Exploitation of New Technology in Facility Design of Hospital District of South Ostrobothnia

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HospiCaseY

Virtual environment (CAVE) as a tool for end-user participation in health facility design, a case study

Keywords: virtual environment, CAVE, end user participation, POE

HospiCaseY is part of the Spaces and Places 2008-2012 programme of the Finnish Funding Agency for Technology and Innovation.

In addition to the Hospital District of South Ostrobothnia project participants include the National Institute for Health and Welfare (THL), VTT Technical Research Centre of Finland, and Seinäjoki University of Applied Sciences, and the companies UKI Arkkitehdit, Kiinteistö Oy Seinäjoen Y-talo, Väinö Korpinen Oy and Philips Valaisimet Oy.

The computer-assisted virtual environment (CAVE) used in the project is a room comprising walls, a ceiling, and a floor. Images generated using computer graphics cards are projected onto these glass-surfaces, which, when viewed through stereoscopic glasses, are transformed into a three-dimensional full-scale environment. Surrounding the CAVE there is a larger, darkened room where the projectors are placed.

The project included models for three different hospital environments: 1) an examination room, 2) a patient room, and 3) spaces from an emergency centre. These environments were selected because hospitals regularly have multiple identical examination rooms and patient rooms. The emergency centre is a new kind of unit, and its design involved several functional issues.

Tools and methods

The end users visited the environment in small focus groups of 6–10 visitors on average. Each visit lasted for an hour. All conversations that took place in the virtual environment were recorded and video-taped. The visits were also photographed. After the visit, each visitor was asked to fill in a questionnaire.

The total number of visitors in the virtual environment was just over 250. The visitors included different kinds of hospital professionals, hospital administrators, construction professionals, representatives of a committee on accessibility, and architects.

The content analysis revealed a total of 14 primary themes. After a further content analysis, a total of 26 secondary themes were identified. The visitors made a total of almost 4,600 observations.

Figure 1: Virtual model of an examination room (image by UKI Arkkitehdit Ltd)

Figure 2: Virtual model of a patient room (image by UKI Arkkitehdit Ltd)

Figure 3: Virtual model of an emergency centre (image by UKI Arkkitehdit Ltd)

Conclusion

According to the questionnaire, more than 90% of the visitors agreed or completely agreed with the statement. Approximately 65% of the visitors found that the environment felt real, and 30% found that the environment felt almost real. A total of approximately 90% of the visitors considered commenting on the environment easy or relatively easy.

Valuable information was gained on situations assessing interaction between staff and patients, like interaction around the examination table in examination rooms, assisting patients around the bed and in the bathroom, monitoring of patients in the emergency centre and the access of patients' visitors to controlled areas and interaction upon the arrival and registration of patients at the emergency centre.

Useful comments were also received on other elements, like room attributes relating to cleaning and maintenance, accessibility requirements of different types of patient, complex processes such as the care of emergency patients and special considerations such as signs. On one hand, the fact that a lot of the comments focused on specific details illustrates that the visitors based their comments on earlier experience. On the other hand, the visitors were also able to imagine and assess the future operation of the facilities realistically, which would have been difficult on the basis of two-dimensional drawings.

The potential use of virtual environments at different stages of the design process offers exciting vistas. Layout alternatives for spaces that are repeated across the facility can be examined in the early stages of project planning and more complex spaces visualised. Different shapes and sizes of spaces and the functionality of the different options can be examined for the purposes of producing preliminary drawings. As the design process progresses, more and more details can be added. Different alternatives can be examined more realistically and more quickly than with traditional methods. Technological development can also enable more extensive use of virtual environments in the future. The equipment associated with virtual environments is already becoming increasingly advanced and compact, and future virtual environments may evolve into mobile solutions that can be adapted to different applications.

In addition to the virtual laboratory, the project also involved two other design tools that promote user participation: a system for managing user requirements and an online feedback system (POE).

HosPilot
Intelligent Energy Efficiency Control in Hospitals
-Pilot case Seinäjoki Hospital

keywords: *energy efficiency, ICT, HVAC, Lighting, Hospital*

HosPilot is CO-funded by the European Commission CIP ICT PSP - Contract number 238933 . Duration: March 2009 to February 2012 www.hospilot.eu

HosPilot background – In the complex environment of a hospital, Heating, Ventilating, Air-conditioning (HVAC) and Lighting account for nearly 80% af all energy use. The potential savings achievable with investments with a payback time less than seven years can reach up 40% depending on the current condition of the hospital, where HVAC and lighting are the major contributors. Half of it, being 20%, can be attributed to the impact of ICT.

HosPilot consortium: Philips Lighting (Netherlands), Philips Iberica S.A.U.(Spain), Acciona Infraestructuras S.A (Spain), Tecnalia – Labein (Spain), VTT Technical Research Centre (Finland), Centre Scientifique et Technique du Bâtiment, CSTB (France), Universitair MedischCentrum Groningen, UMCG (Netherlands), Servicio Riojano de Salud, SERIS (Spain), Granlund (Finland), Hospital District of South Osthrobotnia, EPSHP (Finland), Enoleo (Monaco)

The **ultimate goal** of HosPilot project is to support the decision makers with an integrated approach which helps drastically reduce the energy consumption of newly built hospitals and existing hospitals being refurbished, increasing well being and comfort.

The Pilot case of **Seinäjoki is one of the four pilots** in the project. In the Seinäjoki Hospital both Lighting and HVAC are in focus. For lighting the obtained results of the half of the floor with added state-of–the-art equipment, such as LED-tubes and presence detection, will be compared with the other half of the floor with conventional equipment. For HVAC the comparison will be carried out between selected rooms, some rooms equipped with state-of-the-art equipment, such as variable air volume ventilation and other with traditional equipment, such as thermostatic radiator valves, for example. Both electric and heating energy consumption will be measured and/or calculated from indirect measurements. The predicted energy consumption figures obtained from simulations in design phase are planned to be compared to the actual measured consumption data.

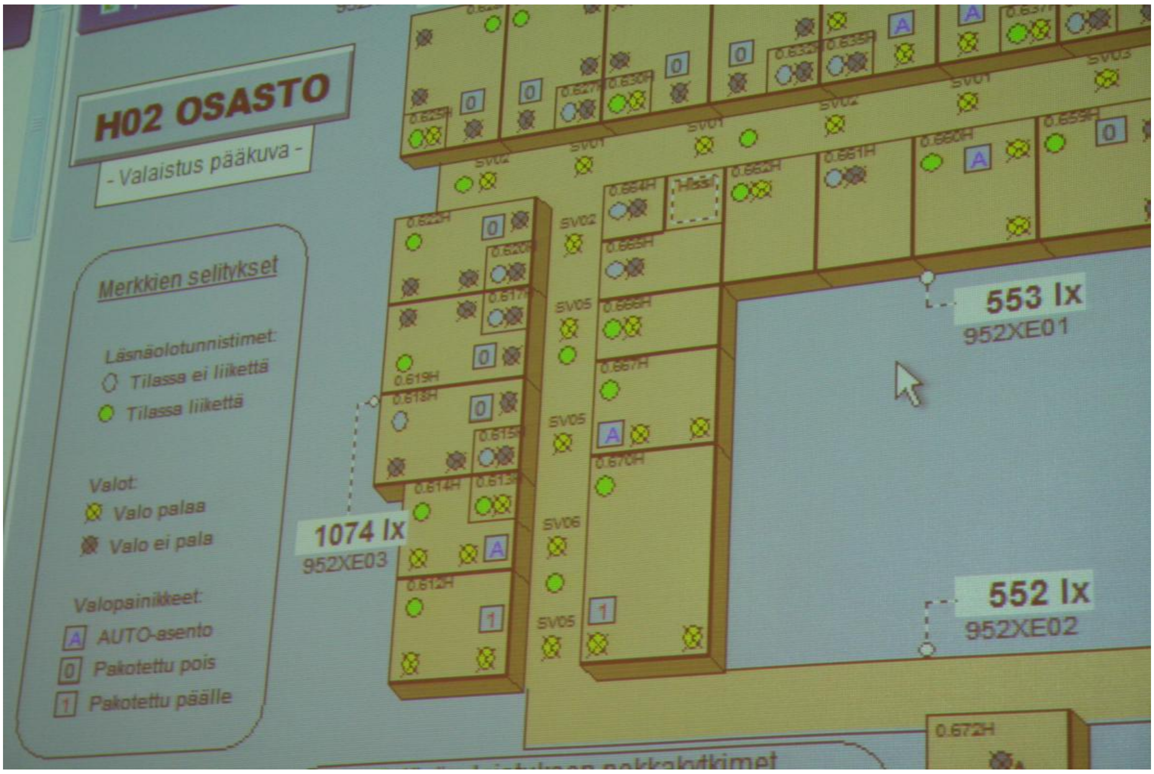
Energy efficiency in the EPSHP is **targeted** as “the same or more comfort with less energy” and not necessarily the lowest possible energy consumption. The final results will be therefore discussed in the terms of energy reduction related to physical variables with direct involvement in user comfort (light, temperature, temperature, etc.), what is the only correct and relevant way for measuring energy efficiency of such a system.

Method and measurement - Electricity

Lighting In the Seinäjoki Hospital both Lighting and HVAC are in focus. For lighting the results obtained from the half of the floor with added state-of–the-art equipment, such as LED-tubes, daylight and presence detection, will be compared with the other half of the floor with conventional equipment. Electrical energy consumption will be monitored.

The lights are controlled by DALI and connected to the hospital building automation system via LonWorks/DALI-gateways. The chosen solution enables gathering of measurement-, status- and consumption data from individual lights.

Controlling All controlling will be carried out with room controllers communicating over a field bus connected to the hospital building automation system via an IP network. Lighting controllers and user interface devices will share information over the field bus, such as room occupancy *status.* Wireless communication will be applied in door switches.



Picture 3 : TAC Vista 5 maintenance screen view including lighting information of the H2 floor “HosPilot“ part.

MEASUREMENTS - HVAC

The conventional HVAC solution consists of no air flow control at room level, heating control by thermostatic radiator valves, no room controller or connection to the building automation system. The solution is applicable for the majority of the rooms in this ward, (patient rooms, offices, rest areas etc).

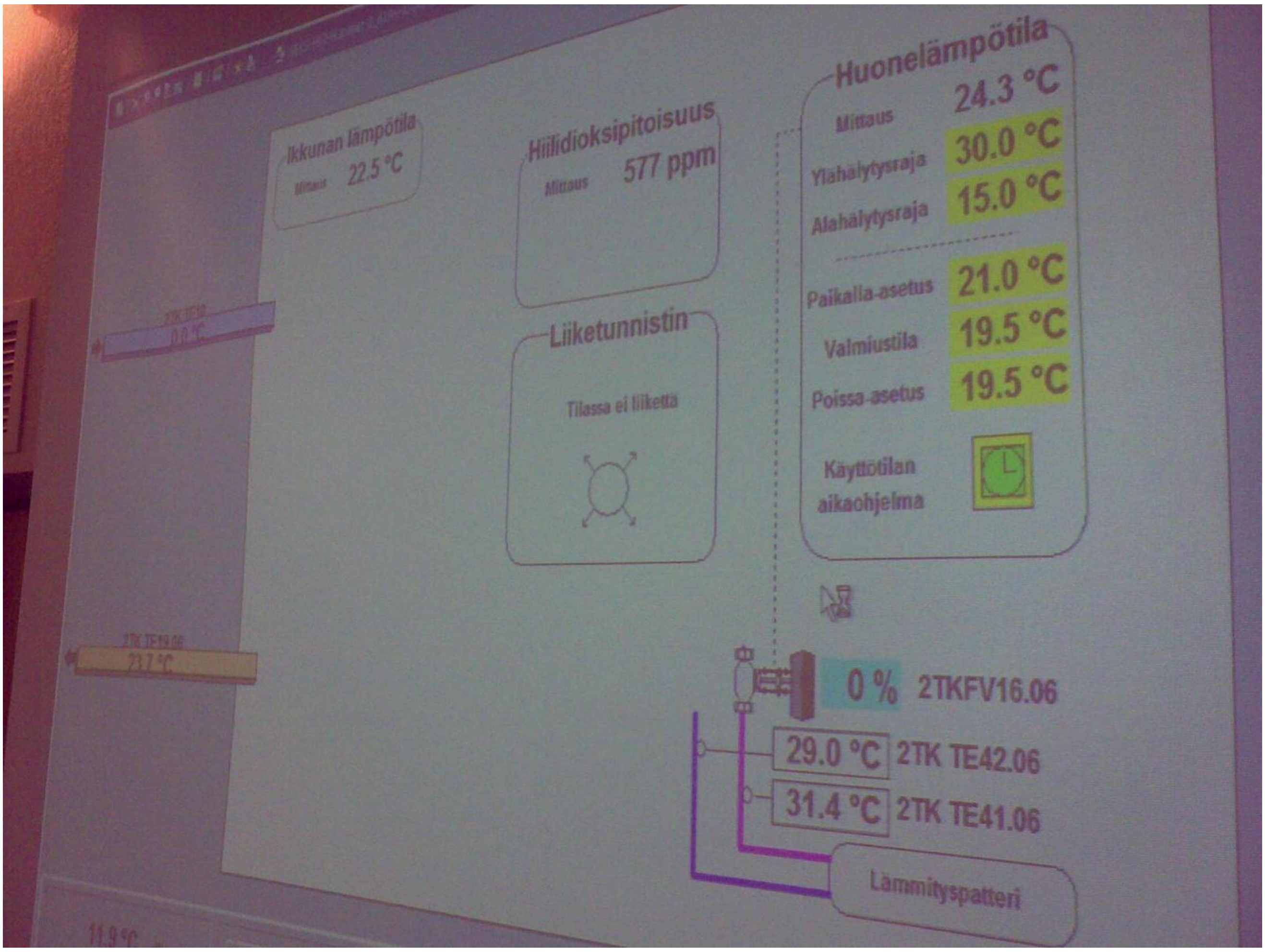
The more advanced technical room level solutions include occupancy, room air quality and room temperature-controlled variable air flow, presence-controlled air flow (minimum/normal), occupancy-controlled heating and window/door switch-activated energy saving mode of air flow control and heating control.

All control will be carried out with room controllers communicating over a field bus connected to the hospital building automation system via IP network. Lighting and HVAC controllers and user interface devices will share information over the field bus, such as room occupancy *status.* Wireless communication will be applied in window and door switches.

On the testing area in this ward there are 17 rooms equipped for Hospilot-purposes

as follows:

VAV boxes+ motorized radiator valves	(5 rooms)
CAV + thermostatic radiator valves	(3 rooms)
CAV + motorized radiator valves	(2 rooms)
CAV + thermostatic radiator valves	(3 rooms)
VAV boxes+ motorized radiator valves	(2 rooms)
Minimum ←→normal air flow-controlled by occupancy sensors + motorized radiator valves	(2 rooms)



Picture 4: Maintenance screen view showing C02-content, occupancy, actual room temperature with it´s settings in different occupancy modes and the position of motorized radiator valve.

Results - Electricity

- The Floor is devided in 6 electricity centres. There are 473 lighting points in the pilot area (H02), in which the number of LED-lamps is 56.This all makes it possible to compare the total electricity usage comparison between these two halves. One of the project goals is to encourage hospitals to investments in energy savings. The monitoring began at 9.11.2010 and will last untill 31.10.2011.

Results - HVAC

All HVAC monitoring in this specific ward is carried out by VTT. The collection of data began in November 2010 and will continue to the end of October 2011. At this stage of the process VTT has not yet formed any conclusions but is continuing with data collection.

Discussion – Electricity

Measurement continues the whole year so that the four seasons in Finland can be taken into consideration. The benefits of daylight detection will be highlighted at spring and summer. Even now the preparative results indicate the benefit of daylight and presence detection by focusing on momentary energy consumption. Monitoring indicates that in the day time only 25 % or less of the total lighting power is in use.

Post occupancy evaluation for end-users concerning lighting is under way. The users have been satisfied with the possibility of adjusting the brightness of the lighting. For example on corridors the power at night is time only 0/10 % of the maximum lightning power because of the wishes of the end users.

Discussion - HVAC

At the deployment stage we had some difficulties with the indoor conditions in the area of new installations, mostly with room temperatures. After some tuning of building automation we have now overcome the difficulties and personally feel fairly satisfied.
As regards the conclusions concerning energy savings, we must bear in mind the weather in Finland. It varies so much over the year that to be sure of the results, it is better to be patient and collect data for a long enough period before making final conclusions.

Next steps

The project monitoring phase has been fully started and will continue almost to end of 2011 in Seinäjoki Hospital to meet the planned 12 months of data acquisition. The whole Project is ending in 2012.