Creating translational knowledge: the role of visual communication design and prototyping methods in the research process

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Abstract

This paper explores the role visual prototyping by visual communication designers can play in the navigation and communication of textile design research. Typically, visual communication is only applied to dissemination of research activities – which happens at the end of a project. The authors argue that visual communication has more to offer when it is included as core element of the research process supported by visual prototyping. Using an illustrative case study of the Bio-Inspired Textile research project at University of the Arts London in collaboration with students from the Graduate Diploma Graphic Design course, the authors discuss how this was explored in practice and the benefits of such an approach. Here the project was conducted between textile design researchers and graphic design students who took on a student-as-researcher role. The Bio-Inspired Textiles research explores how eight different structures found in nature can be applied by textile designers. The communication designers were asked to explore these structures and communicate them through physical and digital typographical prototypes. Using an after-action review method, the paper discusses the insights of the project from both researchers and student perspectives. The authors conclude that visual communication designers can play a vital role within a research process and their methods, such as prototyping, enables the creation of new translational knowledge and its application into design practice.

Visual communication design; Prototyping; Student-as-researcher; Textile research; Knowledge exchange; Translational Knowledge

Traditionally, Graphic design has focussed on developing visual communications in response to client-needs (Wragg & Barnes 2016). In research, this role is often restricted to the dissemination of results. However, there is now a growing demand within industry and academia for a new type of designer. One with the '*expanded capacity*' to undertake and participate in research (Vaughan 2017). In our world full of challenges and 'wicked problems' (Rittel and Webber, 1973), the research space is expanding to encompass interdisciplinary teams that could benefit from the integration of visual communication into the research process as part of the creation of new knowledge.

This paper explores the potential of the role of visual communication designers as researchers, rather than solely as a disseminators of results. The paper describes a knowledge exchange collaboration between visual communication students at University of the Arts London (led by Author2) and Bio-Inspired Textile team (Author1 and Author3), working on an interdisciplinary research project. The Bio-Inspired Textile research aimed to translate knowledge from the field of material science (Naleway et al., 2015) regarding the ways biological structures create extraordinary properties compared to the simple materials that they are made of. Fundamentally, the research focused on how the structural lessons found in nature could be applied to textile design and practice.

Working with Bio-Inspired Textile researchers, the students on the Graduate Diploma Graphic Design course received a live brief providing them with the unusual student-as-researcher role rather than a more typical student-as-professional role. Through a six-week collaboration, the students created 15 typographical prototypes which were used to explore how the biological structures could be translated for a textile design audience. Reflection-in-action (Schön, 1983) followed by an after-action review (Morrison and Meliza, 1999) was used to establish what had happened and what role visual communication had played in the process of creating new knowledge.

The paper concludes that working with visual communication designers and their prototyping methods helped to bring a different perspective – as non-textile experts - and clarity over the key messages needed to translate the biological structures from the material science field for designers. In doing this, the visual communication designers played a vital role in the research process, allowing the Bio-Inspired Textile researchers to create new translational knowledge about the structures for their application into textile design. In exchange, the students gained an advanced level of experience, not only with information regarding the biological structures, but as active participants (students-as-researchers) in the research process through prototyping.

Visual Communication & Research

In academic research, visual communication is generally employed to disseminate outcomes and findings, which happens at the end of a project. Outcomes, outputs and dissemination are all common terms that describe visual communication activities in their relationship to research. This suggests that visual communication happens in service of the research. This is consistent with commercial practices in visual communication where the goal is to achieve communicative efficiency of given content (Frascara, 1988). The knowledge created in the process of developing the communication is rarely discussed, as such designers have faced epistemological and methodological challenges in establishing an evidence-base for visual communication (Wragg & Barnes, 2016). Where visual forms of knowledge production are seen to lack the ‘unambiguous capacities’ of numerical and textual representations (Drucker, 2014), it is contested whether these processes can generate knowledge (Renner, 2017). However, Hinrichs et al (2018) counter this by suggesting that visual communication can serve more than one purpose in research. Apart from its role in communicating already existing insights and knowledge, it can also *‘facilitate exploration’* in order to arrive at *‘new discoveries*’.

To understand how this might happen, practice-led approaches provide a theoretical frame to establish how images can generate meaning in research, particularly through prototyping (Renner, 2010). This paper argues that the exploratory processes of prototyping, reflection, and critique (Poggenhohl, 2018) that designers use to develop their understanding of a problem have something to offer when included as a core element of the research process.

Prototyping in Research

Prototyping is generally exploratory and iterative; a process used to generate knowledge to inform a larger system. O'Leary (1998) notes that prototyping is a particularly useful and flexible tool for investigating nonnumeric and symbolic information. Normans' theory of the 'cognitive artifact' (1991) offers a useful frame to understand how this process might work. He proposes that all design can be understood as an act of representation and therefore, is concerned with cognitive artifacts. Normans defines the cognitive artefact as an '*artificial device'* that '*serves a representational function'* affecting human cognition. In this view, a prototype can be thought of as both a form of cognitive support and as feedback in a research process (Boyd Davis & Vane 2019) as they capture and 'externalize' a design, and thinking in process.

There is a growing body of literature discussing the role of visual prototyping, specifically in interdisciplinary research. For example, in the field of Digital Humanities, designing and prototyping are considered '*core activities*' by Galey and Rueker (2010). In their paper, which explores prototypes as theories, the authors explore whether the arguments embodied by prototypes are 'contestable, defensible, and substantive', and further question whether the prototypes themselves might be considered original contributions to knowledge. Galey and Ruecker suggest three broad functions of a prototype.

- Prototype as tool: functions as an affordance that is used to carry out a given task
- Prototype as experiment: functions as a process that is used to test a theory
- Prototype as theory: functions as an externalisation that is used to communicate an interpretation

However, as Hinrichs et al (2021) note, each of Galey and Rueckers definitions present prototyping as a means-to-an-end. They argue that a prototype can in fact function as *'an object of inquiry with its own mediating characteristics'.* The idea of a design as mediation or translation is particularly relevant in interdisciplinary research, where researchers bring different knowledge, understandings and languages to a project (Ribul & de la Motte, 2018). Specifically in the field of Design, Poggenhohl (2018) suggests that prototypes can play a vital role in making visible to everyone involved what is '*known, half-baked and faulty*' about an emerging design problem. This paper builds on the idea that prototyping in design can be used as a form of translation but rather than focussing on exploring a design problem, we investigate this in the context of research.

Visual Communication & Education

Visual communication as a subject is 'more typically associated with vocational training than knowledge-production' (Nelson, 2013:3). The focus of the practice is often to address and solve an articulated problem. Consequently, studio-based pedagogies in design education are structured to emulate professional practice (Motley, 2017). These 'signature pedagogies' are defined by Shulman (2005:52) as the '*types of teaching that organise the fundamental ways in which future practitioners are educated for their new professions*.' For example, the 'live brief' is a signature pedagogy in design education. Here, an external client sets a creative brief for students and the student-designed responses generate creative visual 'solutions' for the client. This type of project-based learning positions the student-as-professional, requiring them to work as 'design experts;' employing implicit knowledge to 'conceive and develop original products, services, and communicative artefacts' (Manzini, 2015:65). The outcomes of such projects are discussed through critique, where the focus of the discussion is generally on their 'appropriateness' as a 'solution' to the given problem (Cross, 1999, Norman, 1991).

Yet, Drucker (2014) speculates that as visual communication programmes are required to respond to more sophisticated problems, they will require a corresponding sophistication of analysis and knowledge production. Therefore, there needs to be a shift in focus from solely problem solving, where students communicate knowledge that is embedded in their visual design solutions (student-as-professional) to an additional focus on the student-as-researcher. In this new researcher role, students communicate explicit knowledge through process and prototyping to create design knowledge (see Table 1). Therefore, to focus on knowledge production in visual communication, the case study outlined in this paper considers the student-as-researcher and their methods (prototyping) where the design process is viewed not just as one of problem solving but one that aims to 'produce knowledge useful to those who design' (Manzini, 2009:5).

Table 1. Defining the two different roles: student-as-professional and student-as-researcher

Role	**Focus**	**Communication**	**…in order to produce**
student-as-professional	address and solve an articulated problem	implicit knowledge embedded in outcomes	creative visual solutions
student-as-researcher	prototyping	explicit knowledge communicated through process	design knowledge

Bio-Inspired Textiles

Bio-Inspired Textiles (BIT) is an Arts and Humanities Research Council funded research project that combines the fields of biology, material science and design (specifically textile design but also visual communication design as this paper discusses). One of the aims of the research was to develop a practical framework to help textile designers access relevant lessons concealed within the field of material science regarding the extraordinary mechanical properties observed in biology that are the result of structural design.

For example, *nacre* otherwise known as *mother of pearl*, is found in the lining of the Abalone shell. Nacre is primarily composed of chalk, a substance known to be brittle, alongside a nominal amount of protein. It follows that one would expect nacre to be quite brittle, but it can be up to one thousand times more resistant to cracking than chalk alone because of the way the chalk and protein is structured (Barthelat *et al.*, 2007).

As with any scientific discipline, designers find the knowledge from material science, with their mathematical equations, microscopic imagery and discipline specific language, difficult to engage. The gap between the knowledge presented in material science field exploring relationship between the structure (layers) and function (strength and crack resistance) of the Abalone shell and textile practice is wide. This is evident in the limited examples of textile designers drawing on biological structural design from the literature. Such activities tend to be research centred and niche in design (Kapsali and Hall, 2022), but commonplace in material science. Bridging this gap constituted one of the main challenges for the BIT researchers.

Bio-Inspired Textiles and Communication

In order to translate the relevant lessons from biology for textiles designers, BIT researchers drew on the work of Naleway et al. (2015) whose review of the relationship between structure and function in biological materials that demonstrate advanced mechanical behaviours revealed eight recurring structures. The consolidation of such a vast body of knowledge into eight biological structural design elements provided a more consistent framework of terminology for the material science community. However, Naleway at al. took this one step further by providing graphical representations of each biological structural design element offering greater clarity to his audience (Figure 1) and in doing so, created a visual language, accessible to designers and set the scene for non-specialist audiences to engage with this information.

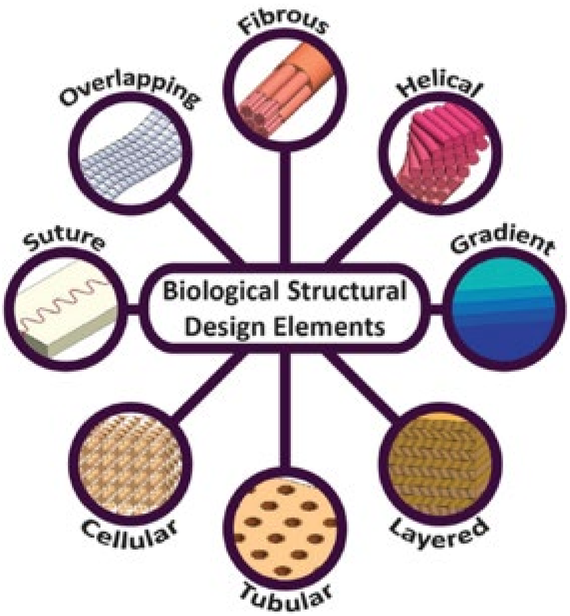


Figure 1. Naleway et al.'s (2015) graphical depiction of the eight most common biological structural design elements.

Typically, in the scientific disciplines, photographic images, such as those from under a microscope are presented to aid understanding. Comprehending the meaning of these photographic images involves experience and specialist training, skills designers do not typically possess. This makes it easy for the information encoded within the photographic image to be misunderstood by the designers. The translation by Naleway et al. (2015) of a photographic representation into a graphic representation (more commonplace in the design disciplines) provides a more accessible way for design researchers to access and apply the knowledge.

In addition to the graphic representations, Naleway et al. (2015) used a combination of photographs from under the microscope and literal photographs of the source of the example to fully communicate the structures. The three visual elements were the key to the translation for the designers (figure 2). Figure 2 demonstrates the layered structure, described in the text as "composite materials that consist of multiple layers or interfaces and are often employed to improve the toughness of otherwise brittle materials" (Naleway et al. 2015:5461). This is first, visually, explained using a graphic representation of the structure followed by a photograph of a biological specimen, in this case the Abalone shell (mother-of-pearl). Finally, physical details of the layered structure are presented with accurate microscopic imagery revealing the layers found in the lining.

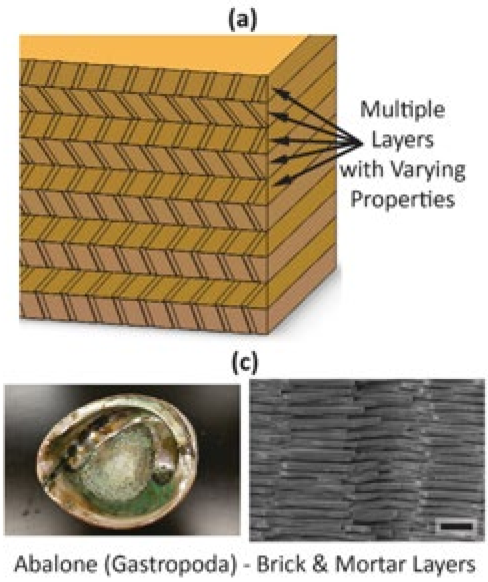


Figure 2. Naleway et al.'s (2015) three types of imagery used to explain biological structural design elements (Top: Naleway et al.(2015), Bottom: adapted by Naleway et al (2015) with permission from Barthelat at al. (2007), Copyright 2007, Elsevier)

The combination of all three of these images represent information that is not necessarily spelt out in the text, often accepted as tacit knowledge for those in the material science field. It was the combination of these visuals, especially the graphic, that enabled the translation of knowledge to be easier to understand by the designers. However, the leap from understanding this information and how it can be successfully applied into textile practice, such as a weave or knit structures was still to be established. It is the application of this knowledge for a textile designer that provided the challenge for researchers to investigate alongside visual communication designers.

Methods

This research was conducted between textile design researchers (Cathryn Anneka Hall and Veronika Kapsali) working on the BIT research project and thirty-two visual communication students undertaking their Graduate Diploma at University of the Arts London led by Laura Knight. The collaboration, which took place between February and March 2022 was designed to involve the graphics students, not as a dissemination exercise or playing the more traditional role of problem solver for a commercial client (student-as-professional) but they were asked to become part of the research process (student-as researcher).

The collaboration was set up as a knowledge exchange activity. Using a live brief, the students were asked to explore the structures in small groups using typographical prototyping as the main tool of investigation. Typographic design was chosen as the visual communication activity as it addresses two important but distinct creative challenges that are relevant to the research; syntax and semantics. Syntax relates to the 'essential or structural forms' of the type (Johnston 1962). Semantics addresses how typography evokes meaning through visual association (Carter, 2007). Typographic design balances both aspects. In total fifteen prototypes were produced by the students which were analysed by the Authors to establish the findings presented here.

Working in this way, the BIT researchers could obtain a non-textile perspective and highlight areas of confusion within the communication of their framework. The project was conducted across a six-week period where the BIT researchers actively engaged with the students on three occasions: to brief the students in the task, provide interim feedback and view the final presentations. One student project is used as a case study to exemplify the process that was taken during the collaboration and demonstrate how prototyping was used. However, all fifteen prototypes were analysed for the research and key examples from across the students' work are used for the discussion of the insights.

Reflection was made by the researchers throughout the collaboration, as a form of reflection-in-action (Schön, 1983), but was only formalised during after action review (Morrison and Meliza, 1999) in which questions such as 'what happened?', 'what went well?', or 'what could be changed?' were asked. Finally, the paper also draws on the reflections made by the students themselves to present both the researchers and students-as-researchers perspectives leading to the insights presented in this paper.

Visual Communication Design Collaboration

The visual communication design collaboration was the third collaboration during the research project. To first, address the challenge of translating Naleway et al.'s (2015) eight Biological Structural Design Elements for a textile design audience, the BIT researchers attempted to outline the relevant design lessons within each structure themselves. To test how this could be applied to textile design, the BIT team piloted two collaborations, one with professional textile designers and second with Graduate Diploma Textile Design students. By working with these two textile specific audiences, the researchers refined their understanding of the design lessons and began to establish how they could be applied to a variety of textile techniques (yarn spinning, knitting, weaving, embroidery, fabric manipulation etc…). Although the communication between the researchers and the textile designers in these two pilots had demonstrated, in the most part, an understanding of the structures and their application to textile practice, it had also highlighted key points of confusion. Thus, it became clear that further refinements were required to bridge the gaps between science and design practice.

The collaboration between the BIT researchers and the Graduate Diploma Graphic students was established to explore these required refinements. The collaboration was created as a knowledge exchange activity to position the students-as-researchers rather than the typical student-as-professional approach used in the dissemination of research outputs/ findings etc, The BIT researchers provided students with experience of an interdisciplinary research brief and the students provided a non-textile perspective of how the structures could be communicated for a specific textile audience. In this way many of the assumptions and tacit knowledge held by both the BIT researchers (both textile designers) and the textile professional and textile student collaborators could be stripped away and further clarity of the key textile design lessons found in biology was obtained.

Bio-Type Project

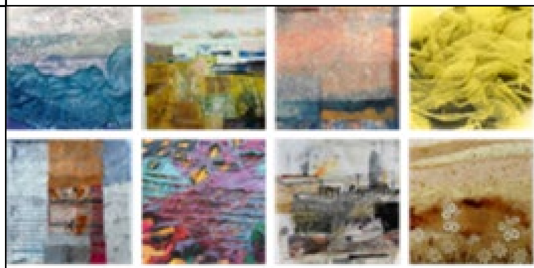
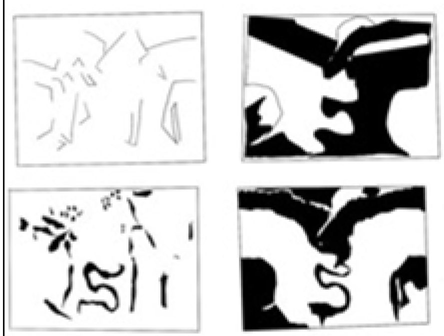
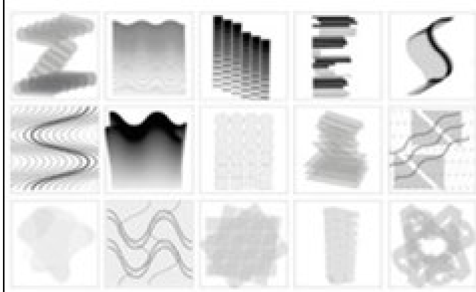
The project, called Bio-Type, asked a group of thirty-two graphic design students to work in groups of two to translate a single Bio-Inspired Design structure into typography as both an alphabet, and a piece of moving imagery, that spells out the name of the structure.

As discussed, this knowledge had already been visually translated into photography and in graphic forms by Naleway et al. (2015). While these enabled the translation of knowledge for the designers, the link to its application into textiles (such as weave or knit structures) was less clear. The main communication challenge was therefore that the essential structures needed to be communicated alongside their creative potential in application. Typographic design was used as the visual communication activity in two ways: syntax (essential structural forms) and semantics (meaning through visual association). To address syntax, alphabets are designed as a series of distinct visual signs, each with its own structural norms. Students would therefore need to explore the ways that the Bio-Inspired structures could be clearly communicated through the basic structures of the letterforms. In addition, the students addressed the communication semantically in their material and visual choices. This provided the opportunity to visually link the Bio-Inspired structure's to their creative application in textile practice.

Students were required to use prototyping to develop their understanding of the concepts. They were asked to generate a wide range of prototypes using different materials, methods and processes and as the project progressed, narrow down and commit to one concept. Using further prototyping, they were then able to develop a set of letterforms that communicated their interpretation of the structure.

As table 2 describes, teaching and learning was delivered through workshops and studio critiques supported by readings and technical learning. The BIT researchers' interactions with the students were deliberately planned across the project at specific points to create knowledge exchange.

Table 2. BioType Project Structure across six weeks

Week	Activity	Output Examples
1	**Brief launched** Students allocated a group and structure and asked to complete the following visual research tasks. 1. Collect 30 images that communicate their structure 2. Produce 10 iconic prototypes based on a single image from the found images 3. Generate 50 symbolic prototypes based on their structure These visual prototypes enabled the students to develop a basic understanding of their structure and begin exploring the possibilities for communicating it visually.	 *Figure 3. Image research into the layered structure, Credit: Yujuan Cui*  *Figure 4. Iconic prototyping of the layered structure, Credit: Moeko Doi*  *Figure 5. 30 symbolic prototypes of the layered structure, Credit: Moeko Doi*

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<td></td>
<td>Exploration Workshop
Building on their visual research, students further explored their understanding of the structures through collective drawing and paper model making. These visual and physical prototypes further developed their understanding of their structures through processes of collaborative making and discussion.</td>
<td>
Figure 6. Paper prototyping of the layer structure, Credit: Laura Knight</td>
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<tr>
<td>2</td>
<td>Briefing with BIT
Researchers presented:
the BIT research
the structures
design questions for each structure
Following the briefing, students were asked to evaluate their prototypes so far, using the design questions set out in the briefing. They were asked to choose the three they considered to be the most effective or consider developing further prototypes based on the design questions.</td>
<td></td>
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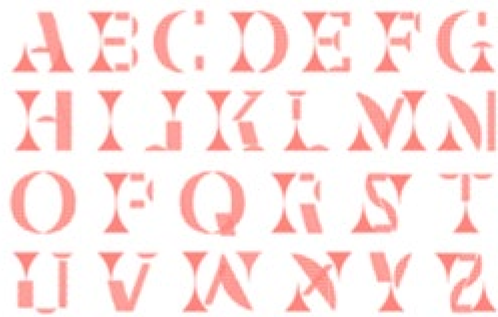
<tr>
<td></td>
<td>Studio
Students presented their chosen prototypes in a studio critique. Prototypes were discussed and evaluated in terms of:
their effectiveness in visually communicating the structure
their potential for development as a response to the design questions</td>
<td>

Figure 7. Prototype presentation for Layer structure, Credit: Yujuan Cui and Moeko Doi</td>
</tr>
</table>

3	**Typographic system prototyping workshop** Students begin to explore typographic systems - using rule-based drawing around a single structure to explore scales of visual dimensions.	 *Figure 8. Typographic system prototypes for Layer structure, Credit: Yujuan Cui and Moeko Doi*
4	**Presentation of prototypes to BIT**	 *Figure 9. Chosen prototype for BIT presentations, Credit: Yujuan Cui and Moeko Do (see also Fig.13)*
5	**Final studio** Peer critique of final proposals	
6	**Final presentations to BIT** *See Fig.13 & 14*	

Case Study: Layered Structure

At the end of the BIT research project (after the collaboration) each design lesson obtained from the structures found in biology was distilled into a simple text relevant to textile designers. The graphic design students' work formed part of the methods that provided this clarity. For layered structures this message is as follows: “Biology can teach us how layers combine materials in different ways for specific jobs” (Bio-Inspired Textiles, 2022).

Just like the Abalone shell with its brick-and-mortar layers of chalk and protein that ensures the mother-of-pearl is stronger and more crack resistant than if it had been made up of either chalk or protein alone, textile designers can ask themselves how they can combine and position textile materials to create specific functions. The example provided by the BIT researchers, is a quilt made from three layers of materials: a woven textile on top, a filler textile in the middle and a softer textile at the bottom. Alone, none of these textiles achieve what all three materials create together.

However, to reach this clear explanation of how layered structures can inform the way we design textiles, the graphic design students explored how this structure could be visually presented. Here we will explore the work of students Yujuan Cui and Moeko Doi.

Beginning with prototyping workshops the students Yujuan and Moeko explored, paper modelling and a hidden drawing exercise in which paper was split into four sections where each person took turns drawing their own section of a letter without looking at the previous (figure 10). This resulted in a disjointed letter form that later inspired the student’s alphabet and moving image.

Figure 10. Paper prototypes (left) and letter sections exercise (right) Credit: Yujuan Cui

Across the weeks, focused on layered structures, the students started to explore digital prototyping and how textile layers could be communicated (figure 11). Prior to interim feedback from the BIT researchers, Yujuan and Moeko developed a concept using three layers of engraved Perspex. Each Perspex layer contained shapes which when brought together in a moving image created the typeface (Figure 12). They specifically designed each layer using a different pattern to represent different materials that together became more than the individual parts.

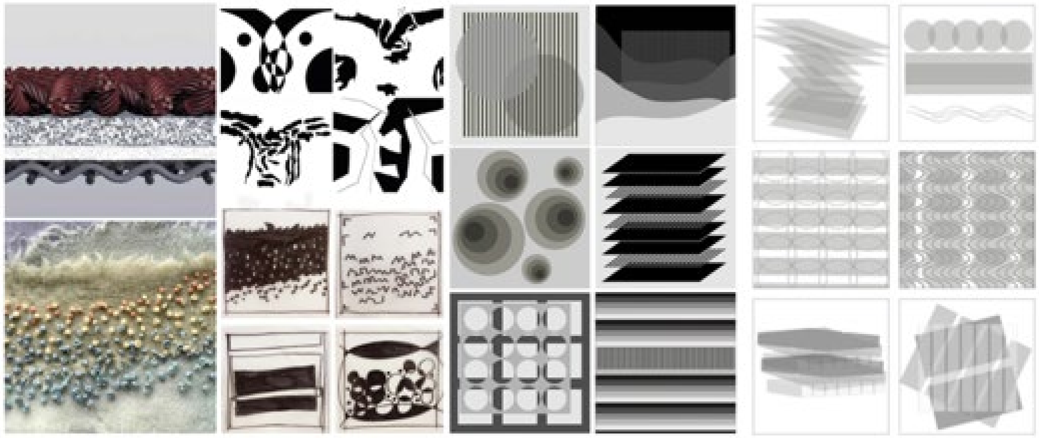


Figure 11. Visual research into the layered structure, Credit: Yujuan Cui and Moeko Doi

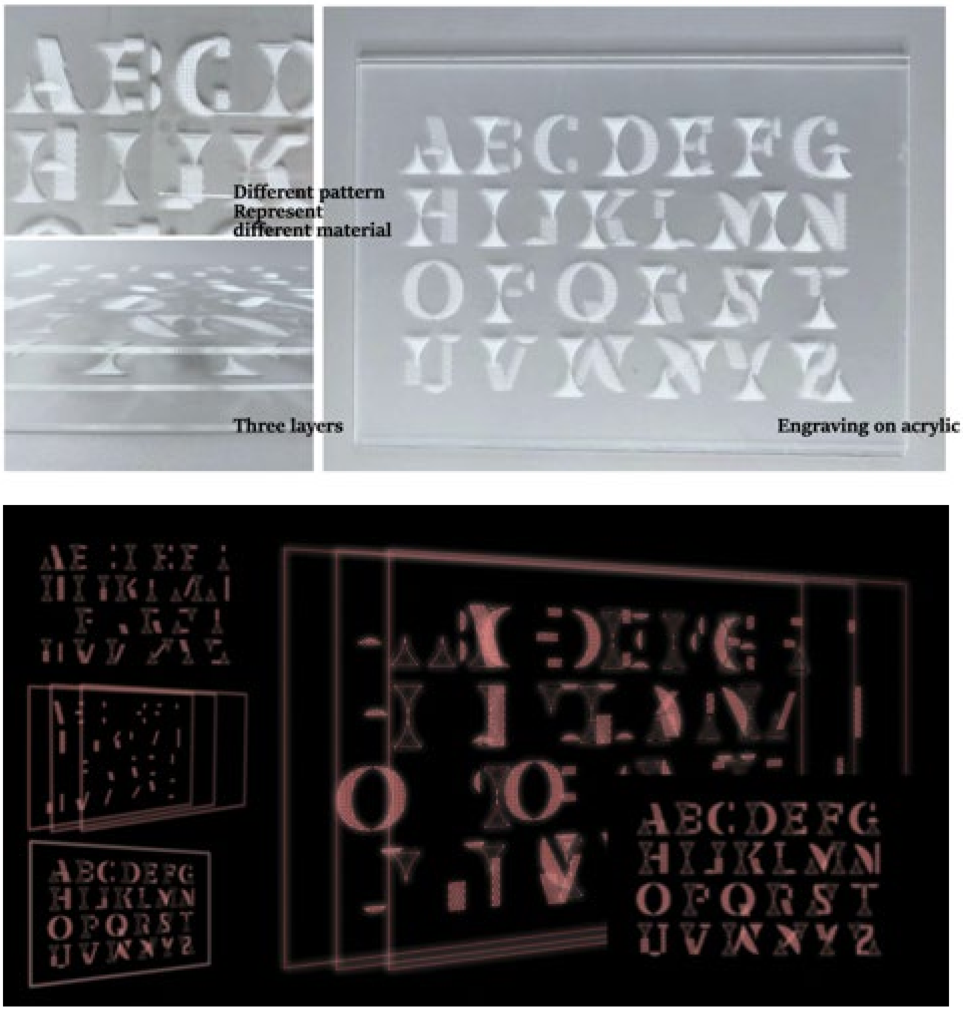


Figure 12. Interim layered concept, Credit: Yujuan Cui and Moeko Doi

The student’s moving image also incorporated lights in an attempt to disguise between the layers. The feedback provided by the BIT researchers was to focus on making the visual as relevant to textile designers as possible and expanding away from lighting and into physical materials rather than solely etchings on a single transparent material.

This led to their final moving image design utilising texture, colour and materials in which the word ‘layer’ appears from the structural layers (figure 13). This was complemented by the students' alphabet design in which they incorporated a similar approach of building different textural components layered one on top of the other to form each letter (figure 14).

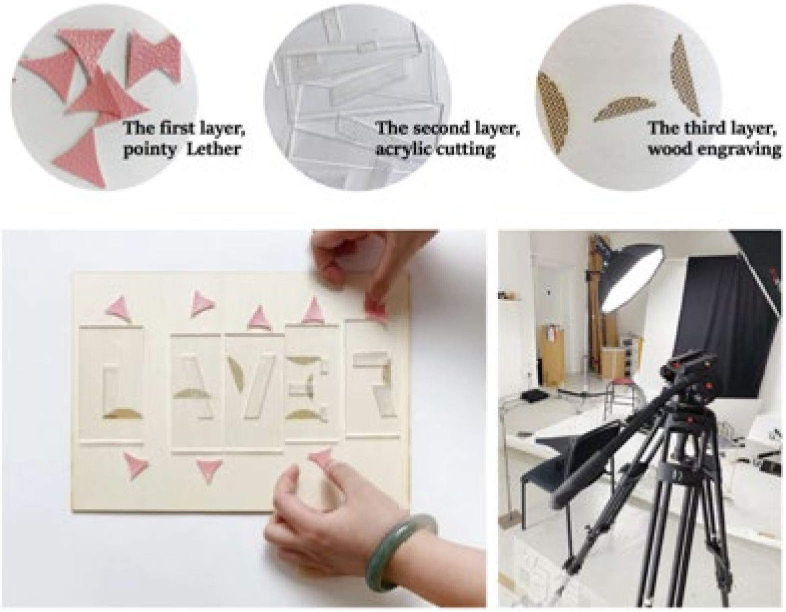


Figure 13. Final moving image design for BIT structure ‘layer’, Credit: Yujuan Cui and Moeko Doi

Figure 14. Alphabet design based on the BIT structure ‘layer’, Credit: Yujuan Cui and Moeko Doi

Discussion

This paper argues that the collaboration between the graphic design students, positioned as part of the research (taking a student-as-researcher role) and discussing their interpretations (prototypes) enabled the students to be an integral part of the research process that provided the BIT researchers with clarity and new perspectives on the translation process of material science topics for textile designers. This was demonstrated in the case study (above), in which the graphic students, Yujuan and Moeko, explored the main messaging of the biological structure 'layer'. The students successfully emphasised, through their physical and digital prototyping, the main message of the structure, namely how using layers provides a different function/property to the final design than those elements alone. This was communicated using different shapes across layers that built a typeface. This visual communication process provided additional clarity for the researchers as they explored the fundamental messages of each structure from Naleway et al.'s (2015) research paper, which later would then be articulated visually and using language for a textile specific audience as part of the official research dissemination.

Furthermore, at the interim stage the BIT researchers provided formative feedback on the work in progress. Yujuan and Moeko's work used transparent, acrylic sheets to communicate the layer structure. The BIT researchers fed back that they should consider using more textile-like materials to make the communication relevant for the textile design audience. It was here that the researchers started to appreciate the differences between communication to a broader design audience and a textile specific one. This was important translational knowledge produced by the student-as-researcher role that forced the BIT researchers to consider what aspects would make the core messages of the biological structures relevant for textile designers.

These forms of insights occurred across the whole body of students' work. For example, in early prototyping, the students working on the 'Cellular' structure began by visualising and prototyping the shapes of plant and human cells (the objects) rather than the 'cellular' structure themselves. Cellular structures found in nature, such as the honeycomb, demonstrate repeating, geometric, hollow units. The honeycomb is made of wax, a relatively weak material, but the cellular structure used ensures stiffness, even though the majority of the structure is formed of air (the gaps in the cells) which is used to store honey and protect larvae. The lesson from biology, in the case of cellular structures, is the opportunity for designers to create stiffness and volume with a reduced amount of material.

However, the research team observed that the designers tended to focus in on the cell shapes from an aesthetic perspective, rather than the structural lesson of creating varied stiffness and demonstrating high volume using little material. This made the BIT researchers take a renewed perspective on the textile prototypes created in the previous textile-specific collaborators. Their interpretations used textile techniques, which by their nature were 3D. Therefore, even if the textile designers had mistakenly taken inspiration from the aesthetic shape of cells, this could still have been interpreted by the researcher (with expert knowledge) as a volumous cellular structure, when it was in fact just a 3D textile technique being used to articulate their incorrect aesthetic interpretation. Thus, due to the BIT researcher's expertise, any misunderstanding of the structural lesson would have been missed.

Therefore, the experience of working with visual communication designers generated design knowledge for the BIT researchers in two ways:

- **Clarity** over the key messages needed to translate the biological structures from the material science field for designers.
- **New perspectives** from non-textile designers that highlighted areas of confusion within the BIT framework

Combined, this created new translational knowledge for the researchers about the communication of the biological structures to aid their application into textile design. This demonstrates the role visual communication designers can play in process and the creation of new knowledge within research.

Role of Prototyping

Visual prototyping played an important role in this process. Students used visual prototyping to develop their understanding of the BIT structures, employing the exploratory processes of prototyping, reflection and critique (Poggenhohl, 2018:176) discussed earlier in the paper.

> “We found that using a mechanical hair clip demonstrated what a flower would look like unwound or completely expanded. We began to appreciate how pedal structures can bend and fold to become something functional as a necessity in biodiverse environments.”

The different workshops in the project pushed students to use different forms of prototyping - 2D, 3D and 4D. This enabled the process of translation (Ribul & de la Motte, 2018) from the language of material science to the language of visual communication.

> “I understood that the key was to use the minimum amount of material. This means using a minimum of multiple materials to establish the character. For example, ideas such as using holes, reducing the number of lines, cutting the letterforms, etc”

The prototyping processes supported students in generating a ‘field of options’. This happened in the context of studio-based workshops which enabled the students to evaluate the prototypes by comparing with others.

> “It was interesting to see how different interpretations collided with each other. Some spirals were flat, some were three-dimensional, and there were helicals viewed from different angles. And I was able to learn from the many directions during the discussions with the group.”

> “I think it was helpful to see how things we learning were interconnected as a way to strengthen our current research.”

The prototypes were presented back to the research team at three points in the process. The prototypes functioned as a ‘material conversation’ (Poggenhohl, 2018) between the students and researchers, communicating their different interpretations of the research questions. The feedback also focussed the inquiry for both students and researchers. Their interpretations produced communication knowledge by providing non-expert interpretations of the research for discussion and critique. These sessions were the pivotal point in the knowledge exchange between researchers and students that underpinned the student-as-researcher role.

For the researchers, it was at this middle unresolved stage that they gained a real appreciation of the successful translation of key ideas, any confusion created, the red flags for them to resolve and any differences between the translation from non-textile designers and the previous textile centred collaborations. In exchange, this new role for the students introduced them to visual communication design as a method driven by process rather than outcomes. The prototyping that the students created during this project were never intended to be used as final communication of the structures, but rather were part of the research process. The final visual communication, for the dissemination of the project, was completed later but was directly informed by translation knowledge developed in this collaboration.

Furthermore, as a knowledge exchange project, three additional types of knowledge for the students in their new role were established:

1. Better technical understanding of the research to be communicated (the structures and material design concepts).
   Illustrated by a quote from the students working with 'Layer' structure:

   "I had a vague understanding of the structure of a layer, but I think I now have a better understanding of what exactly it is."

2. Improved knowledge about how to design the communication within research context.

   Illustrated by a quote from the students working with 'Overlap' structure:

   "Our typeface aims to replicate how this structure can bend into familiar shapes and how flexible structures, such as those found in nature can overlap and condense into diverse forms. We want to create a structure that can be implemented into a system for typography that demonstrates this flexibility of expanding and contracting."

3. Clearer understanding of benefits of using prototyping to develop communication design within a complex research project.

   "For biotype, the methods we used and why they are effective have provided a framework for how to approach a complex project."

Overall, the process generated important knowledge for both researchers and students-as-researchers on the challenges of communicating research to non-experts, the knowledge this creates about the process and what is important for discipline specific communication. As such, the design process was not just one of traditional problem solving but one that produced *'knowledge useful to those who design*' (Manzini, 2009:5).

Conclusion

This paper set out to explore the role of visual communication design and prototyping within a research context. Conducted through a knowledge exchange collaboration between BIT researchers and visual communication students the project explored how a translation of biological structure design knowledge articulated in the field of material science (Naleway et al., 2015) could be communicated to textile designers for its application across textile design practices. The students working with a live brief, took on a student-as-researcher role and became part of the research process, rather (as is more common) than student-as-professional tasked with finding visual solutions to a problem.

Prototyping (physical and digital) was a key tool used by the students to develop their understanding of the eight biological structure design elements and communicate their interpretations back to the researchers. The overall aim was to understand how translate the knowledge found in the field of material science messages for a textile design audience. The typographical prototypes created were pivotal at the interim stage, a point of connection with the BIT research team, for the students-as-researchers to demonstrate their interpretations and receive feedback. For the BIT researchers working with non-textile designers (after two subsequent textile specific collaborations), these prototypes provided clarity over the key messages and new perspectives that highlighted areas of confusion when translating the biological structures from the material science field for textile designers. This enabled the creation of new translational knowledge for the BIT researchers. In exchange the students gained technical understanding of the research content, improved knowledge of visual communication through prototyping and the methods they can use in the role of students-as-researchers working within a complex research space specifically, as part of the process and in generating translational knowledge.

Ultimately, the research concludes that visual communication designers can play a vital role within a research process. Their methods, such as prototyping, enables the creation of new translational knowledge and its application into design practice.

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References

Adamson, G. (2007). Thinking through craft. Oxford, UK: Berg.

Barthelat, F., Tang, H., Zavattieri, P., Li, C. and Espinosa, H. (2007) 'On the mechanics of mother-of-pearl: A key feature in the material hierarchical structure', Journal of the Mechanics and Physics of Solids, 55(2), pp. 306–337. Available at: https://doi.org/10.1016/j.jmps.2006.07.00

Bergström, J. et al. 2011. Becoming materials: material forms and forms of practice. Digital Creativity, 21(3), 155-172.

Bio-Inspired Textiles (2022) Layer, Bio-Inspired Textiles. Available at: https://www.bioinspiredtextiles.com/layer-v2 (Accessed: 10 January 2023).

Boyd Davis, S. and Vane, O. (2020) 'Design as Externalization: enabling research', *Information Design Journal, 25(1), pp. 28–42. Available at: https://doi.org/10.1075/idj.25.1.03van*

Carter, R., Day, B., Meggs, P. (2007) Typographic Design: Form and Communication. New Jersey: John Wiley & Sons

Cross, N. (1995). Discovering Design Ability. University of Chicago Press.

Drucker, J. (2014). Graphesis : visual forms of knowledge production. Harvard University Press, Cambridge, Massachusetts.

Frascara, J. (1988). Graphic Design: Fine Art or Social Science? Design Studies, Vol. 5, No.1 (Autumn, 1988), pp. 18-29

Galey A. and Ruecker, S. (2010). How a Prototype Argues. Literary and Linguistic Computing, 25(4):405–424.

Hinrichs, U., Forlini, S., & Moynihan, B. (2018). In defense of sandcastles: research thinking through visualization in digital humanities. Digital Scholarship in the Humanities (DSH), Advance Articles, [fqy051]. https://doi.org/10.1093/llc/fqy051

Johnston, E. (1962). Writing and Illuminating Lettering. London:Sir Isaac Pitman and Sons

Manovich, L. (2007). Q&A Session at the Digital Humanities (DH) 2007 Conference. Urbana-Champaign, IL, June 2007.

Manzini, E. (2015). Design, when everybody designs : an introduction to design for social innovation. The MIT Press, Cambridge, Massachusetts.

Manzini, E (2009). New Design Knowledge. Design Studies, Volume 30, Issue 1, January 2009, Pages 4-12

Morrison, J.E. and Meliza, L.L. (1999) Foundations of the After Action Review Process. IDA/HQ-D2332. INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA. Available at: https://apps.dtic.mil/docs/citations/ADA368651 (Accessed: 14 June 2021).

Motley, P. (2017). Critique and process: Signature pedagogies in the graphic design classroom. Arts & Humanities in Higher Education, Volume 16(3) 229–240

Munzer, T. (2014). Visualisation Analysis and Design. CRC Press.

Norman, Donald A. (1991), "Cognitive artifacts", John M. Carroll (ed), Designing interaction, Cambridge University Press, Cambridge.

O'Leary, D. (1998). Expert System Prototyping as a Research Tool, Applied Expert Systems, E. Turban and P.R. Watkins (Edi), Elsevier Science Publishers

Poggenhohl, S.H. (2018). Design theory to go : connecting 24 brief theories to practice. Ligature Press, Estes Park, Colorado.

Naleway, S.E., Porter, M.M., McKittrick, J. and Meyers, M.A. (2015) 'Structural Design Elements in Biological Materials: Application to Bioinspiration', Advanced Materials, 27(37), pp. 5455–5476. Available at: https://doi.org/10.1002/adma.201502403.

Nelson, R. (2013) Practice As Research in the Arts : Principles, Protocols, Pedagogies, Resistances, Palgrave Macmillan Limited.

Renner, M. (2017). Practice-led Iconic Research: Towards a Research Methodology for

Visual Communication. Visible Language, Volume 51.3 - 52.1, 8–33.

Rittel, H. and Webber, M. (1973). Dilemmas in a General Theory of Planning. Policy Sciences, (4) 155–169 Schön, D. A. (1983) The reflective practitioner: how professionals think in action. London: Temple Smith.

Schubbach, A (2017). Practice-led Iconic Research: Towards a Research Methodology for Visual Communication. Visible Language, Volume 51.3 - 52.1, 34–55.

Shulman, L (2005). Signature pedagogies in the professions. Daedalus 134(3): 53–59

Vaughan, L (Ed). (2020). Practice based design research. Bloomsbury Academic, London, England.

Wragg, N. and Barnes, C. (2016). Graphic Designers' Sense and Knowledge of the User: Is thinking differently the groundwork for acting differently? Visible Language, Volume 50 (No.3), 28-63.

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