



Bootcamp report

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EXECUTIVE SUMMARY

A successful bootcamp was held as a Learning, Teaching and Training activity (LTT) on 13-17th Nov. 2023 at University of Borås. 5 students and 2 teachers from each higher education partner participated in the bootcamp (UPC had 11 students instead of 5, as more students were enthusiastic to participate in the bootcamp). The program followed the main topics in the Mooc, which were concluded by the survey implemented in textile industry and academia in partner countries and institutions. The overall result was satisfactory as a means of knowledge and cultural exchange.

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1. Bootcamp program

The bootcamp aimed to promote smart textiles principles in advanced textile manufacturing, foster collaboration between universities and companies, enhance transnational innovation, and transfer innovation-based thinking to students through blended learning and flipped classrooms. To achieve these goals, we facilitated transnational student collaboration, tested new educational methodologies (R1A2), and evaluated virtual learning content (R2 and R4) for future training. Preparations included coordinating with partners, developing educational materials, setting up technological infrastructure, and organizing logistics, ensuring a valuable and impactful learning experience. The bootcamp was held based on the below program from 13-17th Nov. at University of Borås.

Responsible Partner	UPC Monday 13 th Nov.	UNIWA Tuesday 14 th Nov.	UB Wednesday 15 th Nov.	TUIASI Thursday 16 th Nov.	Friday 17 th Nov.
Module	Raw materials and products for functional and smart textiles	Sustainability issues in functional and smart textiles	Resource efficient technologies for functional and smart textiles	Smart textiles entrepreneurship	
8:00-9:00	Welcome by UB				
9:00-10:30	Workshop Experiencing smart textile materials (I)	Waste types and recycling methods part 1	Tour of School of Textiles 9-11	Conceptual definition of business models	
10:30-10:45	Rest	Rest	Digital lab Green Room 11-11:30	Rest	Textile museum tour 10:15-11:15
10:45-12	Workshop Experiencing smart textile materials (II)	Waste types and recycling methods part 2	Introduction to Textile Technology master programs 11:30-12	HACKATON Market scenarios and brainstorming for B2C ideas	Company presentation ITP 11:30-12
12-13	Lunch	Lunch Smart Textiles Showroom Plan 2 Drop In	Lunch Smart Textiles Showroom Plan 2 Drop In 12:00 – 13:30	Lunch	Lunch
13-14:30	Workshop Material centred ideation & validation	Life Cycle Analysis	Company visit (FOV fabrics, Digital printing) 13:30-16:30	HACKATON BMC development	
14:30-14:45	Rest	Rest	Opportunity to join Innovation and inspiration seminars Vestindien C	Rest	
14:45-16:30	Workshop Concept development & evaluation	Life Cycle Analysis	15:25-16:30	HACKATON BMC development Evaluation of results	

2. Raw materials and products for functional and smart textiles (Monday 13th Nov.)

On the first day, the UPC training team was in charge of the formative program covering the “Raw materials and products for functional and smart textiles”. The activities take place along a morning session –from 9:00 to 12:00h– and an afternoon session –from 13:00 to 16:30h–, and were developed in groups, since the ability of working in a group is one of the skills defined as the learning goal of the activity. To ensure the heterogeneity of the groups and the networking and cooperation between students of different institutions, the grouping included 4-5 students from all of the HEIs participating in the project (i.e. 1 participant of TUIASI, 1 of UBorås, 1 of UNIWA, and 2 or 3 of UPC were forming each of the five groups).

The objective of the first day was to present the possibilities of raw materials and how they can be selected for the development of smart textiles. To this aim, the students worked through a collection of four workstations during the morning session, and in a design challenge in the afternoon session.

Regarding the morning session, the students worked throughout four different workstations to experiment with thermochromics, light conductive fibres, shape memory materials, and electrically conductive yarns and fabrics. The workstations were designed using two different approaches: from the product or application to the material (materials’ selection processes), and from the material’s properties to the application (material-centred innovation).

The objective of these workstations and the group distribution was, as mentioned before, to enhance the networking and cooperation between the students from different countries. In this sense, the activity was revealed very soon to be a success, since the students started to interact, discuss and enjoy the experiments. Moreover, two more learning goals were achieved, since the students were able to recognize the main raw materials to develop active smart textiles, and to identify the type of raw material required to impart certain smart functionalities to textiles.

Regarding the afternoon session, the student groups worked through focused-on-the-material (material-centred innovation) or focused-on-the-application (material’s selection processes) design approaches to solve a design challenge about the conceptualisation of a textile product based on the use of smart textiles, taking as a starting point the experiments developed during the morning session. The main aim of this activity was to trigger the creativity of the participants of the *bootcamp* from a design thinking approach, and connect the knowledge acquired in the virtual training with the conceptualisation design step.

In 3h, the groups were capable of proposing a concept that was validated by a committee of teachers from all HEIs participating, who also provided some feedback for improving these first concepts of marketable products. In this sense, the students were able to search for, process and analyse information from different sources and, at the same time, they revealed a clear capacity to generate new ideas (creativity) for the development of smart textiles, this meaning that all the learning goals proposed were achieved.

The committee gladly observed the impressive advances made by the students during the first training day on a final presentation. The five ideas finally proposed were:

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- A jacket/vest for high visibility based on the use of optical fibres.
- A pair of calefactable gloves capable of sensing the wearer's temperature and providing heat to fight back the misconnected tissue disease.
- A bike jacket having improved transpiration through SMPs and comfortable but safe protection provided by non-Newtonian fluids-based parts.
- A carpet designed to act as a nursing device, capable of connecting lights and detecting falls for the care of elderly people, also harvesting energy from their stepping.
- A camouflage military uniform, based on thermochromic inks that is both improving the invisibility in forest and desert locations as well as the comfort of the wearer.

Having all the ideas nicely presented, the teaching team concluded that the activities performed clearly helped to break the ice and engage the students in the project, enhancing their networking and revealing an interesting output of skills and competences. Moreover, all the learning goals proposed for the activity were achieved during the session. Hence, the first day of the training could be considered a complete success.



3. Sustainability issues in functional and smart textiles (Tuesday 14th Nov.)

On the second day of the bootcamp, the presentation took place in two parts:

The first part was about textile recycling.

First, the global impact of textiles was discussed, what recycling is, and why it is important. In addition, the way consumers and industries recycle their waste was in the focus. Some of the topics discussed were about recycling classifications, sorting, exploring sustainability, recyclable materials and smart cloths. A model for textiles circular economy was given, and biological recycling of waste and Bio Based Processes were discussed.

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In conclusion, mechanical recycling is well established, but cannot take place infinitely, as the process degrades the quality of the textiles.

Whilst mechanical recycling is adopted in industry, chemical recycling can achieve a high-quality output, however it is not yet sufficiently scaled.

Two novel options including enzymatic and biological processes were discussed. While these options are not yet used in a closed-loop recycling format, i.e. textile to textile, these processes have been demonstrated in open loop recycling i.e. use textiles to make feedstock for fermentation or the use of biopolymers to make textile fabrics.

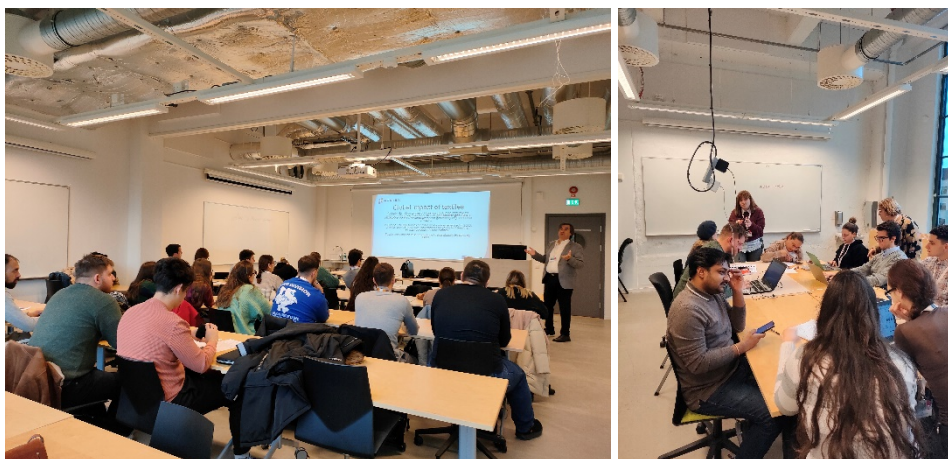
The potential of research to close the loop was highlighted where end-of-life textiles would be used to make novel virgin textile materials, using enzymes and fermentation.

The second part of the second day was about Life Cycle Analysis (LCA).

There was an introduction to the concept of LCA with textiles as a case, the main LCA parameters, the phases of product life, the boundaries and inventory analysis, functional unit.

EU legislation and its influence on the textiles sector and the principles of circular economy were discussed. The following topics were covered as well: Overview and Status Quo of the European Green Deal, Circular economy: definition, importance, benefits and EU Strategy for Sustainable and Circular Textiles.

After the presentations, the students were grouped like the first day. The requirements of that day were to do research and evaluate their project concepts according to the lessons in which they had already participated. At the end, the students and their teams were called to present their projects.



4. Resource efficient technologies for functional and smart textiles (Wednesday 15th Nov.)

University of Borås was responsible for the day. Textile material technology (TMT) group of the Swedish school of Textiles focus is on the resource-efficient processes for functional and smart textiles. That is why the day was planned in a way that the students could have a tour of the Swedish school of Textiles including the labs of Spinning, Weaving, Knitting, Sewing, and research labs with all the facilities to make the research on novel processes for functional and smart textiles possible. The focus of the visit within the research labs was to show the students how to research and innovate smart textiles. They were shown how to measure the electrical characteristics of smart textiles, how the equipment works, and the possible results might be made. In addition, the students visited the labs with different resource efficient technologies such as plasma technology, spray dyeing, Co2-dyeing technology, inkjet printing, Chromojet printing and 3D printing. Then they listened to the Digital lab seminar which was part of the “Borås Textile Days”. The students had the chance to visit the smart textiles showroom as well. In the afternoon, the students had the chance to visit a Swedish textile company “FOV” which is famous for moving towards more resource efficient processes and recently bought an inkjet printer as a result of having projects contribution with the school. At the end students could join the innovation and inspirational seminars which were organised by the “Borås Textile Days”.



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5. Smart textiles entrepreneurship (Thursday 16th Nov.)

The Hackathon Day dedicated to Smart Textile Innovation was a success, providing students with a valuable learning experience in entrepreneurship and innovative product development. Here is a brief recap of how the day went:

The day began with an engaging morning session, where students were introduced to the fundamental concepts of business models and entrepreneurship. They gained insights into the importance of elements like value proposition, customer segments, and revenue streams.

Next, we delved into the fascinating world of smart textiles, showcasing various examples of cutting-edge products. Students were inspired by real-world applications, from fabrics that regulate temperature to wearable health monitoring devices.

The hackathon challenge was revealed: teams were tasked with developing a Business Model Canvas for their unique smart textile product ideas developed in the previous days. The activity was performed in multicultural teams, bringing diverse perspectives and skills.

A workshop on the Business Model Canvas framework followed, giving students a comprehensive understanding of its nine key components. They brainstormed and strategized how to effectively fill in these components for their specific smart textile products.

Throughout the day, mentors and industry experts provided valuable guidance, nurturing the growth of innovative ideas. Students had the chance to refine their business models and gain insights into industry best practices.

Teams engaged in ideation and brainstorming sessions, focusing on innovation and real-world problem solving. They were encouraged to create value for potential customers and explore unique product selling propositions.

Teams prepared and delivered pitches for their smart textile product ideas as the day progressed. They displayed their Business Model Canvases, explaining their vision to peers and mentors. The level of creativity and dedication displayed by the teams was truly impressive.

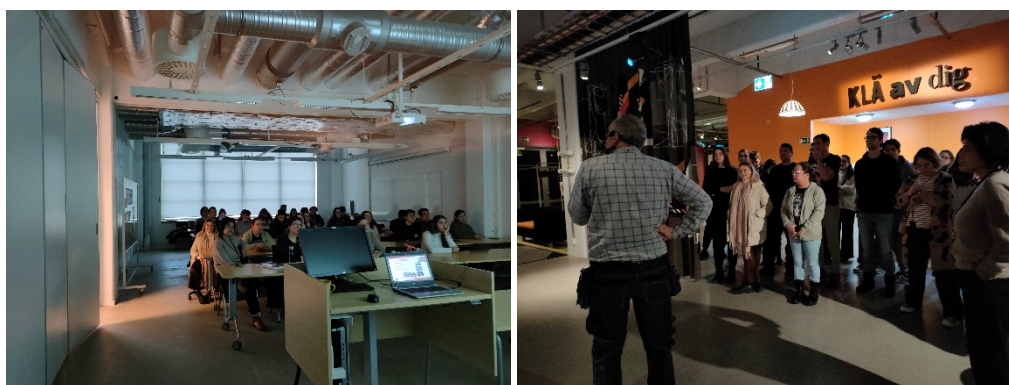
Students networked, shared ideas, and built connections during breaks and lunch. Collaboration was actively encouraged, fostering a vibrant creative thinking and idea exchange atmosphere.

In retrospect, the Hackathon Day was a remarkable learning journey. Students gained an understanding of business models and applied their knowledge to develop innovative Business Model Canvases for smart textile products.



6. Friday 17th Nov

On the last day, the students had the chance to visit the Textile museum at the Swedish school of textiles and listen to a presentation of a German smart textile company ITP.



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7. Evaluation

The bootcamp was met with positive feedback from participants, with 20 out of 21 considering the training appropriate for their knowledge and experience. Participants were highly satisfied with the organization of the bootcamp (weighted average >93%) and the overall training (weighted average >87%). The bootcamp consisted of various thematic days, each focusing on different aspects of smart textiles, with Day 1 (Raw materials and products for functional and smart textiles) and Day 4 (Smart textiles entrepreneurship) receiving the highest satisfaction scores.

The bootcamp received high satisfaction ratings from participants, reflecting a well-organized and effective training program. Key points include:

- **Organization:** The bootcamp was highly organized (95% rating), with a satisfactory venue (93%) and valuable cross-cultural exchanges (95%).
- **Training:** The Moodle platform was effective (91%), and training objectives were clear and met (90%). Topics were easy to follow (94%), and the training length was sufficient (89%). The content was relevant to participants' needs (87%) and met their expectations (91%).
- **Teamwork and Activities:** Collaborative teamwork improved understanding and skills (94%), and additional activities like industry visits were useful (93%).

Participants suggested improvements for the bootcamp, including more coverage of topics like recycling of smart textiles, Life Cycle Assessment workflows, and technologies for 2D and 3D smart textiles. They enjoyed networking, group work, and practical workshops. Suggestions for improvement included addressing the intensity and duration of the bootcamp, organizing visits to factories related to smart textiles, and balancing theoretical and practical components. Feedback for future bootcamps included adjusting intensity, accommodating advanced participants, and providing more detailed manufacturing information. Participants appreciated the blend of theoretical and practical training and collaboration opportunities in the smart textiles field. Overall, the bootcamp was well-received, with participants appreciating the structured organization, relevant training content, and the opportunity for practical and collaborative learning.

ERASMUS +

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