The HMI development
at TES Electronic Solutions

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Introduction

Complexity and functionality of technical systems are steadily growing. So for example almost every electronic system contains a clock, since it is comparably cheap to implement. In every spring and every fall you experience an extra task load by switching to daylight saving time and back. Size and weight of electronic components get smaller over time, so we experience ubiquitous computing. Even your electric tooth brush contains a processor with some 1000s of lines of code. Wireless data transfer allows the communication between various systems with control and knowledge of the user.

Technologies enable new ways of communication in the office, at home or in the car. Target of every technology should be a safer, better, easier, or even only funnier life. The design of the human machine interface (HMI) is critical for success and acceptance of products and technologies. Graphic design, product design, menu structure and interaction process have to be synchronized with tasks, environments, and user groups. Target is to allow the safe and easy use of technology.

In most cases the arenas of human factors, graphic design and product design are distinguished. Work in the mentioned areas is performed by different people with different backgrounds, educations, tools, and processes.

With its HMI activities TES support customers in the development of and realization of various products. This includes the cognition of the product, the interaction with it and the appearance. TES offers a complete service from first ideas to final products. First analyses of existing solutions are followed by the creation of sketches and testing of ideas by using established and latest technologies and methods. With our team of experienced graphic designers, product designers, psychologists and engineers we roll out the concepts, write specifications and style-guides to allow the implementation of the HMI solution.
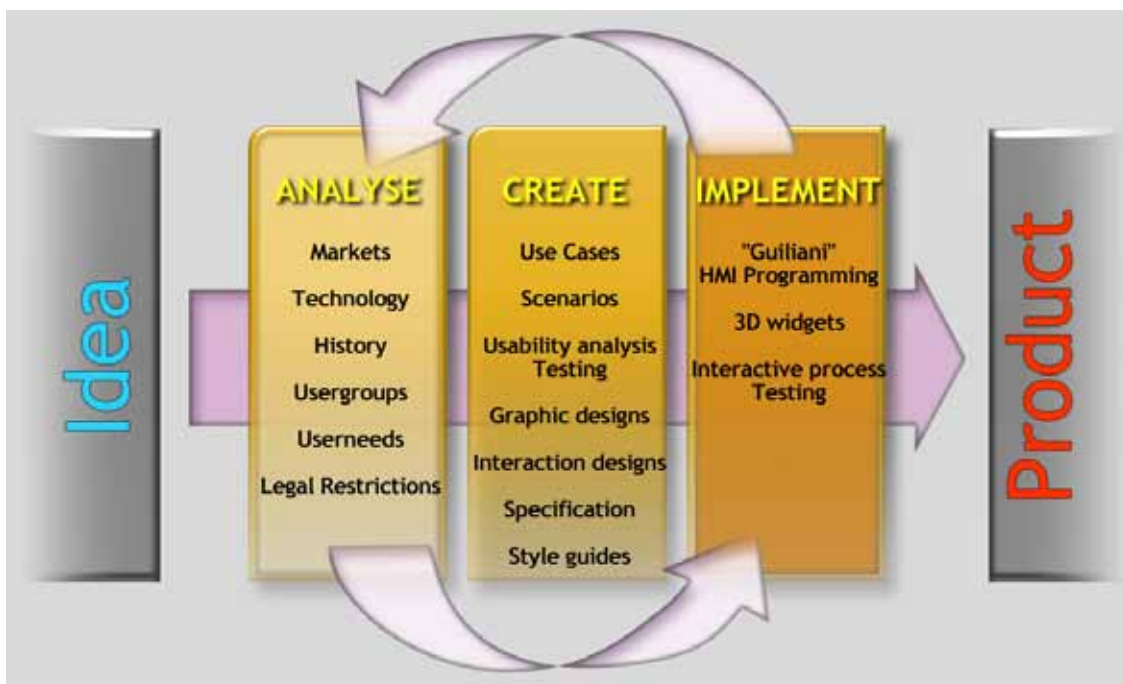

Fig. 1: Produktentwicklungs Prozess

The Cause of HMI Problems

During evolution the human was fitted perfectly for a live in the grass lands and woods of central Africa. An environment hardly anyone lives in today. Today's world is highly pervaded by technology, which moves it into a stage, where our genetic setting is not appropriate anymore. Humans move too fast, sit too much, and experience a far too high amount of information.

Products are often developed along technological guidelines, leaving humans with their specific needs, capabilities, and preferences out. The user is, if at all, only involved in late stages of the development process.

Usability

Usability deals with the ease of use of a product or a technology. Most in focus is the interaction design. This is more static elements like menu structures or menu trees, and more dynamic components like processes and procedures.

Graphic design and product design develop screens, input devices and housings. This includes contrasts, font sizes, the fit between the screen (colors, shapes) and its environment, the design of geographical maps, media information and other information to be displayed; but also the look & feel of a product, materials and components. In a number of rounds experts develop concepts based on use case scenarios and mental models. Analytical methods like cognitive walk-throughs are used to improve the initial concepts.

Legislation may influence the design of an HMI. In automotive context the AAM regulation on driver distraction and the European ESoP play a vital role. Others are standards like ISO 15008/9. Core is the usability testing of an HMI solution. A wide range of tools and methods exist, from complex tools like eye movement analysis or driving simulators down to standardized questionnaires. In listening labs users talk about their experience with technologies after using them.

Usability studies may be held at the very beginning of the development process, for examples as a focus group with relevant customer groups or internal stakeholders. During early phases paper & pencil prototypes may be appropriate. Later on digital prototypes and developmental drops may serve as test material. Late usability studies will be used for latest fine tuning and generation products. TES offers the complete portfolio of services.

User Experience

User experience the part of the HMI development dealing with emotional connotation between technology and user. Target is to design a system that allows the user to build a positive emotional relationship with. This is usually described with expressions like "cool" or "wow-factor". Here the graphics design and the product design is in focus. The use of materials like glass or metal in the screen design may create a high value look and feel. Animated icons and screen changes influence the emotional acceptance of systems.

The analysis and measurement of user experience uses similar processes as the usability. Tools like a semantic differential are included in usability studies. In a first round various versions of a screen design are created. In follow up rounds one design is selected for realization. During the roll-out phase all graphics are created and prepared for the integration into a development tool chain like GUIiani. Style-guides are created if required.

Driver Distraction

The issue of driver distraction is very much in the focus of users and the public. Already short distractions from the traffic flow may lead to critical situations. Not only visual distraction, meaning "taking the eyes off the road", but in particular mental distraction carries a large potential of danger. Mental distraction means, that the driver looks at the road, but does not see the required information, since his neuronal network is busy solving other issues. This may for example happen during a voice input or while memorizing a phone number.

HMIs for vehicles have to be designed in a way that the driver distraction is as low as somehow possible. International standards regulate the design of a vehicle HMI. For Europe the ESoP (*European Statement of Principles*) was developed and published. It describes on a more or less generic level how to design an infotainment HMI. The US-American standard of the AAM (*Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems*) describes, besides the generic rules, a procedure of measuring HMI quality by means of driver distraction.

An HMI design that keeps the needs and the capabilities of the driver in mind will reduce driver distraction. This includes screen design, interaction design and multimodality. The results of an AAM study will indicate which functions need to be blocked while a vehicle is on the move.

Cross Cultural Usability

Culture describes a set of learned values and behaviors. In addition to cultures gained by a common interest (biker's culture, soccer culture, …), regional cultures have a strong influence on cognition, use and rating of technology. To serve different user scenarios, it may be worth to develop own HMI solutions for various regions. This includes language, units, reading direction, but also the use of color and symbols.

Criteria of HMI Design

The development of HMIs requires a set of criteria based on scientific research.

To balance an HMI means to level it with internal and external requirements. External balance is the fit between user group, environment, use cases, and cultural background. Internal balance means a good fit between input procedures, systems outputs and the interaction design.

Consistency is the similarity with-in an HMI and with other HMIs known by the user. Internal consistency leads to a re-use of knowledge gained with-in the HMI, for example general HMI principles or BACK-concept always working the same way. External consistency re-uses experiences, symbols or interaction principles known from other technologies.

An HMI needs to be as simple as possible. Simplicity gives the user the feeling of control over the system. Simply reducing feature, functions or the number of input devices does not necessarily lead to simplicity.

A technology and an HMI need to deliver as much usefulness as possible to the user. Users usually pay for a system, money as well as time and mental effort. The perceived value of a technology needs to be larger than the perceived invest done.

Systems should allow personalization. The HMI should allow reflecting personal needs, preferences, and expectations. This may be the selection of a personal color scheme, links to often used sub-functions or the creation of a favorites' list. Sometimes it is useful to create different HMI solutions for different user groups.
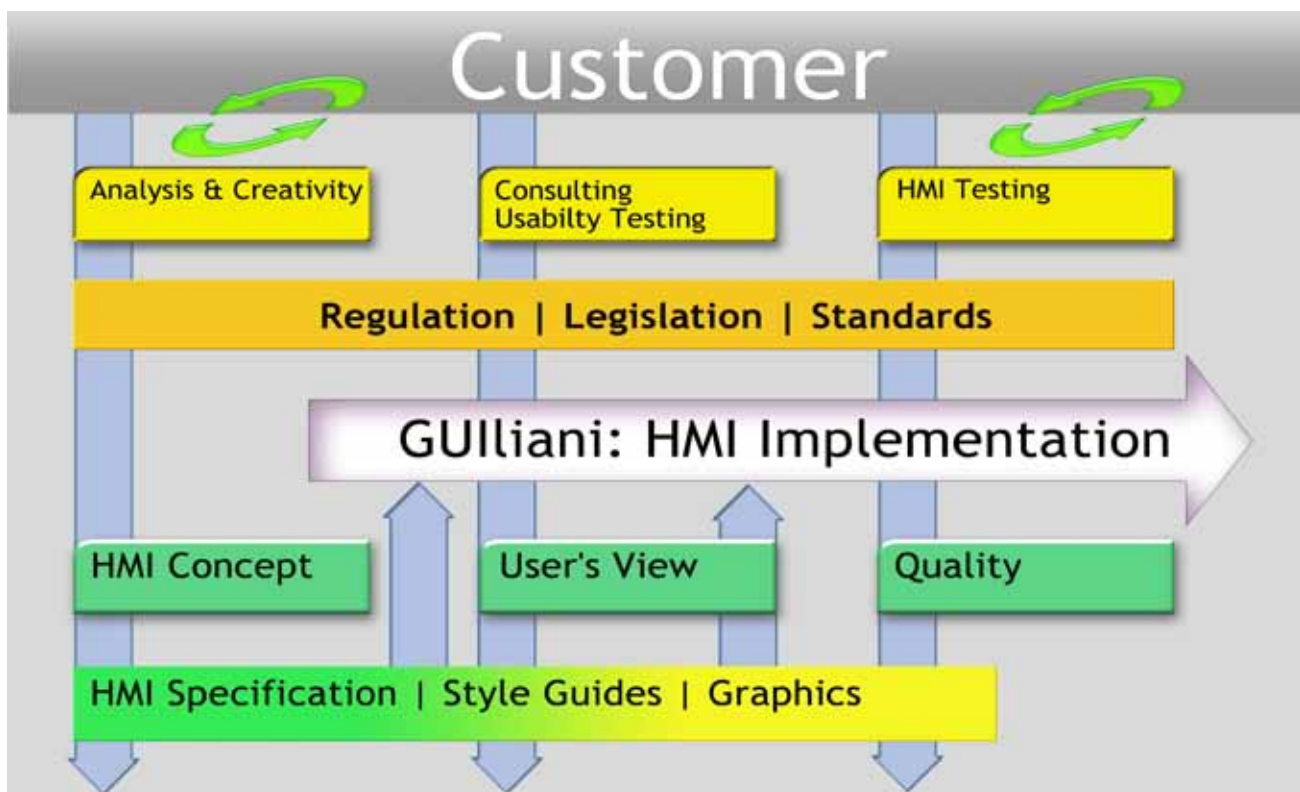

Fig. 2: Prozess HMI Erstellung

The HMI Process

The new development of an HMI start at TES always with an analysis of the situation as is. System requirements, functionality, markets and user groups just as well as the history of a customer are in focus. Predecessors and their weak and their strong points are analyzed just like benchmark systems and technologies from other domains. This leads to an initial concept. During a row of loops this is then turned into a final concept. At the end specifications and style-guide are created.

These serve as the basis for the implementation of the concept. At TES we developed the GUIliani tool for programming an HMI. But other tools may be used as well. During the implementation usability analysis and studies are performed. The results will lead to additional improvements of the HMI.

TES HMI Portfolio

The team members of the HMI group represent many years of experience in designing, testing, specifying, and implementing HMI solutions. HMI solutions where realized for a high number of worldwide selling companies.

Das HMI Portfolio of TES contains:

- Analysis and benchmarks, customer and user analysis, international and cross cultural studies
- Creation of HMI concepts and solutions
- Development and validation of HMI concepts
  - Development of use cases, scenarios, and personas
  - Menu trees, processes, procedures
  - Graphic design, product design, industrial design
  - Implementation of input devices and output devices
- Development of HMI solutions for various user groups, cross cultural HMI design
- Creating and maintaining specifications and style-guides
- Preparation of graphics for implementation in an HMI tooling
- Usability analysis and studies
- Process guidance during HMI implementation
- Implementation of the HMI with GUIliani or another HMI tooling

Literature

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