# *A Concept Proposal of a New Generation Operator Panels*

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## Abstract

How will the future human-machine interface (HMI) product in the industries look like? One common HMI product in industry is the operator panel. This article will give a short review of a Master Thesis which was about developing a concept proposal of a new generation operator panels.

The Master Thesis was done to inspire the product developers at *Beijer Electronics* with innovative ideas before their development of the new generation of operator panels.

More in detail, the project could be divided into three main parts:

- Generating a concept proposal
- Further development of the concept proposal
- Making a basis for a future input unit (HID) prototype for the generated proposal

## Introduction

This Master Thesis was done for *Beijer Electronics Products AB*. It is a multinational group with subsidiaries in 14 countries, over 600 employees and annualized sales of over 1 billion SEK.

Many of *Beijer Electronics*' costumers require that the panel should be customized to their specific needs, e.g. more buttons etc. Therefore one requirement for a new concept of operator panels is that the panel easily could be modified. The input buttons should be placed on separate "building blocks", so called HIDs (Human Interface Devices). Further, the costumer should be able to alter the input buttons' layout, e.g. a button should be possible to change in size, functionality and placement. It should be researched and described how a prototype of this configurable HID should be done, implementing capacitive touch technology.

## Operator Panels of Today

An operator panel is a tool for the human to control and get information from a machine or an industrial process. In a process the panel could for example be used for setting parameters or view important information.

Today there is a wide use of operator panels in different environments. You can find them in industries, workshops, building automation, marine and offshore applications.

The operator panel of today has similar appearance and functionality independent of manufacturer. One common appearance of an operator panel is to have a display surrounded by mechanical buttons in a casing of aluminum or plastic. The use of touch technology makes it possible to use the display itself for input. The buttons are then created in software and shown on the display. Some common operator panels are viewed in figure 1 and 2.

**Figure 1 – Beijer Electronics Exter series**
(www.beijerelectronics.com)

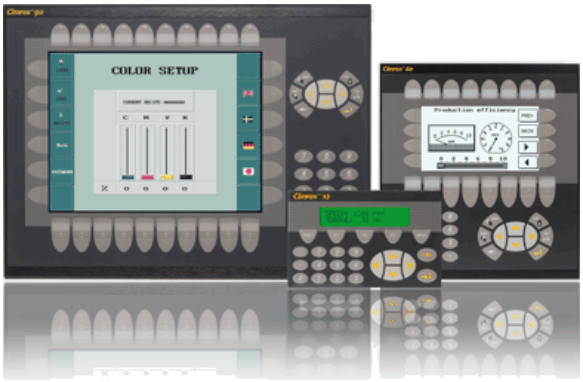


**Figure 2- Beijer Electronics CIMREX series**
(www.beijerelectronics.com)

## The Final Result of the Concept Generation and Further Improvement

In the first part of the project 26 concept proposals were generated through a development method developed by Ulrich and Eppinger. The result were evaluated by the project group and then presented for some representatives from Beijer Electronics. [1]

The representatives chose 2 concepts for further development. During the further development 3D models were created (See figure 3-5). The purpose of these 3D models was to show the principles and ideas. Details such as ventilation and electrical connections were not presented. A third concept (Concept 27) was developed during this phase deriving from one of the chosen concepts and was also presented as a 3D-model (See figure 5).

**Figure 3 - Concept 14**

In Concept 14 (See figure 3) the "building blocks", i.e. the input units (HID) and the display, are fixed in a frame and hidden behind a glass front. Because the frame is mounted in a rectangular hole in a wall the glass front is the only part that is protruding from the wall. The glass front isolates the components and leaves just a plane surface which easily could be cleaned.

**Figure 4 – Concept 13**

In concept 13 (See figure 4) the HIDs are placed in separate frames which are docked onto a

display unit. This concept enables the possibility of accessories, e.g. a remote control. Both the display unit and the input frames are mounted in rectangular holes in the wall.

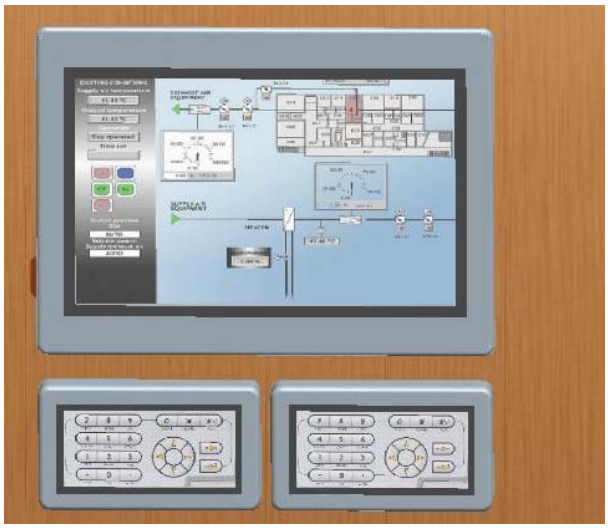

**Figure 5 – Concept 27**

In concept 27 (See figure 5) the HID units are placed in frames which are mounted on the surface of the wall with screws. The frame around the display unit is mounted into the wall and therefore requires a rectangular hole.

Materials and manufacturing methods were chosen for the new parts in the three remaining concepts. The software *CES EduPak 2008* was the source of information for the choice of material. Several property diagrams together with the opinions from external experts motivated why different materials and manufacturing methods best fulfilled the criterions.

The materials and manufacturing methods presented did not lead to any big surprises. The recommended material for the frames in the final concepts was die-casted aluminum like in the panels sold by Beijer Electronics today. The recommended material for operator panel windows was glass. Smaller details like the HID fixture and the component fixture were recommended to be moulded in plastic material.

## A Basis for a Future HID Prototype

In this project a HID is a unit where the input to an operator panel should be done. As said in the objective of the project the input should be done through detecting finger touch with capacitive touch technology. When a finger is close to a sensor its capacitance increases. Therefore it is possible for a microprocessor to interpret the sensor output and forward the detection to a host computer.

Nowadays capacitive touch technology is widely used, for example in the navigation buttons of mp3 players, cell phones and other applications where there is an advantage to replace mechanical buttons. The main advantage with capacitive technology is that no direct contact with the button is needed, i.e. the sensor does not get worn out.

To establish a basis for a future HID prototype the following was presented: guidelines for making a HID PCB, the theory of touch technology, tuning of a touch technology design and programming a HID.

While drawing up the guidelines for the PCB that should hold the HID functionality a schematic and CAD design of an example PCB were made. The layout that was used in the CAD design was presented as guidelines, such as sensor pattern, sensor sizes and trace lengths.

When the theory of touch technology was presented the most basic and important aspects were explained such as how a touch sensors work and how sensors are used to detect a finger's x and y coordinates on an area. A wiring diagram for a single sensor and a sensor pattern

for detecting x and y coordinates are shown in figure 6 and 7, respectively, below.

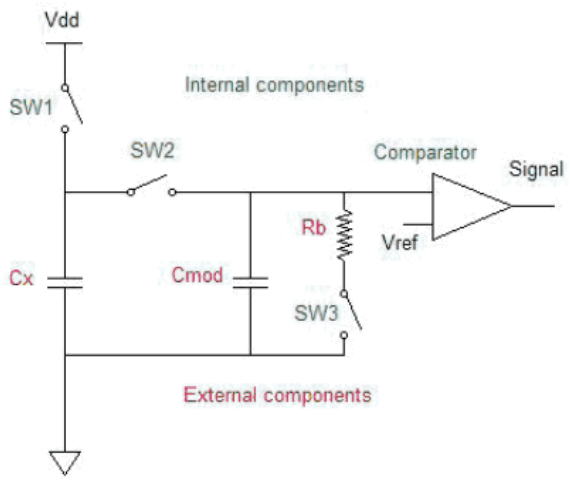


**Figure 6 – A wiring diagram for a sensor. $C_X$ is the capacitance of the sensor. The *Signal* is the input to the microprocessor.**

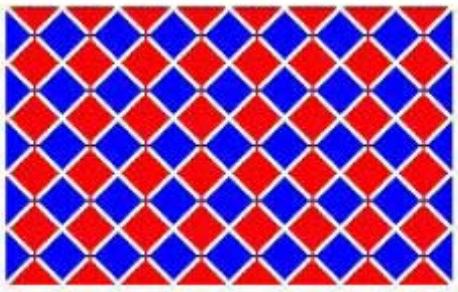

**Figure 7 – A sensor pattern for detecting x and y coordinates.**

In the part with the tuning of a HID design, the recommended tuning procedure, by the microprocessor manufacturer, was described in different steps. A laboratory experiment was done with an evaluation board supplied by Beijer Electronics. It was done to see how a tuning procedure should be done in a similar application as a future HID prototype and with a plastic and glass overlay. The board had a similar processor to the one recommended to use in the prototype and used the same touch technology. The experiment showed that the tuning procedure actually made the output from the microprocessor better. It also showed that it is hard to get a valid simulation because there are a lot of factors affecting the result, for example an air gap in between the sensors and the overlay.

To be able to get an idea about how a HID should be programmed a research about this was done. A chapter was then presented where it was described how the recommended microprocessor for the HID should be programmed. Then a laboratory experiment was done to see how a microprocessor, similar to the one recommended for the HID prototype, could communicate with a computer as a mouse or a keyboard do. The experiment was done with the same evaluation board as in the previous experiment. The experiment verified that it was possible for a HID to communicate as a mouse.

## Conclusions

Several new technologically innovative concepts were generated but many of them were soon rejected because of their use of new unreliable technology. Instead concepts with innovative mechanical design with the new input unit called HID were the most suitable for the future according the evaluation.

After evaluating the presented 3D models the project group consider concept 14 (See figure 3) and 27 (See figure 5) as the best for a possible future generation of operator panels. Concept 13 (See figure 4) could be used if a better docking principle would be developed.

In the project a proposal based on the principle to only use a big touchscreen was rejected. If a touchscreen as big as the front of concept 13 was used, input areas corresponding to 13's HIDs could be implemented in software, then the same functionality and appearance could be achieved. Therefore the project group

recommends *Beijer Electronics* to reconsider this concept because it would probably be cheaper to develop and manufacture than concept 13.

With the theory, PCB layout guidelines and practical experiments presented in this Master Thesis it should be possible to get a working prototype of a touchpad using capacitive touch technology.

There are not so many other factors to consider when designing the touchpad PCB compared to regular touch buttons or sliders. There is one important thing to remember that is hard to imagine when making tests on regular touch buttons, though. That is when designing a touchpad the overlay material has to be thinner compared to when designing buttons or sliders. [2]

## References

[1] Ulrich, K. T. and Eppinger, S. D. (2004). Product Design and Development.

[2] Löfgren, K and Nilsson, H (2009). A Concept Proposal of a New Generation Operator Panels.