



## Advantages of shift changeovers with meetings: Ergonomic analysis of shift supervisors' activity in aircraft building

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### ABSTRACT

Good shift changeovers contribute to ensuring continuity and reliability in shift work. In situations where production is not maintained 24 h a day, changeovers with meetings (SCM) between the two work teams (written plus oral face-to-face handovers) alternate with changeovers without meetings (SCnM; written handovers only). An ergonomic work analysis on an aircraft assembly line showed that (1) incoming and outgoing operators met during the overlap time allotted by the company, and (2) the content of the exchanges was richer for SCMs than for SCnMs. SCMs enabled the operators to pass on and process more aspects of their work than SCnMs did. SCMs also allowed incoming operators to validate their predictions, and enabled both outgoing and incoming operators to update their mental models and work together on peripheral aspects of the technical process over a greater time span. The findings highlight the importance of allowing overlap time in shift work.

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## 1. Introduction

### 1.1. Description of the problem

A shift changeover occurs when one work team is relieved by another in a shift work situation. This is when responsibility gets transferred, mental models get updated to fit the current situation, and tasks get coordinated. According to Grusenmeyer (1991) and Lardner (1996), an efficient shift changeover should include three different stages: (1) preparing information to pass on, (2) executing the shift “handover” during which the outgoing worker communicates task-related information to the incoming worker, and (3) matching the information handed over by the outgoing operator to the information taken off the system by the incoming operator. The second stage is not always possible, however, especially when production is interrupted, as in  $2 \times 8$  shifts where work stops at night and on weekends. In this case, communication between work teams can only occur in writing, via a handover notebook or using audio and video technologies. Two types of changeovers must be

distinguished: changeovers with meetings (SCM), based on written and face-to-face verbal exchanges, and changeovers without meetings (SCnM), only based on written handovers left on site for the next work team. SCM and SCnM differ not only in terms of communication mode (oral vs. written) but also in terms of synchronicity (dialogue in one case vs. one-off message in the other).

In organizations with 24/7 coverage, especially in cases where the production cycle extends across several shifts, flawless coordination of activities is expected of the teams that succeed each other. This requires optimal updating of the operators' representations and mental models. Grusenmeyer (1995) showed how oral exchanges during shift changeovers enabled workers to obtain a shared, functional model of the situation. Clearly, the changeover process is highly instrumental in achieving good coordination. Some studies have claimed that the best conditions for reliability are achieved when the incoming and outgoing operators can communicate orally in person, preferably without an intermediary, perhaps with the help of a written checklist (Parke and Kanki, 2008; Wilson et al., 2005; Gramopadhye et al., 1999). However, organizations seeking increasingly rational production are pushed to eliminate any “unproductive” periods. Shift overlap time is likely to be seen as unproductive by work organizers who ignore its role in providing an opportunity for cross-team updating of mental models, or who fail to see it as indispensable to the proper

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execution of the changeover process. In an earlier study [Andorre and Quéinnec \(1998\)](#) showed that shift operators try to meet even when overlap is not prescribed. What benefits are offered by this exchange and overlap time set aside during shift changeovers?

The goal of the present article was to shed light on this issue by pointing out some of the advantages of SCMs over SCnMs. The arguments presented are based on an ergonomic analysis of the work of shift supervisors on an aircraft assembly line.

One way of testing the hypothesis that SCMs are more advantageous than SCnMs in terms of mental model updating would be to provide evidence of a higher prevalence of malfunctioning (errors, incidents, longer production times, lower quality) in work-organization systems with SCnMs than in ones with SCMs, all other things being equal. Yet the large amount of variability across production situations makes it impossible to compare situations differing solely in the type of changeover used. More importantly, doing so would mean ignoring the ability of operators to anticipate and recover from these malfunctions in their work activity. Two other ways of studying this problem are feasible however: (1) show that when overlap time during shift changes is possible but optional, operators make use of this flexitime to meet, and (2) define the functions that must be performed to achieve a safe, reliable, and efficient changeover and then show that these functions are performed better in SCMs than in SCnMs. We used both of these strategies in the study presented here.

## 1.2. Do operators make use of SCMs?

The shift supervisors in this study worked in a  $2 \times 8$  system, with an SCM between the early and late shifts, and an SCnM between the late and early shifts. SCMs are only effective if the outgoing and incoming operators choose to use the shift overlap time to get together. In the current study meeting with the other operator was optional, with either the outgoing operator deciding to stay later and/or the incoming operator deciding to come in earlier. One way of finding out whether operators think SCMs are important was to look at the extent to which they make use of the overlap time allotted by the company.

## 1.3. Conditions for an efficient changeover: gathering information for updating and expanding mental models

Shift work can be regarded as a teamwork system that relies on cooperation across different shifts; this requires building and updating a shared knowledge base and coordinating work activities ([Barthe and Quéinnec, 1999](#); [Schmidt, 1994](#)). Shift changes are key moments in this process. [Grosjean and Lacoste \(1999\)](#) described two main functions of shift changeovers in a hospital: joint updating of mental models by staff members, and reciprocal enhancement of those models. These functions can be broken down into several sub-functions, the first of which is a prerequisite to the others: (1) gathering information distributed across various sources and checking to see whether it is shared by the incoming and outgoing workers, and (2) comparing and adjusting the analyses, debating difficult topics, planning future decisions, evaluating the short-term consequences of prior decisions and actions, and finally, teaching and learning. In this paper, we will show that SCMs have some advantages over SCnMs in terms of information gathering, since the interactions that take place promote (1) a more complete handover between the outgoing and incoming operators, (2) validation of the incoming operator's expectations, and (3) enhanced exchanges.

### 1.3.1. Preparation and handover of information by the outgoing operator

When preparing a handover, the outgoing operator selects any information deemed useful for the incoming operator. In an SCM system, this information is mostly passed on during an oral interaction; in an SCnM, it is handed over in writing. Putting information down in a written handover requires various cognitive processes, including planning, sentence generation, revising, and graphomotor execution ([Hayes and Flower, 1980](#)), some of which are effortful processes ([Kellogg, 1996](#)). [Ochsman and Chapanis \(1974\)](#) clearly showed the difference between voice and hard-copy modes, with voice mode being richer and more efficient for task achievement. This suggests that it is easier to transmit information orally than in writing. One way of pointing out the advantages of SCMs, then, would be to show that outgoing SCM operators supply more information about the preceding shift than SCnM operators do.

### 1.3.2. Validation of the incoming operator's expectations

When outgoing operators leave work, they know the current state of the situation and make predictions about what will probably happen next. The shift changeover must make it possible for incoming operators coming back to work to fill in their mental model of the situation, and to confirm or refute their own expectations in order to adjust their plans if needed. One of the specificities of SCMs is that they allow incoming operators to validate their predictions in the most explicit and economic way possible, i.e., without having to go to the assembly line themselves to make direct observations. In the present study, we will show that incoming supervisors do not play a passive role in shift changeovers – they take initiatives in order to obtain confirmations from their outgoing counterpart.

### 1.3.3. Enhanced exchanges

During shift changeover meetings, information distributed across the workplace, not yet communicated, or forgotten during earlier shift changes is gathered, and upcoming shifts are prepared. The work situation, and thus the workers' activities, is partially determined by the shift hours (e.g. some departments operate only during the day) ([Toupin and Volkoff, 2007](#)). A changeover must make room for operators to update their mental models to fit both the technical process and the context in which tasks are to be carried out. Part of the work may involve relations with in-house or outside bodies (administrative offices, research agencies, etc.). One way of demonstrating the advantages of SCMs would be to find out whether incoming operators bring up topics that outgoing operators didn't mention, and whether the new topics addressed deal with technical problems or are less directly related to production.

The production process and the operator's experience are constantly evolving. Both are part of a history but also require projection into the future. Shift changeovers provide a means of coordinating operations in two different time frames: (1) an immediate time frame (the here and now) during which the operator gives an account of everything that just happened so decisions about what to do next can be made, and (2) a longer time frame that includes past and future shifts. The transfer of information related to these different temporal spans helps reduce the uncertainty generated by the complex situation facing operators who manage a production system ([Woods, 1988](#)). To demonstrate this additional advantage of SCMs, we looked at whether operators go back over past events (not just ones from the previous shift) and whether they bring up topics related to future shifts.

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