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Workboats

Specialized DP Operator Workspace for PSV Vessels

Øystein Andreassen

Kongsberg Simrad AS (Norway)

Abstract

When oil companies in the North Sea started requiring two system operators on the bridge of platform support vessels (PSV) during certain operations, analyses of incident reports had indicated that the workload could be too high for one operator alone. This information encouraged Kongsberg Simrad to look at whether the working environment on PSV bridges could also be changed in other respects to improve safety and efficiency of operations.

Together with experienced system operators, Kongsberg Simrad evaluated several solutions and ended up by developing a new workplace for the PSV aft bridge. Here, the ergonomics of the DP operator positions has been improved and the position offers a wide range of possibilities for individual adjustments. Within the total workspace, the location of equipment has been carefully planned to support alternative schemes for sharing work between the two operators. In particular, this can be noticed in the arrangement of the positions for ship handling.

Platform support vessels

The platform support vessels considered here are mainly chartered for platform supply and/or ROV support. Common to the operations is that the “action” is on the work deck and the vessel is often positioned with the stern or a side close to a platform or another construction. The risk involved in the operation generally requires a DP system of equipment class 2.

Larger platform support vessels currently being built for the North Sea are approximately 90-100 m long with deadweight around 6000 tons. They are commonly equipped with electric azimuth propulsion, although conventional propulsion with main engines and rudders is still used to some extent.

Figure 1 - Typical PSV Aft Bridge built for a single operator with equipment for an additional vessel automation operator (A: Dual DP, B: Manual Thruster/Propulsion Control, C: Vessel Automation)

PSV bridge design has evolved over the years, but very often we find a relatively large bridge area sectioned into four major workplaces:

- A navigation center located in the forward part of the bridge, sometimes referred to as the "navigating bridge"
- A survey center/ operation planning section
- A radio station
- A DP control center with additional workstations for vessel automation (cargo, power, and ballast) located in the aft part of the bridge, sometimes referred to as the "work bridge"

The equipment at the work bridge is often arranged for a single operator operating all systems; sometimes with an additional workstation for manual maneuvering or for cargo monitoring and control. The workplace is designed with a good field of view towards the work area on deck and towards the construction being supported.

In addition to the workstations for the main systems, there is a wide range of instruments and panels more or less scattered around the operator. Owners and yards generally arrange these items as believed to be practical for the operator – space permitting. However, the impression is that little effort is made to analyze what tasks the operator actually does and how he needs to interact with the equipment to do these tasks in normal as well as in extreme situations. A good solution therefore heavily depends on involvement from experienced operators in the design phase.

Figure 2 - PSV aft bridge with two operator positions, but often manned by one person. A (Vessel Automation), B (Dual DP), and C (Manual Thruster / Propulsion Control and Joystick).

New requirements

Although the workspace on the aft bridge was designed for two system operators, many operations were performed with only one operator on duty. When a Norwegian oil company investigated their most recent DP incidents during PSV operations one significant conclusion was that the workload on the single operator in certain periods appeared to be too high to ensure that he could stay focused on all his tasks. Incidents could happen because the operator was overwhelmed by information and events that made it difficult to sort out what was important at the moment.

As a first consequence two-man attendance on the bridge during PSV operation was required on already chartered vessels. In many cases this could be done with no or minor changes to the equipment (re. Figure 1 and Figure 2). What had to be changed were the procedures and the focus on bridge team cooperation.

Specifications from this company for new vessels now include a requirement for an aft workspace planned and designed for two system operators. In order to see whether there were additional measures that could be taken to improve safety, we therefore decided to look more closely into the tasks and equipment used by these operators. A cooperation with a ship owner with wide DP and PSV experience was therefore established.

Workload and work share

The first task was to analyze the potential operator workload. This was done by a practical approach, analyzing the tasks executed from the workspace and then list the equipment that should be available for these tasks. This included the equipment required by authorities and classification societies as well as owner's and client's requirements.

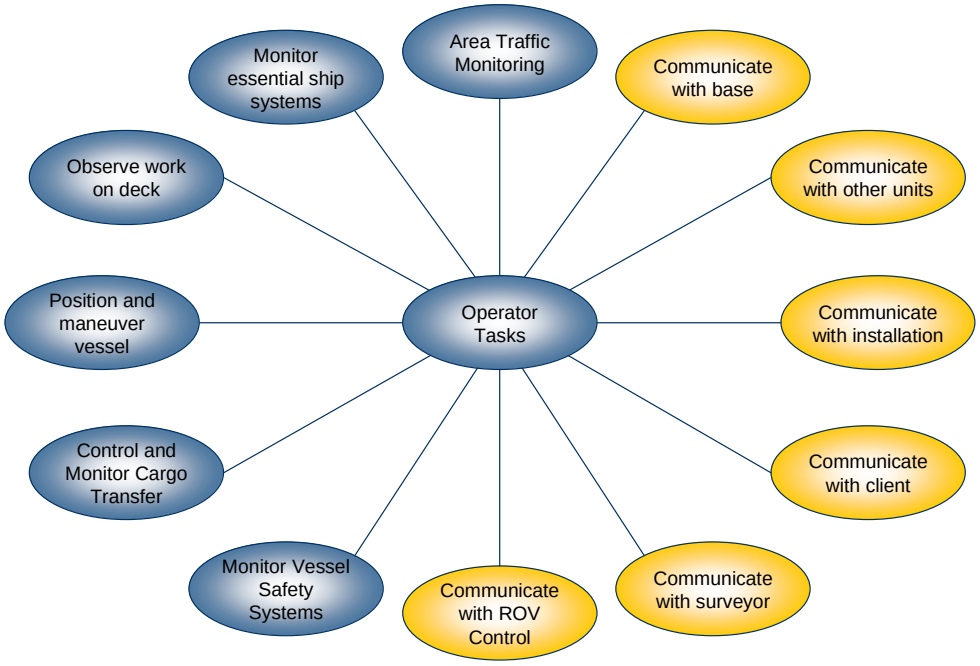

Figure 3 - Operator tasks executed from the workspace on the aft bridge during normal operation. Tasks shown with yellow background are communication tasks.

The task analysis reflected that the vessels operated by the persons we interviewed are designed for platform supply and ROV support. The main tasks were therefore ship handling (position and maneuver vessel) and cargo handling, but as shown in Figure 3 there are a significant number of other, secondary, tasks.

In particular, communication can create a significant workload. Both formal communication as a consequence of the responsibility as a DP operator, Master or Navigator, but also informal communication since "everybody" relies on the person on the bridge as the one who knows

what's going on. This person is also often the one who serves as "switchboard operator" when someone calls the vessel from shore.

Not all tasks listed are concurrent tasks. But as the equipment necessary for the tasks has to be installed, it will be there and may distract the operator(s) as long as it is switched on - even if it is not actually in use.

When examining the equipment installed on the bridge one notice the diversity as well as the number of different systems and devices. Figure 4 illustrates the main systems and groups of devices, but is far from complete.

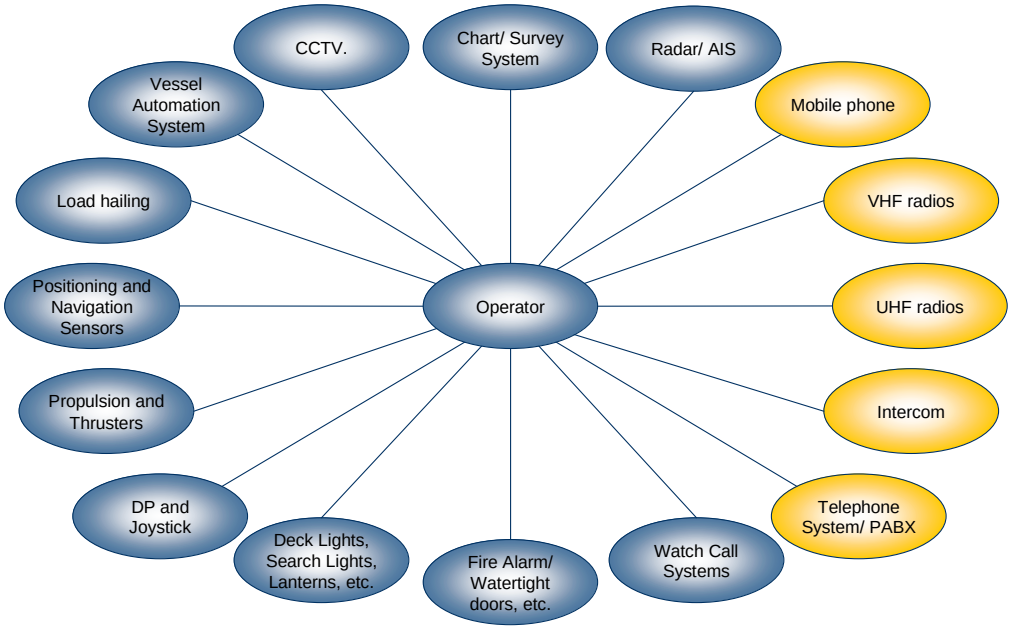

Figure 4 - Equipment used for tasks executed from the workspace on the aft bridge during normal operation. Yellow background refers to communication equipment.

Corresponding to the main tasks, the main equipment is the positioning system (DP), the system for manual remote control of thrusters and propulsion, and the vessel automation system assumed to incorporate functions for cargo handling and power management.

When sharing the workload between two operators the natural split is one main function on each operator. As cargo handling requires communication with the installation receiving the goods, it is sensible that the cargo operator also handles communications. Especially since ship handling can be considered a more intense task requiring "hands on wheels" all the time while the cargo operator will only be monitoring the offloading much of the time.

Arranging the workspace along these lines gives strong directions for where to locate the panels and monitors of the various systems. It was therefore decided to follow these directions, but with an additional requirement for interoperability between the two operator positions. In certain situations it should be possible for the operators to easily take over tasks from each other.

Design considerations

Organizing the workspace in accordance with the main functions became the main principle. Additionally the analysis of operator workload raised some further questions:

- Is all the information actually necessary?
- Can the number of indicators, buttons, levers, and displays be reduced without compromising operational safety and loosing valuable information?
- How can the workspace be designed to give both operators an unobstructed view to the work areas on deck?
- How can the ergonomics of the workspace be improved, especially for the DP operator who can be "tied" to the chair for hours. Operators come in different sizes!

When discussing these questions with owners and experienced operators we quite soon learned that although some of the equipment was in use only in periods they would not want to remove it from the workplace. However, many operators complained that on some vessels, the layout of the workspace would force them to leave the chair for certain tasks. Simple changes to equipment design could therefore be a significant improvement. An example given was to make sure that all phones on the bridge would ring when someone called – not only the one located in the opposite corner of the bridge.

Although one would like to keep all equipment the space required was addressed as a problem. Almost any subsystem today is provided with a computer, a display, and a trackball or keyboard and the workplace dimensions can grow quite large to accommodate it all. On the other hand, one would believe that the use of computer systems should make it easier to combine information from multiple subsystems into fewer monitors.

When raising this question there was little enthusiasm among the operators for such approaches, at least for the essential systems. Operators argued that they would prefer "clean" monitors, i.e. one system one monitor as it would then be easier and quicker to find the information they needed. A high level of integration between systems would otherwise be in conflict with classification requirements.

There were also objections based on practical use. Combining a radar display with a DP position plot, for instance, would not be of much value as the range settings for the two would be significantly different. In spite of this, a certain integration of secondary systems was suggested and the use of touch sensitive displays was encouraged to combine all user interactions in one device.

A typical area where many operators would appreciate integration is alarm handling. By rules or performance standards almost every system is required to report system errors and/ or operational hazards. The consequence being that there are buzzers and reset/ silence buttons in almost every panel. Operators claimed that if a majority of alarms could at least be silenced without having to step out of the chair, it would reduce the stress associated with alarm handling considerably.

Unobstructed view to the work deck is of particular importance to the DP operator. Also the cargo operator should be able to see what is going on outside in case he has to abandon cargo transfer in case of an emergency. This means that the operators should both be located as close to the windows as possible. Indicators, monitors and user interface devices obviously need to be within the field of view, but should be kept outside the central line of sight. Many operators also said that the DP operator in particular should have space between himself and the window to

allow him to step out of the chair and still have reasonable access to the maneuvering controls. This and a requirement for improved operator comfort and less stress on shoulders and wrists suggested that the DP workstation should be designed with more possibilities for individual adjustments.

Finally, building a workspace for interoperability between the positions has a cost implication. If the positions should provide a complete overlap of functions, one could argue that much of the equipment had to be duplicated. This revitalized the discussions about which equipment is significant for which operation. It then turned out that instead of duplicating it, some of the equipment could very well be located so that both operators could reach it. In particular, this applied to communication sets, radar, and to a certain extent, equipment for manual control of propulsion and thrusters.

Summing up the discussions with the operators, the resulting design recommendations became:

- No integration of essential equipment
- Reduce panel surface space requirements by combining control functions for secondary systems
- Improve alarm handling
- Improve the possibilities for personal adjustment of chairs and consoles within the workspace
- Reduce cost for interoperability by locating equipment within reach of both operators or by using main equipment with the possibility for an additional remote control unit.

Evaluation of a common solution

Based on solutions we have seen onboard recent new vessels, the above recommendations were expected. It was therefore interesting to look closer at an arrangement of the aft workspace that is common to many of these vessels and see how well it would meet the design recommendations.

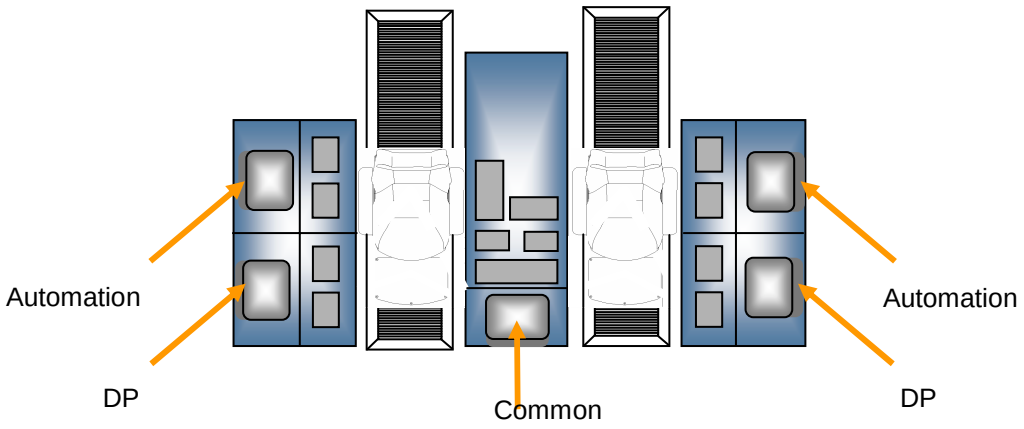

Figure 5 - Aft workspace with two operator positions (example - seen from above)

This workspace has two chairs separated by a console with equipment accessible from both positions. On the opposite side both operators have a single DP operator station and an operator station belonging to the ship automation system. The chairs are mounted on deck rails running in

the vessel's aft-fwd direction and the consoles are located with front against the rails. On several new installations the chairs have armrests with space for levers or instruments.

The location of equipment controls seems to follow a pattern where one main function is allocated to each position. For instance, one position is for ship handling while the other is for cargo control or anchor handling. In addition to the duplication of DP and automation, interoperability between the two stations then has to be ensured through arrangements using the center console.

The center console therefore provides space for radar and communication, as well as indicators for propulsion and thrusters together with emergency stop buttons for these and for cargo pumps. Anchor handlers may have propulsion levers in the armrest of one chair and a joystick in the center console. On an ordinary supply vessels the armrest of one or both chairs may be used for a joystick with all levers for propulsion and thrusters located in the center. We have even seen joystick terminals and DP operator stations mounted on an articulated arm, available from either operator position.

User interface to radios is improved by installing microphones in the chair and keying switches implemented as pedals. This gives a "hands free" operation of VHF and UHF communication. DP position reference systems, sensor repeaters, CCTV and other secondary equipment are most often located in additional overhead consoles.

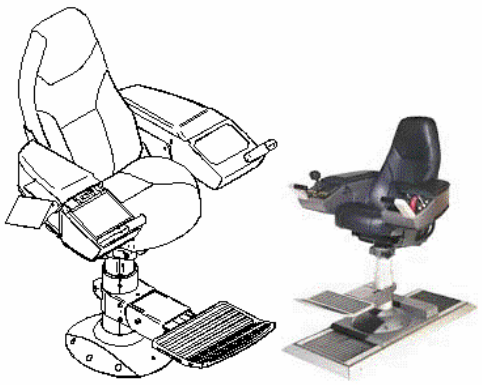

Figure 6 - Chair for installation of levers in armrests (AS Sorlandets Aluminiumsprodukter)

Whatever solution, the main principle appears to have been to separate the main functions and to provide some backup capability for the maneuvering/ positioning task. For many vessels an approach based on the layout shown in Figure 5, with or without controls in the armrests, will work well and provide a satisfactory working environment.

The disadvantages we could find were primarily related to ship handling. In particular, we noticed that the space for thruster/ propulsion levers in the armrests of standard chairs was too small. Very often an additional lever or two had to be located elsewhere. We also noticed that if levers were located in the center console and the joystick in the armrest, operators who like to combine modes from joystick and DP with manual control in one axis would have to relate to controls in three different places at the same time. In worst case, that is.

Other potential drawbacks we identified were that even with chairs having the controls in the armrests, the possibilities for individual adjustments of the working position were limited. We would also like to be able to move closer to the aft windows without monitors and indicators disappearing from the field of view when concentrating on the action outside.

Our decision was therefore to continue the project by developing an improved workspace where these inconveniences could be eliminated.

A new specialized operator workspace for platform support vessels

As our client wanted the same functions to be independently available in each position, a center console as in the above solution could not be used for common equipment. Initially he therefore suggested that the primary functions for vessel handling (DP, Joystick and manual propulsion/ thruster control) should be located in the armrests of each chairs. Every shift in vessel position or heading should be possible without lifting the arms from the armrest with one chair "in command" of this function at a time.

It very soon became clear that armrests for all these controls would become quite large. And still it would be necessary to have side consoles for communication, vessel automation/ cargo control, radars, and miscellaneous panels for window wipers, search lights, lanterns, typhoon, etc.

When comparing the estimated dimensions with the recommended limits for location of equipment "within reach" and "immediately readable" as given by Det Norske Veritas (DNV), we concluded that we would be able to follow the recommendations. However, we could not find a standard chair with armrests the size we needed and we would also have to modify our side consoles to move all panels closer to the operator. Instead, we shifted focus towards a solution where the original side consoles were maintained but the DP operator station and the manual levers were arranged in a way that allowed the use of a standard chair.

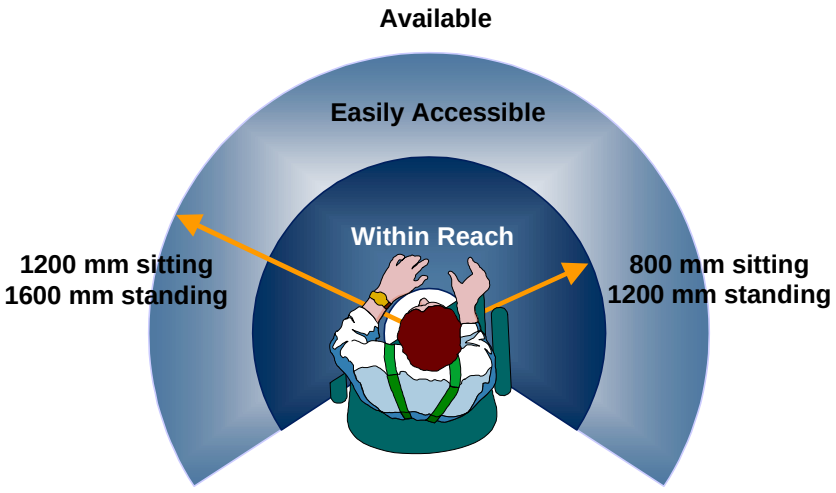

Figure 7 – Recommended location of user interface devices (Det Norske Veritas)

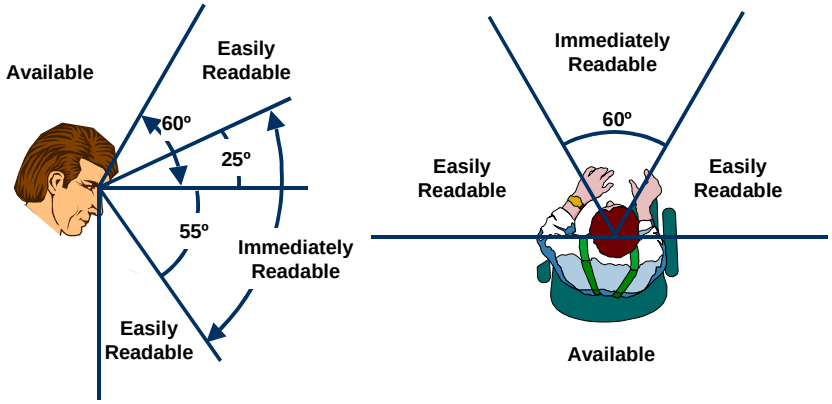

Figure 8 - Recommended location of visual display units (Det Norske Veritas)

This decision was also influenced by a number of operators who considered levers in the chair a major disadvantage for all other tasks than ship handling. If the position was allocated to cargo handling they expected that they would experience the levers as an obstacle.

After several stages of prototyping we ended up with a specialized positioning and maneuvering workstation with controls and indicators enclosed in two new adjustable consoles located close to the windows. With two identical positions next to each other, the operators can cooperate quite easily. They can see what the other operator is doing, and since the most important displays are duplicated they may also cross check system performance.

All levers are located in the new workstation and it is possible to maneuver the vessel by joystick or apply automatic station keeping from the station without having to turn to any of the other workstations.

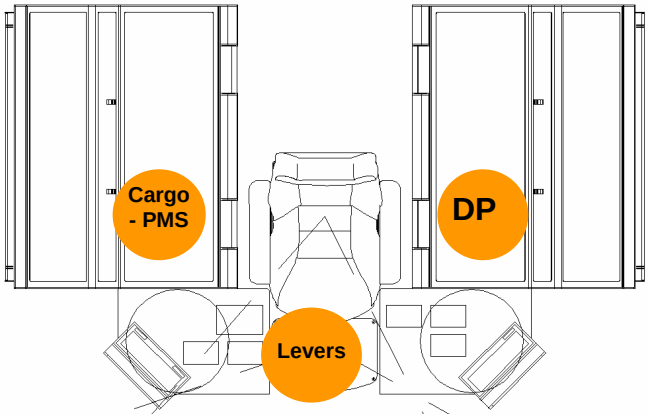

Figure 9 - Basic layout of the specialized operator position

The dimensions of the consoles were selected so that all levers and indicators were within reach and immediately or easily readable. A dedicated DP operator station and an operator station from the automation system were located in the consoles next to the chair, with space for secondary equipment. Communication was located in overhead consoles (Not included in Figure 9).

In an arrangement with two of these operator positions next to each other in a common workspace both operators have access to the main workstations without leaving the chair: Aft and starboard consoles for ship handling and port consoles for cargo handling and/or power management (PMS). Secondary systems are located somewhat behind the chair when it is in its aft position but can be observed by the operator turning his head. He may drive the chair forwards should he need to interact with these systems over a longer period of time. With the chair in an intermediate position all controls and monitors will be conveniently within reach. That situation for each operator would then be very similar to the arrangement already used on some vessels (see Figure 1).

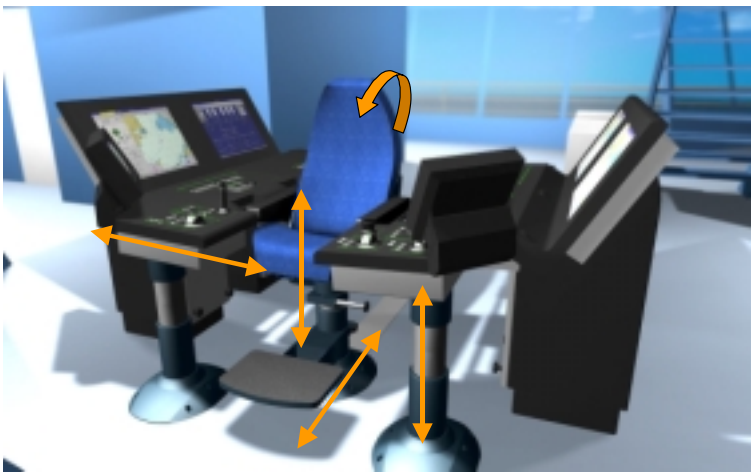

Figure 10 – An adjustable workplace

Originally, the intention was that two monitors should be located in front of the operator and show thruster and propulsion parameters as well as positioning information. This was later expanded so that the final concept can carry altogether four monitors. The two additional ones can be used for miscellaneous purposes according to owner or yard specifications. In principle, both main functions could be implemented in the new consoles but the most likely use of the extra monitor capacity is for a central alarm display, for CCTV, radars, and/or chart displays.

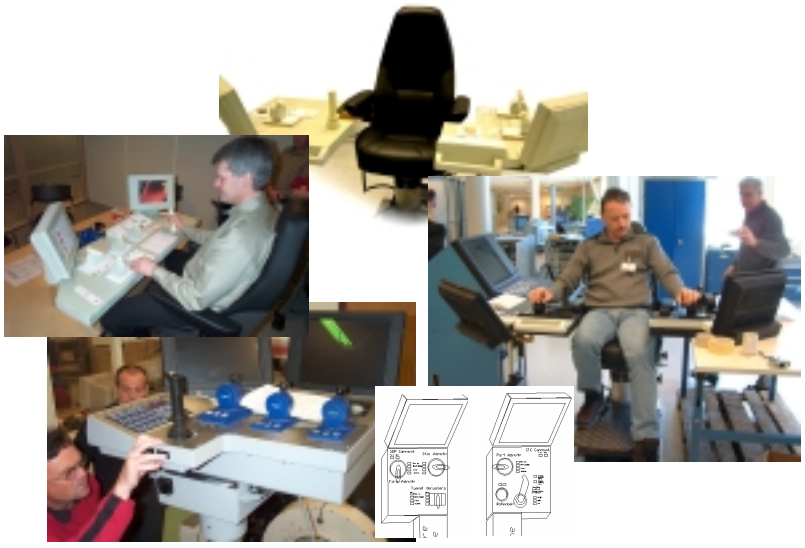

Figure 11 – Various stages of prototyping

In the pilot model one of the additional monitors has been used to demonstrate how control of auxiliary bridge systems (such as window wipers, window heating, deck lights) can be integrated into one display with a touch sensitive surface.

Layout of the new workspace

Figure 12 shows an example of a complete aft PSV workspace with the new operator position for maneuvering and positioning together with other equipment required in this workspace, arranged in accordance with the principles given above. Since the two positions are identical, only one position is explained.

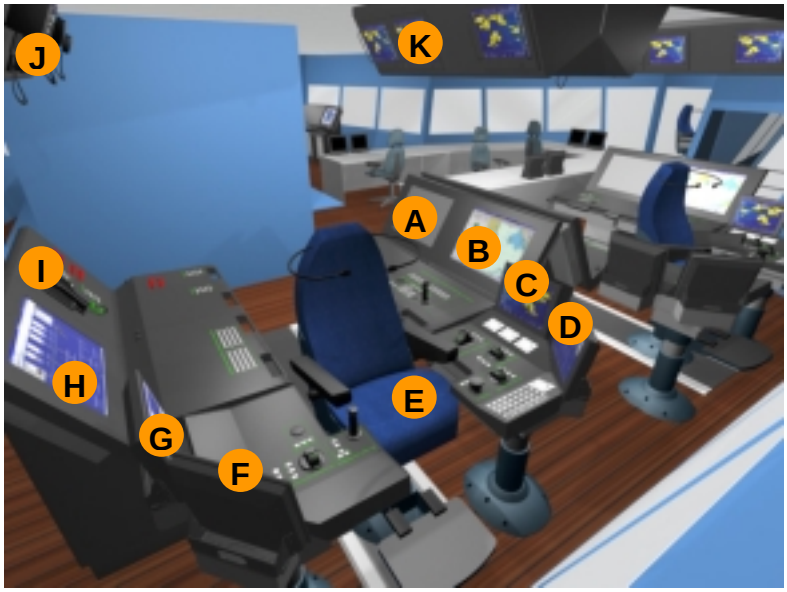

Figure 12 - Aft Workspace

A : Position reference systems. If necessary, complemented by systems installed in the overhead console K. In particular systems like Fanbeam that require operator attention when in use should be located so it can be conveniently reached from the chair.

B : DP Console. Used for ship handling involving advanced DP operations

C : Free space for a monitor. Here suggested used for radar or chart. Alternative location for radar display is in the ceiling between the two operator positions or in position H.

D : Monitor for presentation of thruster/ propulsion information and position keeping information. Levers and panel for operation of the maneuvering system including station keeping functions. Used for manual control of thrusters/ propulsion and for standard position keeping. Console height and distance from the chair can be electrically adjusted (see Figure 10).

E : Chair with built in microphones for VHF and UHF radios, keying switches on pedals. Electric adjustment of height and aft/fore position (see Figure 10).

F : Monitor for presentation of thruster/ propulsion information and position keeping information. Joystick levers for operation of the maneuvering system. Used for manual control of thrusters/ propulsion and for joystick control. The joystick is independent of the joystick in position B. Console height and distance from the chair can be electrically adjusted (see Figure 10).

G : Free space for a monitor. Here suggested used for control of auxiliary bridge systems (window wipers, etc.). Can be combined with presentation of CCTV images.

H : Vessel automation systems (Cargo and/or power plant control). Can be combined with (I) if radar is installed in position (H).

I : Cargo pumps emergency stop switches and miscellaneous equipment.

J : Communication systems (VHF and UHF Radios), mobile phone, and public broadcast radio

K : Position Reference systems and/ or CCTV

Monitors in positions C, D, F, G, J and K are 15” TFT (Thin Film Transistor) flat screens. Remaining monitors are 20” or optionally 23” TFT displays. In addition to the sections shown in the picture, a third overhead console is located in the ceiling between the two positions containing anemometer indicators and navigation sensor repeaters.

In order to avoid confusion, only one position can take command of DP/ maneuvering at a time. Similarly, the vessel automation system can be set up so that only one of the positions can take command of the cargo system at a time. Which position that shall be in command of which function is a matter of organization on board. Most other systems can be operated in parallel and require no changeover mechanisms.