Controlling chemical processing plants is a highly team dependent activity. In most plants, one control board operator must interact with two or more outside operators in addition to coordinating their activities with other plants. Unfortunately at some plants, the crew functions as a team of experts, unable to assist each other and moderate the workload peaks. The result of poor team performance can include ruined product, damaged equipment, and even injured personnel.


In the study, teams of subjects performed simulated combat radar detection under high and low workload conditions. Cross-training was also conducted via positional rotation on half of the teams. Team members were tested after the training to ensure their understanding and proficiency.

There were several results of the study, including validating that cross-training is an effective way to enhance team performance. Those that were cross-trained correctly engaged nearly 25% more targets than those that were not. The cross-trained teams were faster and more accurate than their non-cross-trained counterparts.

Teams that were cross-trained were found to have more efficient communication patterns and volunteer information more readily. Through the knowledge gained in cross-training, teams were able to coordinate their actions implicitly rather than communicating them overtly.

Another important finding was that under high workload conditions, effects of cross-training were most pronounced and the cross-trained teams had the highest performance. Under low workload conditions, the effects were negligible and cross-trained and non-cross-trained teams performed about the same.

The authors of the study suggest that it may well be possible to customize or tailor the cross-training to individual team members. For example, outside operators may only need to be cross trained on certain aspects of a control board job instead of the entire control board job.

The study findings have obvious implications for managing high workload upset and emergency conditions. Rotating through job positions is an effective form of cross training that will increase the effectiveness of the crews, with the greatest benefit appearing during upset and emergency conditions.
Things were so much simpler back in the early days of Distributed Control Systems (DCS). Configuring a DCS used to be no more difficult than deciding which eight instruments to group together on faceplate displays. There used to be no real choices regarding how to display information. Then came first generation DCS graphics, and with it, a whole new set of choices (and arguments) on how to best display the information to operators. These systems still had many constraints, such as only two character sizes and sixteen colors to chose from. Now come Windows NT based control systems that remove many of the configuration constraints; display designers have what seems to be Michelangelo’s color palette to choose from and infinite character sizes and fonts. In a lot of cases, fewer constraints has meant more ways of really screwing up the display systems.

Without question, Windows NT has advanced the state-of-the-art in control system interface capabilities. However, in other ways it poses a serious threat of degrading the operators’ ability to control processes. Harnessing the capabilities and avoiding the pitfalls of the new NT control systems takes far more forethought and planning than that required by their predecessors.

The most significant change between the older DCSs and the NT systems is the way operators find and navigate to information. There is a fundamental difference between how people find information in Windows NT versus older DCSs. Windows and its counterpart, Internet Explorer, have historically relied upon menus and imbedded graphic targets for navigation. In contrast, older generation DCSs relied heavily on dedicated function keypads for navigation, and to a lesser extent, embedded graphic targets. To use the DCS keypads, designers had to delineate instruments into groups and areas. For those that configured the old systems correctly, the dedicated keypads did a good job of coupling the alarm and display information together. When an alarm entered the system, the operator simply scanned the dedicated keypad for the flashing light, and called-up the alarm on the display through a single keystroke. Many NT systems have done away with dedicated keypads and the need for groups and areas. In their place, the NT systems rely upon pull-down display menus and alarm summaries. Relying upon menus and alarm summaries is cumbersome since it breaks the stimulus-response relationship between the alarms and displays and also places added mental demands on operators as they have to recreate the alarm-display relationships (i.e., what is the alarm, how do I get there). The relationships can be built back into the NT display systems, but it requires the designers to carefully define display structures and relationships between information. Failing to create the alarm-display relationships will leave the operators unable to detect process changes and lost when trying to find information and navigate through the displays. A common complaint of operators using the new NT systems is how much more time consuming and difficult it is to find the information they need.

Related to colors is the new use of surface texturing to create a 3D effect for equipment. Although vendors tout the 3D equipment representations as the greatest advancement since the wheel, the feature can interfere with color coding and degrade human performance. The time and effort that is needed to create the 3D effect (which has been estimated to add 15% to the cost of the graphic development) is better spent refining graphic displays or on alarm management.

Another much touted feature of Windows NT is the ability to have four windows open simultaneously. Although this feature helps in cutting and pasting when creating documents, it has limited use in a process control environment. Since the windowing effect shrinks the character image to a quarter of its original size, most text will be difficult to read at normal viewing distances and cause eye strain and visual fatigue. Those that base their display system design concept on using multiple open windows are making a big mistake. Trends are the only viable choice for the multiple open windows since their initial trend image is usually full screen in size.

Common to most NT systems is that they are slower at calling up displays than systems they replaced. The slowness has been both an irritation and a source of error. Some of the first generation NT systems, using 166MHz Pentiums, are an irritation to operators since they can take as long at fourteen seconds for a graphic to build. The latest systems have more cache memory and faster processors, but they are still slower than the DCSs they replaced. NT users have also reported the slowness causing an increase in data entry errors. Apparently operators’ data entry speeds exceeds the NT’s buffer entry rate and the entered data will be missing the first one or two digits. For example, operators thinking they opened valves to 70.0% have actually closed the valve to 0.0%.

Like any tool, in the hands of the naive and inexperienced, the NT control systems can turn work into a disaster, or in the hands of a knowledgeable craftsman, it can prove to be an effective instrument. If you have questions on how to best use the Windows NT features or would like to share experiences of configuring the new Windows NT control systems, please feel free to send us an e-mail at beville@beville.com or call us at 937-434-1093.