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Ergonomics and automation – safe manipulation of complex systems

Modern agricultural machines are growing in their performance and functionalities. Higher power classes result in bigger machine dimensions. Applications like guiding systems become more and more standard of modern agricultural machines. The growing complexity forces agricultural equipment manufacturers to think about the ergonomics and safety of machine control. To reduce the control elements in the cabin the functional range must increase in operation terminals.

Keywords

Human-machine-interface, operating concept, efficiency increase

Abstract

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■ Ergonomics deals with the regularity of work. Its main goal is to produce manageable goods which are easy to use. Aside from the improvement of human - machine - interface the focus is on human adequate design of working systems. A human - machine - interface is usually found where humans work with machines. Work, is therefore understood as a target-oriented act. The basis is task formulations and their fulfilments.

Human - machine - interfaces are found in all areas of life. The user of a system like this is able to operate with machines. He can observe conditions of the machine and, if necessary, is able to stop the process. The following characteristics are typical:

- The human being pursues certain goals.
- There is information exchange.
- The exchange is mutual. The human participates actively and is always able to interfere.
- The information exchange is conveyed, the user enters via an operating element (switch, control)

When ergonomically designing the human-machine-interface, the functional distribution between human and machine has to be especially considered. At first, it is easy enough to implement this. All procedures which can be automated are performed by machines. Processes which cannot be automated are still controlled by humans. The risk involved observing automated processes is that the human is not challenged enough. This under- challenge can turn into excessive demand in case of the machine's breakdown [1].

Operating concepts

During the development process of the tractor new functions which required additional manual control elements such as mechanical levers and buttons have been introduced.

With the introduction of the electronical hydraulic valve or the automatic headland management, the limit of simple levers and control was reached.

As the first tractor producer, Fendt presented the operating terminal as a standard in 1997. Today, modern tractors can not be imagined without terminals. The task range of tractors has been growing constantly since then. Most new applications required another display, thus the number of displays in the cabin increased. Up to three terminals in one cabin are not uncommon: one for the control of the tractor, one for the auto-guide, and one for the control of the accessory equipment.

The position of displays varies from cabin to cabin: at the armrest, at the A-cabin pillar, at the side window, instead of the integration of the instrument cluster in front of the steering wheel or in the side consol. Terminals differentiate in operating strategies. They can be managed with buttons directly on the display or somewhere else in the cabin. More and more terminals can be operated as a touch screen. A combination of buttons and touch screen is possible as well.

Numbers are being adjusted over the turning wheel. If touch screen is available, number changes are also possible through a scroll window or through virtual number fields.

Terminal users have often requested an intuitive, easy, and logical operating system. Above all, there is to be an operating strategy for all applications. This is hardly found at the moment because the terminals are manufactured by different producers and each of them has worked out their very own operating philosophy. Therefore, it is not clearly defined what action or setting is implemented when a button is pressed at the terminal. Some terminals show the current setting. If a button is used, this function is being deactivated. With other terminals this is different, e.g. a button shows the status one is about to enter when pressing it. It is even possible that different operating logics are used in the same terminals. The use of different terminals with different operating logics in the same vehicle is a safety risk. A display showing the activated status as well as the deactivated one would improve this. This improvement can be reached with virtual rocker switches. Both possible conditions are displayed but the currently active status is explicitly marked.

A further step towards safe operating development is the integration of multiple applications into only a single terminal. This would save costs and could consequently be implemented into one operating strategy for all applications. Adjusting between different systems would no longer be necessary. The best location for terminals is at the armrest. There, relative movements between driver and the operating element cannot occur. Tractor manufacturers go more and more over to install the whole operating system at the right armrest. There, the terminal is placed at the ergonomically best location because it no longer requires necessarily another operating location. The terminal is always in sight and even when driving backwards easy to use.

Due to the cancellation between the application and the operating element it is not always possible to show the condition at any time. However, multiple applications can be seen at the same time if the display is divided into areas. Up to four applications are visible if the display is arranged e.g. into quadrants. The driver chooses the best display arrangement for him and his work. If only one terminal instead of multiple ones is used, the driver has a better all-round visibility and higher safety. The cabin is not spoiled with several terminals anymore.

In case of a multiple-terminal-strategy the applications work independently from each other. Settings are saved separately in each terminal. Therefore, if there is an implement change, special settings have to be loaded individually. Applications that are integrated into one terminal can be saved and loaded through a central system that carries out these functions.

The touch screen technology allows significantly a more intuitive manipulating system than traditional input helper ever has (**figure 1**). He has the opportunity to enter directly there where it is obvious. And he does not need to make the logical connection between the display and manipulating element. Nowadays, many people tend to touch a display without knowing whether it is a touch screen method or not. Finger prints on display screens such as ATM clearly show that.

During a customer workshop at the AGCO company, twelve people were confronted with the new "Fendt Vario Terminal 10.4". They were to change settings within the tractor manipulation without having seen the terminal before or without having been explained how the terminal worked. Ten out of twelve people used the touch manipulation for navigating and only two of them used the navigation buttons next to the display occasionally. A very safe and intuitive manipulation can be reached



Fig. 1

Armrest with the new Fendt Varioterminal 10.4" as an example for a manipulation with touchscreen and navigation buttons. Photo: Fendt

with very clear and understandable symbols. The user can always directly choose between the functions on the side of the menu, the complexity of the menu structure can be considerably reduced and is thus more clearly arranged. It is much easier for the user to work with a manipulation structure if functions of similar activities are grouped together. At all hours, he knows where he currently is in the navigation system.

Increase in efficiency through optimized ergonomics and automation

A big step in the tractor's automation techniques was reached through the automatic steering system. The driver has to use most parts of his concentration for steering the machine when driving pass-to-pass without a steering system. Doing that, he has less attention for controlling the accessory equipment. The steering system helps especially by poor visibility such as fog, dust formation or at night time the driver can use the working width and be relieved. The driver can use all his concentration for optimizing the implement with the result that working quality is being increased. A steering wheel system can help to save operating material. In the literature one says that 7-10 % of costs can be saved with less operating materials, increasing performance and improved working quality.

With the use of cameras whose images are shown in the terminal as well, there is a chance that working quality and productivity can be increased. The driver can overlook areas he can not see from his driver seat and therefore is able to interfere early enough if a parameter has to be adjusted or a threat of the machine's defective function is occurring.

Optimized ergonomics reduce the tiredness of drivers. He does less unnatural movements and the risk of illness and thus loss of working hours can be reduced.

Conclusions

Terminals have been established as a central element in the cabin because a modern tractor has several setting and manipulation opportunities. These are getting more and more installed at the armrest where the rest of the tractor's manipulating is also found. Having all setting at the armrest is a great advantage because ergonomically it is always located in the same position of the driver, whether he is turning his seat or driving backwards.

Touch screens provide a clear and a goal-oriented manipulation. Today, displays using the resistive principle are most common. With these, only one point of contact can be measured.

In the future, displays with capacity technology will be used in agriculture once they are in greater dimensions. They are introduced as "Multi touch" which means that there are several points of contact on the screen. A popular example is the Apple iPhone.

In general, customers would like to have only one terminal in the cabin. This requires the integration of all applications into one display. That way, there would be the possibility to

get a unified manipulation logic. For a safe use, the surface has to be intuitive, clearly structured and has to have a quick loading time. The user chooses the terminal according to his needs of tractor use. For more complex applications the customer chooses a higher specialised terminal with a big display. A smaller display is sufficient for standard applications.

Support functions help the user understand the system from the beginning. The so-called driver-assistance-systems are going to support the driver with their setting opportunities in the future.

Literature

- [1] Groth, J.: Mensch-Maschine-Systeme. <http://user.cs.tu-berlin.de/~jag/hci/mms.html>, Zugriff am 05.12.2009

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Note

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