USING BOUNDARY OBJECTS FOR CROSS-DOMAIN COLLABORATION BETWEEN TRADITIONAL FASHION DESIGNERS AND COMPUTATIONAL SPECIALISTS

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Introduction

Fashion and novelty

Fashion designers thrive on creating garments that set trends and establish novelty in the industry. Besides coming up with creative ideas, designers set themselves apart from their peers by using innovative technologies to derive and fabricate their fashion outcomes.

Fashion and technology

The fashion industry has always harnessed the latest in mechanisation and automation for garment-making, from larger scales in factories down to individual craft-persons. Mechanised embroidery, weaving and sewing machines were developed and accessible during the first Industrial Revolution in the nineteenth century (De La Cruz-Fernández, 2014; Humphries and Schneider, 2019; Olson and Kenny, 2015). More recently, there has been a flurry of innovations concerning digital fabrication devices, and they are increasingly accessible to the general population. For fashion designers, there are many opportunities to apply such technologies (such as three dimensional (3D) printing, laser cutting, computer numerical control engraving, and so on) for the creation of forms difficult or tedious to achieve with textile-based design methods.

Fashion-Computational collaborations

However, digital fabrication techniques require levels of digital literacy and computational design knowledge that many traditionally trained designers do not have (Sun and Zhao, 2017). Thus, there are many examples of collaborations where fashion designers lean on the expertise of computational specialists to create digitally fabricated garments designed with computational techniques (Boorman, 2014; McKnight, 2016; Pallister, 2014; Thimmesch, 2015).

Introduction to Boundary Objects

Star and Griesemer coined the term 'Boundary Objects' in 1989, in the context of museum science where there was a need to coordinate the requirements of various groups such as specimen collectors and museum representatives (Leigh Star and Griesemer, 1989). Boundary Objects are not necessarily physical objects, but a way of representing processes and entities that are created for collaboration between groups, especially across domains or disciplines (Leigh Star, 2010). Because of their ability to bridge different domains, Boundary Objects are chosen as a framework for this research. They can involve designers of both fashion and computation domains in reflective analysis to accommodate technologies and methods of the partner discipline with their own design process.

Leigh Star and Griesemer (1989) defined four categories of Boundary Objects (with possibility of expansion into more categories):

> **Repositories –** Collections of objects which are indexed and organised. Example: Library, collection of dress patterns.
>
> **Ideal Type –** Abstract representation of object or locale. Its intentional ambiguity helps in symbolic communication between collaborating groups. Example: Geographical map, fabric swatch
>
> **Coincident Boundaries** – Objects with same boundaries and different contents meant for different groups. Example: Borders of a country, a fashion or art movement.
>
> **Standardise Forms –** Boundary Objects to facilitate communication across groups. Example: Design templates, paper forms

One significant characteristic of Boundary Objects is their 'interpretive flexibility' (Leigh Star, 2010, p. 602), that is, a Boundary Object represents different meanings to different groups. For example, a fashion designer might regard a generated design element on its utility in garment-making, while a computational designer will think instead about the code patterns and design systems for its generation process. These differences in interpretation are spaces for negotiation (Star and Griesemer, 1989) that Boundary Objects can facilitate.

Research Methods

The goal of my research is to explore objects that facilitate cross-domain collaborative work, using the Boundary Object framework. To do so, there are two drivers for exploration: the conceptualisation and design of a **Computational Design Toolkit**, and the organisation and execution of a series of **Computational Design Workshops.** These workshops set up collaborative environments, to bring together fashion designers and computational specialists to perform cross-domain work assisted by toolkits.

The Computational Design Toolkit consists of three components, which are correspondingly applied onto three phases of the Computational Design Workshop to generate specific outcomes (Table 1). The toolkit components embody the characteristics of their respective Boundary Object category, for the negotiation of meaning and conflict resolution between fashion designers and computational specialists. For this specific iteration of the workshops, the author served as the facilitator, in addition to playing the role of the computational specialist to engage with a pool of fashion design participants.

Toolkit component	**Boundary Object category**	**Workshop phase outcome**
Ideation cards	Repository	Phase 1 – Creative insights
Affinity cards	Repository	Phase 2 – Design system directions
Design system	Ideal Type	Phase 3 – Design system and fashion forms

Table 1. Toolkit components as Boundary Objects.

Participant sampling

Participants were recruited from a cohort of traditionally trained, Bachelor-level final year Fashion Design students. In this paper, the outcomes of three participants who completed the study until Phase 3 will be presented.

Workshop Procedure

This series of workshops was held during the second semester of the participants' final year, when they are resolving their capstone collections. This allowed the author to capitalise on their capstone research as a starting point for development of computational outcomes, as their work supplied necessary contextual information for applying the toolkits with.

During this study, the author served both as a facilitator, as well as playing the role of computational specialist. As a facilitator, the author guided the participants through the three phases while ensuring proper research protocol is carried out (such as proper use of the respective toolkits).

<u>Phase 1</u>

The goal of Phase 1 is twofold:

1. to transition the participants' tacit information of their personal design processes and material knowledge into explicit forms through card-based sharing; and
2. with participant project knowledge made explicit, uncover problems they faced in regards to executing their design project that can be resolved computationally in later workshop phases.

Hence, the author prepared a deck of Ideation Cards that serves as a Boundary Object Repository. Each card represents a 'building block' of the ideation process (Vitali and Arquilla, 2018, p. 1161), which can be a design concept, application technique, data source, or meaning.

Participants will retrieve cards from the deck that are most suited for construction of their project direction. In this process of selection, participants are compelled to express their personal knowledge of tacit nature into an explicit form (that is, the physical cards) that allows for efficient application and integration (Suib et al., 2020) into the cross-domain ideation process.

For some participants, the deck contents were insufficient to convey their tacit knowledge. Hence, they worked with the facilitator to compose new card entries more capable of rendering that knowledge explicit. This is in line with the expandable, iteratively changeable nature of repositories (Leigh Star, 2010).

At the conclusion of this phase, each participant would have a selection of Ideation Cards that explicitly conveys the significance of their creative direction, the intended techniques to use, and any supplementary data that can be utilised in for computational design processes in subsequent phases.

Phase 2

Precedent studies are important for the fashion designer's creative process (Sorger & Udale, 2017), and thorough consolidation of visual inspiration helps 'set the theme, mood or concept' (Seivewright, 2012, p. 12) for a collection. However, the syntactic characteristics of the computational artefacts of this workshop are dictated by design systems in Phase 3. These systems are prepared by computational specialists instead of the fashion designers due to the lack of expertise of the latter, hence there might be gaps between the participants' creative intents and the computational specialists' interpretations, which had to be bridged through negotiation via Boundary Objects. At this juncture, the Boundary Objects consist of a second repository of physical cards, each representing a precedent computational fashion design artefact. These were consolidated from significant examples in computational fashion design history by designers such as Iris Van Herpen, Julia Koerner, Anouk Wipprecht, Niccolo Casas, Travis Fitch, amongst others (Casas, n.d.; Fitch, n.d.; Koerner, n.d.; van Herpen, n.d.; Wipprecht, n.d.). As participants might possess limited knowledge of the state of computational fashion designs, this repository could circumvent that constraint to allow participants to identify existing designs they have affinity for, in terms of aesthetic and thematic preferences and coherence with designer intent. These precedent examples were broadly distributed into six categories based on the pattern on how their code was written (Table 2).

Depending on the number of samples chosen of each category and the participants' explanation of their choices, the facilitator and participants will further negotiate on which category of design system to use for generation of creative outcomes in Phase 3.

Phase 3

The author in their role as computational specialist will be informed by the explicit concept knowledge in Phase 1 and the design system preference in Phase 2, to create design systems for each participant. Using the Grasshopper plug-in for Rhinoceros 3D modelling software for its parametric features and the accessibility of its visual coding interface, these systems can take in values and external data to generate outcome variations. The 'supplementary data' from Phase 1 (if any) will be harnessed for these generations, if not, stochastically derived values will be used for random outcomes.

These design systems are the Boundary Object of this phase, specifically an 'Ideal Type', coded embodiments of entire solution spaces of artefact forms. That is, without data or parameters to indicate specific outcomes, design systems are abstract representations of every potential design. Only when data or values from a participant are entered into the system, will generated artefacts take on specific characteristics. Therefore, these systems can be interpreted as 'Standardised Form' Boundary Object for their customisable nature.

After the design systems were written, participants worked directly with the computational specialist via a co-design approach, where the former offered their fashion sensitivities to guide the manipulations of the design system by the latter. Changes can be made instantly in response to their suggestions, for a responsive negotiation process.

It should be noted that the generated artefacts themselves in this phase are digital 3D models, which can be fabricated through additive manufacturing if desired. Due to their 'digital plasticity', these artefacts can be regarded as 'Ideal Type' Boundary Objects, representations at various levels of abstraction for negotiation between fashion participants and computational specialists.

Design System Category	**Examples**	**Brief description**
'Growth'	Reaction diffusion, differential growth	Elements transition to a new state at every timeframe, growing / evolving over time
'Triangulation & Polygonal'	Voronoi distribution, Delaunay triangulation, circle / sphere packing	Based on a distribution of points over a 2D / 3D space, elements are constructed based on the location of points and their spatial relationships
'Tweening'	Smoothing, tweening, digital sculpting, interpolation of lines	Interpolate between 3D curves, fill space with intermediate curves.

'Morphing & Transitions'	Grid deformation, twisted boxes, interpolation of volumes	Transitioning one form into another form. Intermediary forms can be generated and used.
'Lines & Curves'	Spirals, fields, L-system	Manipulation and interaction of lines for creation of visually engaging arrangements.
'Tiling'	Tessellation, repetition, symmetry	The repetition of self-similar elements to fill a 2D / 3D space.

Table 2. Design system categorisations.

Outcomes

Participant A

With a plant-inspired theme, Participant A used natural dyes made from vegetation to colour their fabrics. This figured heavily in the decision to use a 3D Voronoi constructor design system (Triangulation & Polygonal category) combined with a spiral drawing code, due to the aesthetic similarity of its outcomes to leaf veins and cellular structures of plants. During negotiation, it was decided to use this code to generate a headdress design as well as buttons to complement the collection. Participant contributed sketches as their data, which were integrated into the linework of the Voronoi structure.

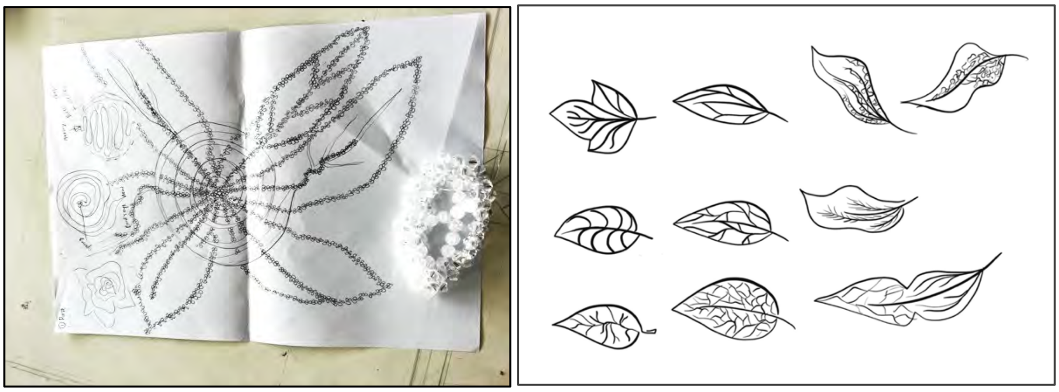

Figure 1. Sketches as data. (Participant A)

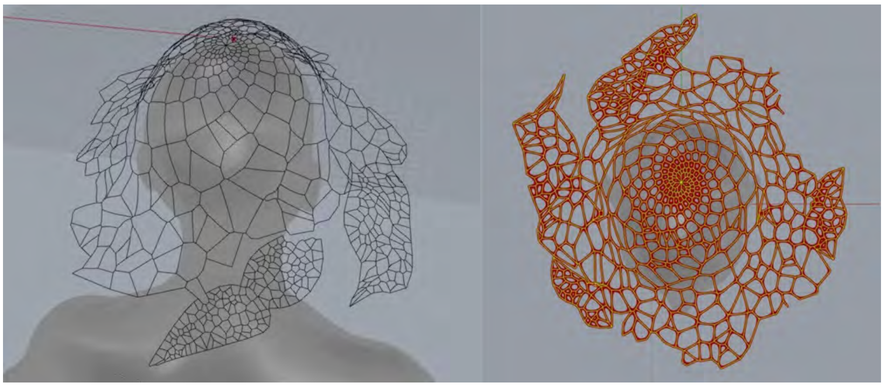

Figure 2. Generated linework and 3D Voronoi structure for headdress.

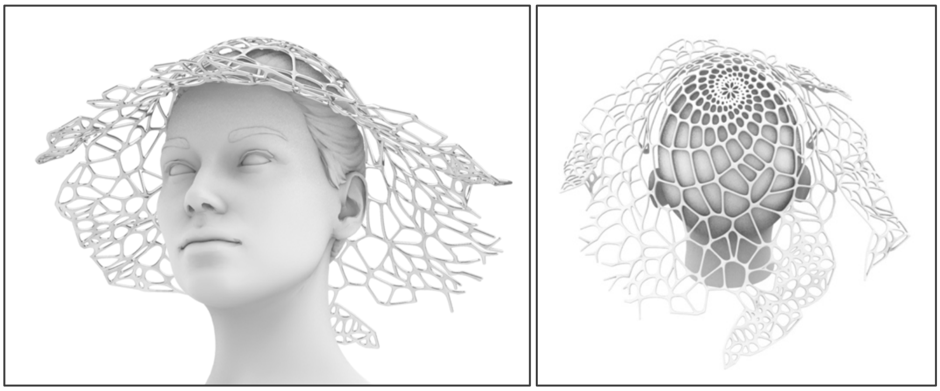

Figure 3. 3D model of artefact on digital mannequin.

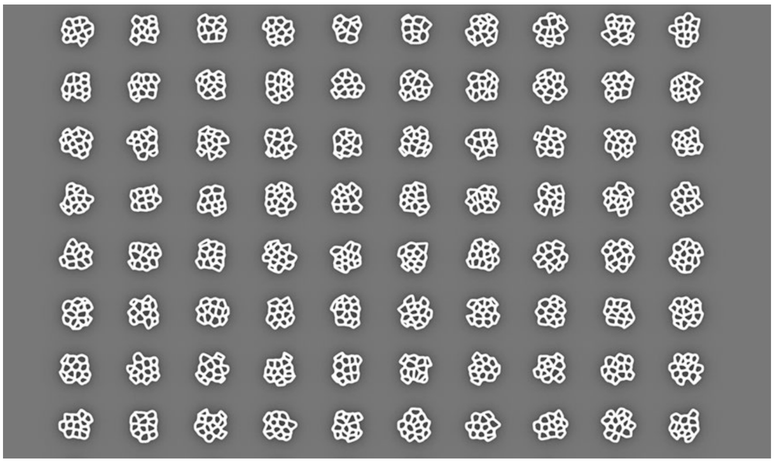

Figure 4. Stochastically generated Voronoi button variations.

Participant B

This participant took cultural and natural cues from their homeland, channelling them into their work through laser-cut motifs on textiles. The use a morphing design system that position graphical elements repeatedly along flowing lines was written, to fit in with the pleats and drapes of the collection. This design system used data in the form of the participant's abstract 2D motifs, which were converted into 3D building blocks for the code. Four eyewear variants were generated as outcomes of their workshop.

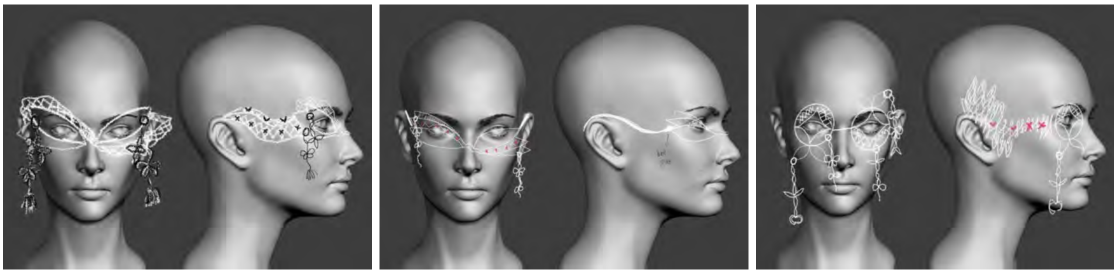

Figure 5. Sketches. (Participant B)

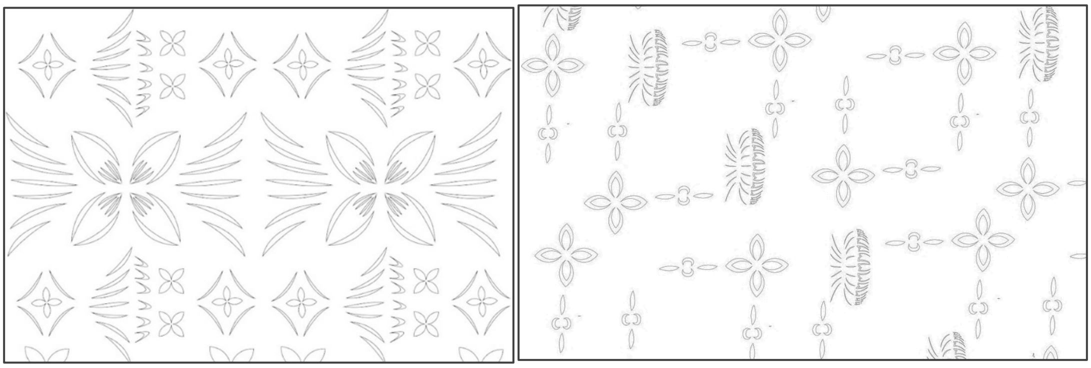

Figure 6. Abstract natural, cultural motifs as data. (Participant B)

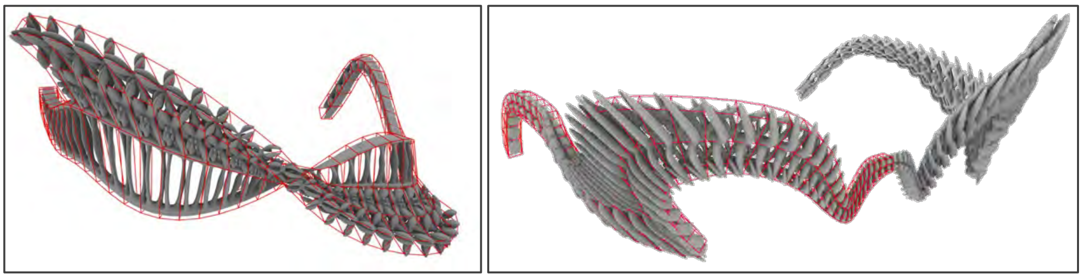

Figure 7. Generating forms using morphing design system.

Figure 8. 3D models of artefacts.

Participant C

This participant chose growth, progression and decay as the main thematic drivers behind their floral inspired capstone. Thus, a 'Growth' design system was selected for simulating 3D differential growth to emulate the folds of flower petals. Additionally, the participant requested to use some physical ceramic shards they possessed as base structures for the outcomes. This digital-physical divide required us to convert the physical volumes of the shards into digital 3D representations, before using the design system to generate organic floral extensions from these base models. The artefacts consist of a pendant and a brooch.

Figure 9. Left: Sketches. (Participant C) Right: Physical ceramic shards

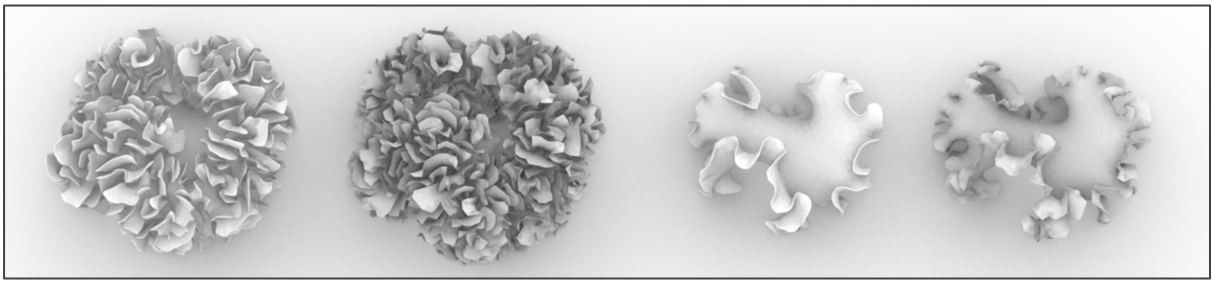

Figure 10. Demonstration of differential growth simulation.

Figure 11. Left: 3D models of artefact. Right: 3D printed artefacts with physical ceramic.

Discussion

This research to develop Boundary Objects to aid cross-domain, collaborative work aims to bridge the ability gap of Fashion Designers and what is required for computational design work.

The field of Boundary Work is as relevant as ever as we see computational technologies and thinking pervade into other disciplines. Even though there is recent focus on STEM and computation in K-12 pedagogy, there are many practitioners already in industries who were traditionally trained and did not have the opportunity to gain relevant knowledge for harnessing of new computational technologies. This affects many industries, not the least fashion designers who are often compelled to pursue the latest technologies to maintain relevance. Until the time when computational training pervades out of K-12 levels into industry specific applications, there is need for research on transitional methodologies to tide the industry over this interim period.

Future Work

The development of this computational fashion design toolkit is far from complete, as it has always evolved in tandem with methods developed by computational design communities as well as evolution of computing technologies. The author acknowledges the need to refine research protocol to allow greater measure of participant involvement with the development of artefact outcomes. In addition, they wish to study the effects on participants' design processes from interventions with computational thinking approaches. The resultant insights can not only inspire development of methods for boundary work but spur the development of tools for computational fashion design.

References

Boorman, E. (2014, September 16) 'Smarter: Anouk Wipprecht's Intel Edison-powered, 3D-printed "Synapse Dress" Logs Your Mood', *Materialise.Com*. Available at: https://www.materialise.com/en/blog/wearable-tech-just-got-smarter-anouk-wipprechts-intel-edison-powered-3d-printed-synapse-dress

Casas, N. (n.d.) *NICCOLO CASAS | ARCHITECTURE*. Available at: https://www.niccolocasas.com

De La Cruz-Fernández, P. A. (2014) 'Marketing the Hearth: Ornamental Embroidery and the Building of the Multinational Singer Sewing Machine Company', *Enterprise & Society*, *15*(3), pp. 442–471. https://doi.org/10.1093/es/khu031

Fitch, T. (n.d.) *Fitchwork*. Available at: https://fitchwork.com

Humphries, J., & Schneider, B. (2019) 'Spinning the industrial revolution', *The Economic History Review*, *72*(1), pp. 126–155. https://doi.org/10.1111/ehr.12693

Koerner, J. (n.d.) *Julia Koerner—JK*. Available at: https://www.juliakoerner.com

Leigh Star, S. (2010) This is Not a Boundary Object: Reflections on the Origin of a Concept. *Science, Technology, & Human Values*, *35*(5), pp. 601–617. https://doi.org/10.1177/0162243910377624

Leigh Star, S. & Griesemer, J. R. (1989) Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, *19*(3), pp. 387 – 420. https://doi.org/10.1177/030631289019003001

McKnight, J. (2016, February 17) 'Fashion label Threeasfour unveils two 3D-printed dresses for Biomimicry collection', *Dezeen.Com*.

Olson, J. S., & Kenny, S. L. (2015) *The industrial revolution: Key themes and documents*. ABC-CLIO.

Pallister, J. (2014, March 18) 'Software advances are "blurring boundaries between design disciplines" ', *Dezeen and Mini Frontiers*. https://www.dezeen.com/2014/03/18/daniel-widrig-3d-printing-design-software-advances/

Seivewright, S. (2012) *Research and design* (2nd ed). AVA Academia.

Sorger, R., & Udale, J. (2017) *The fundamentals of fashion design* (Third edition). Bloomsbury, Bloomsbury Visual Arts, an imprint of Bloomsbury Publishing Plc.

Suib, S. S. S. B., Van Engelen, J. M. L., & Crul, M. R. M. (2020) 'Enhancing Knowledge Exchange and Collaboration Between Craftspeople and Designers Using the Concept of Boundary Objects', *International Journal of Design*, *14*(1). http://www.ijdesign.org/index.php/IJDesign/article/view/2876/897

Sun, L., & Zhao, L. (2017) 'Envisioning the era of 3D printing: A conceptual model for the fashion industry', *Fashion and Textiles*, *4*(1), p. 25. https://doi.org/10.1186/s40691-017-0110-4

Thimmesch, D. (2015, October 29) 'Materialise and threeASFOUR Set Their Sights on Revolutionizing the Fashion Industry via 3D Printing', *3dprint.Com*. https://3dprint.com/102806/aterialise-threeasfour-fashion/

van Herpen, I. (n.d.) *Collections | Iris van Herpen*. Available at: https://www.irisvanherpen.com/collections/ (Accessed: 15 April 2022).

Vitali, I., & Arquilla, V. (2018, June 28) 'Developing a Design Toolkit for the Internet of Things', *Design Research Society Conference 2018*. https://doi.org/10.21606/drs.2018.447

Wipprecht, A. (n.d.) *Anouk Wipprecht Fashiontech*. Available at: http://www.anoukwipprecht.nl