Improving Knowledge Transfers at Witzenmann GmbH through the Application of the InKTI – Interdepartmental Knowledge Transfer Improvement Method

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Abstract

Shorter innovation cycles and an increase in market demands and regulations force companies to change the way they work. Especially in engineering, several departments are closely working together to achieve a company's goals and increase its innovation potential. Studies show, that knowledge has a positive effect on the operational performance of a company and product innovation. Therefore, it is necessary to manage knowledge effectively and efficiently. Several approaches and models already describe how knowledge management could be realized. Some focus on knowledge transfer as part of knowledge management but rarely describe how to support the improvement of knowledge transfers in product and production engineering. Therefore, the InKTI – Interdepartmental Knowledge Transfer Improvement method was developed to support the improvement of knowledge transfers (in terms of speed and quality) in product and production engineering. This method has been applied in a field study. The findings and improvement potentials have been considered in the further development of the method. This paper contributes to the continuous validation of the InKTI method through a second field study at the company Witzenmann GmbH (Witzenmann), which is a world market leader in the area of flexible metal elements. The research need is to improve knowledge transfers at Witzenmann. Based on this, a concept for the validation of the InKTI method at Witzenmann is developed and implemented. Lastly, the results and findings of the first and second validation studies are compared.

Keywords
knowledge transfer, product-production-codesign, support method, improvement, validation.

1. Introduction
To become an innovation, an invention needs to satisfy a demand situation in the market and successfully penetrate the market (Albers, Heimicke, et al. 2018). Nowadays, short innovation cycles, increasing market demands and regulations as well as the challenge of aging employees force companies to reconsider their way of working (VDI 5610 2009). One of the main factors for companies, that has a positive effect on product innovation is knowledge (Bas et al. 2015; Al-Sa'di et al. 2017; Lee et al. 2013). Therefore, managing knowledge within a company is important to

secure its competitive advantage. According to Probst et al. (2012) knowledge management consists of several core processes. Several studies highlight, that transferring knowledge is one of the main processes to increase a company's performance (Lee et al. 2013; Al-Sa'di et al. 2017, Montgomery et al. 2023). The knowledge transfer between product and production engineers is focused on in this research since it is a critical factor for the success of manufacturing organizations. Efficient transfer of information and competencies is necessary to enable the realization of innovative product ideas in practice. It is imperative for product engineering to align with manufacturing and assembly processes to ensure a seamless transition from conception to implementation. However, several challenges contribute to a reduction in the efficiency and effectiveness of knowledge transfers in product and production engineering (Klippert, Schäfer et al. 2023). Various approaches and models are described in the literature, which addresses the topic of knowledge transfer, but rarely focus on supporting the improvement of knowledge transfers, especially in product and production engineering. Therefore, the InKTI – Interdepartmental Knowledge Transfer Improvement method was developed (Albers et al. 2023) and validated in a first field study (Klippert, Schäfer et al. 2023).

This paper describes the second validation of the InKTI method through a field study at Witzenmann GmbH (Witzenmann), which is a world market leader in the area of flexible metal elements, like bellows and hoses. To support the successful transfer of knowledge into practice, the application of the InKTI method at Witzenmann initially demanded the demonstration of the requirement for research and the analysis of the status quo of knowledge transfer inside the company. Secondly, a concept for validation was developed including the initial process of the application of the method, the data collection, and a ranking of the objectives and requirements concerning the method (cf. Albers et al. 2023). Thirdly, the InKTI method was applied in a selected validation environment at Witzenmann. The method was evaluated in terms of its success, support, and applicability. Lastly, both the results and findings of the first and second validation studies are compared.

2. State of Research

2.1 Knowledge Management in Product and Production Engineering

Knowledge management consists of six core processes: knowledge identification, knowledge acquisition, knowledge development, knowledge distribution, knowledge utilization, and knowledge retention (Probst et al. 2012). It is used to manage a company's valuable assets and knowledge (Darmawan, 2022). Syahchari and Herlina (2022) investigated whether knowledge management significantly affects the company's performance. As a result of their study with 126 Indonesian companies they prove, that knowledge management is essential, as it provides a method to organize the conversion of resources into capabilities within a company. They highlight, that knowledge acquisition and knowledge-sharing can increase knowledge capabilities within the company and therefore, the company's performance. Especially in engineering, it is indispensable to manage knowledge appropriately, since many departments and employees with an interdisciplinary background are involved in the engineering process (Darmawan, 2022). The engineering process is part of the product life cycle, which entails strategic product planning, product and production system development, production, product distribution and usage as well as the recycling or disposal of the product (VDI 2221 2019). Here, product and production system development, as well as production, are focused, which in the following are referred to as product and production engineering (PPE). Knowledge management in PPE is helpful in many ways. For example, it helps speed up the development of new products or modification or reengineering of production processes by using existing references instead of starting from scratch (Albers, Rapp, Spadinger et al. 2019; Albers et al. 2022). Managing knowledge is often associated with extensive IT infrastructure and using appropriate software tools (VDI 5610 2019). These are only some aspects of many since establishing a knowledge management culture in a company or motivating (especially elderly and experienced) employees to share and document their knowledge are also key for successful knowledge management (Albers, Rapp, Spadinger et al. 2019). Lee et al. (2013) highlight, that knowledge sharing, application, and documentation are especially important in knowledge management. Al-Sa'di et al. (2017) state, that the ability to share knowledge is key to increasing the operational performance of a company.

2.2 Knowledge Transfer as Part of Knowledge Management in Product and Production Engineering

In literature, knowledge transfer is defined differently. Here, knowledge transfer is understood as the identification of knowledge, which is then transmitted from a knowledge carrier to a knowledge receiver, and can be reused unchanged or adapted or serve as input for the generation of new knowledge (Grum et al. 2021; Thiel 2002). The transfer partners can be individuals or collectives. In an engineering context, the transfer of knowledge does not only depend on knowledge conversion (cf. Nonaka and Takeuchi 1995). It also depends on the content, that is being transferred, the needed transfer activity, the persons included as well as the transfer direction and goal (Albers and Gausemeier 2012;

Rauter 2013). In addition, it depends on the organization and the way it designs the process of the transfer. Some models focus on describing knowledge transfer as part of knowledge management, which includes various steps of knowledge transfer, different modes of knowledge transfer, performance measurements, and influence factors as well as requirements such as motivation and coordination (Liyanage et al. 2009; Schmidt et al. 2016). Klippert, Ebert et al. (2023) describe five success factors of knowledge transfer in PPE: *knowledge culture*, *networking*, *standards*, *willingness*, and *competence*. On the one hand, successful knowledge transfer has a lot of opportunities, such as reducing response time or errors and improving the quality of products and processes (Liyanage et al. 2009). On the other hand, knowledge transfer faces many barriers and challenges, which occur on different levels: organization, project, in and between teams, personal as well as tools and processes (Gericke et al. 2013). For example, a lack of documentation or communication skills hinders effective and efficient knowledge transfer in PPE (Klippert, Schäfer et al. 2023). Furthermore, Montgomery et al. (2023) present counterproductive knowledge behaviours, which can impede effective knowledge transfer: Knowledge hiding, knowledge hoarding, knowledge withholding, knowledge manipulating, knowledge-sharing hostility, and knowledge rejection. Those barriers and challenges as well as counterproductive behaviours need to be considered when aiming to improve knowledge transfers. Firstly, it is necessary to understand where and how knowledge is being transferred to identify improvement needs. Unless those improvement needs are not addressed properly, it is not possible to exploit the potential of successful knowledge transfer (Klippert, Stolpmann and Albers 2023).

2.3 Improvement of Knowledge Transfers in Product and Production Engineering

There are already several approaches and models that describe how to design interdepartmental collaboration between product and production engineers and highlight, that managing knowledge is very important (Lindemann and Lorenz 2008, Putnik and Putnik 2019). The VDI's guideline 5610 (2009) outlines requirements and criteria for knowledge management and transfer methods in engineering. These encompass the application domain, supported core activities, knowledge objects considered, prerequisites. employee skills, and available infrastructure. The method's integration and compatibility with the business process are assessed for the application domain. Determining the supported core activities and the processing of explicit or implicit knowledge with the method or tool are essential considerations. The organizational culture, employee skills, and infrastructure availability also play a crucial role in assessing the method or tool's suitability. Those approaches, models, and guidelines do not particularly describe how to support the improvement of knowledge transfers in product and production engineering, which is why Albers et al. (2023) developed the InKTI method (see Figure 1). This method is the basis for this research and has been validated in a field study to prove, whether it supports the improvement of knowledge transfer in PPE (Klippert, Schäfer et al. 2023).

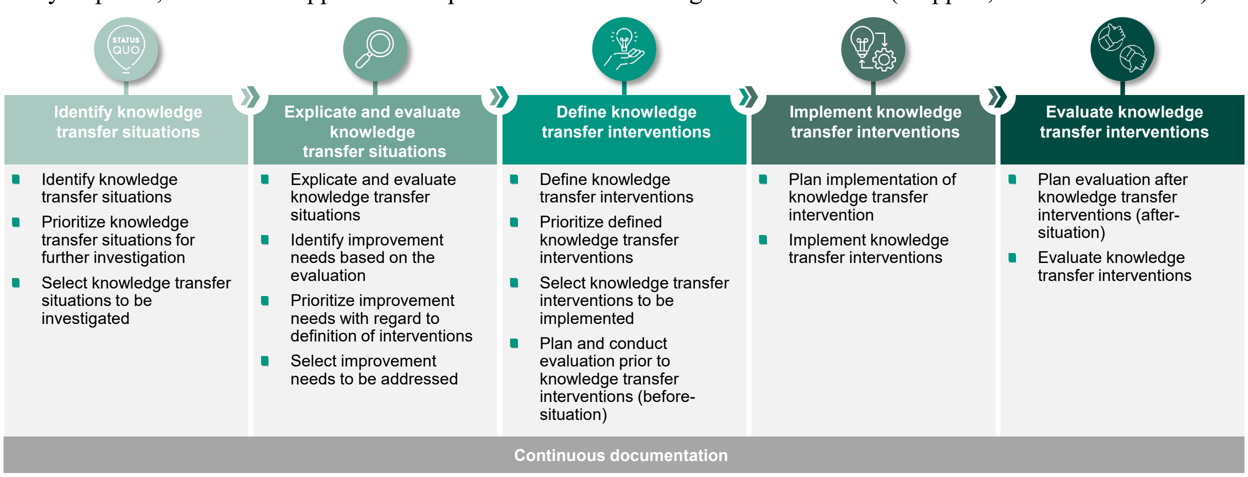

Figure 1. InKTI – Interdepartmental Knowledge Transfer Improvement method (Albers et al. 2023)

2.4 Validation of the InKTI Method at Protektorwerk Florenz Maisch GmbH & Co. KG

Methods are often not applied in product development because they are abstract and not user-friendly, or they have to be adapted to the given circumstances and there are no tools to support them. Validation early in the development process can solve these problems by making the methods adaptable, motivating, and applicable. Influences such as development situations, people involved and development tasks influence the validation results (Klyatis 2021; Dühr et al. 2022). Albers, Walter et al. (2018) identified three types of design research environments: laboratory study, Live-Lab study, and field study. For the first validation of the InKTI method, a field study was conducted at the company Protektorwerk Florenz Maisch GmbH & Co. KG (Protektor) (Klippert, Schäfer et al. 2023). A field study ensures high external validation, which is key to developing a method, that should be applicable in practice. This field study included:

- Analysis of the current state of knowledge transfer and requirements for the validation environment at Protektor
- Definition of a validation concept for the InKTI method at Protektor
  - Design of a reference process for the validation in the field
  - Definition of the types of data collection
  - Evaluation of the relevance of the method's objectives and requirements (Albers et al. 2023)
  - Application of all 5 activities of the InKTI method at Protektor
  - Success, support, and application evaluation of the InKTI method through surveys
- Implementation of the validation concept at Protektor
- Conclusions as well as further development potentials of the InKTI method

By applying the InKTI method six relevant knowledge transfer situations could be identified. The evaluation of two of those six situations resulted in the following improvement needs:

- Relationship and trust between participants
- Interdepartmental understanding
- Structure, maintenance, and retrievability of knowledge
- Timing and extent of integration of different departments

To address these improvement needs, knowledge transfer interventions were defined. Previous studies show, that by implementing speed- or quality-dependent knowledge transfer interventions, the speed (Albers, Rapp and Grum 2019) or quality (Klippert, Stolpmann, Grum et al. 2023) of knowledge transfers can be increased. After implementing two knowledge transfer interventions (*regular meetings for project overview* and *common structured folder structure*) a positive effect on the speed and quality of knowledge transfers in PPE at Protektor could be measured.

As an outlook, the authors state, that the method could be improved by supporting the identification of knowledge transfer situations by e.g., giving an overview of exemplary knowledge transfer situations in PPE. In addition, an objective evaluation of knowledge transfer situations should be realized to avoid subjective biases.

3. Aim of Research and Methodology

Looking at the current state of research, it appears, that managing knowledge is key for companies to increase their performance or product innovation. In this matter, knowledge transfer as part of knowledge management is especially important. This research focuses on knowledge transfers in PPE and aims to improve the speed and quality of knowledge transfers. To support the improvement of those knowledge transfers, the InKTI method is used and validated in a field study at Witzenmann. To ensure the need to improve knowledge transfer in PPE at Witzenmann, a survey was conducted. In total 45 employees working in the fields of product development, production technology, production, technical sales, and others participated. The results of the survey are summarized in Figure 2 and Figure 3. They show that most of the employees agree with the need and the potential to improve interdepartmental knowledge transfers. The willingness to improve knowledge transfer is high for the majority of the participants whereby some do not totally agree or do not agree to put in the additional effort. The participants of the survey confirm, that a method to support the identification, explication, and evaluation of knowledge transfer situations is helpful. In addition, methodological support for the definition and implementation of knowledge transfer interventions is seen as helpful. The participants agree, that the application of a method shall be supported by a tool or guideline. In conclusion, there is a need at Witzenmann for a method to support the improvement of knowledge transfers in PPE.

The following research questions (RQ) are addressed:

- RQ1. In which field of application can the InKTI method be applied at Witzenmann? (Sec. 4)
- RQ2. How can the InKTI method be validated at Witzenmann in terms of its contribution to success, support performance, and applicability in a field study? (Sec. 5)
- RQ3. Which measurable added value does the InKTI method offer in terms of improving knowledge transfer in product and production engineering at Witzenmann? (Sec. 6)
- RQ4. What are the similarities and differences between the results and findings of the validation studies at Protektor and Witzenmann? (Sec. 7)

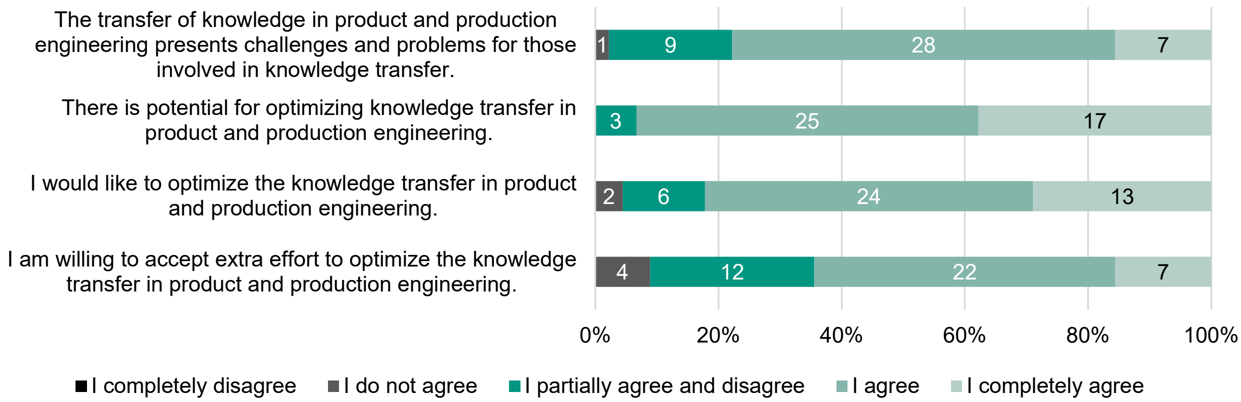

Figure 2. Results of the survey regarding challenges, problems, and potential for improvement as well as the readiness for improvement at Witzenmann (n=45)

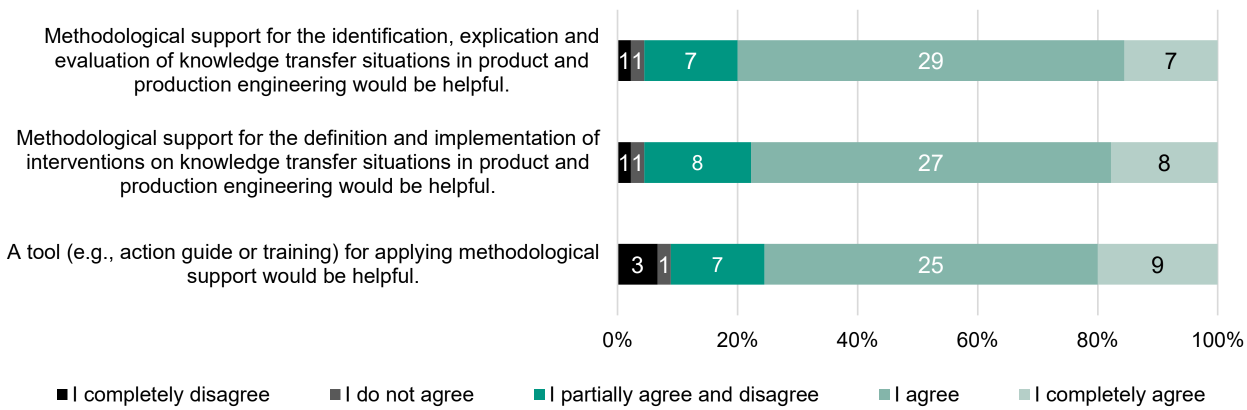

Figure 3. Results of the survey regarding the need for methodological support and a tool to improve knowledge transfers in product and production engineering at Witzenmann (n=45)

Firstly, the current state of knowledge transfer in PPE at Witzenmann is analyzed to answer RQ1 (Sec. 4). A suitable field of application shall be identified and the prerequisites for the application of the InKTI method at Witzenmann shall be conducted to verify Witzenmann as a valid validation environment. To answer RQ2 a validation concept should be designed, which includes an initial and real process of application (Sec. 5). In addition, the data collection format is defined. For the validation of the method, the objectives and requirements for the success evaluation, support evaluation, and application evaluation of the method are evaluated regarding their relevance. Thirdly, the InKTI method is applied to the defined field of application, the results of the application and evaluation are discussed and further improvement potentials are presented (Sec. 6). To answer RQ4 both study results and findings are compared to identify similarities and differences in the application of the InKTI method in industrial environments (Sec. 7).

4. Current State of Knowledge Transfer at Witzenmann and Analysis of Requirements for the Validation Environment

Witzenmann pursues a highly interdisciplinary engineering approach. New products are designed by interdepartmental teams, involving product development, production, technical sales, as well as production planning and control. For the application environment, a novel product for the market of alternative and renewable energy concepts was chosen as the subject of investigation. The participant group comprised a total of 30 individuals who were involved in various method activities throughout the study. The number of active participants varied during each method activity. During the analysis of the current state of knowledge management at Witzenmann, several knowledge transfer situations and tools were identified. Departments transfer knowledge through both formal and informal tools and methods. Particularly noteworthy is the communication through internal company platforms and scheduled meetings in customer projects. The transferred knowledge includes technical information about product requirements as well as organizational information such as deadlines, milestones, production plans, and quantity lists. The analysis revealed several challenges and obstacles to successful knowledge transfer between departments through observations, surveys, and personal interviews. Communication during recurring customer project meetings, knowledge retrieval, and pre-project initiation knowledge assessment were identified as three of the most affected situations with hindered knowledge transfer. To evaluate the research need to improve the knowledge transfer in PPE, a survey was conducted among 45 employees of Witzenmann. The survey revealed that the support provided by the InKTI is highly required for the identification, explication, and evaluation of knowledge transfer situations as well as the definition of interventions and the documentation of knowledge transfers (see Figure 4).

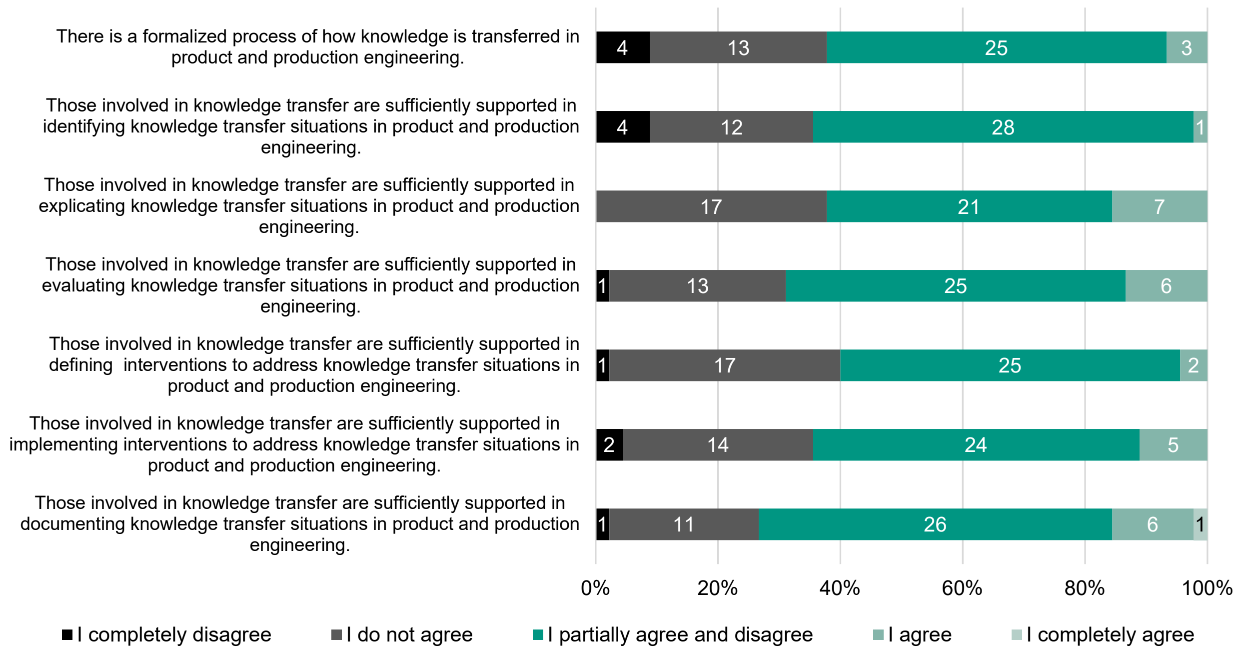

Figure 4. Results of the survey regarding the support in knowledge transfer in product and production engineering at Witzenmann (n=45)

5. Concept for the Validation of the InKTI Method at Witzenmann

The *concept for the validation* of the InKTI method included the application as well as its evaluation. In Figure 5 the initial *reference process* for the validation at Witzenmann based on the real process of the application at Protektor (Klippert, Schäfer et al. 2023) is visualized. On the left-hand side, each of the five activities of the InKTI method is shown. Those activities are applied over six months. One milestone took place to select knowledge transfer situations, which should be further investigated. Furthermore, an intervention workshop was conducted to define knowledge transfer interventions. The validation of the InKTI method was completed by evaluating the measurable added value through the application of the method. The *data collection* is divided into qualitative and quantitative as well as subjective and objective collection to obtain an evaluation that is as reliable as possible. Subjective data is obtained qualitatively in interviews and conversations. Examples of this are, among others, the questioning about the current status of the knowledge transfer at Witzenmann but also the perception of the implementation of the method. Quantitative subjective data is obtained and analyzed in the evaluations. Objective qualitative data collection takes place in the form of observations in the company. Here, the everyday life of employees of Witzenmann is observed. This type of data collection also serves to identify knowledge transfer situations and initial associated problems. The *application of the validation concept* for the InKTI method remained congruent with its previous application at Protektor (Klippert, Schäfer et al. 2023), ensuring enhanced comparability of outcomes. The first and second activities of the InKTI method took longer than expected due to the limited availability of participants caused by holidays, illness, and vacations. Additionally, the extensive process of identifying, explicating, and evaluating knowledge transfer situations contributed to doubling the originally scheduled time frame. As a result, all subsequent activities of the InKTI method were delayed, hindering the allocation of sufficient time for an exhaustive evaluation of the interventions post-implementation. Consequently, some interventions could only be initially assessed, as the practical application was yet to be realized in the engineering processes at Witzenmann. Moreover, the initially intended month for method evaluation had to be halved without compromising the evaluation's rigor. For the *evaluation of the InKTI method*, 16 objectives and requirements are used for assessing the success, application, and support by the InKTI method (Albers et al. 2023). Those have been evaluated regarding their relevancies in the survey mentioned in Sec. 3 and 4. These results will be considered at the end of the validation to interpret the evaluation results.

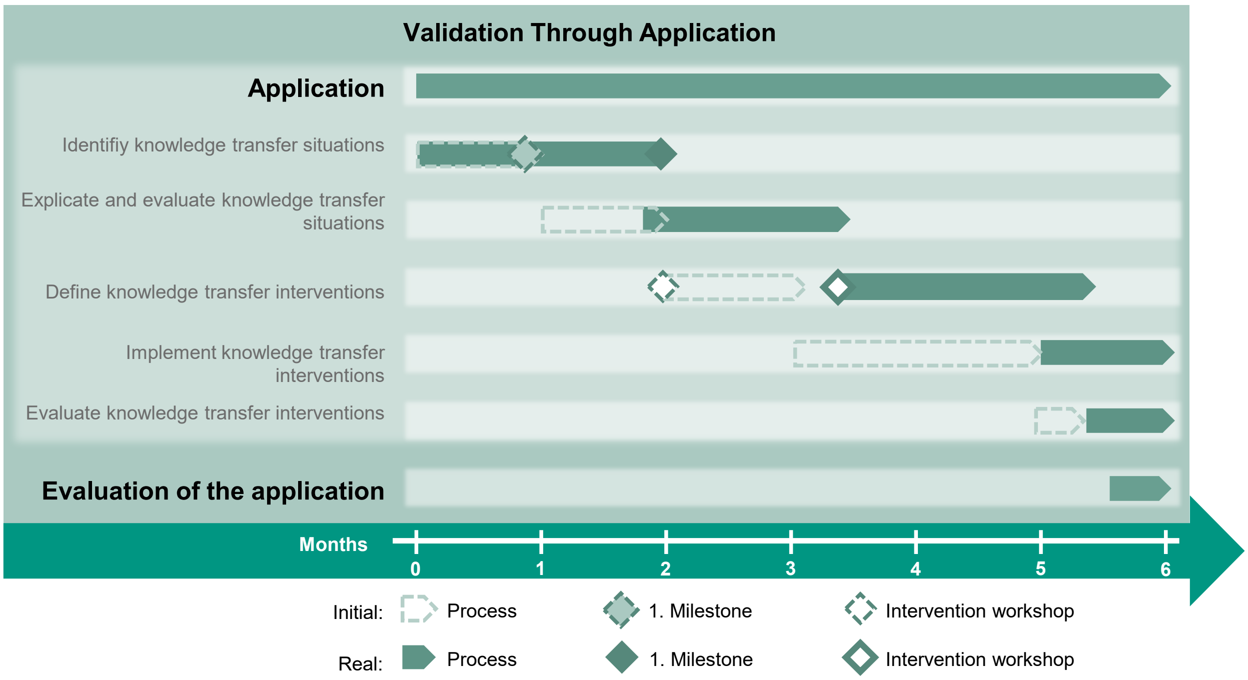

Figure 5. Initial vs. real process for the application and validation of the InKTI method at Witzenmann

6. Implementation of the Validation Concept of the InKTI Method at Witzenmann and its Results

By implementing the validation concept all five steps of the InKTI method were applied at Witzenmann. The application of the steps as well as their findings about the method will be described and discussed in this section.

Identify knowledge transfer situations: In the first activity, 26 individual knowledge transfer situations were identified and added to a list of exemplary knowledge transfer situations in PPE (cf. Klippert, Ebert et al. 2023). This was done through expert interviews, personal observations, and questionnaire studies with employees of Witzenmann. Several of these identified situations showed an initial potential for improving knowledge transfers in PPE. To further investigate, which of those knowledge transfer situations should be investigated further, they were compared with each other. The situations were assessed based on their relevance (how important they are for the overall success of knowledge management and how often they occur in practical business settings) and their changeability by employees both from product as well as production engineering. Three situations were selected, which were intended to be improved: *meeting culture*, *interdepartmental exchange,* and *qualitative knowledge assessment*

Findings: The process of identifying knowledge transfer situations was not yet clearly defined. A more precise definition of a knowledge transfer situation and a systematic process is necessary for future applications. Furthermore, templates and guiding questions for identifying knowledge transfer situations could be established. By this, the applicant of the method could ensure, that all relevant aspects are considered and not overlooked or forgotten. Furthermore, a comprehensive identification of knowledge transfer situations needs more time, since relevant events during an engineering process do not occur constantly or regularly.

Explicate and evaluate knowledge transfer situations: The three selected knowledge transfer situations were explicated and evaluated according to Klippert, Ebert et al. (2023). The employees of Witzenmann filled out an explication and evaluation sheet for each of the situations. The moderator of the method was able to summarize the results and automatically identify improvement needs. During the evaluation of the framework conditions, the main improvement needs lie in the category of *knowledge management*. This primarily concerned the absence of standards and rules for knowledge transfer. However, it is worth noting that all respondents perceived the presence of knowledge promoters positively. In the category of *goals and knowledge culture*, areas requiring attention were also identified. According to the respondents, there were no specific knowledge-related goals embedded in the company's culture or strategy. Additionally, not all employees in the organization were fully aware of the significance and importance of knowledge transfer. Regarding the *operational structure*, respondents expressed that the timing of integrating involved business units was perceived as either too late or inadequate. The level of coordination at interfaces also indicated a moderate need for improvement. The results obtained from the evaluation tool used for assessing the framework conditions aligned with the findings from the researchers' observations and statements from the interviews conducted as part of the initial activities of the InKTI method during the first descriptive study.

Findings: While explicating and evaluating knowledge transfer situations, the employees suggested using easier wording, since they were not familiar with some of the terms, which made it difficult to answer appropriately. Ensuring that participants have an adequate understanding and can respond thoughtfully is crucial for obtaining accurate results.

Define knowledge transfer interventions: The results of the previous method activities served as the basis for the intervention workshop, attended by a total of 10 participants, including two moderators. These participants had been involved in previous activities of the InKTI method. During a work session the participants were divided into groups of two to three individuals, each assigned to one of the three identified knowledge transfer situations for further examination. Their initial task was to collectively agree on the current state of their respective situations, confirming, adapting, and supplementing the results of the evaluation. The analysis of the knowledge transfer situations revealed challenges related to communication between product and production engineers due to inadequate planning and time constraints. The existing knowledge was incomplete and difficult to access, affecting the availability of information. Interpersonal dynamics were characterized by limited trust in available knowledge and diverse opinions, leading to hesitancy in knowledge-sharing. Complicating matters further were (mis)judgments stemming from inadequate knowledge, and decision-making faced obstacles due to complex implications and limited participation of essential specialists. Knowledge transfer also faced challenges from time pressure, duration of situations, insufficient methodological competence, and a lack of willingness to learn among certain individuals. Poor and inconsistent documentation, lack of participation, and motivation further hindered knowledge transfer, as did unclear communication channels and varying tool usage. Lessons learned were rarely recorded or communicated, and the management and beneficiaries of these lessons remained undefined. The initiation of communication and the involvement of relevant parties were often unclear, and the acceptance of external knowledge was limited due to a lack of openness. The workshop provided valuable insights into knowledge transfer at Witzenmann. The participants showed a keen interest in the subject matter and appreciated the additional time for discussion. Some situations were further refined during the workshop, leading to a better understanding of the context. While participants faced challenges in formulating concrete interventions and measuring criteria, the workshop's limited duration prevented the development of fully-fledged interventions. Collaborative efforts in the post-workshop phase were necessary to refine two feasible interventions: *meeting effectiveness* and *lessons learned*.

Findings: To define knowledge transfer interventions within a workshop, it is necessary, that all people involved in those knowledge transfer situations should have the same understanding of how knowledge is being transferred and where there is a need for improvement.

Implement knowledge transfer interventions: Before implementing the two selected interventions, it was essential to also quantitatively capture the as-is state. To improve *meeting effectiveness*, rules and guidelines for efficient and effective meetings were defined and documented. Additionally, a new template for meeting protocols was developed for regular meetings to ensure more consistency and clarity in documenting discussions. These rules, guidelines, and templates were added to the company's wiki for easy access by employees. To implement the *lessons learned* intervention, the article in the company wiki was revised and supplemented with further assistance as well as best practices and guidelines. An overview of the process and the corresponding responsibilities in the process of creating lessons learned is given and a template with eight short questions to help identify lessons learned more quickly is provided. Two instructions on how to document lessons learned during and at the end of a project are attached as well. The *meeting effectiveness* intervention was introduced, tested, and evaluated within the customer project group of battery cooling pipes at Witzenmann. The *lessons learned* intervention was presented to the company's process team and adapted with the resulting comments. To make the interventions accessible to the entire company, a German and English version was created in each case.

Findings: Since in the workshop, time constraints limited the discussion and precise definition of all interventions, developing and implementing interventions proved to be time-consuming and a significant step in the method's application. Various parties were involved in the implementation, and each department handled it differently. In addition, the implementation of defined interventions needed approval from different boards and committees. In addition, defining appropriate participant groups for the intervention implementation in certain knowledge transfer situations, which affect the entire organization, posed challenges. Some participants did not fully adhere to the new interventions, continuing with their previous practices, which hindered the successful implementation of partial interventions, blocking the complete execution of many processes and obstacles.

Evaluate knowledge transfer interventions: To evaluate the effect of the interventions a survey was conducted (n=6). Regarding the improvement of *knowledge transfer quality,* the respondents stated that they were better prepared for the meetings and their content after the implementation of the intervention *meeting effectiveness*. Additionally, a consistent agenda is now followed in the meetings. The clarity and comprehensibility have significantly improved through the introduction of the protocol template. The time in the appointments themselves can be used more effectively due to the implemented rules and the “Idea Parking Lot”. By sending the meeting protocol to absent participants, they are better informed. Overall, it can be concluded that the quality of knowledge transfer situations has improved in almost all queried aspects. The *speed of knowledge transfers* has also improved. The respondents reported using and having more time on average for the preparation of the meetings. The participants invest twice as much time to prepare a meeting (from 4 to 8,33 minutes), have six times more preparation time available (from 1,5 to 9 minutes), and only need half the time to process the contents of the meeting afterward (from 5,9 to 2,5 minutes). The intervention of *lessons learned* was examined for an improvement in the *quality of knowledge transfer* using seven questions. The employees felt significant support regarding the subject after implementation. The demonstration of the process chain and those responsible have helped the respondents to better identify them now. Lessons Learned can be identified more often, respondents feel more supported, and the process is more systematic. However, the formal and targeted dissemination of knowledge could not be improved by the intervention. It needs to be examined why and whether the intended template was perceived as unsuitable for systematic dissemination. In conclusion, this intervention has contributed to a slight improvement in knowledge transfers. The *speed of knowledge transfers* was not assessed, since the intervention could not be appropriately implemented in the timeframe of six months. Hence, an evaluation at a later point is necessary to evaluate the effect of the intervention.
The evaluation of the InKTI according to its success, support, and applicability is displayed in Figure 7.

7. Comparison of Field Studies at Protektor and Witzenmann

Both field studies are compared to identify similarities and differences in the application of the InKTI method in industrial environments. The results and findings are shown in Figure 6 and Figure 7.

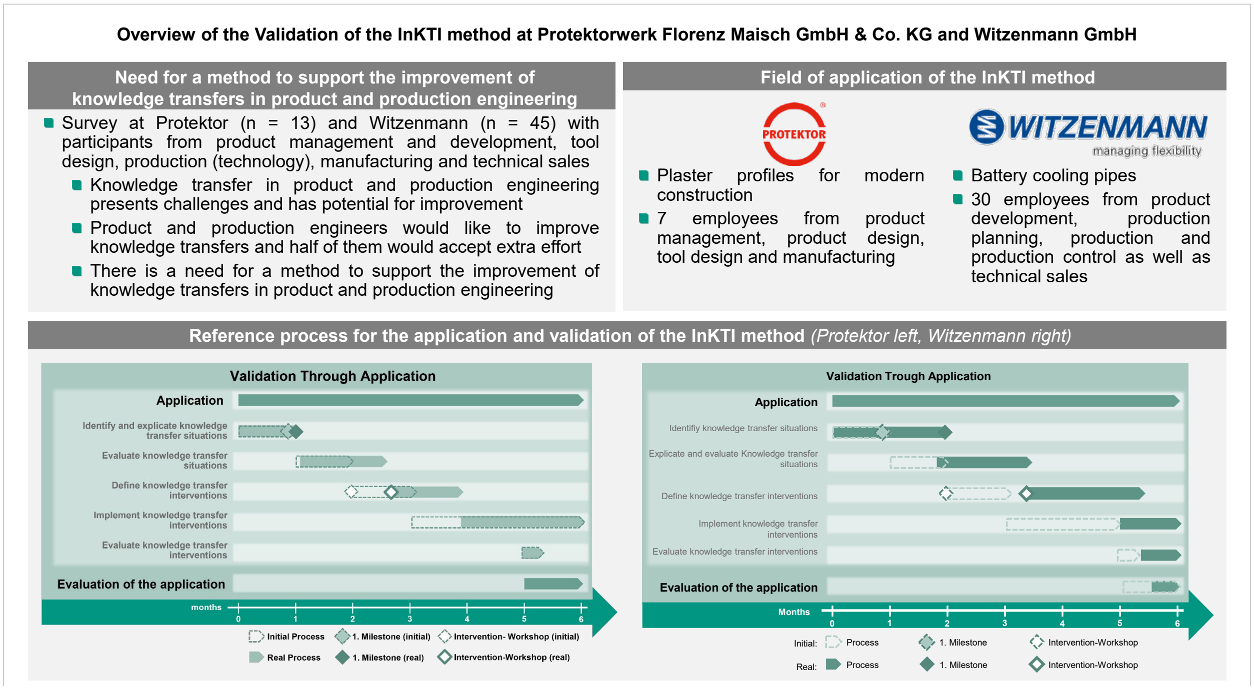

Figure 6. Comparison of the first and second validation studies of the InKTI method (part 1)

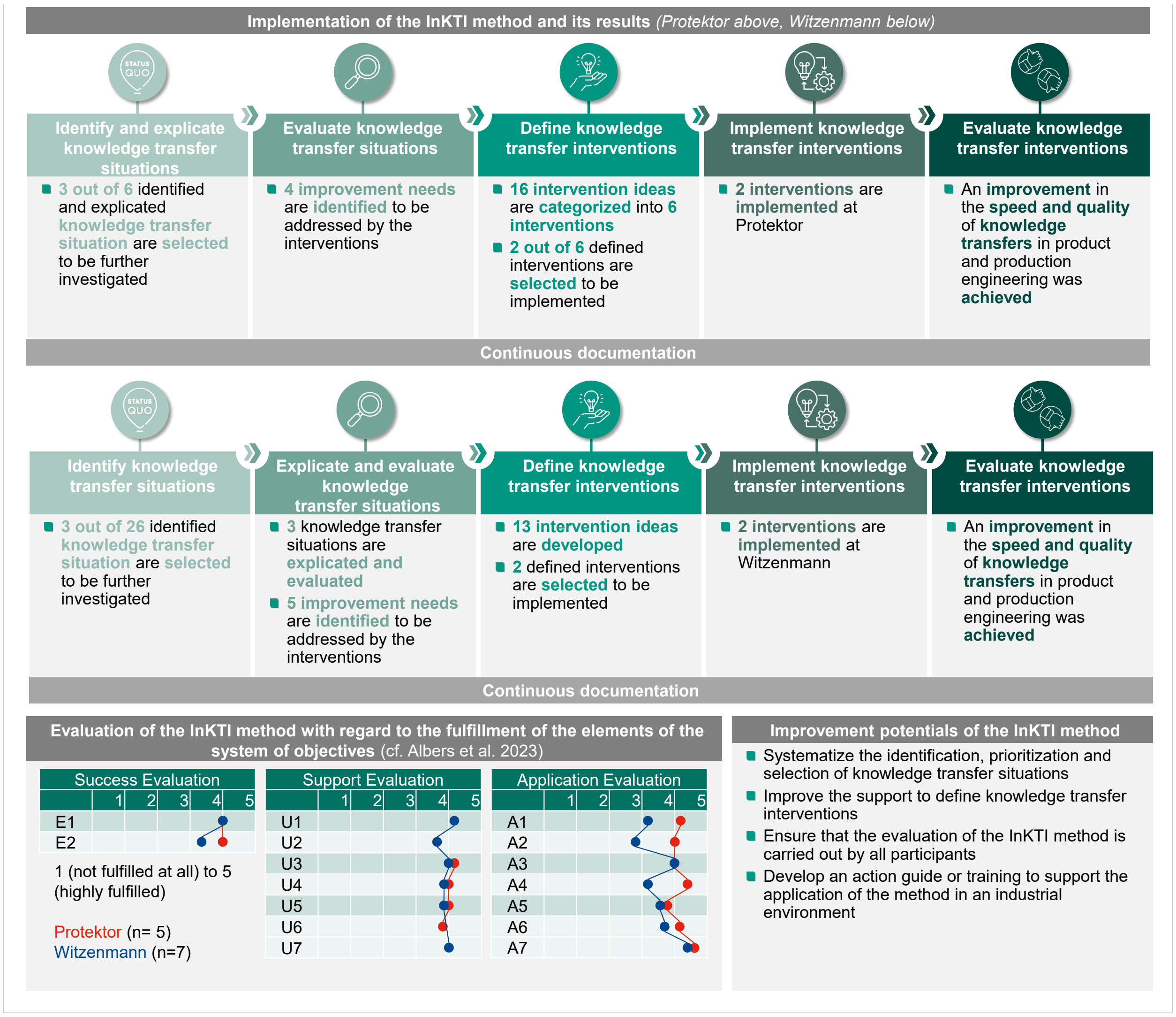

Figure 7. Comparison of the first and second validation studies of the InKTI method (part 2)

8. Conclusion and Outlook

Successfully transferring knowledge in PPE is challenging, but if done correctly, it has many potentials. To support the improvement of knowledge transfers in PPE the InKTI method was applied at Witzenmann. To answer RQ1 the current state of knowledge transfer and a field of application at Witzenmann was identified (Sec. 4) and to answer RQ2 a concept for validation of the InKTI method was developed (Sec. 5). This concept includes an initial process for the application and validation of the method as well as objectives and requirements of the method for the success, support, and application evaluation. The concept of validation was implemented in the defined field of application (answer to RQ3, Sec. 6). The results show, that the InKTI method supported the improvement of knowledge transfers by increasing the speed and quality of knowledge transfers in PPE at Witzenmann. To answer RQ4 both field studies have been compared (Sec. 7). On the one hand, the studies show some similarities in the results of the activities of the InKTI method as well as the improvement potentials of the method. On the other hand, the reference process for the application and validation of the InKTI method as well as the evaluation differ from each other. Nevertheless, the InKTI method supported the improvement of knowledge transfers in PPE at both companies.

Based on this research, further improvements in the InKTI method were identified (Figure 7). The identification of knowledge transfers was rather unsystematically, so, future research should investigate how to systematically identify situations in which knowledge is being transferred in PPE and suggest a procedure on how to prioritize and select those for further investigation. The defined interventions should be continuously evaluated and further improved to increase their benefits at Witzenmann. In general, the application of the method should consider several human factors, e.g. their motivation to participate, their competencies, and experiences since those are essential for a successful application. An additional tool, e.g. an action guide or training could further support the application of the InKTI method.

References

Albers, A. and Gausemeier, J., Von der fachdisziplinorientierten Produktentwicklung zur Vorausschauenden und Systemorientierten Produktentstehung, *In R. Anderl, M. Eigner, U. Sendler und R. Stark, Smart Engineering. Interdisziplinäre Produktentstehung,* acatech Diskussion. Springer Vieweg. Berlin, Germany, 2012.

Albers, A., Heimicke, J., Walter, B., Basedow, G. N., Reiß, N., Heitger, N., et al., Product Profiles: Modelling customer benefits as a foundation to bring inventions to innovations, *Procedia CIRP*, 70, 253-258, 2018.

Albers, A., Klippert, M., von Klitzing, M. and Rapp, S., A method to support the improvement of knowledge transfers in product and production engineering, *Proceedings of the Design Society*, 3, 283-292, 2023.

Albers, A., Lanza, G., Klippert, M., Schäfer, L., et al., Product-Production-CoDesign: An Approach on Integrated Product and Production Engineering Across Generations and Life Cycles, *Procedia CIRP*, 109, 167-172, 2022.

Albers, A., Rapp, S. and Grum, M., Knowledge Transfer Velocity Model Implementation – An Empirical Study In Product Development Contexts, *Published in: Gronau, N. and Grum, M. Knowledge Transfer Speed Optimizations in Product Development Contexts: Results of a Research Project*. GITO mbH Verlag, 2019.

Albers, A., Rapp, S., Spadinger, M., Richter, et al., The reference system in the model of PGE: proposing a generalized description of reference products and their interrelations. I*n Proceedings of the design society: international conference on engineering design* (Vol. 1, No. 1, pp. 1693-1702). Cambridge University Press, 2019.

Albers, A., Walter, B., Wilmsen, M., Bursac, N. et al. Live-Labs as real-world validation environments for design methods. *DS 92: Proceedings of the DESIGN 2018*, 15th International Design Conference; pp. 13-24 2018.

Al-Sa'di, A. F., Abdallah, A. B., and Dahiyat, S. E., The mediating role of product and process innovations on the relationship between knowledge management and operational performance in manufacturing companies in Jordan. *Business Process Management Journal*, vol.23, no.2, pp. 349-376, 2017.

Bas, C., Mothe, C. and Nguyen-Thi, T., The differentiated impacts of organizational innovation practices on technological innovation persistence, *European Journal of Innovation Management*, vol. 18, pp. 110-127, 2015.

Darmawan, B. A., Improving MSMEs Operational Performance: the Role of Knowledge Management and Product Innovation. *Proceedings of the First Australian International Conference on Industrial Engineering and Operations Management*, Sydney, Australia, December 20-21, 2022.

Dühr, K., Kopp, D., Rapp, S. and Albers, A., Validating a Design Method to Improve Collaboration in Distributed Product Design – What Needs to be Considered, *NordDesign 2022*. Kgs. Lyngby, Denmark, 2022.

Gericke, K., Meißner, M. and Paetzold, K., Understanding the context of product development, *In DS 75-3: Proceedings of the 19th International Conference on Engineering Design (ICED13),* Design For Harmonies, Vol. 3: Design Organisation and Management, Seoul, Korea 19-22.08, 2013.

Grum, M., Klippert, M., Albers, A., Gronau, N., Thim, C., Examining the quality of knowledge transfers–the draft of an empirical research, *Proceedings of the Design Society*, 1, 1431-1440, 2021.

Klippert, M., Ebert, A. K., Tworek, A., Rapp, S. and Albers, A., Systematic Evaluation of Knowledge Transfers in Product and Production Engineering. *In ISPIM Conference Proceedings*. The International Society for Professional Innovation Management (ISPIM), 2023.

Klippert, M., Stolpmann, R., & Albers, A., Knowledge Transfer Quality Model Implementation-An Empirical Study in Product Engineering Contexts. *Procedia CIRP*, 119, 847-854., 2023.

Klippert, M., Stolpmann, R., Grum, M., Thim, C., Gronau, N. and Albers, A., Knowledge Transfer Quality Improvement-The Quality Enhancement of Knowledge Transfers in Product Engineering. *Procedia CIRP*, 119, 919-925, 2023.

Klippert, M., Schäfer, L., Böllhoff, J., Willerscheid, H., Rapp, S., and Albers, A., Improving Knowledge Transfers at Protektorwerk Florenz Maisch GmbH & Co. KG through the Application of the InKTI–Interdepartmental Knowledge Transfer Improvement Method. *Proceedings of the Design Society*, 3, 2255-2264, 2023.

Klyatis, L. M., Accelerated reliability and durability testing technology, *John Wiley & Sons*, New Jersey, 2012.

Lee, V., Leong, L., Hew, T. and Ooi, K., Knowledge management: a key determinant in advancing technological innovation?, *Journal of Knowledge Management*, vol. 17, no. 6, pp. 848-872, 2013.

Lindemann, U. and Lorenz, M., Uncertainty handling in integrated product development, *In DS 48: Proceedings DESIGN 2008*, the 10th International Design Conference, Dubrovnik, Croatia. pp. 175-182, 2008.

Liyanage, C., Ballal, T., Elhag, T. and Li, Q., Knowledge communication and translation- A knowledge transfer model, *Journal of Knowledge Management*, 13 (3). pp. 118-131. Emeral, 2009.

Montgomery, N., Michailova, S., and Husted, K., Knowledge rejection: Antecedents and behavior types. *In ISPIM Conference Proceedings*. The International Society for Professional Innovation Management, pp. 1-17, 2023.

Nonaka, I. and Takeuchi, H., The knowledge-creating company: How Japanese companies create the dynamics of innovation, *Oxford university press*, 1995.

Probst, G., Raub, S. and Romhardt, K., Wissen managen. Wie Unternehmen ihre wertvollste Ressource optimal nutzen. *Springer Gabler*, Wiesbaden, Germany, 2012.

Putnik, G. and Putnik, Z., Defining Sequential Engineering (SeqE), Simultaneous engineering (SE), Concurrent Engineering (CE) and Collaborative Engineering (ColE): On similarities and differences, *Procedia CIRP,* 84, pp. 68-75, 2019.

Rauter, R., Interorganisationaler Wissenstransfer. Zusammenarbeit zwischen Forschungseinrichtungen und KMU, *Springer Gabler*, Wiesbaden, Germany, 2013.

Schmidt, D.M., Böttcher, L., Wilberg, J., Kammerl, D. and Lindemann, U., Modeling Transfer of Knowledge in an Online Platform of a Cluster, *In: Procedia CIRP*, 26th CIRP Design Conference, Elsevier, 2016.

Syahchari, D. H. and Herlina, M. G., Improving Firm Performance Through Knowledge Management and Open Innovation, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Istanbul, Turkey, March 7-10, 2022.

Thiel, M., Wissenstransfer in komplexen Organisationen. Effizienz durch Wiederverwendung von Wissen und Best Practices. *Deutscher Universitätsverlag*, Wiesbaden, Germany, 2002.

VDI - The Association of German Engineers, VDI 5610 – Part 1. Knowledge management for engineering. Fundamentals, concepts, approaches, *Beuth- Verlag*, Berlin, Germany, 2009.

VDI - The Association of German Engineers, VDI 2221 - Part 1. Design of technical products and systems - Model of product design, *Beuth- Verlag*, Berlin, Germany, 2019.

Biographies

Monika Klippert graduated with a bachelor's degree in Mechanical Engineering in 2017 and received a master's degree in 2019 from the Karlsruhe Institute of Technology (KIT). She is a doctoral researcher in the research group Design Methods and Design Management at the IPEK – Institute of Product Engineering at the KIT. Her research interests include innovation and knowledge management as well as Product-Production-CoDesign.

Dean Siebert was a student at the University of Applied Sciences Karlsruhe in the field of International Business and received his Master's degree in 2023. He had already been employed as a working student at Witzenmann for 2 years before his master's thesis in the research and development department. During his thesis, he accompanied several development teams in their projects and observed the challenges of knowledge transfer they faced during the cycles.

René Rösler graduated with a Diploma in Mechanical Engineering from the University of Karlsruhe. After leading Product Development at Witzenmann for several years, he now coordinates product management and focuses on enhancing organizational processes and methodologies. Empowering knowledge management and optimizing knowledge transfer are core drivers of his work at Witzenmann.

Hendrik Rust gained his experience in various positions in a medium-sized company and two corporate groups. Most recently, he was managing director of a German global market leader. In the last 20 years, Hendrik Rust has invented, pre-developed, discarded, or brought to market numerous products. One consumer product he was in charge of developing has been sold over 60 million times to date and is very well known in Europe. He is now lecturing on Product Development and Entrepreneurship at the University of Applied Sciences in Karlsruhe, Germany.

Albert Albers has been a full professor for product development and head of IPEK – Institute of Product Engineering at the Karlsruhe Institute of Technology since 1996. He received his doctorate in 1987 under Prof. Palandan of the University of Hannover. Before his appointment to Karlsruhe, Prof. Albers worked for LuK GmbH & Co. OHG, most recently as head of development and deputy member of the management board. He is a founding and former board member of the Scientific Society for Product Development WiGeP, a member of the German Academy of Science and Engineering (acatech), and a member of the Advisory Board of the Design Society. Since 2008, he has been President of the Allgemeiner Fakultätentag (AFT e.V.). In addition, Prof. Albers engages in the VDI and serves on the advisory boards of several companies. In 2016, he and the IPEK team were awarded the Honorary Award of the

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