



Advancing industrial digital and green innovations
in the advanced textile industry through innovation
in learning and training

WP2 German National Report



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1. Introduction

In 2021, a total of 135 companies produced technical textiles in Germany. The number of employees in this branch of the textile and clothing industry amounted to around 13,148 people. Manufacturers exported more than 166,000 tons of technical textiles worth around 4.9 billion euros abroad that year. The total turnover of the German textile industry was 11.8 billion euros. (Source: Gesamtverband der deutschen Textil- und Modeindustrie e.V., November 2022)

The leading German textile manufacturer is from the sector of mobility, with sales of around 1.9 billion euros in fiscal 2020. The company specializes in the development and production of textiles for the automotive industry. (Source: Statista Research Department, 03.01.2023)

In Germany there are 9 universities where you can study highly qualified textile technology. (Universities for clothing technology/fashion were not considered!!). Each of the universities has a special focus such as Textile Mechanical Engineering - Textile Manufacturing - Product Development - Smart Textiles - Innovative Textiles - Functional Textiles - Textile Electronics - Research and Development.

Textile technology is concerned on the one hand with preparing natural fibers such as cotton, wool, flax, hemp, etc. for the textile industry, and on the other hand with the development and production of chemical textile fibers (e.g. waterproof and windproof functional fibers and membranes). Further processing, i.e. dyeing and printing of yarns and textiles, also belongs here. There is often an overlap between textile and apparel technology, which focuses on the design and production of a wide variety of textiles (e.g. outerwear). The technical part always predominates in these engineering courses. Thus, the focus is less on design and the artistically creative, but rather on optimizing the industrial production of textile fibers and clothing, improving their quality, and developing new working and production methods. You should have an interest in mathematics, physics and technology, but also in business administration. English is helpful for this international industry.

Contact persons for all following universities have been researched.

TU Dresden Textile and Confection Technology, Master (M. Sc.)
TU Dresden Processing Machines and Textile Mechanical Engineering, Diploma
Kaiserslautern University of Applied Sciences (Pirmasens location)Leather and Textile Technology, Bachelor
HS Albstadt-Sigmaringen Textile and Clothing Technology, Bachelor
HS Hof Innovative Textiles, Bachelor
HS Niederrhein Textile Products Field of Study Textiles, Master
HS Niederrhein Textile and Clothing Technology Field of Study Textile Technology, Bachelor
HS Reutlingen Interdisciplinary Product Development, Master
HS Reutlingen Textile Chain Research, (M. Sc.)
HS Reutlingen Textile Technology-Textile Management, Bachelor
RWTH Aachen Plastics and Textile Technology, (M. Sc.)
RWTH Aachen Textile Engineering, (M. Sc.)
TU Chemnitz Textile Structures and Technologies, Master
West Saxon University of Applied Sciences Zwickau Textile Structures and Technologies, Bachelor

Furthermore, there are 16 textile Research Institutes with 1.400 researchers which provide training, ranging from basic textile knowledge to specific material and production techniques as well as management skills. Also associations, interest groups, textile cluster organisations and private vocational educators were researched that offer training courses and workshops etc. on the topics of sustainability - digitization - business processes.

2. Technologies / Innovations

Sustainability: One university explicitly offers the study program Sustainable Engineering. Several universities refer to the topic of sustainability and emphasize that the study program imparts essential knowledge for sustainable textile processing and production.

AI and digitalization do not (yet) appear as buzzwords in the study descriptions.

Business processes: Here, manufacturing and production processes as well as process optimization are listed as teaching content in some study descriptions.
process optimization are listed as course content.

Table 1. German Universities and Universities of Applied Science

University	Description	Focus of the training	Contact	Website
TU Dresden Textile and Confection Technology, Master (M. Sc.)	The Master's program Textile Machinery and Textile High Performance Materials Technology (formerly Textile and Confection Technology) with the degree "Master of Science" (M. Sc.) was successfully certified on September 30, 2016 by the Quality in Studies and Teaching Commission of TU Dresden and limited in time until March 31, 2024.	"Master of Science" (M. Sc.)	Univ.-Prof. Dr.-Ing. habil. Dipl.-Wirt. Ing. Chokri Cherif Institute director and holder of the professorship for textile technology TU Dresden Hohe Straße 6, Room 138 01069 Dresden Phone: +49 351 463-39300 Fax: +49 351 463-39301 itm.master@tu-dresden.de	www.tu-dresden.de
TU Dresden Processing Machines and Textile Mechanical Engineering, Diploma	After the four-semester basic study period, students of the mechanical engineering program can continue their studies in the main study period in the optional compulsory field of study Processing Machinery and Textile Mechanical Engineering. This field of study is offered jointly by the Institute of Textile Machinery and High-Performance Textile Materials Engineering and the Processing Machinery and Processing Engineering Professorship of the Institute of Natural Materials Engineering.	Processing Machinery and Textile Mechanical Engineering - Diploma	Univ.-Prof. Dr.-Ing. habil. Dipl.-Wirt. Ing. Chokri Cherif Institute director and holder of the professorship for textile technology TU Dresden Hohe Straße 6, Room 138 01069 Dresden Phone: +49 351 463-39300 Fax: +49 351 463-39301 itm.master@tu-dresden.de	www.tu-dresden.de

Kaiserslautern University of Applied Sciences (Pirmasens location) and Textile Technology, Bachelor	<p>The majors "Textile Technology" and "Leather Processing and Shoe Technology" have a long tradition at Kaiserslautern University, with the unique selling point that an engineering degree in the field of leather and shoe technology can only be obtained at the Pirmasens campus of Kaiserslautern University throughout Germany.</p> <p>By combining the two focal points "Textile Technology" and "Leather Processing and Shoe Technology", the university has met the changing demands of the market (e.g. sneakers and leisure shoes are made of knitted performance fibers and in various areas, such as in the clothing and automotive industries, textiles are combined with leather) and offers students in-depth knowledge along the value chain of the textile and shoe/leather industry. The synergy from the combination of the two fields promotes the development of novel and innovative product ideas and trains experts with interdisciplinary competencies, including materials science, manufacturing and production processes, and quality management.</p> <p>The field of activity of textile engineers ranges from product development, manufacturing and quality management to trade and research.</p> <p>As a Bachelor of Engineering majoring in Textile Engineering, the graduates work in traditional areas of the textile industry, such as textile manufacturing, the fiber, dye and auxiliaries industry, the apparel industry, textile machinery manufacturing and sales, as well as in the automotive and aerospace industries, and in research institutes and government agencies (customs, criminal investigation, etc.).</p>	Bachelor of Engineering	Prof. Dr.-Ing. Luisa Medina Head of study program luisa.medina@hs-kl.de University of Kaiserslautern Carl-Schurz-Str. 10-16 66953 Pirmasens	www.hs-kl.de/en
HS Albstadt-Sigmaringen Textile and Clothing Technology, Bachelor	<p>Textile and Clothing Technology: several study models to study flexibly - combined studies - flexistart - international - part-time</p> <p>Textile products are often used in a quasi "hidden" way - they are not recognizable at first glance - but they ensure that modern airplanes take off or that firefighters can safely face fire. Textiles can therefore often be</p>	Bachelor /Master New: Sustainable Engineering is a unique study program that	Albstadt Campus: Albstadt-Sigmaringen University Poststrasse 6 72458 Albstadt Prof. Dr. Jutta Buttgerit Dean of Studies Textile and Clothing	https://www.hs-albsig.de/studienangebot/bachelorstudienangebote/textil-und-bekleidungs-technologie/

	<p>described as a driver of innovation, because they are versatile and fascinating - just like their later fields of work.</p> <p>New: Sustainable Engineering - Sustainable Products and Processes. Majors: Textile and apparel technology, mechanical engineering, or materials and process engineering.</p> <p>How can aspects of sustainability already be considered in the development and design of products? How can a product be designed to be durable and easy to repair? Can issues such as recycling and disposal of a product already be considered during development? Which supply chain processes have the greatest environmental impact and how can these be optimized? How can materials be mined, produced and transported in an environmentally friendly way? How can they be used efficiently for production to avoid unnecessary waste generation? What legal requirements already exist with regard to environmental protection and by which organizations and bodies are these being brought into being? Who bears the social responsibility? What benefits, but also what risks, does a new technology bring?</p> <p>Sustainable Engineering is a unique study program that addresses the issue of sustainability along the entire value chain. The combination of sustainability knowledge and engineering expertise enables a holistic view of the product development process.</p>	addresses the issue of sustainability along the entire value chain. The combination of sustainability knowledge and engineering expertise enables a holistic view of the product development process.	<p>Technology/Textile and Clothing Management, Vice Dean Faculty Engineering buttgerit@hs-albsig.de</p> <p>Phone: +49 (0) 7571 732 - 9251</p>	
HS Hof Innovative Textiles, Bachelor	<p>Faculty of Engineering: Innovative Textiles (B.Eng.) The know-how of the study program lays the foundation for mastering material-related challenges such as process optimization in the production and finishing of textiles, taking into</p>	Faculty of Engineering: Innovative Textiles (B.Eng.) Bachelor	<p>Prof. Dr.-Ing. Claus-Ekkehard Koukal Head of study program</p> <p>Phone: +49 9281 409 - 8545</p>	www.hof-university.com

	<p>account technical, economic and ecological aspects.</p> <p>Hof University of Applied Sciences is a member of several textile-related networks (e.g. TEGEWA e.V. or the Alliance for Sustainable Textiles). Ideal to establish business contacts with potential employers at an early stage, e.g. for internships and research topics for the bachelor thesis. Study excursions to innovative textile technology companies and discussions with experts from research and industry are also an important part of the Bachelor's program.</p> <p>The Hof and Münchberg sites are important centers of textile and materials research.</p>		<p>claus-ekkehard.koukal@hof-university.de</p> <p>Hof University of Applied Sciences Alfons-Goppel-Platz 1 95028 Hof Fon: +49 (0) 9281 / 409 3000 Fax: +49 (0) 9281 / 409 4000 E-Mail: mail@hof-university.de</p>	
<p>HS Niederrhein Textile Products Field of Study Textiles, Master</p>	<p>Successful completion of the program opens up a wide range of career opportunities for graduates. In addition to leading positions in all areas of the textile and clothing industry and in the textile processing industry, this also includes the fiber and chemical industry and activities in consulting and marketing companies. In addition, the master's program qualifies students for scientific work in research institutes or universities and entitles them to pursue doctoral studies in various fields. Interesting research areas are all questions along the textile chain in the technical and organizational field.</p> <p>For the textile and clothing majors there is the possibility to choose the focus on textile electronics. In cooperation with the Department of Electrical Engineering, courses are offered with in-depth topics on textile electronics, innovative and future-oriented topics in the fields of textiles, clothing, electrical engineering as well as medicine and architecture. Interesting fields of research in textile electronics round off the range of courses offered in this field of study. The program can also be taken part-time according to the respective Master's degree program.</p>	<p>Master of Science (M.Sc.)</p>	<p>Prof. Dr. rer. nat. Lutz Vossebein Dean Textile Technology, Textile Testing and Quality Management Head of Public Testing Department</p> <p>Phone: +49 2161 186-6010 lutz.vossebein@hs-niederrhein.de</p> <p>Niederrhein University Department 07 Webschulstr. 31 D-41065 Mönchengladbach</p> <p>Prof. Dr.-Ing. habil. Maike Rabe Head of Research Institute "FTB" Textile Finishing and Ecology</p> <p>Phone: +49 2161 186-6110 maike.rabe@hs-niederrhein.de</p> <p>Prof. Dr.-Ing. Alexander Büsgen</p>	

	All Master of Science degrees meet the requirements for doctoral studies		<p>Management of Textile Trade and Technology Textile Technology, in particular Fabric Technology Head of MTTT/Technical Textile Department</p> <p>Phone: +49 2161 186-6024 alexander.buesgen@hs-niederrhein.de</p>	
<p>HS Niederrhein Textile and Clothing Technology Field of Study Textile Technology, Bachelor</p>	<p>The field of study Textile Technology represents the study focus Textile Management and Sustainability as well as Textile Technologies.</p> <p>The major in Textile Management and Sustainability covers a broad, forward-looking range of subjects from the entire field of textile technology and management theory. In textile technology, fundamental knowledge is taught from design theory to thread, surface and finishing technologies to quality management and quality assessment of textile materials. A major focus is on management subjects such as organization, marketing and human resources management. Sustainability also covers topics such as process-integrated environmental protection through resource-saving and low-emission production to life cycle assessment, circular economy or sustainable design and teaches the basics of essential eco-labels.</p> <p>In the major field of study Textile Technologies, the textile production stages of spinning, weaving, knitting, braiding, finishing and finishing as well as the production of narrow textiles, nonwovens and composites are taught. Innovative materials are presented, especially in the field of technical textiles. Complex requirements for the raw materials used (origin, ecological footprint, mechanical, thermal and chemical resistances), as well as the production processes, manufacturing technologies and closed-loop</p>	<p>textile and clothing technology major in textile technology, bachelor's degree</p> <p>The major in "Textile Technologies" trains as a junior engineer for the diverse technical and business tasks in the textile industry. The very practice-oriented range of subjects includes material sciences, textile production and related quality analysis. You will also be introduced to the contents of the organization</p>	<p>Prof. Dr. rer. nat. Lutz Vossebein Dean Textile Technology, Textile Testing and Quality Management Head of Public Testing Department</p> <p>Phone: +49 2161 186-6010 lutz.vossebein@hs-niederrhein.de</p> <p>Niederrhein University Department 07 Webschulstr. 31 D-41065 Mönchengladbach</p> <p>Prof. Dr.-Ing. habil. Maike Rabe Head of Research Institute "FTB" Textile Finishing and Ecology</p> <p>Phone: +49 2161 186-6110 maike.rabe@hs-niederrhein.de</p> <p>Prof. Dr.-Ing. Alexander Büsgen Management of Textile Trade and Technology Textile Technology, in particular Fabric Technology Head of</p>	<p>https://www.hs-niederrhein.de/textil-bekleidungstechnik/fachbereich/</p>

	<p>technologies are components of this major. However, the study also imparts essential knowledge for sustainable textile processing: use of chemicals such as dyes, novel water-saving finishing processes for fashionable jeans, or manufacturing methods that minimize the discharge of fibrous microplastics into the environment. Valuable basic skills in technology enable engineers to develop new, environmentally friendly products and sustainable processes. Finally, it is important how sustainability can be made visible with the help of eco-labels such as GOTS, green button or Ökotex. That, too, has to be learned.</p>	<p>of a global industrial and commercial enterprise in the textile sector.</p> <p>The focus of the "Textile Technologies" concentration is on the creation of textile products.</p>	<p>MTTT/Technical Textile Department</p> <p>Phone: +49 2161 186-6024 alexander.buesgen@hs-niederrhein.de</p>	
<p>HS Reutlingen Interdisciplinary Product Development, Master</p>	<p>1. interdisciplinary product development, master</p> <p>Graduates will be trained to fill interface functions in particular in the design, pre-series and series development and construction departments of suppliers and manufacturers of products in areas such as transportation, energy technology, architecture and construction, medicine and health, clothing, sports and leisure, and technical textiles. Within interdisciplinary product developments, they will assume the "translator functions" between the individual disciplines and thus optimize the flow of information. The resulting improved interaction between the disciplines can shorten development times and improve the quality of the results. Graduates should be able to integrate themselves in interdisciplinary working groups in a target-oriented manner and to guide interdisciplinary working groups in their work in a targeted manner as well as to promote their cooperation.</p> <p>(2) Graduates will remain specialists in the field in which they completed their bachelor's degree even after completing their master's degree. Their special qualification through the study program consists in the ability to work effectively with specialists from other</p>	<p>Master M. Sc. Bachelor</p>	<p>Reutlingen University / Reutlingen Hochschule Alteburgstrasse 150 72762 Reutlingen Germany / Deutschland E-mail: info@reutlingen-university.de Phone: +49 7121 271-0 Fax: +49 7121 271-1101</p> <p>Prof. Dr. Klaus Meier Dean of Studies Bachelor Textile Technology - Textile Management, B.Eng. Dean of Studies Master Interdisciplinary Product Development, M.Sc. Textile Chain Research, M.Sc. Professorship Advanced Textile Materials Member of the board of the teaching and research center IMAT Appointment by arrangement Building 1 Room 117 Phone +49 0 7121 271 8011</p>	<p>www.reutlingen-university.de</p>

	<p>disciplines. To do this, they do not need to be able to master the other disciplines, but they must be able to understand them.</p> <p>The course of study will bring together the following disciplines:</p> <ul style="list-style-type: none"> - Textile Technology - Design with previous knowledge of materials technology - Engineering sciences (mechanical engineering, mechatronics, electrical engineering) - Chemistry and process engineering - Computer science <p>2. textile chain research, (M. Sc.)</p> <p>This consecutive degree program is offered as a course of study for university graduates who have already successfully completed an undergraduate degree in textile or clothing technology or business administration. The objective of the Master's degree program in Textile Chain Research is to independently plan and carry out scientific research projects through research and development work in areas of the textile and apparel industry and, if possible, to publish their results. Students are given the opportunity to deepen their competencies in a freely chosen field.</p> <p>Graduates of the program have the options of occupying specialist or management positions in the textile industry, in the clothing industry, in textile retailing or in textile-oriented research institutes.</p> <p>To achieve this goal, they broaden and deepen the knowledge, skills and competencies acquired in the bachelor's program in the fields of textile technology or management.</p> <p>The consecutive course of study leading to the degree of Master of Science (M.Sc.) comprises a standard period of study of 2 semesters.</p> <p>3. textile technology-textile management, Bachelor</p>		Klaus.Meier@reutlingen-university.de	
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	<p>The bachelor's program "Textile Engineering" is an undergraduate engineering program in which engineering and textile technology expertise along the entire textile production chain is taught in an application-oriented manner. The specialized knowledge of textile engineers includes technical correlations, basic functions and the structure of machines and equipment for production as well as chemical fundamentals. Textile process engineering is covered, starting with fiber materials, through yarn and surface production, and the making-up and finishing of textiles.</p> <p>Sustainability as a technological, economic and social goal is an elementary component of this education.</p>			
RWTH Aachen Plastics and Textile Technology, (M. Sc.)	<p>.... Textile Technology</p> <p>The study program is mainly concerned with the development and design of textile machines and new processes for the production of textiles of all kinds. Spinning machines for cotton are included, as are intelligent air-jet looms, man-made fiber production and processing, and processes for producing technical textiles for use in composites and medical textiles.</p> <p>The three-semester course is divided into two parts. During the two-semester examination phase, students should complete all compulsory and elective modules that accompany their studies. In the final third semester, they work independently on a scientific topic and complete their master's thesis.</p>	M. Sc.	<p>RWTH Aachen University Templergraben 55 52062 Aachen</p> <p>Univ.-Prof. Dr.-Ing. Wolfgang Schröder is dean and chairman of the faculty council. He is also head of the Chair of Fluid Mechanics and the Institute of Aerodynamics. Phone: +49 241 80-953 05 dekan@fb4.rwth-aachen.de</p>	https://www.rwth-aachen.de/cms/~a/root/?lidx=1
RWTH Aachen Textile Engineering, (M. Sc.)	<p>In the master's program (4 semesters), students deal with the development of processes and methods for the production of fibers, yarns and textiles of all kinds, as well as with the design and construction of textile machinery and the simulation of textile structures and processes along the entire textile value chain. Textile mechanical engineering is internationally oriented.</p>	M. Sc.		

	Furthermore, students acquire specialized knowledge on the development and design of textile machinery, new methods and production processes as well as the manufacture and processing of natural and man-made fibers. They deal with the production of technical textiles.			
TU Chemnitz Textile Structures and Technologies, Master	<p>The aim is for graduates to be able to find creative and innovative textile solutions for technical applications.</p> <p>Textile chain in its transformation to a cycle</p> <p>Basic technological lectures: Fiber materials, thread and surface formation, finishing, making-up.</p> <p>Choice of three in-depth options: Fiber-plastic composite, textile sustainability or textile machinery and product development.</p> <p>Special lectures e.g. outdoor and high-performance textiles, knitting simulation</p> <p>Master theses with company participation</p> <p>Practical implementation of the course contents as textile projects in the technical center</p>		<p>TU Chemnitz, Chair of Textile Technologies Reichenhainer Straße 70 09126 Chemnitz Prof. Dr. Holger Cebulla holger.cebulla@mb.tu-chemnitz.de Tel.: 0371 531 35318 Dr. Christoph Müller christoph.mueller@mb.tu-chemnitz.de Tel.: 0371 531 37989 Dr. André Matthes andre.matthes@mb.tu-chemnitz.de Tel.: 0371 531 35319</p>	https://www.tu-chemnitz.de/mb/studium/studiengaenge.php?sg=maste_r_textile-strukturen-technologien#allgemein
West Saxon University of Applied Sciences Zwickau Textile Structures and Technologies, Bachelor	<p>The textile industry has long been dedicated not only to the production of garments. Above all, technical innovations and advancing digitalization are changing the textile industry significantly. The study program Textile Structures and Technologies addresses this variety of topics. The spectrum of course content ranges from an insight into the entire "textile chain" to the production and processing of textile fibers and the development of high-performance materials.</p> <p>Study focus: In the area of "Functional Textiles", knowledge is primarily imparted on functional textiles and smart textiles. These include, for example, (electrically) conductive textiles, antibacterial coated medical textiles or water-repellent protective clothing. The focus "Textile and leather-based automotive components" offers special knowledge on the use of textiles</p>	<p>Bachelor</p> <p>As a graduate of the bachelor's program, there is the possibility to transfer directly to the master's program Textile Structures and Technologies at the TU Chemnitz.</p>	<p>West Saxon University of Applied Sciences Zwickau Department of Student Affairs Paul-Kirchhoff-Building (PKB) Dr.-Friedrichs-Ring 2 A 08056 Zwickau</p> <p>Student Advisory Service Dipl.-Ing. Judith Hummel +49 375 536 1705 Judith.Hummel@fh-zwickau.de</p> <p>Technical Textiles</p> <p>Institute Director Prof. Dr.-Ing. Silke Heßberg</p>	www.fh-zwickau.de/studium/studieninteressenten/studienangebot/textile-strukturen-und-technologien-bachelor/

	in the automotive industry. This involves, for example, the design of vehicle interiors as well as the production and processing of leather and artificial leather.		Klinkhardtstraße 30, Room 310 08468 Reichenbach +49 375 536 2520 silke.hessberg@fh-zwickau.de	
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Table 2. Textile Technology – Master Thesis and Doctoral Thesis

Institute	Description	Focu s	Contact	Website
Institute for Textile and Process Engineering Denkendorf	Within its broad research spectrum, the DITF offers numerous study, semester, master and doctoral theses. The DITF are closely linked to the University of Stuttgart via three chairs:	study, semester, master and doctoral theses.	<p>German Institutes for Textile and Fiber Research Denkendorf Körschtalstraße 26, 73770 Denkendorf</p> <p>T +49 (0)711 93 40-0 F +49 (0)711 93 40-297 info@ditf.de</p> <p>Prof. Dr. rer. nat. habil. Michael R. Buchmeiser Chair of Macromolecular Materials and Fiber Chemistry - Institute of Polymer Chemistry +49 (0)711 93 40-101 michael.buchmeiser@ditf.de</p> <p>Prof. Dr.-Ing. Götz T. Gresser Chair of Textile Technology, Fiber-Based Materials and Textile Mechanical Engineering - Institute of Textile and Fiber Technologies (ITFT) +49 (0)711 93 40-216 goetz.gresser@ditf.de</p> <p>Prof. Dr. rer. pol. Dipl.-Ing. Meike Tilebein Institute for Diversity Studies in Engineering +49 (0)711 93 40-300 meike.tilebein@ditf.de</p>	www.ditf.de/de/ditf/lehre.html
Institute for Textile Machinery and Textile High Performance Materials Technology			<p>TU Dresden Zeuner Building, Room 115 George-Bähr-Str. 3c 01069 Dresden Dipl.-Ing. Martin Kern Teaching Organization</p> <p>Phone +49 351 463-34693 Fax +49 351 463-34026 martin.kern@tu-dresden.de</p>	https://tu-dresden.de/ing/maschinenwesen/itm/studium
Institute for Textile Technology at			Dr.-Ing. Dieter Veit Academic Director and Deputy Director of the Institute	

RWTH Aachen University			<p>Chair of Textile Mechanical Engineering and Institute of Textile Technology Building: 4161 Room: 121 Otto-Blumenthal-Strasse 1 52074 Aachen Phone: +49 241 80 23456 dieter.veit@ita.rwth-aachen.de</p> <p>Lecturer Technical Textiles: Thomas Gries https://www.ita.rwth-aachen.de/go/id/lwnr Univ.-Prof. Prof. h. c. (MGU) Dr.-Ing. Dipl.-Wirt. Ing. Thomas Gries Otto-Blumenthal-Strasse 1 52074 Aachen Phone: +49 241 80 23400 Fax: +49 241 80 22422 ita@ita.rwth-aachen.de</p> <p>Lecturer Industry 4.0 and digitalization in textile technology: Dr.-Ing. Yves-Simon Gloy, Dr.-Ing. Fabian Schreiber https://www.ita.rwth-aachen.de/cms/ITA/Studium/Lehrveranstaltung/~xuwvp/Industry-4/</p>	
University of Augsburg			<p>Prof. Dr. Nadine Warkotsch Vice President for Research and Sustainability Augsburg University of Applied Sciences Phone: +49 821 5586-3303 nadine.warkotsch@hs-augsburg.de</p> <p>Prof. Dr. Stefan Schlichter Professor for Machines and Processes in Textile Technology for Composites at the Augsburg University of Applied Sciences Managing Director of ITA Augsburg gGmbH stefan.schlichter@hs-augsburg.de</p> <p>Tobias Kolb Head of Communication Augsburg University of Applied Sciences Phone +49 821 5586-3556 tobias.kolb@hs-augsburg.de</p>	www.hs-augsburg.de/Resort-Forschung-und-Nachhaltigkeit.html
ita-augsburg			<p>Prof. Dr.-Ing. Philipp Abel Deputy Director of the Institute, Senior Engineer, Chief Pilot Recycling & Fiber Composites Phone: +49 821 8090 3414</p>	https://www.hs-augsburg.de/fmv/Transferprojekte-Nachhaltigkeit.html
Textile Research Institute			<p>Textile Research Institute Thuringia-Vogtland e.V. Zeulenrodaer Street 42</p>	www.titv-greiz.de

Thuringia-Vogtland e.V.		07973 Greiz Tel.: 03661 611-0 mail@titv-greiz.de	
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Table 3. Trainings in Germany with Focus on Sustainability, Digitalization, Product Development, Quality Management

Institute	Description	Focus of the training	Contact	Website
Akatex Academy for Textile Finishing	The Academy for Textile Finishing offers seminars, conferences and advanced training for textile printers, embroiderers and other textile decorators. The events take place in Germany and Austria. Topics focus on sustainability in the textile finishing industry, the practice of finishing, digitalization and automation, and much more. Partners are manufacturers of finishing machines, materials for finishing, textiles, associations and institutions. With the "Textile Finishing News", the Academy for Textile Finishing has been offering a digital content platform since 2020. It thus supplements the seminar program with even more industry knowledge. The news is dedicated to the topics of textile printing, embroidery, finishing in general, apparel, promotional textiles, machinery, trade shows and events. An editorial team at the Academy carefully researches the topics and prepares the information for further sharing via social networks, the newsletter and other channels.	textile printers, embroiderers and other textile decorators with focus on sustainability in the textile finishing industry	Aka Merch & Textil GmbH Dürener Str. 210 50931 Cologne Germany Managing Director: Stefan Roller-Aßfalg Phone: +49 (0) 221 8456 7407 E-mail: info@aka-tex.de	https://aka-tex.de
DTB Dialog Textil-Bekleidung	The DTB - Dialog Textil-Bekleidung is the knowledge network of the textile industry and with its technical expertise the number 1 contact for all questions along the textile chain. More than 230 member companies are currently organized in the DTB. The main focus of the DTB network is on the core competencies of quality management, product development, sustainability, sourcing, digitalization and training. With numerous webinars on daily topics, the DTB facilitates regular training for its members and all interested parties.	quality management, product development, sustainability, sourcing, digitalization	Dialog Textil-Bekleidung e.V. Chapel Street 13 D- 85622 Feldkirchen Susanne Pass / GF pass@dialog-dtb.de Stefanie Stockerl, Marketing stockerl@dialog-dtb.de Phone: +49 89 90 13 96 31 Mobile: +49 17652737875	www.dialog-dtb.de

ITA Academy, Academy of ITA Aachen	Many companies are facing a major challenge: to use Industrie 4.0 solutions sensibly. To prepare companies for the digital future, the Digital Capability Center (DCC) was opened in Aachen in 2017. In the Model Factory 4.0, digital solutions for production are developed and expertise in the industry is imparted for implementation in their companies. Tailored formats are offered for managers and technicians from various industries. Workshops and seminars provide basic knowledge on the topic of Industry 4.0, condition monitoring, sensor technology and automation. The digital transformation in companies is accompanied from the first workshop to the implementation project.	Digitization in production sustainability	ITA Academy Vaalser Straße 460 D - 52074 Aachen	https://dcc-aachen.de/de/ https://dcc-aachen.de/de/2021/09/01/neue-schulungstermine-2/
Academy of the TITV Greiz	More than 60 employees with interdisciplinary competences work on high-tech solutions, where classical textile technology is the basis for new materials, smart products and processes. Especially by combining electronics and textiles, innovative products for completely new fields of application are developed in a targeted manner. For the practical implementation of research and development services, the institute has an electronics laboratory, a smart textiles laboratory and an accredited testing laboratory in addition to pilot plants for the textile processing chain. The technical potential and the long-standing know-how of our employees guarantee the development of processes and products according to the individual requirements of our customers.	Smart Textiles Textile refinement		www.titv-greiz.de/de/akademie
Netzwerk Q 4.0	NETZWERK Q 4.0 is a joint project of the Institut der deutschen Wirtschaft (IW) and the Bildungswerke der Wirtschaft and other educational institutions and is funded by the German Federal Ministry of Education and Research (BMBF). Its aim is to provide trainers with modern technical and social skills in times of digitalization so that they are able to shape the content and	Sustainability Digitization	Institut der deutschen Wirtschaft Köln e.V. Postfach: 10 19 42 / 50459 Köln Besucheranschrift: Konrad-Adenauer-Ufer 21 / 50668 Köln	https://netzwerkq40.de/de/ https://smartausbilden.podigee.io/24-nachhaltigkeit

	<p>processes of training in their companies in line with current developments in digital transformation.</p> <p>The project's regional coordination offices are located throughout Germany at the Bildungswerke der Wirtschaft and other educational institutions. They work toward strong networking among local companies and other players in vocational education and training, develop tailored qualification offerings, and implement them in a sustainable manner. Together with the project partners, a nationwide NETWORK Q 4.0 is being created, which is jointly dedicated to the nationwide qualification of training personnel.</p> <p>The Institut der deutschen Wirtschaft (IW), together with the Bildungswerke der Wirtschaft and other educational institutions, is developing and testing region- and industry-specific continuing education formats for trainers and other instructors in training. This strengthens them in specifically adapting dual vocational training to the requirements of digital change.</p> <p>The training courses are designed in an innovative blended learning format, in which so-called group learning phases alternate with self-learning phases and are accompanied by a practical project.</p>			https://netzwerkq40.de/de/partner/baden-wuerttemberg/trainings/nachhaltigkeit/nachhaltigkeit-in-der-ausbildungspraxis-vermitteln#event-0
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3. Workshop Transformations of the textile industry

On 28.9.2022, the IVGT held the workshop "Transformations of the textile industry - energy use, circular economy, digitalization, training and smart processes" in Bremen. It was elaborated to what extent digitalization, green innovations as well as "smart" processes are already implemented in the textile industry with focus on technical textiles and which prerequisites are needed for a further implementation. The participants agreed that adaptations in the textile industry, especially in manufacturing processes, are urgently needed to cope with climate change and to further improve the sustainability of the sector.

The following questions were addressed: What strategic and technological capabilities need to be built within companies to drive innovation and stable growth in the industry?

How can digitalization and sustainability be more widely implemented within the company to drive the production of advanced materials (technical textiles), taking into account environmentally friendly practices, and become the norm?

How can transformation succeed? Recycling technologies, New materials, New players in the cycle, New business models, Figures for evaluation (CO₂, etc.), Design with/for recycling, Cooperation and networks

Which preconditions have to be created?

In-house education and training to equip IT professionals with basic knowledge in textile as well as to equip textile professionals with basic knowledge in digitalization using tools in the field of digitalization.

4. Existing Initiatives – association (Projects/strategies/documents/tools)

The German textile and fashion industry stands for quality, value and durability. These are all attributes that contribute to sustainability. First and foremost is the quality of the products of our German textile and fashion industry with around 1,400 medium-sized companies that train in Germany, pay taxes and provide around 130,000 jobs and added value.

Only if the quality is right will the valuable products of our medium-sized companies be purchased. Longevity is the best form of sustainability for us. Many of our medium-sized companies are family businesses in the third and fourth generation, which operate sustainably and set standards and bear responsibility where they also produce outside Germany.

Sustainability has always been part of the DNA of the German companies. This includes transparency along the supply chain. Medium-sized companies maintain business relationships with their suppliers that have grown over a long period of time. Or they have their own locations in the producing countries where they manufacture. There, our medium-sized companies personally stand up for good working conditions and explicitly against child labor. That is why, as an umbrella organization, the association textile + mode is also involved in the Alliance for Sustainable Textiles.

Sustainability is also at the top of the list for the German textile and fashion industry when it comes to the transformation of the economy towards a climate-neutral and digital economy and society. A survey by textil+mode clearly shows that sustainability is relevant in all areas of the industry. For a good fifth of the companies surveyed, the share of sales of sustainable products is already over 50 percent. More than 90 percent of all companies surveyed plan to further expand their sustainable product shares. The companies in the German textile and fashion industry assume that the demand for sustainable products will continue to be high to very high. www.textil-mode.de

<https://textil-mode.de/de/newsroom/blog/textilien-gegen-den-klimawandel/>

4.1 Textiles against climate change

Textiles can make a significant contribution to slowing down global warming in the future. Several projects currently show this. Cellulose fleeces were developed that effectively fish the carbon dioxide out of the atmosphere. The filtered-out CO₂, in turn, can be used to produce climate-neutral fibers and yarns.

The analyses of the Intergovernmental Panel on Climate Change are clear: In order to slow down global warming, it is no longer enough to reduce the emission of the greenhouse gas carbon dioxide little by little. Rather, the amount of carbon dioxide in the atmosphere must be actively reduced. This can be achieved, for example, by reforestation forests that absorb carbon dioxide (CO₂) or scatter rock flour on fields that bind CO₂. In addition, devices have been developed in recent years with which the carbon dioxide can be filtered directly from the air. This procedure is called direct air capture. The collected carbon dioxide can then be stored underground in obsolete natural gas fields in the long term or used as a raw material in the chemical industry. However, the direct air capture systems developed so far have a disadvantage. When the filters are filled with carbon dioxide, they must be replaced with fresh ones. The full filters must then be reprocessed by heating them and dissolving the carbon dioxide from the tissue. This makes the filtering process relatively complex and expensive. **The German Institutes for Textile and Fiber Research (DITF), together with various partners in the CORA project, are now developing a direct-air capture system that continuously removes CO₂ from the atmosphere. The annoying filter change is eliminated. The basis of the future plant are cellulose fibers to which the CO₂ binds.**

Airy cellulose fleece

Carbon dioxide is only contained in small concentrations in the atmosphere. Therefore, very large amounts of air must be pumped through the plants, which requires energy. In order to reduce the flow resistance, the cellulose fibers were

processed into an airy fleece. The fleece is to be guided through the future plant in an endless belt. First, it passes through the air flow, from which it filters out CO₂ and also water. It then runs through heat chambers in which it is heated so that the CO₂ and water detach from the fleece again. The system is to be operated in an environmentally friendly way with solar energy or heat pumps. For future application, the project partners plan to connect the systems as a module to the airflow duct of building air conditioning systems. This would have the advantage that you could use the already existing pumping and ventilation technology and would not have to install it additionally. It is also conceivable to operate the facilities in areas where there is a lack of water. The water from the plants there would be a valuable asset that would make the operation particularly economical.

4.2 Using CO₂ for plastics

Scientists from the Institute of Textile Technology at RWTH Aachen University have shown together with companies how the separated carbon dioxide can be used sensibly in the textile industry using the example of the so-called CO₂ sock: The sock contains elastic yarns consisting of a special form of the plastic polyurethane (PU), for the production of which, among other things, CO₂ is normally processed into elastic yarns by spinning PU fibers out of a chemical solution. But solvent spinning has several disadvantages. On the one hand, solvents are required, some of which are harmful to the environment. On the other hand, it is complex because a number of containers and equipment are necessary for the chemical process. Furthermore, solvent spinning is significantly slower than melt spinning, in which plastics are heated, melted and then spun. Plastics that can be melted by heat are called thermoplastics. **The researchers of a project partner have succeeded in producing polyurethanes that melt like thermoplastics and can thus be processed on melting spinning plants without the use of solvents. Suitable melt spinning processes were developed at the ITA for the processing of these polymers. Nice side effect of this so-called thermoplastic polyurethane (TPU): Because CO₂ is processed from exhaust gases in the TPU, the climate is protected. The CO₂ no longer enters the atmosphere, but is used sensibly.**

Of course, a sock does not last forever and will eventually be disposed of. **Since the TPU can be melted down again, it could theoretically be recycled in the future.** So far, however, socks are made of a colorful mixture of different materials. Such mixed textiles are therefore still often burned. For ITA researchers, it would make sense to separate the carbon dioxide from the exhaust gas again and use it repeatedly for TPU production. In this way, the carbon could be recycled. In the successor project "CO₂Tex" the ITA team is now working on optimizing the processing of the TPU. TPU adheres more strongly than other yarns, which leads to higher friction and challenges in further processing. The project aims to improve the properties of the TPU so that it can be easily processed into surface textiles. This would allow the climate-friendly yarn to be used on a large scale in the future.