SozioTex – An interdisciplinary research group

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1   Extended Abstract

Being confronted with growing automation and interconnectedness of production lines as
well as decreasing relevance of large scale production in favor of smaller lot sizes, the
German textile industry has to face tremendous challenges: Not only the technical and
economic developments, but also social factors – especially the demographic change –
put manifold pressures on the industry, since the proportion of elder workers above 45
years is higher-then-average here [LKL16] and the recruiting of young skilled personnel
for tasks in strenuous working conditions as weaving mills remains difficult. Hence, the
task is to connect the necessity of technological innovation with existing workplace
practices in order to generate new and adequate social courses of action. Obviously, this
problem demands technical knowledge as well as expertise in organizational and social
developments. Consequently, all these challenges and aspired changes must involve
learning processes designed, initiated and accompanied by professionals.

Therefore, an interdisciplinary team of researchers was implemented at the Institute of
Textile Technology of RWTH Aachen in order to conduct the project "SozioTex - New
socio-technical systems in the textile industry", granted by the Federal Ministry of
Education and research. The project aims at the development and implementation of a
digital assistance system for weaving mills, which supports workers heterogeneous in age,
gender, qualification and cultural background in adapting to varying contexts and
scenarios concerning industry 4.0. In order to provide the transfer to further applications
and industrial sectors, a main result of "SozioTex" will be the design of a generic
procedure model for related industrial projects.

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1.1 Participatory Research Design

To bring forth these goals, the prospective users (managers and employees of three weaving mills in Germany) participated in requirement analysis and design from the very beginning of the project, for example, by taking part in workshops, surveys and group discussions. This participative approach in systems design enables the SozioTex team to utilize of the expertise of the employees and to develop sustainable, apposite solutions [LAB90], [LLD14].

The interdisciplinary research group encompasses three scientific disciplines: engineering, education and sociology. This joint approach to research within SozioTex is justified, since it exceeds the boundaries of the scientific system by involving people working in entrepreneurial companies, which are confronted with the development of assistance systems and the occurring problems as well as the implementation of the system. In regard to the choice of method and profitability [DDS06], the present research is based on a combination of systematic approaches and methodical designs which is derived from the genuine methods of the three disciplines involved.

In SozioTex the major methodical reference is "Systems Engineering", an engineering approach to analyze and solve problems systematically. It combines systematic thinking and procedure models into a problem-solving system reinforced in engineering sciences. Also, Systems Engineering has similarities to other engineering systematics such as construction systematics for machine construction systems according to VDI guideline 2221 [HWF12].

Based on the logic of the Systems Engineering phase concept, the participatory approach employed in the research project (Figure 1) is explained as follows: In the system engineering phase concept, the processing of a problem situation precedes the phase of a so called "kick-off". This phase marks the period from the occurrence of a problem to the decision to do something to cope with the problem [HWF12]. As a sign of problem awareness, studies of the last few years can be used, e.g. on demographic change in German society. The results of this scientific study are also found in the preliminary study.
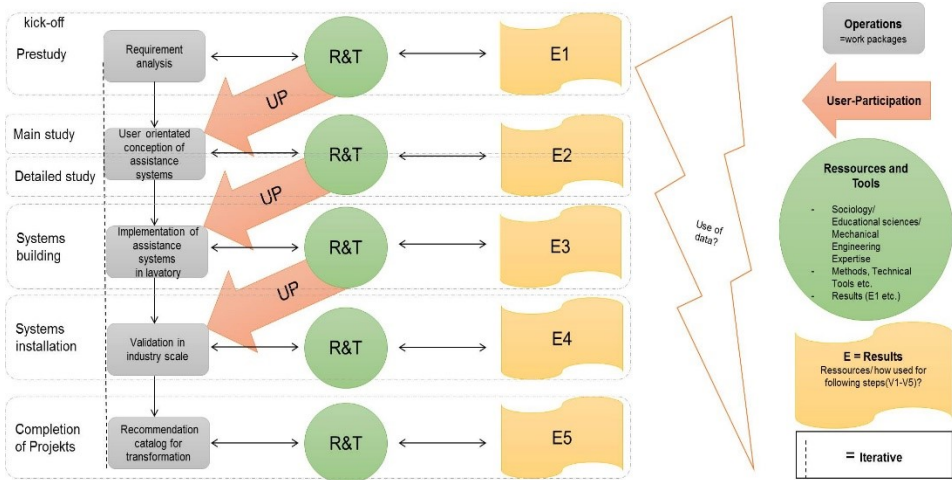
Fig. 1: Methodical approach for designing sociotechnical systems exemplary on assistance systems

This aims to analyze the limitations of the problem and the design area, in this case the German textile production, as well as to identify requirements and to summarize them in a requirement catalog. Then, the main study focuses on the development and refinement of a solution concept by concentrating on the field of observation based on preliminary study.

The supported working processes are systematically analyzed and evaluated in terms of performed manual activities and the use of tools. As a result, critical activities which require support are derived. During this step, the forms of assistance which are suitable for supporting critical activities are examined simultaneously. The results of this step are described in a morphological box, which serves as a springboard for the development of assistance system concepts. Subsequently, a value analysis is conducted to compare and evaluate those concepts. Its results lead to the selection of an assistance system concept to be implemented in the further research of the SozioTex team. Within the framework of the detailed study, the point of view is further narrowed down by carrying out work process- and work place analyses in three weaving companies, with focus on product change as central work process during ongoing work.

By taking into consideration the results of the preliminary main and detail studies, concepts for the overall assistance system with its subcomponents and a qualification concept are developed. At the end of the development phases (preliminary, main, detail studies), concept decisions are made, which are then followed up by further development and implementation steps.

The aim of the system construction is the implementation and evaluation of experimental prototypes. From the synthesis of these prototypes, a complete assistance system is

developed. During the phase of system implementation, the assistance system is realized in a real-world condition lab, the textile learning factory 4.0 in Aachen, Germany where it will be validated in user studies.

A recommendation catalog for the design and implementation of assistance systems with the example of textile production will be drafted as project completion for the transfer of the project results. Furthermore, the implemented assistance system will be used in the learning factory 4.0 for transfer activities such as workshops or training courses beyond the course of the project.

1.2   Conclusion

The interdisciplinary research group SozioTex aims at the participatory development and implementation of a digital assistance system for the attendance of modern weaving machines and connected technical devices in "industrie 4.0" contexts. The assistance system is expected to increase productivity by supporting complex work procedures and to stimulate and accelerate learning processes. A main result of the project is the development of a methodical approach with respect to the concept of systems engineering and with regard to the participation and needs of future users. The first phases of project conducting include the identification of basic requirements and the identification of critical tasks to be supported, as well as weaving-machine related stress factors. A work place and work process analysis investigated necessary functions to support the critical tasks. Central aspects resulting from this study were the integration of machine data and maintenance clues in a homogenous application, a communication function and a platform for knowledge exchange and storage, furthermore, the incorporation of learning-promoting tools for heterogeneous qualification needs.

Relating requirements and critical tasks to suitable forms of assistance, formed the base for deriving possible assistance system concepts. Requested components were identified and a technological concept for the assistance system was selected. Several features, as mentioned above, will be implemented in a unique assistance system. Currently, they are designed in detail and merged into the frame of the assistance system. The next step will consist of testing the prototype of the system with prospective users, in a laboratory context and adapting it with regard to their feedback. Subsequently, further test iterations on the shop floor are designated. Moreover, the work and process organization is presently analyzed and proposals for the support and adaptation of organizational issues, with regard to the assistance system, will be delineated. In combination with a concept for qualification and learning tools, this provides a socio-technical approach for the design and implementation of digital assistance systems in industrial contexts.

The hitherto achieved results confirm that an assistance system for the attendance of weaving machines and supporting the processes it is embedded in should be an appropriate support for learning activities of heterogeneous staffs. Moreover, the SozioTex team found out that communication and knowledge archiving are crucial functions to meet the work conditions and the shortage of skilled workers in the textile industry by e.g. saving the

knowledge of retiring workers and making the job profile more interesting for young successors. Thus, an assistance system designed following these main guidelines should help to sustain the qualification of elder workers and to support young employees in gaining experience knowledge. The exchange of knowledge between young and elder workers, colleagues experienced in intuition concerning the weaving process and such experienced in digital technologies, as well as between experts for different technical and procedural features is stimulated. The members of heterogeneous staffs have the opportunity to contribute their special knowledge and experience for the benefit of the company, as well as the employees. Further research will show if, and under which conditions, they will make use of this.

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