

## DISSEMINATING KNOWLEDGE OF ELECTRONIC TEXTILES AT ART SCHOOLS AND UNIVERSITIES

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This paper aims to give an impression of how knowledge of e-textiles is shared in art schools and universities. With this paper, we intend to create a context for future reflections on e-textiles education and knowledge dissemination for educators in this field. We hope to stimulate knowledge sharing on e-textiles between institutes and with the e-textiles community at large by identifying opportunities for open learning.



*Students present their semester project. Copyright Wearable Senses, Industrial Design, Technical University of Eindhoven, The Netherlands*

### The context of e-textiles education

The field of electronic textiles is multi-disciplinary and operates at the intersections of textile and fashion design, industrial design, furniture design, computer science, interaction design, and media art. The students who are taught in this field are diverse and possess a skill set associated with their future work field. When students create electronic textiles in higher education, they are primarily judged by the quality standards of their specific field of study. Consequently there are many ways to teach this subject.

Although end-goal requirements of students differ, the skill set that is necessary to create an electronic textile is the same. Students need to have a basic understanding of the textile technique and electronics

they intend to work with and to know how to tackle integration issues. This common ground in e-textiles education indicates that there may be opportunities for dissemination of knowledge that transcend the boundaries of the disciplines. We believe that this kind of dissemination is possible through the sharing of educational artifacts, i.e. all media that are produced for and through educational contexts.

In the following sections we will give insight into e-textiles education at five art schools and universities. At the end of each chapter we will highlight the educational artifacts that are in use at the institute.

### Wearable Senses at the faculty of Industrial Design (ID), Eindhoven University of Technology (TU/e)

Three years ago, the theme Wearable Senses (WS) was set up, applying the mission statement of the ID department, with a unique focus on those intelligent interactive products, systems, and services that are close, near, or on the body. In the course of time, the theme has been expanded with a textile electronics workshop and a material library with high-end innovative textile and electronic materials. Wearable Senses have a strong network of industry partners (regional, national, and international) and in this way receives support on different levels from both the textile and the electronics world. The main application areas of the theme are expressive clothing and accessories, sports garments, interior textiles and interesting deviations.

Within the theme, students work in close collaboration with the WS-staff and are considered as junior employees, actively contributing to the development of the theme's vision, identity, knowledge, methods, skills and tools. Each semester, bachelor and master students work alongside each other on various educational activities. One of these educational activities is the intelligent textiles module. This is a one-week course in the ID master in which multiple design crossovers are being made between textiles and electronics, using or in search of what we at Wearable Senses like to call 'boundary objects'. [1]

In the module around twenty students systematically explore the aesthetic quality and potential of textile electronics with a hands-on approach. The students design and create textile electronics interactions or effects. These designs take the form of interactive textile samples, which are sensitive to certain stimuli, smart or intelligent, and contain expression.

During the module, students work in groups of three to four people. On the first day, each group works on a different technique: 1) weaving, 2) knitting, 3) embroidery, 4) cut/overlock/sew/heat press, 5) laser cutting/3D printing. Day one ends with presenting samples to each other and explaining opportunities for design of each separate technique. After day one, there are five 'technique expert' groups, each containing four students. On the second day, students rotate and new 'hybrid technique' groups are formed. Day two, having the same assignment as day one, ends with presenting 'hybrid samples' to each other, and explaining opportunities for design by combining two techniques. On days three to five, the student groups are given the assignment of systematically exploring the combination of techniques, and successively creating a textile electronics interaction or effect. The module concludes with a demo of the final results.

Educational Artifacts: physical e-textile samples, previous student projects on display, presentation boards (A3 size with working textile mockups and annotations), digital documentation of circuits and textile techniques, tools and skills in video explaining design steps, construction, materials and electronics specs. At ID we call this specific video capturing environment, in which students document their work, the 'Library of Skills'. [2]

## Electronic Textiles at the Royal Academy of Art, The Hague

Electronic Textiles are taught at the Royal Academy of Art in The Hague (KABK) as part of the Introductory Courses, which are classes designed to give students basic skills in technical subjects that are not covered in the regular course program. Students have often undergone at least one year of study as the courses are intended for specialization after acquiring basic knowledge in one's field.

The course Electronic Textiles introduces students to the field of e-textile design over the course of seven lessons of three hours each. The emphasis of this course is on the aesthetical design and integration of electronics in textiles. Students are taught both textile techniques and simple electronic circuits through the creation of e-textile samples. The course buildup comprises a series of short workshops to acquire skills and produce a volume of e-textile samples, an individual project, and lectures that place e-textile design in a social and cultural context.

Students are first introduced to a basic principle of textile design: building a material through the repetition of a pattern. They are shown an overview of textile techniques that can be repeated ad infinitum and are challenged to make modular textile electronics using a textile, a LED, conductive thread and a soft button. This is called an e-textile building block. Over the course of the first and second lessons the e-textile building block is used in a pattern where nine LEDs are connected in a parallel circuit. The third lesson introduces movement in textiles by using a small motor in a pattern, where a moving component breaks the repetition. The fourth lesson focuses on felting raw wool with electroluminescent wire, exemplifying the inclusion of electronics in a textile and creating a new material. The fifth lesson teaches students screen-printing with thermochromic ink and controlling color change through resistive heating. The last two lessons are reserved for an individual project: a high quality sample with sketches and a presentation explaining the intended use for the material. The learning goal of this assignment is for students to implement their newly acquired knowledge in a product that fits into the context of their field of study.

Educational Artifacts: physical e-textile samples, lecture slides and digital documentation of circuits and textile techniques, project documentation.

## Department of Design & Computation Arts at Concordia University Montréal

The Department of Design & Computation Arts is part of the Faculty of Fine Arts at Concordia University in Montréal. Students in Computation Arts are taught a broad spectrum of media from motion graphics, 3D software, physical computing, sound design, video editing, graphic design and interactive arts through to performance media. In combination with the arts curriculum, students take programming classes, which are taught both within Computation Arts and in Computer Science. The undergraduate program is a 4-year course program. Students have core classes (design, networked culture, basic programming) and electives, which permit them to choose a direction (physical computing vs. 3D modeling vs. motion graphics). The Computation Arts program has the goal to form designer/artists who can work both commercially and independently. The focus is on creating meaningful, artistic products, which respond to today's cultural climate.

There is a strong emphasis on self-learning with a series of inspirational technical workshops, which are complemented by a number of physical resources available to students. The Computation Lab is a resource center where students can get help with various programming languages. The Sense Lab is a

physical computing lab, which is equipped with e-textiles equipment such as sewing machines, embroidery machines, and soldering and circuit-making tools. There are full time technicians in both labs to help students with their projects.

Students have access to one specific wearables class, Second Skin, usually taught by Joanna Berzowska from XS Labs. However, they are encouraged to explore body-interfaces in other classes (i.e. wearable controls and physical computing / installation projects utilizing e-textiles). Open design practices are encouraged via a number of online and in-situ didactic platforms. Class instructors and students make use of online forums to share information and techniques. Student projects are documented and posted online. Hands-on exchanges are encouraged in open lab contexts. Collaborative projects are also encouraged in order to foster better communication and project development. Computation Arts holds both end-of-the-year and open studio class events. Within the context of these events, students are encouraged to showcase gallery-ready projects, which are technically and aesthetically resolved and accessible to a wide-range public.

Educational Artifacts: a wide range of online resources and online project documentation.

### The Smart Textile Design Lab at the Swedish School of Textiles at the University College of Borås

In 2008 the Smart Textile Design Lab (STDL) [3] was initiated as part of the research initiative Smart Textiles at The Swedish School of Textiles funded by Vinnova. [4] The lab focuses mainly on experimental design research. There are three overall themes in the STDL: textile sound design, textile interaction design and dynamic textile patterns. This is an important foundation for the integration of electronic textiles in our education.

The researchers, post-doc, doctoral candidates, and master students in textile design have a shared environment, with individual workspaces, but with a joint meeting and working areas. Other meeting places are the Material Library and the weekly Design Seminars, where both smart textiles/electronic textiles and more traditional approaches to the textile field are covered. The lab has research collaborations with the national textile industry, producing interior and technical textiles, and has collaborations with the transport industry and a furniture producer amongst others. Researchers and doctoral candidates supervise students in individual projects as well as in joint collaborations with and without industrial partners.

The lab has integrated its research topics with existing basic courses in the textile design education to widen the perspectives in the three main textile techniques that are taught: weaving, knitting, and printing. In the basic weaving course optical fibers will be introduced in the near future and the weaving class is being extended with workshops on light as a design material. The notion of dynamic textile patterns [5] has also been added by printing with thermochromic (TC) ink in the basic classes, which naturally brings in conductive materials as both a heat source and to exemplify a new design variable in textile design.

Master students attend basic textile courses where necessary; later they are given more individual hands-on supervision and support for their own design projects. Regarding electronics, workshops have been given in topics such as integrating LEDs in woven structures (including how to build a simple circuit

with a resistor, light, and energy source), stretch sensors and buttons, and how to connect a textile material to a computer program and control it. The Smart Textile Design Lab organizes its own workshops and invites external experts to teach.

In the STDL there is an ongoing project called Smart Textile Sample Collection where textiles are developed by the meter to be used in joint projects with industry (e.g. the Recurring Patterns [6] project) as well as during workshops. For example, one material was developed for a dynamic textile pattern workshop using thermochromic ink; this textile was plugged into a system where students and designers could control heat sections from a program and change the textile's color.

An important aim of the STDL is to teach students the basics of electronics and programming and provide them with a vocabulary that allows them to communicate with other professionals such as electrical engineers and programmers. A Digital Fika [7] (translation: digital coffee), an informal meeting/coffee break combining basic hands-on demos with discussions, starting with how to use a multimeter, reading textile sensory data and controlling inputs and outputs to create a textile expression, has been introduced in this regard.

Educational Artifacts: Smart Textile Sample Collection and Material Library.

### Technology and Ecology at the fashion design department at Utrecht School of the Arts

Design education is 'based on social idealism.' [8] This certainly applies to the education of fashion students in Utrecht, who are taught to think from a social perspective. In designing they consider the consumer's point of view, how the consumer emotionally adapts to the world through positive aesthetics, and how to place design in a contemporary context. Historically the fashion industry has stretched people's minds by seducing them to stay ahead of the curve by consuming 'newness', thus achieving wide social acceptance for new concepts in clothing. Looking at consumers' attitudes toward innovation, it seems that they want clothing conceived by fashion designers and not by technicians. This implies that fashion designers and fashion design education must get involved in new technological developments.

To aid this development, the class Technology and Ecology is taught at the Utrecht School of Arts to second year fashion design students. The aim of this course is to inform students about what innovations are, or soon will be, available in the textile and fashion industry, to inspire them to explore and integrate innovations in their design process and to give students tools to easily communicate and collaborate with technicians. Technology and Ecology is an 8-week course of two hours per week. The main focus of these lessons is the interaction between fashion, technology and innovation and how this contributes to a more sustainable environment. The course poses questions like: Which functionalities can technology add to clothing and to what purpose? And how can fashion designers design for the future?

Five lectures introduce students to past, present and future innovations in fashion to help them develop their vision on design innovation. The lectures cover innovative design, adoption issues of technology, critical reflection on fashion and innovation, ecological issues and experimental tools. 1) Introduction to by-wire.net and 200 visuals of innovative projects 2) Innovations in the production process of textile and garment fabrication 3) Recycling & cradle to cradle [9] 4) Old vs. new textile 5) Wearable electronics.

During the first lecture students are exposed to innovations ranging from garments of Inuits, who made animal skins flexible so that their people could move to colder environments, to contemporary examples

of self-growing textiles, sensory active protectors and moving garments. Students then choose three examples to explore through literature and online documentation, resulting in a short report discussing the technology/ecology aspect of projects, the projects' participants, the users, and the added value for consumers. After these lectures, students choose one subject and start an individual artistic research on materials, technology, ecology, and function inspired by innovative projects from the by-wire.net library. [10] They conclude their research in a communicative and conceptual item of clothing. Students present their research and prototypes to their peers.

Educational Artifacts: the digital project documentation in the by-wire.net library, lecture slides and physical e-textile garments.

## Discussion

In summary, knowledge dissemination of e-textiles in the five institutes presented here takes place mainly through the educational program by overlapping education and research, sharing student work in class, by presenting work of students in the institute, and by organizing events with specialists. Many of the educational artifacts we have discussed in this paper are unavailable outside the walls of the institute, even though they have the potential to extend further. Contributing to open learning, as a counterpart of open design, is currently not actively pursued, as it is not part of the core activities of educational institutes. This raises the question if institutional contribution to open learning benefits institutes.

If educators want to contribute to open learning, the most effective way would be to share educational artifacts online. Looking at the institutes discussed in this paper, there are many artifacts, such as lecture slides, lists of online lectures/articles/blogs, students' project reports, technical schemas for electronics and textiles and the Library of Skills, which are already of a digital nature and are therefore highly suitable for sharing. Other artifacts, such as materials, samples, and finished prototypes, are of a physical nature and would need to be digitized if they are to be shared online. Research is needed into the best methods for digitizing. Besides sharing artifacts, educators may also consider transforming their educational artifacts into textbooks (e.g. Open Softwear) [11] or online courses. In the future we hope to see more knowledge sharing on e-textiles by educational institutes. Through sharing educational artifacts we have the opportunity to teach and inspire the entire international e-textiles education community and beyond.

## **References and Notes:**

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