MICRO-SCENARIOS AS THE FOUNDATION FOR PREVENTING INFORMATION INPUT OVERLOAD IN SUPERVISORY CONTROL

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Abstract: Process control in control rooms is currently in a state of technological flux driven by recent developments in information technology. The continual integration of new control devices carries with it the risk of overburdening the human operators, with a major source of danger here being information input overload. This article addresses this phenomenon and presents possible micro-scenarios that can be the foundation for subsequent user interface requirement specifications and concepts.

Keywords: User Interfaces, Process Control, Human Supervisory Control, Ergonomics

1. INTRODUCTION

Information input overload is a frequently experienced phenomenon of everyday working life: The process of dealing with urgent work is hampered by having to deal with too many incoming documents, both in hardcopy and electronic form. Just looking through the resulting large piles of documents on the desk takes up too much valuable time. And to make matters worse, superiors always seem to want the latest figures on one thing or another. Even in our leisure time, the amount of information available to us is constantly increasing, and studies have shown that even schoolchildren are affected by information input overload (Akin, 1998). This article will highlight this phenomenon in an area which, because of its particular characteristics, is severely affected by information overload - the supervisory control of technical processes.

2. CURRENT CHALLENGES IN INDUSTRIAL PROCESS CONTROL

Modern industry is to a large degree dependent upon automated technical processes. They assist in the production of high-quality products with the minimal use of time, energy and raw materials (Charwat, 1992). Dynamic technical processes, because of their time behavior, have constantly changing process and system variables (Johannsen, 1993). Operators, who supervise and control the processes from the control room, only intervene in running processes when necessary, normally the processes are run automatically.

Today's process control systems have graphical user interfaces displaying an enormous amount of data – more than 2 million process variables and up to several thousand process images can be displayed. As human processing of these masses of data is not possible in real time, the difficult challenge for automation engineering is to ensure that the process control system makes the data required by the operator ready for use. Another challenge is presented by progress in information technology, which opens up the possibilities of even more optimized process control and, with it, improved plant outputs. As human operators, with their limited cognitive skills, are responsible for the smooth running of processes, it is obvious that new concepts are needed for integrating modern information technology into existing automation structures. This article therefore puts the case for taking existing knowledge on information input overload as well as scenarios into account when developing these concepts.

3. INFORMATION INPUT OVERLOAD

Hall (1998) summed up the problem of information input overload in a single sentence:

> "Too much information arriving too fast, much of which is irrelevant or of questionable quality, can harm both employees and their companies."

For a more comprehensive summary on causes and symptoms as well as countermeasures refer to Mengis & Eppler (2004).

In industrial process control where, due to the demands of real-time affordance, the problems surrounding information input overload are all the more acute, the consideration of information input overload when designing human-machine interfaces has until now tended to be implicit. Today's process control systems therefore contain many features intended to suppress information input overload, but these have tended to be integrated unsystematically, and not as the result of deliberate consideration of the problem (Hollnagel, Bye & Hoffmann, 2000).
In the nineteen sixties, Miller (1960, 1962, 1964) published studies of the effects of information input overload on cells, organs, individuals, groups and social institutions. The results show that it is possible to cope for a time with increasing quantities of information, but that after a certain point it is no longer possible for further processing resources to be made available (Figure 1).

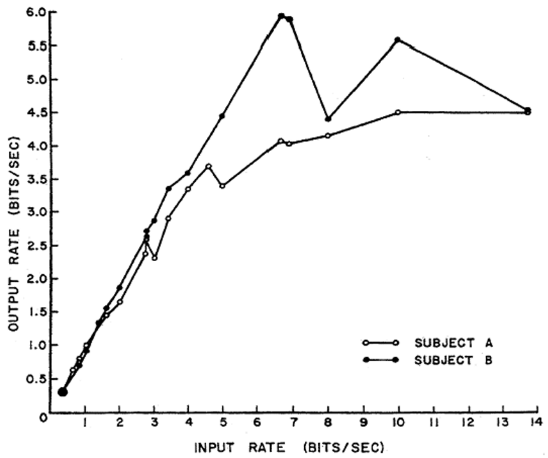

Fig. 1. Performance curves for two subjects (Miller, 1960).

Miller identified the following seven strategies used by individuals, groups and social institutions for coping with the flow of information (see Table 1):

Table 1: Seven strategies for coping with information input overload (after Miller, 1960, 1962, 1964).

Strategy	Description
Omission	Temporary and arbitrary non-processing of information
Error	Incorrect processing
Queuing	Delaying response during high load in hope of catching up later
Filtering	Neglecting to process certain categories of information while processing others
Approximation	Being less precise for the sake of speed
Multiple channels	Distributing processing if possible
Escape	Escape from the task

Miller also investigated the frequency with which the various strategies were used. The most frequently used strategies are *filtering* and *omitting*. The difference between these two strategies is that *filtering* involves some preprocessing of data, whereas *omission* tends to be unconscious and unsystematic. The most seldom-used strategy is e*rror*, which is not surprising, as the consequences of this strategy cannot be justified: errors are easily discovered and the person responsible easily identified. Also, the consequences for a person's work/organization can be very negative. The maxim here, therefore, seems to be: "Better do nothing at all than make a mistake".

4. MICRO-SCENARIOS,CONSEQUENCES AND IMPLICATIONS

In the following, possible scenarios for each of Miller's seven strategies (1960, 1962, 1964) are outlined, although other scenarios could of course apply. Scenarios are narrative descriptions of what a user may do and experience during his or her work (Carroll, 1997). They can be fragmentary, incomplete and informal, yet they should allow deriving implications for system design from them. Since – due to their volume – the following scenarios are reduced to a maximum they are called micro-scenarios. They were created in a workshop with usability engineers experienced in the area of industrial automation. These micro-scenarios also serve to highlight possible negative consequences of their application, the assumption being that these consequences could include lost time and production and premature wear of technical components. The consequences were derived from the micro-scenarios in the expert workshop as well.
Finally, as a last step of the workshop, implications were inferred by the experts. They are too abstract to be translated into a user interface concept directly, but they build the first user interface requirements. For lack of space only a selection can be presented here.

4.1 Omission

Scenarios:

- Process parameters are only checked sporadically and selectively.
- While the operator is talking on the phone in the control room to a colleague on the service team, he is unaware of newly-arriving system messages relating to the technical process.
- The operator forgets to keep a log and to give his/her colleagues important information at the shift handover.
- There is a flood of messages, during which dozens of system-generated fault messages are displayed within a matter of seconds; the operator is only able to read a small number of them and misses the rest, which he must then retrieve later.

Negative consequences: