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Using data-assisted design to craft responsive uniforms

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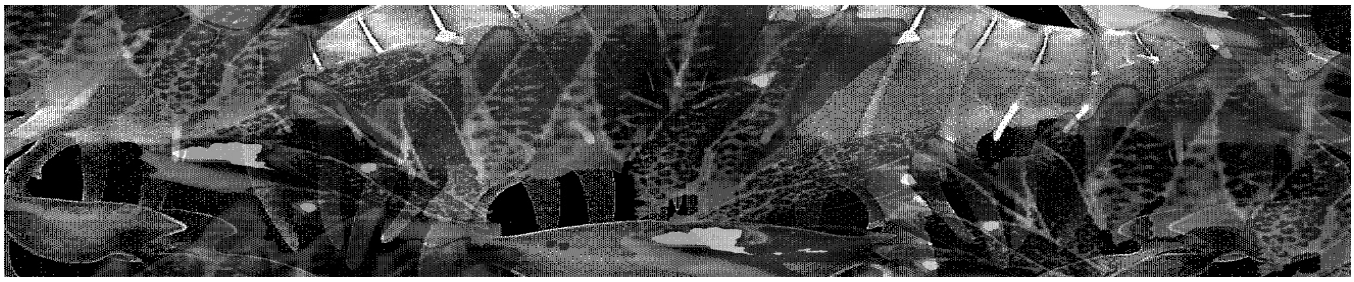

Fig. 1. Excerpt of an initial weave design file created from source images of sea creatures.

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Abstract

Collaborator Anna Routson and I develop a garment design and production system using data from the everyday life of the wearer. After generating initial designs based on answers to personal questions, we modulate design parameters using an algorithm with inputs of volume, light, and accelerometer data captured from wearable sensor boards. The algorithm outputs design files that vary from the original according to user data. Select files are hand woven on a TC2 Jacquard loom and constructed into seasonal garments. The relationship of garment to wearer inspires its long-term use as a uniform, in turn encouraging decreased consumption of fast fashion garments and textiles. By integrating the life of the wearer into textile design, the distinction between consumer and designer begins to dissolve.

Keywords: data-assisted design, algorithmic design, digital weaving, textiles, distributed making

Introduction and objectives

Garments serve as a second skin. Material, structure, and shape coalesce, reflecting the wearer's lifestyle and environment. The data-assisted design system makes this relationship explicit whilst resisting the centering of data usage to the detriment of human decision-making.

At the same time, the TC2 Jacquard Loom affords the weaver total control over each intersection of warp and weft. The weaver and designer can bring their ideas to life perfectly via the loom computer's assistance. However, this accuracy is achieved at the loss of some human error and caprice—a key component of the creative process that can yield unexpected discoveries.

By interlacing human-to-human with human-machine interaction, the data-assisted design system preserves and extends the potential of the human being to pursue nondeterministic creative trajectories. Algorithmic processing with data types mapped to design parameters makes for a structured approach to iterative development that nonetheless allows for unanticipated aesthetic outcomes. The system is thus situated in a growing field of creative interactive fabrication systems wherein users embrace the act of fabricating as the locus of value without set expectations for the results of the process [3]. At the same time, we engage in "hybrid" craft research by articulating a method wherein computational fabrication and the agencies of maker, machine, and material come together to produce aesthetically rich design [9, 10, 11].

On the industry level, we present an alternative to the global standard of creator-led fashion through the synthesis of designer, maker, wearer, and researcher roles. Whereas prominent fashion houses today are led by artistic directors whose ideas determine designs produced downstream, we envision a ground-up alternative that privileges the circumstances of the wearer and "recipient" as meaningful variables in the design.

The garments produced are intended to be worn as uniforms. Because the textiles will be handwoven using quality yarns and sound weave structures, they will stand apart from the landscape of mass-produced textiles for their durability, beauty, and craft value.

Further iterations of a given textile design can be produced through additional data collection and modulation instances, utilizing prior generated designs as the base. An endless set of iterations could be generated and saved as digital files for future use. In practical terms, one uniform every few seasons would be sufficient, revealing a long-term evolution in the textile whilst meeting the wearer's needs.

The project objectives are:

A. to apply a nascent design philosophy to one industry and mode of production as means to inspire further work in data-assisted design procedures,
B. to offer an alternative to the dominant mode of garment design and production,
C. to engage in an experimental and synergistic method of working with data and weaving technologies.

The primary questions posed are:

1. How can art, design, and life be merged so that distinctions between designer, maker, and consumer dissolve? What does collaboration look like under these circumstances?
2. How can data-assisted design processes catalyze people versed in traditional craft to develop new modes of design thinking?
3. Can data collection from individuals be made for poetic and liberating purposes? Can we humanize the use of data?

The project will be presented in the form of a multimedia exhibition. Anna and I will wear the finished uniforms in a live presentation that combines elements of a runway show, art exhibition, and choreographed performance. The research and development process will be shown as digital files on monitors, printed design files, video and audio recordings, stations where viewers can interact with the textile design algorithm, and sensor board data collection demos. Programming in the form of interactive workshops where participants develop their own data-assisted design systems could be organized.

The project will be open-source: all files and documentation will be publicly accessible via cloud-based storage. The data-assisted design system need not be limited in application to textiles and fashion: we intend to disseminate the design methods and principles to practitioners across disciplines to create an interdisciplinary distributed network of production.

Background and philosophy

The term *uniform* brings to mind vocational or trade garments, traditional ethnic costume, or military regalia. We imagine a uniform that does not denote a group or classification of people so much as pertain specifically to the individual's life and habits. Such a uniform evolves in step with its human partner in a nondeterministic trajectory. As the wearer goes about life, updated data sets can be collected and inputted to the textile design algorithm to produce updated patterns. Uniforms for multiple individuals can be generated using one algorithm, allowing distinct designs to evolve as variations on a shared structure.

Our work draws on previous uniform projects by Andrea Zittel and Varvara Stepanova. Stepanova designed Constructivist uniforms in an effort to destabilize elite aesthetics in favor of utility and bodily freedom, and more recently, Zittel has constructed several series of uniforms as answers to the question "how to live?". For both, the limitations posed by making and wearing uniforms made possible a liberation of body and spirit. How could one function in society in an intentionally ambiguous, yet ordered way? How should the second skin look and feel, distinct from expectations produced by market-driven desire?

Fig. 2. Varvara Stepanova, constructivist uniform designs in LEF magazine, 1923. Stepanova's designs aspired to a neutralization of identifiable body characteristics, including sex.

Fig. 3. Andrea Zittel, AZ Uniform Project, Second Decade, 2014. For Zittel, the production of uniforms proposes that liberation may be possible through the creation of a set of personal restrictions or limitations. By constructing variations on one silhouette, or using materials that change or deteriorate visibly over time, she questions the dual demand for permanence and variety in consumer objects [13].

Making uniforms goes against the grain of the fashion industry, where high demand for variety and novelty drives mass production. The industry cycle of two collections per year, shown in February and September, requires fashion houses and designers to regularly produce new garment styles and templates. Rising production volume increasingly drains the global supply of fresh water and energy while generating solid waste, wastewater, and CO2 emissions.[1] By making uniforms we exercise a will to decrease consumption: the more people participate, the more destabilized the entrenchment of fast fashion will become.

The convergence of technical craft and data-assisted design offers a vision of an alternative future for fashion and garment production: a more democratically creative enterprise wherein clothing wearers are restored from passive consumers to agents whose everyday decisions impact the look and feel of their second skin. While digital weaving is still a niche craft practice, we can disseminate data-assisted design principles and processes to communities of handweavers, designers, and artists around the world. In doing so, we instill forward-thinking design as an aspect of contemporary craft and contribute to bridging the divide between craft production, artistic value, and industry.

Timeline

Phase I: Groundwork (Oct. 2020 – Jan. 2021)

- Conversations about design philosophy
- Generate initial design methods and files
- Develop *aeiyou* textile design algorithm and investigate possible data inputs from sensor board
- Select materials for the undergarment, set fabric pattern and sensor placement
- Select weaving yarns and sample initial textile designs on the TC2.

Phase II: Structure (Feb. – Aug. 2021)

- Develop methods for working with data collected from sensor boards, including sample rate and quantitative analysis suitable for inputs into *aeiyou* algorithm
- Iterate on and finalize *aeiyou* algorithm
- Finalize uniform design, calculate cloth requirement and cutting pattern

[1] The fashion industry's CO2 emissions are projected to increase by more than 60% to nearly 2.8 billion tons per years by 2030 – equivalent to nearly 230 million passenger vehicles driven for a year, assuming average driving patterns [7].

- From the sampled initial designs, select to use as base design for algorithmic processing

Phase III: Production (Sep. – Dec. 2021)

- Run data collection and input results of analysis into *aeiyou* algorithm
- Weave selected textile designs on the TC2 and construct first uniform instance
- Repeat data collection and algorithmic output for additional uniform instance, showing evolution

Phase IV: Presentation (Jan. – Mar. 2022)

- Determine venue and format of presentation
- Prepare project documentation and files for public release
- Present project to the public and invite feedback

Phase V: Community Networking (Apr. 2022 – May 2023)

- Prepare documentation of data-assisted design process
- Train designers, hand weavers, and artists in data-assisted design principles and procedures and invite them to participate and share their results.[2]

Materials

- Adafruit Circuit Playground Express, coded with MakeCode
- Powermesh undergarment, constructed using found pattern, for sensor board placement and as underlayer of woven uniform
- Photoshop to design initial files
- aeiyou, open-source weave drafting software written in JavaScript
- TC2 Jacquard Loom (accessed at Praxis Fiber Workshop)
- Sewing machine

Methods

[2] In *Patterning Sounds*, George Jaramillo and Lynne Mennie disseminated data-driven design procedures to Scottish textile artists and invited them to create patterns based on recorded audio fed into spectrogram analyzers. We use *Patterning Sounds* as a model for the community networking phase of this project [6].

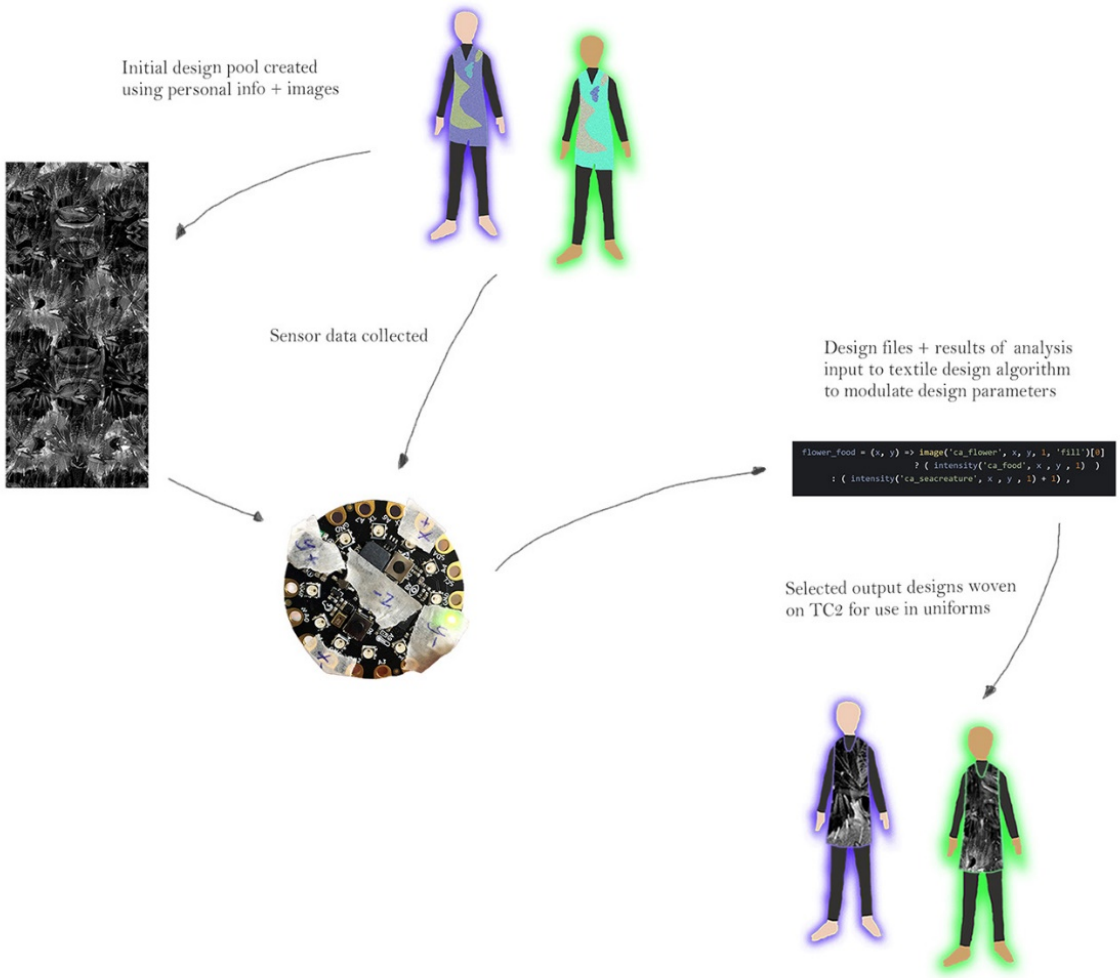


Fig. 4. Flow chart of steps in the data-assisted design system.

A conversation mimicking a “get to know you” session between designer and client generates the key words used in Google image searches to procure source images for use in generating a pool of initial design files in Photoshop. Of the pool, 3-5 files are selected for their aesthetics and sampled on the TC2. Of the samples, one is chosen as the base design on which to apply algorithmic manipulation following data collection and analysis.

Both researchers participate in a data collection period of 24 hours by wearing identical power mesh undergarments with Adafruit Circuit Playground Express sensor boards sewn in at the neck collar. During the data collection period, the sensor boards log values for ambient volume, light intensity, and z-axis acceleration every 30 seconds. At the close of the data collection period, we analyze the data using straightforward mathematical methods and input results for each researcher into an *aeiyou* design algorithm that accepts initial design files as images and manipulates chosen parameters (ie. fill pattern scale or ratio of warp and weft visibility) according to input values.

The output design files are reviewed and woven as yardage on the TC2. In the woven cloth, variations of life conditions between the researchers over the 24-hour data collection period will be discernible within the predetermined parameters.

Future evolutions of the same design file can be made via additional data collection periods, or additional files from the initial design pool can be run through the data-assisted design system. In the final phase of the project, the data-assisted design process is packaged and shared with craftspeople, designers, and artists with an invitation to participate.

Budget

Equipment and materials		
Circuit Playground Express boards and accessories	$60	
Power mesh fabric	$20	
Undergarment pattern	$17	
Linen 20/2 yarn	$100	
Sewing machine and accessories	$200	
	Subtotal	$497
Digital resources		
TC2 Jacquard Loom Rental – 2 weeks	$900	
Photoshop subscription	$300	
	Subtotal	$1200
Personnel		
aeiyou technical support	$600	
Researcher salary – 2 researchers at 400 hrs each	$32,000	
Graphic design support for final project documentation	$300	
	Subtotal	$32,900
	TOTAL	**$34,597**

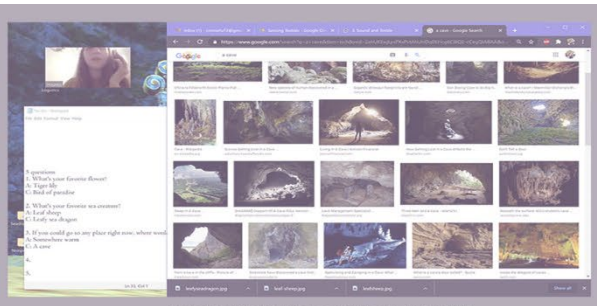
Limitations

- We utilize the TC2 Jacquard Loom, which is not widely accessible. To those who wish to enact data-assisted design methods but are unable to weave the generated textiles, we can build a list of TC2 users who are open to collaborating with artists and designers. Additionally, the files created via data-assisted design can be used as image files for expression in mediums outside of textiles. They can be printed on paper or fabric for use as standalone prints or wallpaper, or treated as visual assets for educational purposes.
- The *aeiyou* software is being developed by Haumed Rahmani and is accessed via CodePen through the browser. It has no graphical UI; instead, to modify the design algorithm, users must have basic familiarity with JavaScript. Until a UI is built, people who wish to use our textile design algorithm or an algorithm of their own will need to grasp the fundamentals of code. To support, we can offer detailed documentation and a pool of preset algorithms.

Documentation

Phase I: Groundwork (completed Oct. 2020 – Jan. 2021)

We prompted the design process by asking each other simple questions.



Collaborating by phone and Zoom, 1 Jan. 2021

5 questions
1. What's your favorite flower?
A: Tiger lily
C: Bird of paradise

2. What's your favorite sea creature?
A: Leaf sheep
C: Leafy sea dragon

3. If you could go to any place right now, where would you go?
A: The ocean
C: A cave

4. What's your favorite food?
A: potato
C: chickpeas

5. What's your astrological sign?
A: Virgo
C: Pisces

We googled our answers and selected representative images

1C 1A 2C 2A 3C 3A 4C 4A 5C 5A

then manipulated them in Photoshop to produce initial Jacquard weave design files

Image citations

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Fig. 5. Visual layout of documentation from Phase 1.

- We convert the initial designs into weavable files (correcting long warp or weft floats, ensuring that a pattern is discernible), apply additional weave structures where necessary, and select 3-5 for sampling on the TC2.
- We conducted tests for collecting z axis acceleration, light levels, and volume data from the sensor boards. All values collected at increments of 30s are captured in a .csv file stored on the board and accessible by the user after the collection period.
- Black cotton 20/2 and off-white 20/2 linen yarn chosen for their durability and natural fiber content
- Microsoft MakeCode is an in-browser code editor with easily comprehensible blocks. The code for data capture is constructed in a shareable MakeCode file and loaded onto the sensor boards.

Fig. 6. MakeCode code block for sensor board data collection. MakeCode's visual layout and ease of use makes it a useful tool for disseminating data-assisted design procedures.

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Fig. 2. Designs by Stepanova in LEF Magazine. 1923. *The Conversation*. https://theconversation.com/sublime-design-varvara-stepanovas-unisex-sports-uniform-27587.

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Researcher bios

Anna Routson is a textile artist and educator who holds a BFA in Textiles from Kent State University. She is well-versed in handweaving, digital weaving, patterning, crochet, netting, and dyeing processes. She has been the Studio Manager of Praxis Fiber Workshop, managing the facilities and developing educational programming since 2015.

Connie Fu is an artist and researcher whose work integrates digital processes with traditional craft. Her interdisciplinary practice brings performance, video, and sound together in multimedia environments that playfully question the binaries of digital/traditional and art/craft. She holds an MFA in Painting from Pratt Institute and a BA from Harvard University. www.connie-fu.com.