

## **Behind the Scenes – Unintended Effects of Increased Technology use in Operational Train Traffic**

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Information technology has been an increasingly pervasive component of most workplaces throughout the past half-century, and has resulted in changes to how, when and where we work. In operational train traffic, the main actors are train traffic controllers and train drivers and their workplaces are no exception to the rapid implementation pace of new IT across society. The work of traffic control is performed in a control room—an environment that has long been technology intensive, and automation is anticipated to play an even more increasing role in the future. At the same time, the train drivers that traditionally has relied on their “out the window” perception are now requested to work with a variety of modern driver systems and are thus exposed to more information technologies within the cab than ever before. Overall, the last two decades have presented a rapid growth of railway technologies, mostly with the aim to increase capacity, and we pose the question as to how this has affected the work practices in Swedish operational train traffic. In this study, the aim is to investigate the effects increased technology use has had on the work conducted by train traffic controllers and train drivers respectively but also how it has affected the collaborative aspects of their work.

Prior research on Swedish traffic control reveal inefficient decision support systems and a lack of precise details in the information presented. To address these issues, new control systems and more usable interfaces have been developed and implemented (e.g. Andersson et al., 1998). In a comparison of traffic control in Sweden and Great Britain, work with automatic functions was described as a “turn it off syndrome”, indicating a lack of trust for the automation, which the controllers switched off as a result (Golightly et al., 2013). When it comes to the train drivers, Jansson (2005) described how they were driving in an “information vacuum”, but this has later started to change and from the international research community it has been described how train drivers are exposed to multiple driver systems designed around signal awareness, train protection, and to aid decision-making (Naweed, 2014). The effects of increased technology inside the cabs are an understudied area in Swedish train traffic, although some initial descriptions of train driving and the technologies used for this task is addressed in Andreasson et al. (2019). Another aspect that research has not fully covered is the perspective of joint collaborative work between traffic controllers and train drivers, and how this collaboration is affected by changes in the technologies used as work support (although, see Andreasson et al., 2019).

The study was conducted in the domain of Swedish train traffic and the main data collection techniques were interviews and observations of work by train traffic controllers and train drivers in situ. The participating traffic controllers were employed by the Swedish infrastructure manager and the train drivers worked for Sweden’s largest railway undertaking for passenger trains. All participants had 2-30 years of work experience. 19 traffic controllers and 13 train drivers participated in the study and there was approximately 130 hours of observations (these were close to evenly divided between the roles but with a slight overweight on observations of traffic controllers). The observations were complemented with informal interview questions to add clarifications to what was observed. Further, three pair-wise in-depth interviews were conducted with one traffic controller and one train driver participating in each interview session. These pair-wise interviews were 1,5-2 hours long and mainly concerned the relationship between the roles and aspects of collaboration between them. Field notes were carefully taken during observations and audio recordings from the

interviews were transcribed. All data were analyzed based on the systematic process of thematic analysis.

The findings show that changes to the IT systems, or the implementation of new IT systems, used by train traffic controllers and train drivers affect their work in multiple ways. It was for example shown that traffic controllers are struggling with the increased automation and regularly switches off the automatic functions to manually take over the control. One of the participants explained that: “It does not think for itself so it is best to disconnect it. It varies how often people disconnect the automatic functions but we all do it.” This is in line with prior research, for example the prominent paper by Bainbridge from 1983 in which she points to “ironies of automation” and describes how users tend to do manual take-overs in critical situations, thus turning the automatic functions off in the situations they are especially intended to support. In the cabs, the drivers are equipped with more technology and more information to be attentive to. However, the importance to stay focused on events outside the train, to anticipate and react to surrounding factors such as weather conditions, and passenger behavior at platforms, etc., has not changed. The result is thus that the drivers are expected to pay attention to more sources of information and multi-task in way that they previously did not have to. One of the participants, a driver of 30 years and also an instructor for the train driver education, expresses concerns regarding changes in driver behavior that he believes are caused by the increased amount of information digitally presented in the cabs. He says: “I see drivers looking at their tablet instead of out the window. It is usually in the difficult areas you want this information but those areas are also the ones that are the least appropriate for you to be sitting there and looking down.” More information, no matter how valuable, puts higher demands on the drivers and especially regarding how they divide their attention between all the relevant sources of information, constantly shifting their visual attention from monitoring the outside of the train to attending to information presented inside the cab.

Yet another relevant perceptible on how the increased technology use has affected the way of work in operational train traffic is from the perspective of collaboration between traffic controllers and train drivers. Both roles depend heavily on a functioning communication and collaboration between them to enable a successful execution of their respective tasks. A train driver describes how access to more IT has resulted in fewer points of contact with the traffic controllers: “In terms of information, it is like a new world. We don't need to call and ask the controllers as much as we used to. Now we can look at our tablet”. A traffic controller describes his point of view with the words: “We have noticed that the tablet is used to take own initiatives as a driver. That can create huge problems for us”, and refers to the fact that drivers do not have access to the overall traffic situation. Clearly, technology brings changes to work practices and due to the collaborative nature of operational train traffic, these changes spread and affect also the other role and the collaboration between them.

In summary, the main findings of this study points to the importance of designing for the actual work practices that the technology are intended to support. IT is drastically changing work practices and it is of utmost importance that these implementations are made with the human user in mind and with respect to all nuances of work, not just the main task but also informal activities associated with aspects such as communication and collaboration. Although to a large degree undocumented, these aspects of work are founded in professional knowledge and expertise and are thus central for a safe and efficient performance. These aspects of work need to be understood and preserved to inform the design of new technology so that it does not unintentionally disrupt informal work practices critical to the overall safety of the system of operational train traffic.

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