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APPLYING MATRIX-BASED METHODS FOR IMPROVING USER EXPERIENCE OF A DRIVER ADVISORY SYSTEM

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Abstract

Users need tools to accomplish complex tasks in dynamic use situations; but meanwhile want the experience of product interaction to be intuitive and enjoyable. To achieve the goal of handling technologies and motives and mapping functions from the users' perspective, matrix-based method can be applied by designers. But those positive effects can only be achieved, if the method is viable and usable. In this work, a matrix-based method is applied in the case study of a rail driver advisory system (DAS) with a twofold purpose: (1) to adjust the method in order fit the specific and limited in term of resources frame of the project, and (2) to create new concepts for the complex interface of DAS in order to improve the drivers' experience and acceptance. The methodological proceeding with useful insights and best practices are presented in the paper. Furthermore, new dynamic DAS interface concepts are proposed as result of use case-based (i.e. functions most likely to be needed in a use case are clustered in one interface) approach.

Keywords: User experience, Complexity, Design methods

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1 INTRODUCTION

Products become increasingly complex, due to a variety of reasons: new technologies, novel interfaces, multi-functionality, use in dynamic situations (Bijl-Brouwer & Voort, 2008) and combination with other products and services. In this challenging context, users need advanced tools to achieve their goals, while designers make efforts to eliminate the *perceived* complexity of products and provide an enjoyable overall user experience (UX). Positive UX emerges when users' needs and motives are fulfilled via product usage (Hassenzahl, 2010). Designers should ensure that their solutions are understandable, usable and enjoyable, and provide the complexity that users need in a manner that is understandable and elegant (Norman, 2010). Thus methods to manage complexity and consider experience-related factors are needed. Matrix-based methods from the field of complexity management can be considered in the context of UX design (UXD). To achieve the goal of handling technologies, users' motives and usage environment, matrix-based methods can provide a systematic way to build up function clusters and consider their integration into new interfaces (Michailidou et al., 2014). But those positive effects of method application can only be achieved, if the method is viable and usable. Like other methods coming from academia, matrix-based methods for UX need to be applied on real products and be adjusted to practitioners' needs. Furthermore, UX methods are usually applied on business-to-consumer products –we believe that business-to-business products can be a challenge worth studying for UXD. In this work, matrix-based methods are applied in the case study of a rail driver advisory system (DAS) with a twofold purpose: (1) adjusting the method to the specific and limited -in term of resources- frame of the project, and (2) create new concepts for the complex interface of DAS to improve drivers' experience and acceptance. Following section presents the background of the study, while section 3 covers the methodological proceeding. New DAS interface concepts are presented as result of a use case-based approach. The paper ends with a conclusion and an outlook on future research.

2 BACKGROUND AND OBJECTIVES

2.1 Matrix-based methods to manage complexity in User Experience Design

Users need complex products, but meanwhile want the experience of product interaction be intuitive and enjoyable. An approach to reduce perceived complexity of products, proposed in previous work of the authors (Michailidou et al., 2014), suggests clustering functions that address similar users' motives or clustering functions that are needed in the same situation, and integrating them into an interface. So instead of an overloaded, static interface, interfaces with selected elements, offered to users when they need them, can be created. The process of clustering requires a good understanding of interdependences of UX-related elements and can be achieved by using matrix-based methods. Users' needs and motives, use cases, functions, markets and users are defined as relevant domains. The suggested methodological proceeding can be summarized in five steps:

1. **Adjust meta-model**: Based on an initial meta-model (Figure 2, left), the most relevant relations among UX domains are identified, according to the focus of each specific project.
2. **Enter elements of relevant domains**: Elements of the selected domains are entered into the matrices as tables and/or rows. The amount and level of detail of data can differ in each project.
3. **Define relations among elements**: This step concerns the identification of relations in each matrix within the UX team. Outcomes are filled matrices and additional comments or insights.
4. **Select approach to cluster**: Next steps concern the identification of related functionalities and their rearrangement in a new interface. Important here is to proceed with a user- and experience-centred integration. Two approaches are possible: use case-based (i.e. functions most likely to be needed in a use case are clustered) and motive-based (i.e. functions addressing similar motives are clustered).
5. **Create interface concepts**: Functions identified as related to each other in a comprehensible for the user way, are integrated into a new interface.

In the referred work, the applicability of the method and its positive effect on UX were assessed within a research project, while high organizational effort was identified as major challenge. Applying the method on further projects and product categories and adapting the approaches for a more simplified, realistic implementation, had been defined as next steps.

2.1.1 Objective 1: Adjusting matrix-based method and create practical guidance for application

To find acceptance by practitioners, methods should not only provide valuable results but also meet their requirements concerning ease of use, fittingness in design process and satisfaction with the way the method works. First objective of this work is therefore to adjust the method for a practitioner-centred (Van Kuijk, 2010) application. While previous work had an academic perspective, the focus here lies on practicality. The research question is thus, how the method can be adjusted to fit in a limited in terms of time and resources project, which is a realistic setting for industrial application.

2.2 Driver Advisory Systems (DAS) for Rail

Driver Advisory Systems (DAS) and Driver Assistance Systems aim at enhancing "better", in terms of safety, speed, comfort, or energy efficiency, driving. While Advisory Systems only give recommendations, Assistance Systems can proceed to partially or fully autonomous operations. In cars, Assistance Systems are used broadly, while Advisory Systems are more common in rail. This implies that rail drivers can decide whether to follow the recommendations provided. In this work, only DAS for rail are considered. Common aim of DAS is recommending an optimum speed-profile for time and energy efficient operations. DAS also provide information about track data, schedule and operations. Rail DAS are relatively new in the European market but increasingly popular due to companies' energy targets. Broadly used DAS are "TTG Energymiser", "Cubris Greenspeed" and "Knorr-Bremse LEADER". DAS interfaces may differ in design, but mostly contain a depiction of recommendation, current speed, timetable, speed restrictions and speed profile. Displays are usually customizable.

2.2.1 Knorr-Bremse LEADER

A successful DAS is LEADER developed by Knorr-Bremse. LEADER aims at improving time and energy efficiency. Punctuality comes first, but energy savings up to 20% can be achieved if there are buffers in the timetable. The LEADER interface is fully customizable with several possible layouts; the most common of them (Figure 1, right) is used as reference for the interface concept created in this work. It was chosen as reference product because of its popularity in the German market and its high usability performance.

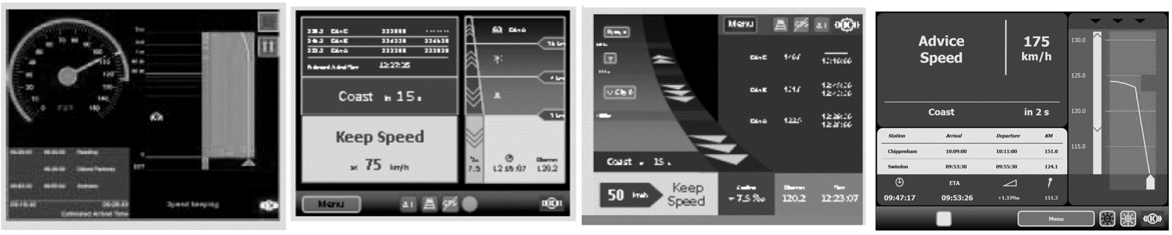

Figure 1. Various interfaces offered by LEADER from Knorr-Bremse

The selected interface has five main areas: The **advisory area** (upper left side) contains current recommendation, resulting speed and next recommendation. The **schedule area** (middle left) shows a short extract of the schedule, containing station names, scheduled arrival and departure time and kilometre posts of upcoming stations. The **information bar** (bottom left) depicts real time, estimated time of arrival (ETA), current topography gradient, and current kilometre post. On the right side is the **planning area**, visualizing topography and the advised speed-profile. Speed restrictions are indicated by colouring the allowed speed. An arrow indicates current speed. This standard display changes in some special occasions: When there is **no signal** or if a calculation is not possible, the DAS will inform about the according reason. When there is **unrecoverable delay** or **traffic at a station**, LEADER displays the detected event in the advisory area instead of a recommendation. When **arriving at, or leaving a station** there will also be no advice – drivers should concentrate on the track and the signalling. At the **end of each trip,** an overview including evaluation on punctuality and energy efficiency, can be displayed.

2.2.2 Why User Experience Is Important for DAS

Designing the interface of a device used in rail operations is not trivial. Not only does the physical circumstance of being on a train (bucking, temperature, usage time) create a dynamic usage environment. High standardization and norms induce various requirements. Safety and suitability are crucial for every element in the driver's cabin. In the case of DAS for rail, **the customer is not the user**. Still, designing the system to perfectly fit user needs is essential. **Driver's perception of DAS is critical for its success.** A DAS cannot influence the speed profile of a train directly. It is the driver's decision whether to follow the advice or not. Therefore it is important to involve drivers in the DAS deployment process to ensure acceptance. Positive effects can only be achieved, if drivers are willing to follow the recommendations. Trials will only be successful if **drivers trust DAS**. The introduction of a DAS represents a change of the working environment. As with all changes, some users may have a **first negative reaction**. Drivers must be convinced that this change improves their working environment and supports them in their daily tasks and not feel being replaced by the system. Resistance from drivers can lead to big delays in the integration process. Those aspects can be addressed through a user-centred design process and a product providing positive experiences. Design should be conducted hand in hand with the drivers to collect deeper insights and show drivers that their opinion is respected. This is especially critical when it comes to the decision which DAS will be chosen in **trial phases** (i.e. multiple systems are tested over a period of time): Before operators decide whether and what kind of DAS they install, a trial phase usually takes place. Functionality and experiences in this period are critical. In short time, drivers should get used to the system, approve its benefits and drop their hesitations. Design of DAS has to enforce the aspect of helping but not replacing drivers. Thus two aspects are essential: (1) DAS shouldn't disturb drivers in any way and create as little effort as possible and (2) drivers have to see personal benefits. From the academic perspective, DAS is an intriguing product for exemplary method application: DAS are **complex** tools used in **dynamic use situations** and thus meet the aim of the method. LEADER is considered a **"well"-designed** product, so improvements in UX are not obvious, but would have a big impact. Furthermore, DAS are products used as **working tools**. Since UX methods are mostly applied on business-to-consumer products, this case study is also in that sense interesting.

2.2.3 Objective 2: Improving UX of DAS

The second research question is whether the method is applicable in the product category of information systems used as working tools. DAS was chosen as representative for this product category. The previous section highlights problems concerning usability und UX aspects of DAS, which influence drivers' acceptance and experience with DAS. Second objective of this work is therefore to create new, improved in terms of perceived complexity and UX, interface concepts for DAS. Knorr Bremse LEADER had been defined as reference product. First requirements are:

Usability – Avoid Annoyance of Drivers: It is very important that drivers immediately see DAS as a helpful tool. In the long term, drivers might learn to trust DAS and appreciate its benefits, but the common trial-phase is crucial for the buying decision. Any additional effort can drop acceptance. Thus usability aspects (i.e. as little effort as possible, intuitive interface, effective information presentation) are vital.

UX – Amplify Benefits for Drivers: A driver would follow DAS recommendations only if his needs are in some way fulfilled via product usage. Relevant are the needs to increase competence (i.e. gain knowledge and improving driving skills) and stimulation (i.e. get entertained). Possible approaches to address competence could be energy-efficiency-ratings, detailed evaluations at the end of trip, explanations of advices, depiction of relevant track information, best-of ratings of drivers and trips. Approaches to address stimulation could be gamification or individualization: Using a DAS should make driving less stressful an even more enjoyable. Drivers can get bored on long trips, but still have to be concentrated on the track, looking out for unexpected events. Track information, learning possibilities, or short distractions would entertain drivers and even improve their sensibility for critical events (Wickens & Hollands, 2009). Another factor which could make a DAS more pleasing is the chance for social interaction (Norman, 2005) and individualisation. A DAS cannot serve as a platform for chatting, but even best-ratings at the end of each sections or messages from the Back Office could have an impact. Since the driver has to insert a driver ID anyway, individual settings are possible.

3 APPLIANCE OF MATRIX-BASED METHOD

3.1 Adjust meta-model: Setting up the Multiple Domain Matrix

The basic meta-model of Michailidou et al. (2014) was the starting point for the analysis. The domains function, motive, use case and user have all been considered relevant for an initial system analysis of the situation as-is. In the process of applying the method, the meta-model was modified.

MDM	Function	Motive	Need	Use-Case	User
Function	is mutually exclusive with	fulfils	satisfies	is used in	
Motive		can occur at the same time with	meets	can occur in	
Need				is relevant in	
Use-Case	influences	stresses	stresses	san occur at the same time with	
User	steers	has	has	is effected by	

MDM	Function	Motive	Use-Case
Function	is mutually exclusive with	fulfils	is used in
Motive		can occur at the same time with	can occur in
Use-Case	influences	stresses	san occur at the same time with

MDM	Function	Motive	Use-Case
Function		is helpful when	is used in
Motive			should be considered in
Use-Case			calls for same functions as

Figure 2. Basic, reduced and adjusted MDM

3.2 Defining the Elements

3.2.1 Motives and needs

Emotional factors of interaction are addressed by the domains “need” and “motive”. According to the definition of UX, fulfilment of needs and motives via product usage are a measure for UX quality. The set of psychological needs presented by Sheldon et al. (2001) was selected. As described in 2.2.3, needs for competence and pleasure-stimulation are highly relevant beside suitability (security) aspects. Motives, as representations of “be-goals” (i.e. cause to perform an action; cp. Hassenzahl, 2010), are results of intensive user research and can be collected directly from real users. Due to the limited resources of this study, motive acquisition could not be performed in great extent. Analysis of online material (interviews with rail drivers, blogs) and the author’s personal experience with DAS were used to derive motives. A challenge at this step was the distinction of drivers’ vs. other users’ motives. But since the primary goal was to improve the driver’s experience, only driver’s motives were considered.

1	Regaining delay	6	Relaxing	11	Proving good performance
2	Driving as fast as possible	7	Getting entertained	12	Getting credit for performance
3	Arriving in time	8	Enjoying the track	13	Getting informed
4	Driving energy efficient	9	Improving driving skills	14	Getting to know the track
5	Intensively concentrating	10	Avoiding evaluation	15	Regaining control over situation

Figure 3. Drivers’ motives

3.2.2 Functions

Technical aspects of DAS are represented by the domain “function”. A function is a solution-neutral, operational relationship between input and output variables of a system. Different functionalities of the observed system are supposed to be listed, but only functions perceivable from the user's point of view are relevant. Phrasing functions as “noun + verb” forces thinking about “do-goals” (Hassenzahl, 2010) rather than “motor-goals” of an activity. The proceeding for collecting DAS functions was conducted by analysing existing DAS. Ideas were then aligned to derive abstract levels and hierarchies and search for additional elements. Finally, functions were clustered in three categories (Figure 4).

Advise/Recommendation	Inform/Information	Configure/Setting
recommendation to coast	inform about next advice	setting: set brightness
recommendation to reduce speed	inform about inability to advise	setting: go to menu
recommendation to keep speed	inform about next station	setting: show version info
recommendation to increase speed	inform about km-posts	setting: end run
recommendation for a certain speed	inform about topography	setting: insert delay attribution
alert driver of recommendation change	inform about speed limits	setting: hide advice/information
	inform about time schedule	
	inform about estimated arrival	
	inform about estimated departure	
	inform about real time	
	inform about BO-messages	

1	inform about next advice
2	inform about next station
3	inform about km-posts
4	inform about topography
5	inform about speed limits
6	inform about time schedule
7	inform about estimated arrival
8	inform about estimated departure
9	inform about real time
10	inform about BO-messages

Figure 4. Selected DAS functions

3.2.3 Use Cases

Temporal aspects of interaction are addressed in the “use case” domain. Circumstances before, during and after usage of DAS, which could influence UX, were collected in cognitive walkthroughs (Polson et al., 1992). At the beginning, all aspects were listed and structured in a morphological case. Then, selection criteria were defined to eliminate the use cases: aspects concerning drivers were not further considered here, but were included in the “user” domain. Furthermore, only use cases, which could be automatically detected by DAS were selected.

Train status	Keeping speed	Speed changes	Hold	Reaching station	Leaving station
State of DAS	No signal, no advice	No compliance	New B.O. message		
State of driver	Driver does not know track	Driver knows track very well	Driver with no experience	Very skilled driver	Driver stressed
Environment	Night	Day	Tunnel	Bad visibility/ Bad weather conditions	High solar irradiation
Schedule/ Track status	Delay	No buffers	Temporal speed limit	Speed limit	Frequent stops
	Unrecoverable delay	Disrupted run	Long distances between stops		
DAS integration	Trial phase	DAS unknown	DAS used for long time	DAS evaluated for first time	DAS evaluated (driver interested)
Drivers' acceptance	Driver trusts DAS	Driver sceptic towards DAS	Driver does not want to use DAS	Driver not interested in DAS	Driver resisting use of DAS

1	reaching / leaving a station
2	halt
3	new BO message
4	no compliance
5	no signal / no advice
6	disrupted run / delay
7	long distance between stops / keeping speed for long time
8	frequent stops
9	no buffers
10	unrecoverable delay
11	many speed changes
12	bad visibility (night / tunnel / bad weather conditions)

Figure 5. Collecting use cases (left: full list; right: selected use cases)

3.2.4 Users

Although not being the only users of DAS, just drivers were considered in our study, as key stakeholders to the product´s success. Drivers’ characteristics collected in the morphological case were further analysed and two “extreme” archetypes could be identified: drivers with no or little experience, who are rather thankful and positive towards DAS and advanced drivers, who are sceptical or even negative towards DAS. Of course, there are many further driver types in this spectrum.

3.3 Setting the frame and defining relevant matrices

After a primary analysis of UX-related elements, the basic meta-model was adjusted (Figure 2, middle and right): only functions, motives and use cases were further considered and according relations were rephrased. The domain “user” would have been interesting if more possible user groups were considered –which was not the focus of this study. Relevant needs had been defined, but further consideration of this domain would make sense at the point of concept evaluation.

3.4 Determining dependencies

In the next step, relations were identified in each of the selected matrices: “[function] is helpful when [motive]”, “[function] is used in [use case]”, “[motive] should be considered in [use case]” and “[use case] calls for same functions as [use case]”. Matrices were filled by the authors and differences were discussed. Extended workshops with experts were not possible in the limited time frame. But since one of the researchers has expertise in UXD for more than 3 years and the other can be considered a product expert because of his previous working experience with DAS, this limitation was acceptable. Results were documented and matrices were imported in LOOMEO for further analysis. Matrices were all binary.

3.4.1 First level analysis

Analysis of the multiple domain matrix (MDM) “[function] is used in [use case]” provided interesting insights. Taking a closer look at functions, one can identify **functions used in every use** case, like “inform about time schedule”, and uncommon **functions that appear only in specific use cases**, like “inform about topography”. Taking a closer look at use cases, one can identify **use cases that call for all functions**, like “many speed changes”, and **use cases that call for the same or similar functions**, like “leaving station” and “frequent stops”. This first-level analysis inspired the next steps: Functions used in every use case should always be visible. Uncommon functions that are relevant only in specific situations can be “hidden” during irrelevant use cases. A meaningful next step towards designing for less perceived complexity is therefore to proceed with a use case-based integration. Use cases calling for all functions should be identified to avoid a possible cognitive overload for the driver. Use cases calling for same or similar functions could be represented by the same interface ordering. The new interface concept presented in 4.2 based on this approach.

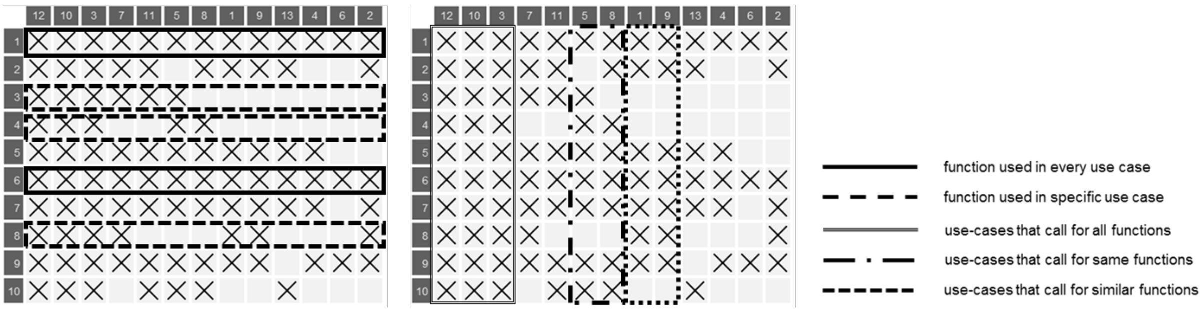

Figure 6. First level analysis of MDM "[function] is used in [use case]"

3.4.2 Second level analysis

The second-level analysis aimed at confirming if the conceptualized approach is applicable, looking for inconsistencies in the matrices, as well as gaining further insights. It was also important to carve out, which use-cases can actually be automatically detected. Insights at that point were (among others): influence of the motive "driver does not want to be evaluated" and special possibilities for the use-case "halt". Then, a second round of matrix analysis was performed with focus on the adjusted MDM "[function] is used in [use case]". An important result is that there are two further functions relevant in every use case ("inform about real time", "inform about estimated arrival"). Functions always relevant were removed and only the resulted MDM was further considered.

4 RESULTS

4.1 Applying the method on Graphical Interfaces

The analysed product is a graphical interface. Because of special characteristics of such interfaces adjustments of the method were required (Table 1: methodological proceeding).
Information as Function: Aim of DAS is to inform drivers and enable some settings, not fulfil a technical function in classical terms. Relations in the meta-model had to be adjusted, like the relation "is mutually exclusive with". The first step of the methodology encourages adjustments to provide further possibilities. Problematic, however, was to differentiate functions. During the analysis, some elements (e.g. *"inform about time schedule"*) had to be rephrased.
Alterability of Graphical Interfaces: Elements of graphical interfaces can be changed and scaled almost endlessly. Depicted information can change any time and be provided at altering times. The challenge of providing the right information at right time was addressed by a use-case-based approach. Differentiation of information ("always required", "sometimes required", "always available but not important") seems common for graphical interfaces and was an early result of the method.

Table 1. Proceeding in the DAS-case study (left) and insights (right)

Adjust meta-model: The basic meta-model was used as basis for the analysis. The domains "need" and "user" were not further considered.	A further adjustment of the meta-model was needed during the analysis.
Enter elements: Elements of domains "function", "motive", and "use-case" were defined. Functions, derived from cognitive walkthroughs were divided into three groups: recommendations; information; settings. Only information was analyzed in matrices. Motives and use-cases were derived from online research (blogs from users, interviews with users) and authors' experience.	Definition of functions should be conducted carefully. Functions should be as differentiated as possible. For better results, interviews or workshops should be considered, depending on the particularities of the each product.
Define relations: Dependencies in the function-motive DMM and the motive-use-case DMM were defined by the authors. The altered relations allow an easy-to-acquire definition of the dependencies. The function-use-case DMM and the use-case DSM were computed. Both matrices were analyzed to identify which functions are adequate to combine, and which functions are	While conducting the analysis, insights, special characteristics, and ideas for elements were documented. Those were implemented accordingly. Two rounds of analysis were conducted: one with the matrices as they were computed and one with a scrutinized and

required in the different use-cases. Use-cases which required a similar set of functions led to a single display.	slightly altered matrix. Scrutinizing the computed matrix led to further insights.
Select approach to cluster: A use-case based approach was selected, since it was clear from the analysis that main cause of DAS complexity is that all information is present continuously, though unnecessary.	Matrix analysis led to the idea of creating use-case based interfaces.
Create interface concepts: A basic interface concept was created: Recommendations and always-visible-information were combined into a constant part of display. Remaining information was organized in a tab-system that is dependent on current use-case.	Recurring elements were used in different displays to avoid confusion of an altering interface.

To analyse graphical interfaces, following steps (not utilized in this study) can also be executed: (1) The function DSM can be computed indirectly and utilized to identify functions that are required often together. This is especially useful if a higher number of functions is analyzed. (2) The motive DSM can be used for a better understanding and differentiation of the motives. (3) The function-need DMM is useful for the evaluation of the interface. (4) The motive-need DMM shows which needs are most relevant and should be considered for UX evaluation. Matrices can be used to determine, which additional functions should be introduced to address neglected motives or needs. (5) A differentiation of more users can be useful in the case of more stakeholders.

4.2 New Interface Concept for DAS

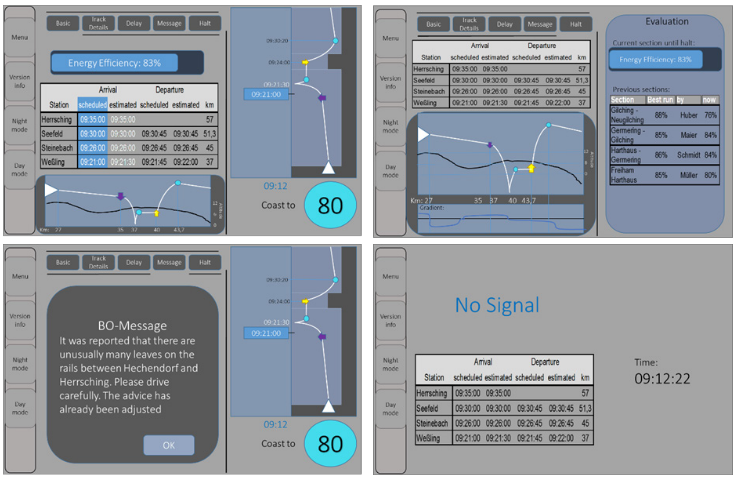

Figure 7. New interfaces (from top left, clockwise: basic, track details, message, halt)

The new interface consists of 3 areas: planning area (right), information area (middle) and setting area (left). Analysis showed that there 3 function types: (1) functions present at all times; (2) functions relevant only in particular use cases; (3) functions relevant at any time, but not very present on the display. Functions *build* elements that *are arranged* in tabs. Functions of type (1) were integrated into the planning area, which is always visible and includes recommendations and time/speed information. Functions of type (2) were integrated into the information area, which is organized in 5 tabs changing according to the use case detected or manually selected. Functions of type (3) were integrated into the setting area, a small but always present part of the display.

Table 2. Information area concept

Area /*Tab*	**Use case**	**Elements (corr. functions)**	**Comment**
Planning	Always visible	current recommendation	Recommendations indicated as colored arrows: coast to 80 km/h, retard to 60 km/h, accelerate to 90 km/h.
		speed profile incl. next recommendation	Next recommendation, derived from speed profile, depicted as symbol in speed curve.
		time-area	Integrated elements: time schedule, ETA, real time: The bar on the left depicts scheduled arrival time and ETA. Speed profile is plotted on km-axis. Actual arrival time-ETA-distance corresponds to delay.
Information/ *Basic*	12, 10	schedule, topography, evaluation element	Evaluation element is introduced to increase stimulation and give a live-evaluation of energy efficiency in reference to a calculated optimum.
Information/ *Track details*	5, 8	next stop, topography, km-posts	Use-cases requiring information about topography also require information about km-posts, so that drivers know when topography changes and connections of topography-efficiency (e.g. efficient to coast when driving uphill).
Information/ *Delay*	7, 11	speed limits, next station, back office-message	
Information/ *Message*	4	back-office message	Appears also in special situations (2.2.1) and is active until driver's confirmation.
Information/ *Halt*	3 (≠1)	schedule, topography, evaluation element, ranking	Appears only if hold is not near station; evaluation and ranking elements are introduced to increase stimulation.
Information/ *No signal*	6	schedule	Estimated departure time was helpful in some use-cases and ETA is most helpful if put in comparison to scheduled arrival time.
Settings	Always visible	menu, version information, night mode, day mode	

4.3 Discussion of results: Insights on applicability of the method

The matrix-based method of Michailidou et al. (2013) was applied in an exemplary project concerning DAS improvement. Because of project-specific characteristics, various **adjustments** in the proceeding were necessary. The basic MDM had to be adjusted in at least two iterations. Even with few matrices in focus a benefit could be achieved. The acquisition of motives was performed based on customer reviews, which provided adequate input to proceed. Since DAS are actually information systems, in the domain "function" information elements were considered. A new step in the proceeding was added, because setting a specific frame was necessary to achieve useful results in limited time. The involvement of experts could be limited to a person with good knowledge of the technical system and a person with expertise in UXD. Finally, matrix analysis and interface design proved to be a highly iterative process. We believe that despite those iterations the method is applicable in resource-limited projects and can offer a benefit for the product category of working tools and/or information systems. **Advantages** of the method became obvious: The controlled definition and compilation of elements enabled a well-regulated process considering UX principles and user-related domains. The process of defining functions was fruitful: the differentiation of recommendations, information, and settings arose from that process and led to interface concept ideas. The concept that was specified throughout further appliance of the method is feasible and coherent with all requirements and use-cases. Possibilities for further analysis were revealed, like for evaluation of interface concepts. In summary, the method allowed a controlled process for increasing UX and creating a new interface concept. The concept seems highly adequate for managing complexity. **Difficulties** appeared, but could be handled within the methodology. Defining a project-specific frame (3.3) was critical. Applying the method for first time on a new product requires a flexible application. Meanwhile, the definition of elements and their dependencies requires a concept, in which elements would be implemented. Resources were limited and no interrogation of users was possible, since DAS are available only business-to-business. The author was familiar with the product, but not involved in its development. At some points, more effort could have provided better results; for example definition of motives and addition of new functions were limited. Another difficulty arose from the nature of product and its customers: Different rail operators have different requirements regarding standardization and safety (for example some operators do not allow displaying the planning area for safety reasons), so the new interface is not adequate for every customer. Still, analysis can be repeated for changing requirements. After analysis is conducted once, most elements and dependencies remain. Additions and adjustments can be implemented without much effort. So the method provides an easy way to create customer specific interfaces that fit customer's needs and requirements.

5 CONCLUSION AND FUTURE WORK

This work aimed at the application of a matrix-based method for managing UX-related complexity. The method had only been applied on one case study before and despite considered applicable for any product, it was to be clarified how exactly it could work in another project. The product analysed (rail DAS) is complex and already proven in praxis. UX is of special interest for those complex working tools. Improvements are not self-evident and can be considered a success. The method was adjusted to fit the specific and resources-limited project frame and the special characteristics of graphical interfaces, with the goal to create less complex DAS concepts and thus improve drivers' experience and acceptance. Method appliance required a detailed analysis of the state of the art. Appliance was conducted using LOOMEO for matrix analysis. According to limitations and characteristics of the product, an adjusted MDM was created. Matrices adequate for the analysis were chosen and elements and dependencies acquired were defined. It appeared to be necessary to clarify the analysis frame, which led to a basic interface concept. The concept was a result of insights gained while depicting the system and of a motive-based and use-case-based approach: Functions were assigned to motives with the regarding DMM and motives were assigned to use-cases in another DMM. An indirect function-use-case DMM was generated and analysed to define which functions were relevant in which use-case. Further analysis defined functions which could be combined. Two rounds of analysis were conducted. Throughout the analysis constrains concerning safety and other matters of rail business were respected. Method appliance led to three results: (1) an adapted methodological proceeding, viable for creating innovative interface concepts for informative graphical interfaces; (2) an evaluation of the method as applicable for utilization on the introduced product; (3) a new concept for rail DAS interfaces which displays information right when required, under consideration of UXD principles. Many possibilities for analysis were considered, but only some were used for the actual analysis. Further approaches (presented in 4.1) could be tested in future studies. The method was adjusted to the requirements of graphical interfaces: it could be tested, if this proceeding is viable in other interfaces. Analysis was conducted only by the authors and an assessment was not possible: it could be tested, how different the results would have been, if analysis had been conducted by a team of developers. Furthermore, the new interface could be further developed and evaluated. Despite limitations, applying the method with limited resources is worthwhile. The analysts gained a new view on the system; especially the differentiation of use-cases provided a point of view which is not respected in current DAS interface concepts. Thus, from our point of view, the method is a viable tool for either a single developer or a small team of developers assigned to design new interface concepts.

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