# Case Study

## Prototyping at Statoil Tjeldbergodden

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A number of models and methods support an extended understanding of the *human in the loop* by involving actual users. This was successfully applied through low-fi prototyping and operator involvement in a project to upgrade the control room at Statoil Tjeldbergodden.

Statoil Tjeldbergodden 1 is an industrial complex situated on the mid-western Norwegian coastline. It comprises four areas: a methanol plant, a gas receiving station, an air separation plant and a gas liquefaction facility [1]. As part of a major modification of the plant, it was decided to upgrade the existing Infi90 control system human machine interface (HMI) to ABB's System 800xA. It was determined that the new system should handle 20,000 tags and would consist of approximately 240 process graphics.

The models and methods used in this case study have been introduced in [2] and a brief overview is given in the Factbox 1. This case study particularly focuses on how low-fi prototyping Factbox 2 was applied to the control room upgrade project. By using this simple and effective technique, several iterations of the design were completed with minimum effort.

### Information navigation

The problem faced by knowledge workers and control room operators in many industries is how to find the right information quickly and efficiently. The control system operator interface often consists of anywhere between 20 and a few thousand process graphics, and the operators must be able to quickly identify and navigate to the right one.

The system used at Statoil Tjeldbergodden prior to the upgrade meant operators had to navigate through links in the process graphics 2. These links were scattered everywhere, often following the process flow. To find the quickest route to the desired graphic meant operators had to be very familiar with the plant layout. Clearly a new HMI was necessary.

### Thumbnails for browsing

The first design proposal was inspired by navigation in Microsoft PowerPoint, Windows Explorer and some

photo editors where the idea of thumbnails is employed. Basically, a thumbnail is a small visual copy of an object and acts as a direct link to the object. Thumbnail navigation is an intuitive way of navigating because the user can recognize the visual content of the object that is sought, especially if there are many of them, without having to remember its name. When applied to process graphics, the idea was to use simplified images of these graphics as thumbnails in a panel along one side of the screen display 3. Overlaying the thumbnails with dynamic information – for example showing the number of active alarms with highest priority or other aggregated status indicators – was considered to add extra value.

The concept demonstrator was developed in a graphic editor and inserted into Microsoft PowerPoint presentation slides. Several images were created that contained different process graphics. The corresponding thumbnails showed which process graphic was selected as well as some alarm information. This allowed the designers to demonstrate the concept almost like a working prototype, where clicking on a thumbnail would move to the next slide or "sublevel" showing a new process graphic and its corresponding thumbnail.

The user tests were conducted in an informal manner through a workshop attended by operators, site management, ABB project team and developers. The users liked the concept of a dedicated navigation area, but there were some issues with the thumbnails:

- There was not a sufficient number of links at a time.
- The "visual recognition" effect was not very important because many process graphics look similar.
- The level of detail in the thumbnails was judged to be too high, thus cluttering the operator interface.

### Tabbed browsing

With this feedback in mind, the team started a new design phase. With inspiration from the Opera web browser, Microsoft Excel and Microsoft Visual Studio 2005, a concept of using tabs

**Factbox 1** Models and methods applied in industrial automation system design

Many models of humans with respect to how they perceive and process information exist. Each of these represents some aspects of the cognitive process of the human mind, thus helping designers to better understand the human operator in his respective role.

Rasmussen's model of human behavior – also known as the SRK model – helps designers combine information requirements for a system with aspects of human cognition. It is used to decide (a) at which level of human behavior (skill-based, rule based or knowledge-based) the operator performs specific tasks and (b) what information should be available and presented to the operator. This model can also be used to give an overview of specific tasks allocated between the human and the control system.

Endsley's situation awareness model describes how humans look for and interpret information in complex and dynamic systems, and how decisions are made based on this information.

The system design process includes a number of methods related to collecting relevant information on the *human in the loop* that impacts the design of the human machine interface (HMI):

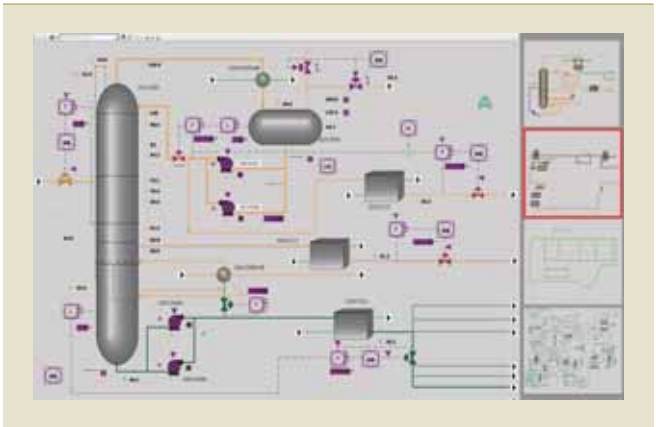
- A Requirement Specification translates overall goals and objectives of the system into specific system specifications.
- A Task Analysis, of which there are two types: Hierarchical and Cognitive, aims to understand the task, goal and expectations which the user will demand of a new system.
- A Functional Analysis – also referred to as task allocation – divides the labor between the human and the control system.

To ensure a well-designed and safe automation system, the system designer needs to combine the outcome of the above-mentioned various models and methods.

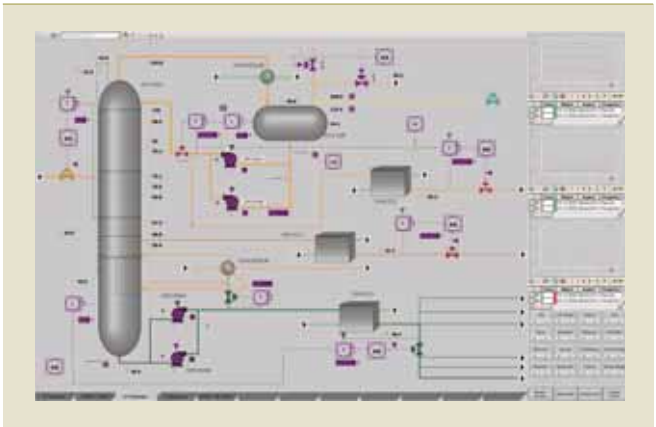
1 The Tjeldbergodden site

2 A screenshot of the old system with display links

3 Thumbnail navigation



4 Tab navigation



for process graphic navigation was developed. By building on the mental idea of flipping through paper documents in a pile, tabs would be employed to enable the user to quickly switch between several documents within an application. When used for process graphics, the idea is to position a bar of tabs at the bottom of the user's screen in combination with a navigation area on the right 4. The tabs show all process graphics in a process area, while the navigation area is used to navigate between the various areas.

The user tests were again implemented using image editing and Microsoft PowerPoint, and several interesting issues were revealed:

- The users have a mental model of a logical and structural hierarchy of process graphics in the plant. This hierarchy is based on the different functional areas of the plant, and the displays could be organized into three different types:
  - Process displays – showing a section of the process on an overview level
  - Detail displays – presenting more details about a part of the process shown in the process display
  - Matrix displays – showing the shutdown logic for a section of the process
- The users would like to navigate directly to detail and matrix displays from the navigation panel, not via the respective process areas.
- The users couldn't find a way of navigating directly from a detail display to the parenting process display without first having to think about which area they were in.

The final step in the paper prototyping process was to include the users' suggestions in finding a solution to these three problems. The first suggestion centered on direct access to the detailed tabs panel and matrix tabs panel for each of the process areas through links in the navigation area. The second suggestion was to include a context-sensitive "up"-button in the tabs panel for the detail displays that navigates directly to the parent of the current display.

**Factbox 2** Lo-fi prototyping

Low-fidelity (Lo-fi) prototyping is used to get user feedback as quickly and as efficiently as possible. Normal prototyping often involves some form of construction and/or programming, and developers must often wait until the main product is almost finished before testing can be carried out using potential users. Lo-fi prototyping, on the other hand, uses simple methods, such as sketching on paper, PowerPoint and image editors, etc, to create straightforward mock-ups that demonstrate the main functionality – all within a matter of hours. This method ensures that user feedback comes at the very beginning of the project rather than at the end, making major changes possible.

## Conclusion

The use of paper prototyping provided several benefits for the project team. First of all, the concept was quickly developed, and because simple paper prototypes were used, the final design was established with a low level of effort. Experienced users are a great source of ideas and knowledge. Bringing them into the project at an early stage lead not only to a feeling of ownership but also to a feeling of having contributed to the final solution.

The use of paper prototyping combined with knowledge and ideas from experienced users means final designs are usually established with a low level of effort.

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References

[1] http://www.statoil.com/tjeldbergodden (November 2006).

[2] Charlotte Skourup, John Pretlove, "Design methods – Putting the human in focus", ABB Review 1/2007, pp 30–33.