

Creating an environment to fight the fashion system: Fashion Tech Farm

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0930 – 0945	Opening <i>Prof. Calvin Wong , CEO & Centre Director of AiDLab., Cheng Yik Hung Professor in FASHion, PolyU</i>
0945 – 1015	Keynote Presentation: Everything Everywhere All at Once <i>Dr. Delman Lee, Vice Chair at TAL Apparel Limited</i>
1015 – 1045	Keynote Presentation: Navigating Uncharted Territory with Meaning-driven and Design-centred Innovation <i>Prof. Erin Cho, Dean and Professor, School of Fashion and Textiles, PolyU</i>
1045 – 1105	Panel Discussion: AI and Design: Creative Innovation and Challenges Moderator: <i>Prof. Jeanne Tan, COO and Assistant Centre Director, AiDLab, Professor, School of Fashion and Textiles</i> Panelists: <i>Dr. Delman Lee, Prof. Erin Cho, Prof. Calvin Wong</i>
1105 – 1120	Refreshment Break
	Paper Session: Form, Interactivity and the Human Experience Chair: Jun Ho
1120 – 1240	A-Vibe: Exploring the Impact of Animal-form Avatars on Students' Connectedness and Social Presence through Delivering Honest Signals in Live Online Classes <i>Tianqin Lu and Jun Hu</i> An exploration on UX Automotive in the 5G era new interaction processes through gesture control and haptic feedback <i>Venanzio Arquilla, Fausto Brevi, Federica Caruso, Flora Gaetani and Peng Lu</i> Comfort Between the Top and Bottom: A Cost-Effective Ergonomic Monitor Stand with Automatic Height Adjustment Based on Machine Learning <i>Yanze Wang and Jianfei Ma</i> Giving Form to the Invisible: Can we make in-home network data traffic tangible to users? <i>Sabine Junginger, Beat Tödl and Tom Ulmer</i>
1240 – 1400	Lunch Chair: Dr. ir. Miguel
1400 – 1500	K-means based group clustering approach for Group recommender System in a metaverse environment <i>M.W. Geda, Yuk Ming Tang, Sze Chit Leong, C.K.M. Lee and Chung Hin Lai</i> Interstitial Diagramming: Mapping Temporal Experience <i>Stephen Neely and Michael Arnold Mages</i> Big data analytics for marketing strategy <i>Jingying Liang, Yuhua Jiao, Sui Ying Chung and C.K.M. Lee</i>
	Paper Session: Innovation in Product and Service Design Chair: Amy Chen
1500 – 1540	Disappearing Stitch: Exploring e-textiles design for disassembly <i>Amy Chen</i> A Priori: Design Knowledge in AI <i>Ryan Bruggeman, Estefania Ciliotta Chehade, Yi Han and Paolo Ciuccarelli</i>
1540 – 1600	Refreshment Break
1600 – 1730	Workshops: Human-Centred AI Design Methods to Understand “Textiles Hand” Chipp Jansen, Lissy Hatfield, Zhengtao Ma, Boyuan Tuo, Elif Ozden Yenigun, Sharon Baurley, Kun-Pyo Lee and Stephen Wang

	Conference Programme (6 July)
0900 – 0930	Conference Registration
0930 – 1000	Keynote Presentation: Acceleration with AI for Fashion <i>Prof. Calvin Wong , CEO & Centre Director of AiDlab., Cheng Yik Hung Professor, PolyU</i>
	Paper Session: Innovation in Product and Service Design Chair: Cyriel Diels
1000 – 1020	Towards a Data-Informed-Design (D-I-D) Framework for Autonomous Vehicle Design <i>Cyriel Diels, Kostas Styliadis, Farhana Saba, Cynthia Charwick, Herin Haramoto, Yichen Shu, Jiayu Wu and Dale Harrow</i>
	Paper Session: Fashion: Process, Visualizations, Artifacts and Beyond
1020 – 1040	Deep Fabric Prints Generation for Fashion <i>Fangjian Liao, Xingxing Zou and Waikung Wong</i>
1040 – 1100	Refreshment Break
	Chair: Dr. Edgar Rodriguez
1100 – 1140	The Effect of Heel Base Design on Plantar Pressure and Wear Comfort of Healthy Females <i>Luk Sin-Hang, Kit Lun Yick and Li-Ying Zhang</i>
	M-VTON: Multi-layer Virtual Try-on System <i>Kaicheng Pang, Xingxing Zou, Fangjian Liao and Waikung Wong</i>
1140 – 1300	Exhibition & Tour Atrium Link, Hong Kong Science Park
1300 – 1430	Lunch
1430 – 1530	Short papers & Interactive Demo Mixed Reality (MR)-assisted Spatial Logistics Facility Layout Design <i>Wai Wai Chong, Ka Man Lee, Yung Po Tsang and Yim Shan Au</i> Effect of Body Shapes, Garment Size and Silhouette on the Visual Effect of Body Image <i>Xing Su, Jiayin Li, Pik Yin Mok and Jintu Fan</i> AI Ethical Issues (AIEI) Cards: Supporting Responsible AI-Enabled Solutions Design in Healthcare <i>Fan Li and Yuan Lu</i> New Design Concepts to Enhance Communication and Interaction among Unsociable Young People in Co-living Areas <i>Hi Ying Lon and Yi-Teng Shih</i> The Connection of Educational Toy and Technology <i>Lok To Christy Chen, Sin Ting Charis Chiu and Yi-Teng Shih</i> Slow Tourism Service System for the Post-Pandemic Decade <i>Ka Po Tsui and Yi-Teng Shih</i> Designing a product that imitates and substitutes a guide companion for the visually impaired <i>Wai Dik Au, Yi-Teng Shih</i> An Interactive Neural Network-Based System for Confined Stylization of Product Design <i>Tang Man Kit</i>
1530 – 1545	Refreshment Break
1545 – 1715	Workshops: Wearables for Personalised Posture <i>Tong Lo, Narges Pourshahrokhi, Tom Stables, Rama Gheerawo and Ali Asadipour</i>
1900 – 2200	Conference Dinner

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	Unorthodox Interventions – Fashion Garment Creation through Modification of FFF 3D Printing Processes <i>Lionel Zhen Jie Wong and Hoi Shan Jamela Law</i>
	Creating an environment to fight the fashion system: Fashion Tech Farm <i>Marina Toeters, Loe Feijs, Troy Nachtigall and Beam Contrechoc</i>
	Paper Session: Wearables and Alternative Skins
	Chair: Prof. Dr. Dagmar Johanna Steffen
1030 – 1130	Doctor Kiwi - A persuasive game concept to treat skin sores among children in New Zealand <i>Edgar Rodríguez Ramírez, Mailin Lemke and Gillian McCarthy</i>
	"I had pee sneezes" Factors influencing the health-seeking process and use of wearable devices among women with pelvic floor disorder <i>Edgar Rodríguez Ramírez, Mailin Lemke and Gillian McCarthy</i>
	FeedBreath: Designing Complementary Treatment Wearable Biofeedback System for Teenagers with anxiety disorder <i>Paolo Perego, Livia Teresa S. Stevenin and Qi Wang</i>
1130 – 1140	Closing Ceremony
1140 – 1240	AiDLab Tour & Networking AiDLab, 16/F, 19W, Hong Kong

Creating an environment to fight the fashion system: Fashion Tech Farm

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Abstract. We describe here the design and implementation of the Fashion Tech Farm (FTF), which aims to drive sustainable innovation in garments and fashion [1]. We describe our goals, design principles, and the implementation. The design principles are rooted in an understanding of the fashion system, open networks, and entrepreneurial thinking. After four years of work on the FTF, we review three projects to evaluate how far the work has achieved the main goals and how our design principles are developing.

Keywords: Fashion design, enterprise design, innovation, e-textiles.

1 Introduction

Spaces like FabLabs and MakerSpaces [2, 3] have become centers for design research into textiles, often collaboratively with academic, societal, and commercial partners. Most of these are supported by public or private funding; yet many spaces close once the external funding has ceased [4].

We present a case from the perspectives of design researchers and designers where the design goal is to re-inject innovation into the fashion system by setting up a new kind of enterprise. We do this from a first-person perspective in that our reflections upon the process as design researchers bring insight from an action research perspective, a process recently shown to be important in design research [5]. This aim is expressed by Todeschini et al. when they write "*the technological innovation in garment materials and manufacturing processes enable a new way to think about business models that go beyond scale economies and scope advantages generated by fast fashion.*" [6]. Fashion and technology have been intertwined since ancient times [7-9]. Yet, in the landscape of innovative spaces, it is hard to find examples that are at once commercially viable, collaborative, and sustainable.

Despite the rise of fast fashion in the past decades, innovation in the field is somehow lost. The fashion clothing and textiles industries are complex and multi-stakeholder [10, 11]. Yet recent design research has shown that design often emerges from everyday practice [12]. The process itself is as important as the outcome [13]. The fashion industry expands with harmful side effects because of globalization. McKinsey [14]: "Globally, the fashion industry is responsible for around 40 million tonnes of textile waste a year, most of which are either sent to landfill or incinerated." In practice, many companies refuse to share their process in the name commercial protection, yet design research has shown the value of sharing samples and the design process [15]. In a framing of designing a financially viable, collaboratively innovative, and sustainable-minded space, we describe the context, design goals, design principles, implementation, and example projects of FTF. We reflect upon the projects to understand how the implementation works, and whether the principles are feasible and effective.

2 Situated Context (Context of Design)

Recent research has highlighted the importance of the context and situation of design [16]. Designers often look at an artifact, how people use it, and for what purpose [17]. Auto-ethnographic research [18] is important when reflecting on an artifact like a dress, but as this is an institute the authors take a poly-ethnographic approach as situated designers and design researchers in the institute. The way we describe and evaluate the projects borrows from the duo and trio-ethnography argued by Dejardin et al. to produce valuable meaning in dialogic reflection [19]. Our situation and context are the actual FTF in Eindhoven. We look at three project examples as artifacts in order to reflect on the situation of the FTF as a designed environment.

3 Our Design Goals and Design Principles (FTF framework)

The design goals of FTF are 1) to establish a stable profitable business, 2) develop an ecosystem of designers around it, and 3) plant seeds for a truly innovative fashion tech system. Here “profitable business” means generating enough income to sustain a family, grow the business, and involve others. The design principles are rooted in a modern understanding of the fashion system, open networks, and entrepreneurial thinking.

The fashion system. The Fashion system is under pressure and out of control [14]. Therefore, our first design principle is: Not to play by the rules of this fashion system and that means no attractive launch of another label. Our second design principle is: To introduce innovative technologies in projects and products (that means no projects which are just more of the same). We value tactility, hands-on prototyping, and user focus to make desirable functional products from our first-person experience [20] in the team.

Open Networks. Open source arose in software engineering [21]. Its principle is that knowledge, code, and design patterns are shared as much as possible. The next principle is therefore to connect people and establish and grow networks based on mutual respect and trust.

Entrepreneurial principles. First: Real paying customers. Next: Avoid too large upfront investments, which come with financial risks and may thus lead to loss of control. It is preferred to grow slowly, reinvesting profits into the business and into the network. With that comes the last entrepreneurial principle: to share profit amongst all the individuals in the collective.

4 Implementing FTF

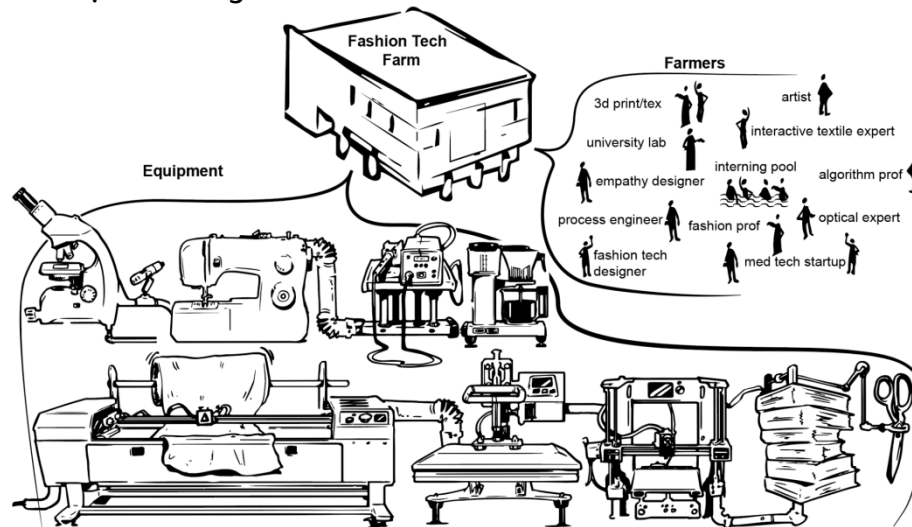


Fig. 1. FTF, its 'Farmers', and its tools. Illustration by Ruud van Reijmersdal.

Fashion Tech Farm is located in the Brainport region, Eindhoven, The Netherlands. The annual Dutch Design Week provides a platform for exhibiting to an international design public. FTF is more than a single company. It is home to a number of small companies, researchers, artists, engineers, interns, and residents, ranging from established to start-ups and young talents founding their first companies [1]. We call all these persons and entities "Farmers". The FTF workspace is a physical structure, not virtual, based on our experience that trust grows when people meet physically. Acts of making together, eating together, meeting visitors, etc. cannot be done virtually. Shared tools are chosen to stimulate digital ways of physical prototyping and construction, including a large 3D printer, sublimation printer, and laser cutter [22].

5 Example projects of FTF and Experiences

Three large and multifaceted projects initiated and executed at FTF were selected to report here as exemplars. We used them as carriers for collecting experiences and reflecting on the operation of FTF.

5.1 Sustainable Medical Gown (SMG)

The Sustainable Medical Gown [23] assignment was set by the national government and aims to reduce medical waste. At FTF a social scientist, an LCA expert, a business developer, a textile circularity expert, an emphatic designer, a pattern maker, and a UV-C disinfection expert (former intern) developed with by-wire.net [24] an isolation gown + system of use that can lower the environmental impact by 92% compared to the current practice of using disposable gowns.

History. When the Covid pandemic started, the emphatic designer and by-wire.net redesigned an earlier prototype of a facemask, achieving first sales five days after the first prototype. Selling thousands of facemasks, the team learned about user preferences and design acceptance. A national call to reduce medical waste occurred as medical waste piled up. We responded to the call, based on the facemask project and the innovation capacities of the larger FTF team.

Learnings. FTF was required to produce rapidly 150 gowns for user testing. The available FTF team was notably over-skilled to run the (small-scale) production. It was only because of solidarity and the mutual trust in the FTF community that the production part of the project was successfully completed. We became conscious of the lack of persons excelling in real production in the FFT.

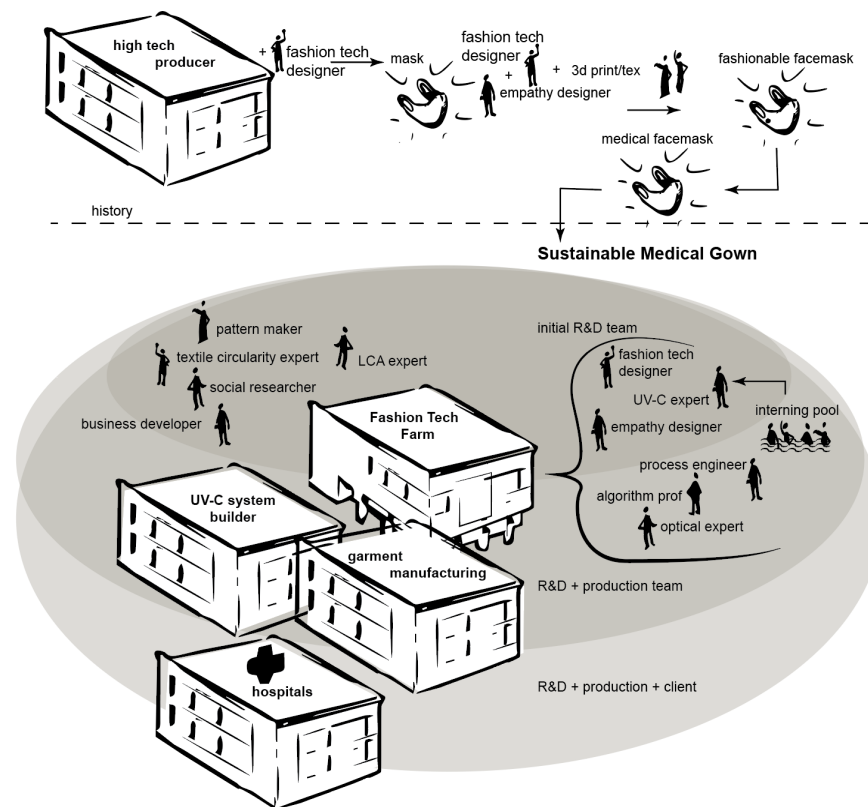


Fig. 2. Visualization of FTF stakeholder involvement for the SMG project, showing how the network of Farmers was formed, expanded, and was leveraged. The shading of the three areas corresponds to the expanding network during a project. In many cases, selected parties from the expanded network are invited to become farmers later.

5.2 Wearable Phototherapy for Jaundice (WP)

WP is a project by the FTF Med Tech startup Bilihome [25] developing a solution to support parents and newborns with jaundice in the first weeks of life. The wearable device can be worn by the baby during breastfeeding, with skin-to-skin contact, while providing blue light therapy. The garments are both aesthetic and technological, appearing to be much like an ordinary baby jumper.

History. The employees of Bilihome used to work in the field of high-tech medical products. By-wire.net [24] worked on blue light applications and advanced baby goods for high-tech partners. At the beginning of this development (2019) the team was 3 people. Along the way more partners within and outside of the FTF connected to this development: Hospitals as clients and researchers for the testing.

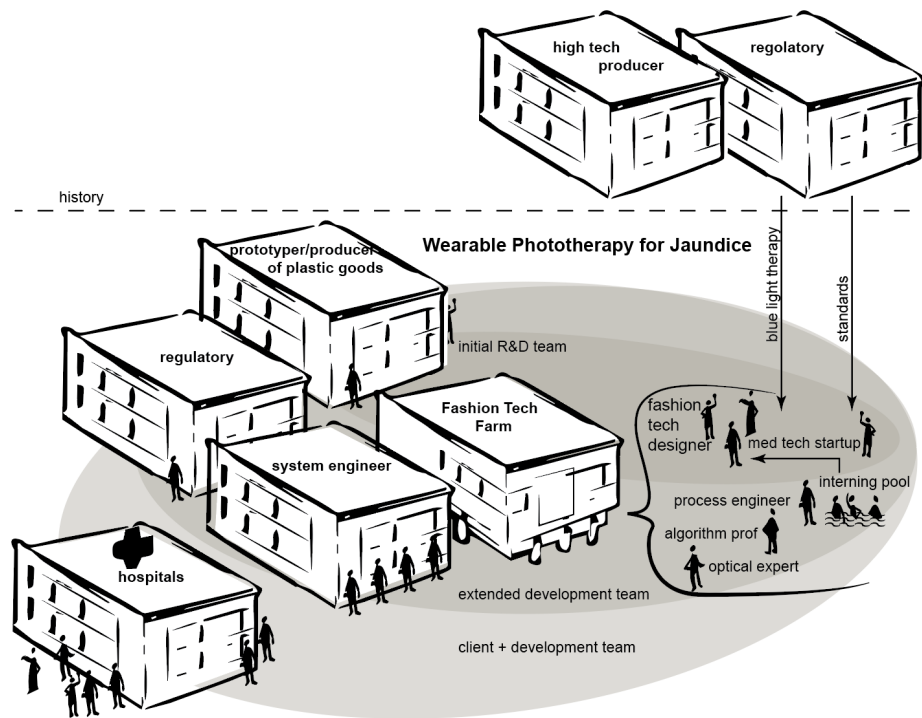


Fig. 3. Network visualization of stakeholder involvement during the WP project.

Lessons. The project began as a concept with a small and agile team (receiving a Red Dot Design award in 2020). The collaborative and sustainable practices of the FTF continued, but Med Tech developments require investments, Investors ask for patents, turning some parts of the project into a closed development (the Farmers seemed to understand). We learned about navigating through regulatory aspects as this product is defined as a medical device, and the expertise of the Farmers helped in that process. It was disappointing to find that sustainable challenges are more complicated than we thought because of the medical regulations.

5.3 Visual Identity By Experience (VIBE) [26]

By-wire.net was asked by a European consortium to research how wearables can motivate young people (genZ) to visit musea. 18 interactive vests and bodywarmers with integrated speakers and vibrators are developed and used for 9 days in a museum in Barcelona.

History. We co-developed the national ecosystem for printed electronics production (PE) since 2016. We decided to apply this printed electronics technology in this project and get a societally relevant and real test case for the robustness of this system.

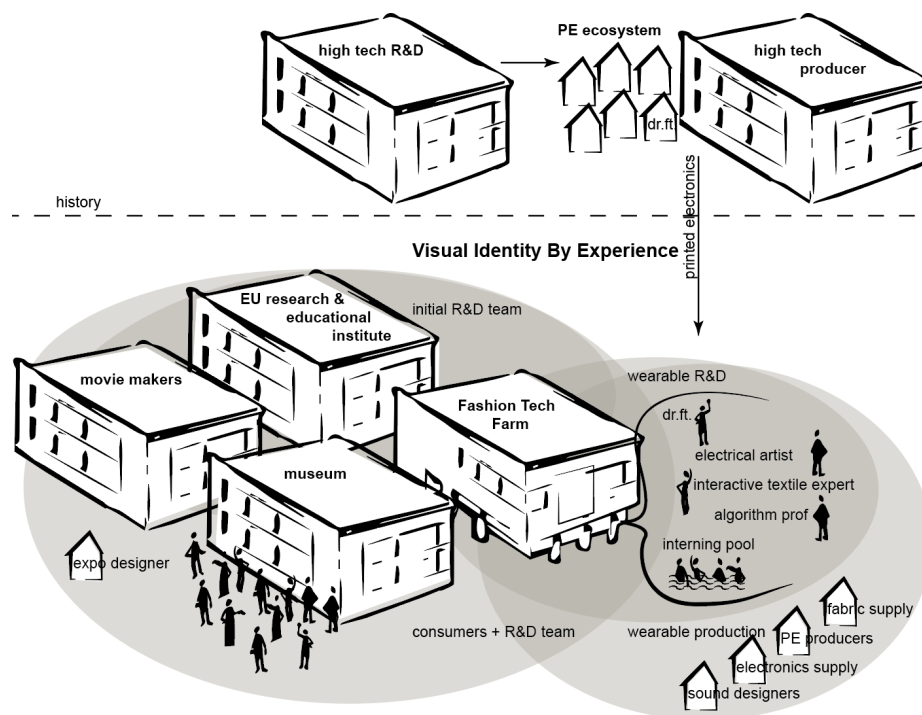


Fig. 4. Network visualization of stakeholder involvement during Visual Identity for Experience

Lessons. Looking back, we are critical as the wearable was mainly developed inside FTF, but there were problems in connecting to the music composers, the space designers, and the external communication team abroad. We were overly ambitious in using printed electronics sourced locally; the technology was immature and soldering backstage in the museum was needed to fix broken tracks. Owing to lack of time, the electronic effects were not in sync with the specially composed music. The public did not notice any of these problems, yet we look back on it as a stressful experience full of lost opportunities.

6 Evaluation and Reflection

As Farmers at the FTF, we offer a critical reflection on the FTF framework in action. Our analysis borrows from the duo- and trio-ethnographic methods as a poly-ethnographic discussion. The design principles of Section 3 can be seen as an idealistic way of working, aimed at contributing to long-term design goals. We make a distinction between general design principles and “our” design principles. The FTF of Section 4 is based on practical decisions, seized opportunities, and serious investments. Section 5 describes exemplar projects, how we experienced them. Looking back, we ask if and how:

1. the implementation facilitates the intended ways of working;
2. the design principles and implementation are effective for acquiring innovative interactive electronic textile projects; and
3. the projects reinforce the design principles and viability of FTF.

Our design principle, fashion system: *To not play by the rules of this out-of-control fashion system* has been respected. In SMG (1) the gowns are now being commercially offered to hospitals (still under negotiation). Similarly for WP (2) we created a business model where the device is bought by

hospitals and loaned to patients with insurance companies paying the hospital for the treatment. A national investors foundation supports the project: FTF and by-wire.net are negotiating for a scale-up project. The VIBE project (3) is an EU-funded project where by-wire.net was hired for the wearable. Museum visitors have free access to the use of the wearables. None of these three (or other FTF) projects originally had a goal to put profitable products on the market, yet the experience of the Farmers made this easier to achieve.

Our design principle, fashion system: The principle *to introduce innovative technologies* has been applied as follows. SMG (1) introduces UV-C cleaning as an intermediate local cleaning method to extend the lifetime of a gown. WP (2) combines blue light and wearables (romper). VIBE (3) integrated printed electronics of actuators in the museum setting. Although some of the technologies were known and validated, the combinations in these contexts are all new applications.

Our Design principle, fashion system. *To value tactility, hands-on prototyping, and user focus to make desirable and functional products:* All three development processes depended on hands-on textile prototyping, which goes beyond typical fashion system practice. SMG (1) included an extensive textile selection process and multiple cycles of user testing in six hospitals where nurses tested the gowns. WP (2) included an extensive textile selection process with chemical tests, multiple cycles of user testing, and user validation processes with 45 subjects divided from different target groups. VIBE (3) included extensive user testing with GenZ on the identity design process.

Design principle, open-source: *To share as much as possible.* SMG (1) is *almost* 100% open-source. We made a booklet, a video and put the full report and construction-related documents on an open website. This worked out positively as caregivers submitted voluntarily to participate in user tests. The “almost” refers to the design patent filed on the thumbhole, which we did because the funding-body wants projects to generate intellectual property (IP) rights – so we compromised. Fortunately, 99% of the projects’ achievements do not depend on the use of the specially developed thumbhole of the gown. WP (2) is half open as it is partially investor driven; the investors tend to favour IP approaches. Still, we tried to be open as much as possible, also to facilitate feedback gathering. VIBE (3) is open-source: the report is published on vibe-experience.com and the code on github. VIBE was presented to the public in the Dutch Design Week.

To connect people, establish and grow networks. The SMG (1) team grew during the development process. Interns became fully paid team members. Business developers became members of the core team. Well-established connections became stronger while the user test production had to be done. The WP (2) team grew slowly but surely from 3 to a team of about 20 persons and 50 supporters in the wider network. VIBE (3) was a loose international network, transformed into a formal consortium for the duration of the project. But the collaboration with the international community did not become stronger. We have learned a lot:

Entrepreneurial actings

Have real, paying customers. SMG (1) was an assignment for a national government based on a fixed amount of money and an accepted offer from the team’s side. WP (2) is an assignment for Bilihome based on an investor model with the hope of reaching a break-even point 4 years from now. VIBE (3) is EU-funded, so not really matching our definition of real, paying customers.

Avoid overly large upfront investments. The pre-investment for SMG (1) was to develop a project proposal based on the government’s aim to reduce medical waste plus an offer. For WP (2) there

was no pre-investment from FTF's perspective; on the contrary, the med tech startup pays rent for office/lab space in FTF, contributing to its economic feasibility. For VIBE (3) the pre-investment was needed to develop a project proposal based on the funding call.

Share profit amongst the individuals in the collective. The total SMG (1) budget is spread within the Farmer collective and community. WP (2) assignments are used to pay Farmers and enlarge the community. The VIBE (3) budget gave the opportunity to hire Farmers to execute jobs and strengthen the connections with suppliers. However, we also felt the tensions between the demands of funding bodies and investors and the Open Network design principles, as was to be expected.

7 Conclusions and Future

To assess our work to date, first recall our design goals: 1) to establish a stable profitable business, 2) develop an ecosystem of designers around it, and 3) plant seeds for a truly innovative fashion tech system. Regarding 1), the FTF has been operational for almost four years now, is economically stable and manages to support itself. However, return on investment is not yet comparable to industry standards. The building is expensive and keeping up with the sustainability goals to upgrade the FTF to be energy-efficient is difficult. The ecosystem of designers is strong, contributing demonstrably to the design communities in the Eindhoven region. Regarding 3), it is sure that FTF is planting seeds for innovation.

Does FTF address all problems of the fashion system? Todeschini et al. [5] present 15 drivers of sustainable innovation, five of which have significant overlap with the design goals and major activities in FTF: sweatshop free, (all our production is local), collaboration (the core of the FTF concept), zero-waste (for example the Sustainable Medical Gown), wearables (the VIBE project), and Slow Fashion (projects on innovative aesthetics). Being critical: it is only 5 out of 15.

The most important lesson is that the collaborative atmosphere and the open nature of the FTF are the main enablers of projects. This confirms the “emergence” argument of Gaver et al. [12]. We facilitate and encourage the ad-hoc improvised processes of the FTF. A second lesson is that we have to be realistic: we cannot directly address the totality of problems and troubles of today's fashion system, nor the problem of consumer waste. Economically, FTF is stable, but cannot handle independent big investments yet; there is a tension between the open-source design principle and the IP policy of some of the investors. Yet that tension is vital for innovation.

What is the academic contribution of this work? We refer to Mukendi et al. [27], who classify 465 articles on Sustainable Fashion, and find two main categories of research, viz. pragmatic and radical, but at the same time identify several important gaps for current and future research directions. FTF is radical in the sense of [27]. Mukendi et al. [27] write: “In lieu of being able to change the education system, the provision of places and spaces for development in these areas may fall on the third-sector of civil society, but studies investigating the role that could be played by third-sector organizations is presently lacking.” Mukendi et al. [27] also argue that: “Much SF research is undertaken in silos, however, by

crossing disciplinary lines, exciting new ideas may be introduced into the field.” In this paper we have shown that it is possible to create a non-school space for innovation, operating across disciplines. Moreover, we described and critically analyzed the working of FTF from a first person perspective.

Learning about our characteristics and our sustained belief in the strength of diversified creativeness and entrepreneurship, we remain confident in being able to improve the human context in future fashion production.

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