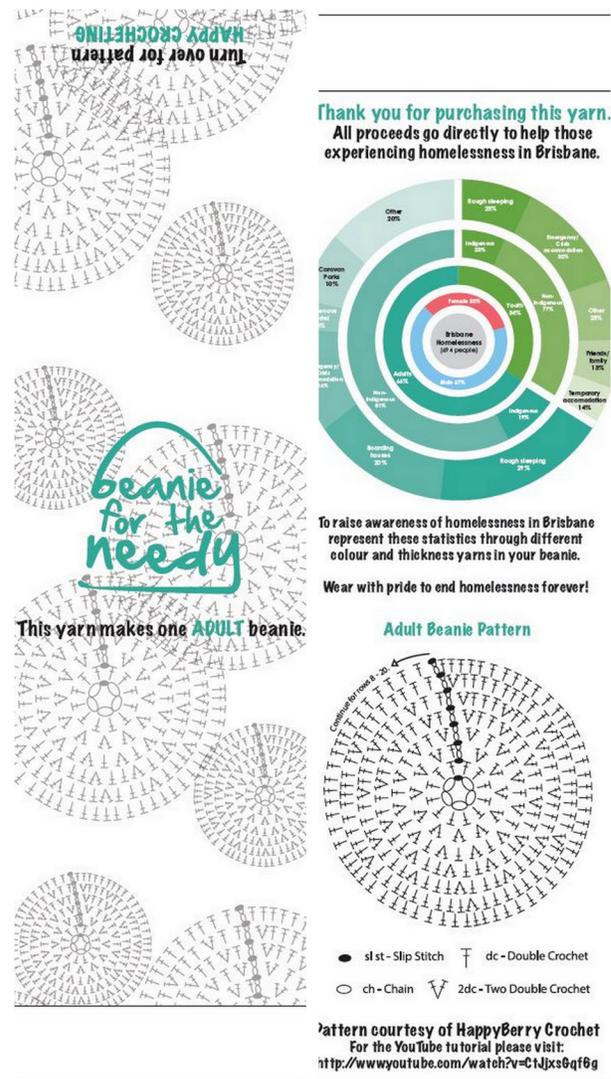

FIGURE 5: Beanie for the needy © *Anna O'Reilly 2014. Left to right: Yarn wrapper (packaging) designed by O'Reilly provides instructions for crocheting an adult beanie, as well as an explanatory infographic also by O'Reilly:*

"The information designer's role is to transform individuals from passive citizens to engaged citizens by educating them about homelessness in their area and providing a method to get them involved…These are not just any regular beanies, ingrained in their pattern is the pattern of homelessness. Combining the pattern of homelessness with the crochet pattern for beanies creates a powerful metaphor."

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SUBTLE BODY COLOR BRACELET

Nicole Cameron's work similarly shows how form follows data, but more specifically it demonstrates how the integrated exploration of these two variables has come to a conceptual strategy that drives these outcomes. The work is a bracelet that integrates three models of color: RGB, CMYK, and the spiritual Chakra understanding of color and how it relates to the body (FIGURE 6, 7).

Here the data has served as a launch pad for further investigations, and ultimately driven a conceptual framework for the formal outcome. An original interest in the body's chakras prompted her design inquiry and subsequent exploration revealed that these had color. This, in addition to other understandings of color (e.g. RGB and CMYK models) became the scaffold or framework for her thinking. The resultant bracelet has been designed for the "spiritually aware" designer or creative or those who want to improve their practice. "Worn on the body, it serves as a daily reminder of the chakras and symbolic colors allowing the individual to acknowledge the emotional, mental, and physical associations the

FIGURE 6: *Subtle body bracelet © Nicole Cameron 2014*

FIGURE 7 (BELOW): *Working progress through material exploration in the Subtle body bracelet © Nicole Cameron 2014*

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chakras have on the body, including, the importance of maintaining balance in order to work at the individuals optimum." Subtle communication means that the data is present without this spirituality being overt. As Cameron describes, "each of these variables influence design and the way people perceive [it]." Exploration of the chakra dataset was oriented towards a formal solution that would relate it to the body (as the data similarly describes the "subtle" body).

Early efforts looked at natural materials and necklace, this evolved into a bracelet as shown above. Paper based explorations were undertaken but the required curvature for wearing on an arm was problematic. A panel-based form that related to both the color data and the context of use was developed: "the CMYK area (bottom part of the diagram) was flared outwards to allow for the widening of the wrist and to also accommodate the fourth value K." In this way, the data and formal explorations moved across a variety of datasets and formal possibilities. While the initial dataset consisted of chakra hues and hue frequencies, further enquiry led to expanding this to hue CMYK percentages and hue RGB values. Given the concept and context of use, the formal mapping destinations include position, size, shape, as well as the more literal, direct mapping to color hue. As shown in FIGURE 8, a chakra hue is depicted directly through the colored ellipse and more abstractly by size of the ellipse to denote its frequency.
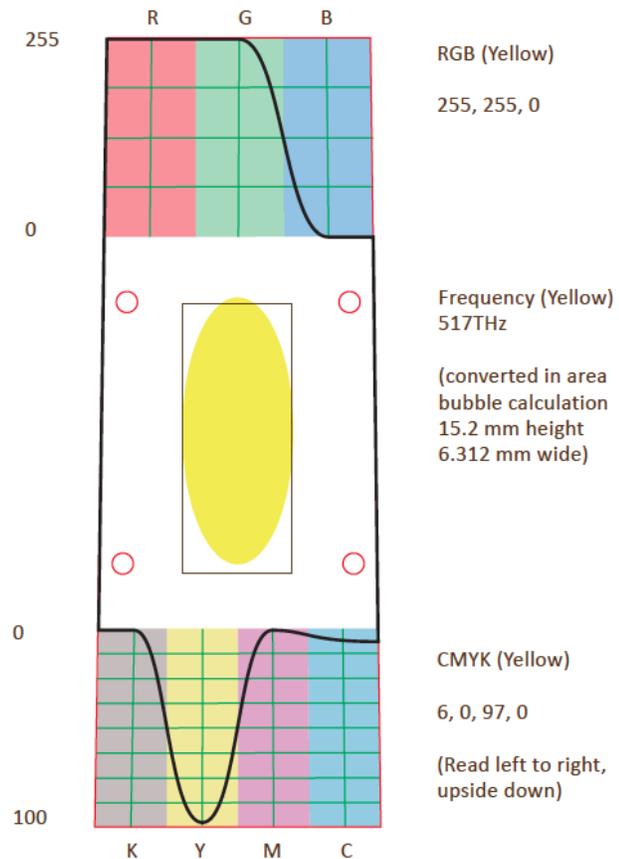

FIGURE 8: *Data mapping annotated in a panel of the Subtle body bracelet © Nicole Cameron 2014*

TABLE 2: *Subtle body bracelet*

| | FORMAL VARIABLES | | |
	COLOR HUE	POSITION	AREA
CHAKRA (HUE, POSITION ON BODY)	●	●	
HUE FREQUENCY			●
CMYK VALUE		●	●
RGB VALUE		●	●

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CONCLUSION

Broadly speaking, our approach of including formal elements and audience engagement within the design problem locates this work within a context of artistic visualization; visual representations of non-visual data that can be read, but which may not be recognizable as visualizations.[10] Furthermore, while the student efforts shown here are a part of the growing trend of information art, "where data is a means to express personal feelings and to create works that reach out to our senses and emotions;" they are also denotive.[11] That is, unlike some information art, all of these works have data at their core, representing it in some shape or form. Each involves a data to form mapping that allows one to "read" the data held within (albeit with training).

These examples demonstrate how formal, non-data "ink" can be synthesized with the data and its communication in a deep and thoughtful way. As a result, we see that highly evocative and thoughtful artistic visualizations are created. This work is conceptually deep, has a strong composition, and delivers "functionally." It marries form to data and function–be that the function of communicating or representing data, or an innovative new function of effecting social change such as through changing people's attitudes towards food purchases in Burnes' Food Miles project or changing passive citizens into active agents to improve the conditions for the homeless, as in O'Reilly's Beanie for the Needy. The strategies serve to emphasize the need for original thinking, exploration of full design possibilities and an agenda to say something with the data and add value to it, rather than simply documenting it. They show how the novice information designer can engage with this new domain in an engaging way, one that facilitates their creative voice as well as leveraging data for contributions that range from evocative to utilitarian to facilitating behavioral and social change.

BIOGRAPHY

Jen Seevinck is an electronic artist, researcher, and lecturer in Interactive Visual Design at QUT with a PhD in Computing Sciences, Masters in Electronic Arts and Bachelor of Design Studies. Her work spans interactive art, design, tangibles, and visualization focusing on interaction design for creative and emergent audience behaviors.

Jeremy Kerr is an academic and designer, whose research interests range from sustainable design to music branding/promotion to new approaches in visual communication and narrative design. He teaches in Interactive and Visual Design at QUT with a PhD in Design and Bachelor of Design (Visual Communications) (1st Class Honours).

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