

IMPROVEMENTS TO THE CONTROL ROOM OPERATOR WORKSPACE AT POINT LEPREAU

T. Hitchcock and H. Storey
Control Computer Group, Point Lepreau, NB Power
Lepreau, New Brunswick, Canada, E0G 2H0

E. Davey
Crew Systems Solutions
Deep River, Ontario, Canada K0J 1P0

B. Patterson
Human Factors Practical
Dipper Harbour, New Brunswick, Canada, E0G 2H0

ABSTRACT

The Point Lepreau control room operator workspace was designed in the mid-seventies. Through the eighties and nineties, station staff have introduced new operational practices, added new control room resources, and modified or replaced some existing control room equipment to improve the overall effectiveness of control room operations. By 1994, it was recognized that the existing operator console and workspace equipment was limited in supporting certain operating functions and would restrict further incremental expansion and workspace improvements. Subsequently, station Operations staff undertook a design study to systematically characterize operator control room workspace needs and design a workspace that would integrate new and old facilities to better support efficient operation into the next century.

This paper describes the findings and lessons learned from the initial workspace reassessment study, console redesign and implementation, and early operational experience with the new workspace implementation.

BACKGROUND

CANDU plant control centres are designed to support Operations staff in supervision and control of plant operation. However, the support requirements are never static. For example, the workspace support needs of Operations staff change as new operational practices and control room systems are introduced to improve plant safety and production performance.

This need to accommodate ongoing operational changes and improvements places demands for change on the control room workspace layout. Ideally, a workspace that offers flexibility in configuration, versatility of function, and expandability may best support ongoing operational refinements.

Through the eighties and nineties, station staff at Point Lepreau introduced many changes to refine and improve the overall effectiveness of control room operations. By 1994, it was recognized that the existing operator console and supporting workspace equipment (see [Figure 1](#) and [2](#)) was limited in supporting workspace improvements (e.g., addition of Generic Monitoring System display terminals) and future incremental expansion. Subsequently, station Operations staff undertook a design study to systematically characterize operator control room workspace needs and design a workspace that would integrate new and old facilities to better support efficient operation into the next century (Feher and Davey, 1995). The primary emphasis of this study was to design an improved operator console.



[Figure 1](#): Console Desk at Time of Assessment (1994).

The objectives of the design study included:

- Document current control room workspace usage and the critical factors important in supporting plant operation,
- Develop inventories of control room tasks and supporting resources,
- Characterize control room resources by frequency of use and required accessibility, and

- Report assessment findings and recommendations for workspace improvement.

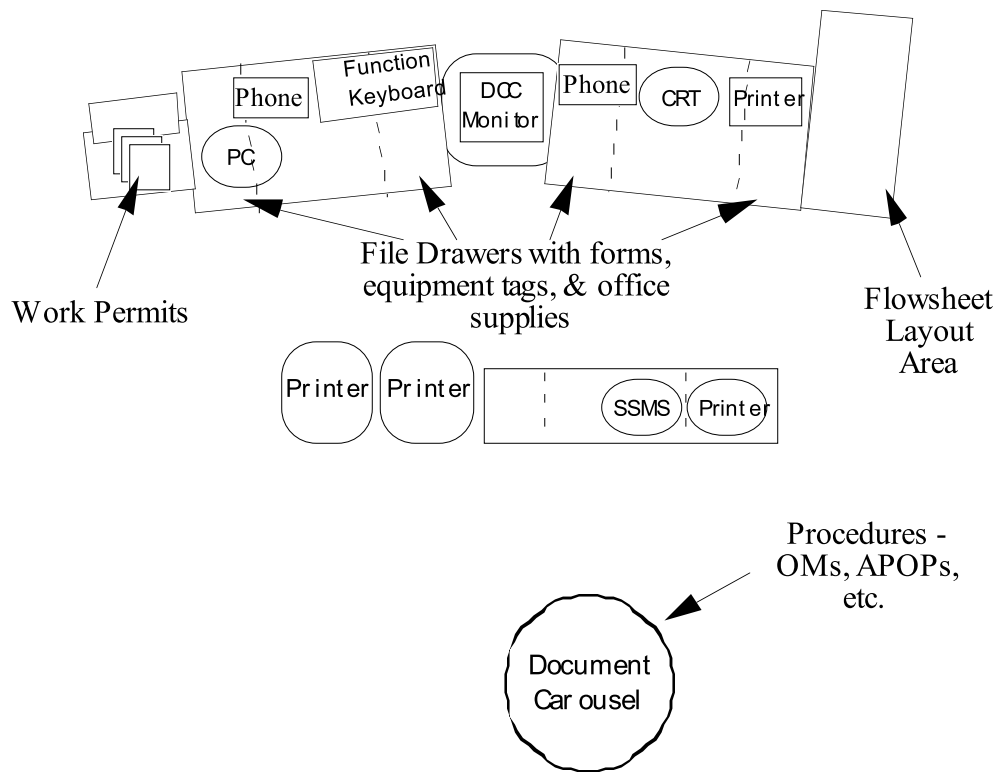


Figure 2: Control Room Operator Workspace at Time of Assessment (1994).

CHARACTERIZING USER NEEDS AND IMPROVEMENT PRIORITIES

The assessment team comprised a senior operator from Point Lepreau and two control centre designers from the Control Centre Technology Branch of AECL at Chalk River. The following activities and information sources were used by the assessment team in determining workspace needs:

- Review of crew roles and responsibilities for all operational situations,
- Observations of crew work practices and use of resources in the existing control room,
- Interviews with selected Operations staff to determine suggestions for workspace improvements and improvement priorities, and
- Discussion of future workspace needs with Operations staff, Trainers, Technical Unit staff and Point Lepreau management.

Key findings from the assessment phase included:

- Additional free surface areas are required for temporary layout of procedures, flowsheets, and documentation in support of multiple tasks,
- Operating procedures and reference documentation need to be located closer to the seated operator work-positions to simplify access,
- Computer-based support for frequently performed monitoring, control, analysis and administrative tasks should be made accessible at the console desktop, for example:
 - VAX and network applications should be accessible to both the Senior Power Plant Operator (SPPO) and Power Plant Operator (PPO) seated work-positions,
 - Current standalone monitoring and analysis applications should be made accessible from desktop networked personal computers, and
 - The PPO should be provided with a dedicated Digital Control Computer (DCC) display and keyboard.
- Computer keyboards should be relocated to adjustable drawers beneath the desktop to improve positioning for keyboard tasks and free-up console workspace.

PROPOSED IMPROVEMENTS

The development of console and workspace improvement proposals involved consideration of the PLGS organization, technical capabilities and constraints, and operator needs. The assessment team established the following design principles to guide selection and development of workspace improvements:

- Design the layout to support the current operational philosophy, staff structure and work relationships,
- Locate the control room resources in support of each user according to:
 - The frequency of access or use,
 - The importance of accessibility, and
 - The major operational tasks to be supported.
- Provide support for the preferred and backup mode of use in performing each task.

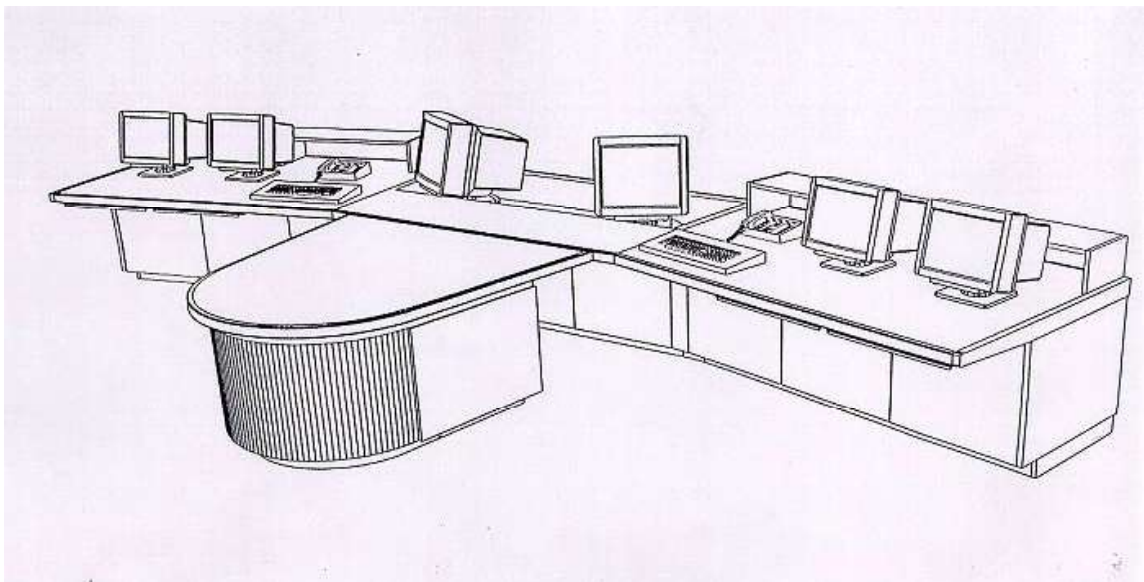
Point Lepreau station management and the assessment team also established the following project constraints to limit design options and the cost of prospective changes:

- Retain the console pedestal location to access existing floor penetrations for control desk power and interface wiring,
- Re-use as much of the existing control room resources as possible to minimize change costs,
- Introduce only inexpensive changes that can be easily implemented during plant shutdown, outage, or at power with minimal disruption to normal operations,

- Maintain important lines of sight,
- Maintain important communication paths,
- Maintain current traffic patterns to the control panels and the control room entrances and exits.

The proposed new console and workspace layout based on the principles, constraints and assessment study findings are shown in [Figure 3](#) and [Figure 4](#). Key improvement aspects addressed by the proposed console and workspace features include:

- Increased Console Desk Surfaces - Increased work surfaces for organization of SPPO and PPO work,
- Layout Space for Operating Manuals - Addition of a shelf to the front of the console for layout of Operating Manuals when working at the panels,
- Operating Procedure Accessibility - Addition of a central console document carousel for improved accessibility and storage of Operating procedures for the SPPO and PPO,
- DCC Display and Function Keyboard for PPO - Addition of a DCC display and function keyboard for the PPO console work position,
- Reduced Desk Clutter - Relocation of computer keyboards to trays beneath the console top, and
- Document Storage - Addition of bookcases and filing cabinets immediately behind the console for storage of reference documentation and supplies.



[Figure 3](#): Proposed New Console Design (1995).

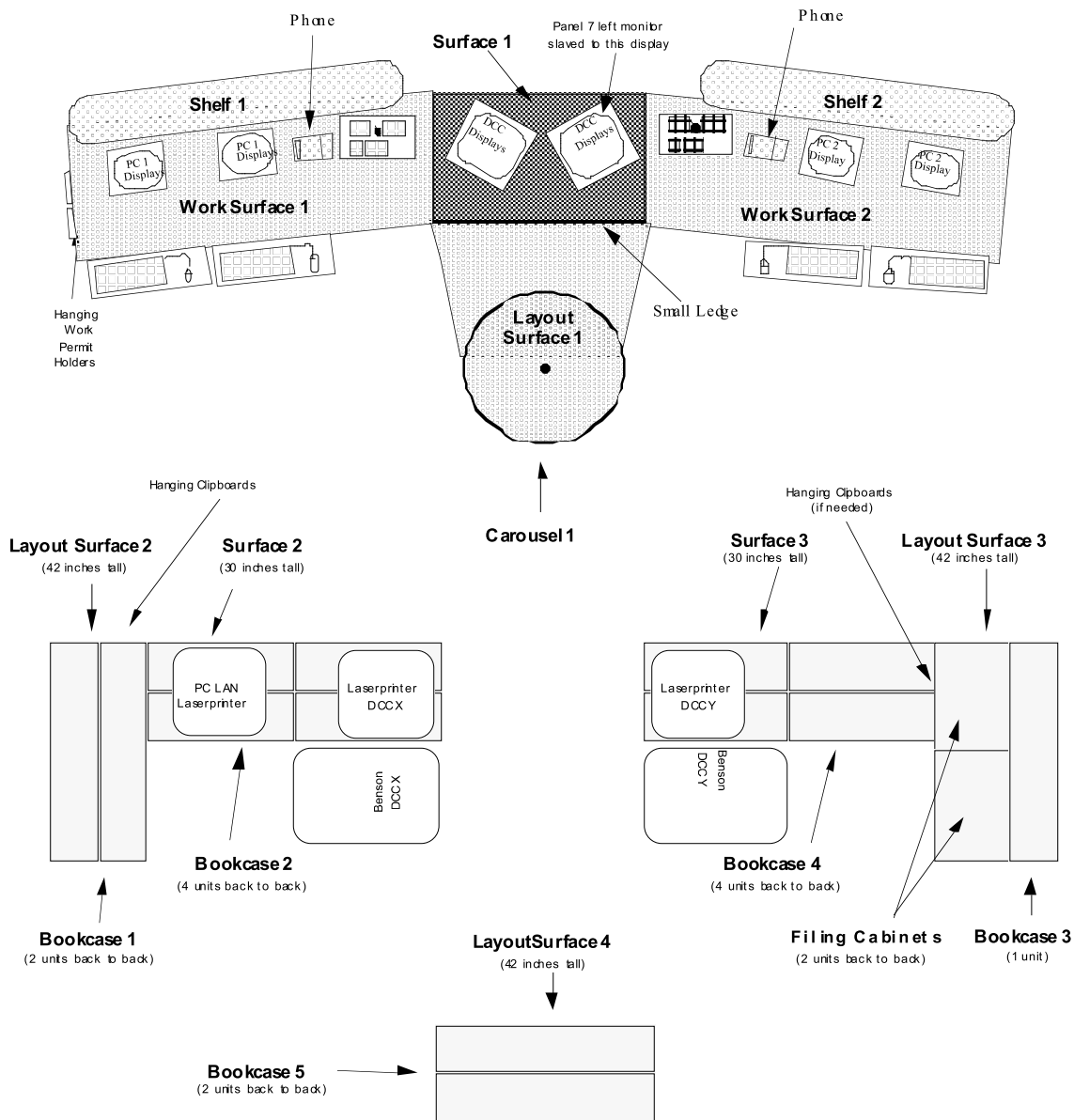


Figure 4: Proposed Control Room Operator Workspace (1995).

This workspace design provides a substantial improvement in documentation layout areas and accessible storage, and is implemented with commercially available equipment and components

IMPLEMENTATION

The Point Lepreau Control Computer Group undertook implementation of the console upgrade. This group developed additional requirements for the upgrade pertaining to accessibility, serviceability and expandability (e.g., provision of spare rack mounted

equipment locations to accommodate future needs) to ensure maintenance and support needs would be met.

Each wing of the console is divided into three sections. Each section contains a 19 inch rack mount chassis for mounting industrial PCs for the control room operators use. The outer sections of the console house rack mounted computers for monitoring signals gathered by the station's distributed data acquisition system. The middle sections house Management Information System computers. The 19 inch rack space in the inner sections have been left empty for future expansion. The console surface of the inner sections is used to mount the DCC keyboard. Currently, a DCC keyboard is provided only on the SPPO wing of the console. Installation of a second DCC keyboard on the PPO console wing is planned as a future improvement.

The centre section of the console provides two swivel bases for mounting DCC monitors in a recessed area. The swivel bases allow the monitors to be used from both sides of the console and recessing the monitors into the desk ensures that the monitors do not block operator sight-lines to key panel indications.

This project provided an excellent opportunity for the station's Electrical Maintenance staff to clean up the central console wiring, confirm or correct documentation, and create new under console space for future expansion needs. The layout of the central console wiring before and after the console upgrade is shown in [Figures 5 and 6](#) respectively. The new wiring implementation consists of channelized cable termination racks (see [Figure 6](#)). The opportunity to clean up the console wiring and improve wiring channelization was an additional benefit of the console upgrade.



[Figure 5](#): Central Console Termination Rack Pre Change-out.



Figure 6: Central Console Termination Rack Post Change-out.

The equipment for the new workspace design was acquired in 1996. A modular approach to console implementation was selected to simplify construction and installation. Installation and commissioning of the new console in the Point Lepreau control centre was completed in 1998.

The console was replaced with the station at power during a low traffic period in the control room (i.e., 4 PM Friday to 8 AM Monday). Prior to the installation, the SPPO work location, PC, and phone were relocated to a temporary desk close to Panel 7 to facilitate plant monitoring and DCC keyboard access. Next the DCC keyboard on the operator's desk was disabled by disconnecting the process interrupt input to the DCCs and all the discrete inputs for each of the function keys. With this isolation complete, removal of the old console and installation of the new console could begin.

The center section of the new console had been pre-wired as much as possible in order to shorten the installation time. In addition, measurements and floor markings had been made for the new console ahead of time to further shorten the installation period required. The new console was put in place, secured, leveled and the equipment re-installed in the weekend time frame allotted. Two views of the finished console are shown in [Figures 7 and 8](#).

To date the workspace equipment and storage areas behind the console have not been altered to the extent originally proposed. For example, Operations staff decided to retain the large circular document carousel since it provides an excellent area for document layout and discussions.



Figure 7: Installed Console - Side View (1998).



Figure 8: Installed Console - Front View (1998).

OPERATIONAL EXPERIENCE

Early operational experience indicates that the new console workspace design provides substantial improvement in supporting operator tasks. Specific improvements cited by Operations staff over the past design include:

- Console Layout Space - The larger desk surface better supports layout and organization of work documents and permits two computer workstations and a DCC keyboard/monitor interface to be located at each work position without cluttering the console surface,
- Layout Space for Operating Manuals - The shelf along the front of the console is very useful for layout of Operating Manuals and test procedures when performing panel actions, and
- Central Console Peninsula - The central console peninsula has proven useful as a work surface to support discussions between the SPPO and PPO, and as a layout surface for shift group discussions. Although it may appear as a physical barrier, experience has shown that the console peninsula has proven to promote and better support control room communication.

However, the success of any design is dependent on the relevancy of past design assumptions to current operational needs. Operations staff have identified two design aspects that have not proven out as intended:

- Carousel for Operating Documentation - The purpose of the addition of the console carousel was to improve the accessibility of the Operating documentation to Operations staff. Formerly, Operating documentation was stored in a large carousel with other reference information at the rear of the control room. The new console carousel has not worked for a number of reasons:
 - The carousel does not have the capacity to house all the current Operating documentation,
 - Operations staff find it distracting when other staff come into their work area to use or update the Operating documentation, and
 - The carousel restricts comfortable use of the peninsula desk surface as a meeting table.
- Console Drawer Storage - The former console drawers for storage of pencils, tape, tags and forms were removed in the new design and relocated to cabinets behind the console to improve console legroom. The items commonly stored in these drawers are not items of frequently used or requiring quick accessibility. However, Operations staff have found the lack of drawer storage at their work location inconvenient, and a drawer unit has been retrofit to the new console to meet this need.

FUTURE WORK

We expect that the new console will easily accommodate future Operational needs to support control room change for some time. As more experience is gained with the new console and workspace layout, we expect further refinements to be initiated. The same console and workspace upgrade will be implemented in the PLGS simulator in the near future.

CONCLUSIONS

This paper has described the PLGS experience with characterizing operator control room workspace usage and support needs, and the development of successful and cost-effective solutions for better supporting current and future operational needs. The project experience has also demonstrated two additional benefits. First, large scale control room modifications can be safely installed with the station at power. Second, the console and workspace upgrade offered an excellent opportunity to improve equipment maintainability and expansion capabilities.

Although not all aspects of the design have proven to be useful as intended, the design and research efforts up-front proved to be invaluable in the successful restructuring of the control room area. Several aspects of the new console design have also been adopted by AECL for use in the new CANDU control centre currently under development.

REFERENCES

Feher, M. and Davey, E. (1995). Recommendations for Control Room Operator Workspace at Point Lepreau. AECL Research Control Centre Technology Branch report HMSD-19-TCN-1 Revision 0, Atomic Energy of Canada, Chalk River, Ontario.