

Ulf-L Andersson:

Could a single beep have saved 19 lives?

A railway accident in Norway can raise some interesting questions on human communication. Simple questions such as how to attract attention to warning messages and more complex questions such as how people build mental models out of limited input information. Problems we meet in many technical communication situations.

At 13.07.10 on the 4th of January 2000 the northbound train 2369 left the platform at Rustad station, three minutes ahead of schedule, and entered the single line track to Rena. It drove past the exit signal at Rustad at 13.07.58. At 13.07.15 the southbound train 2302 left Rena, entering the same single track line. At 13.12.55 (exact time due to seismic observations) the two trains crashed into each other. About three quarters of the passengers survived with more or less serious wounds, while 19 people died, some of them burned to death in the flames.

Why did they leave?

At first it appears that the northbound train 2369 must have left Rustad station in spite of a red exit signal. The automatic block signal system should give a red exit signal when a southbound train has left Rena. Rustad is an unmanned station. No one was on the platform when the train left. The train driver and the guard were both killed in the accident and cannot give evidence. In such cases it is so easy to blame those who cannot defend themselves ("the human factor").

So why did they leave Rustad? And why ahead of schedule? The driver and guard were both experienced, knew the railway line well, and had good service records. Train 2369 was a motor wagon set of two carriages. When leaving the station and at the crash both driver and guard were in the driver's part of the train. So, if the driver missed a signal it would be likely that the guard should remind him.

Normally they should meet the southbound train at Rustad. However, if that train was delayed, the regional dispatch center at Hamar could change that without giving any other notice than changing the exit signal at Rustad to green. The train driver just had to follow the signals.

It cannot be ruled out that the exit signal at Rustad during a couple of seconds could have been green (for example because of an intermittent logical failure). There had been some minor signal problems earlier on the railway line. If, however, it were green for a longer period it ought to have been seen in the signal log at Hamar, and no such recording was made.

A possible scenario could be that, when their train entered Rustad station, the driver (and guard) somehow from the entry and distant signals got the impression that the exit signal was also green and from that created the mental model that the train crossing was at Rena instead. A short green exit signal could have been enough to convince them that their mental model was right.

More mental models

Although there seems to have been a bit confusion on what had happened and the magnitude of the accident at various alarm centers involved, the first police were at the crash site about 13 minutes after the crash. Five minutes later came the first ambulance and the local fire brigade. At this time the alarm centers had understood that it was a major accident and had called out fire brigades and put hospitals on full alert.

The two trains were powered by diesel engines and had together around 4500 litres of diesel fuel on board. When they collided, each having a speed of about 90 km/h, the fuel tanks burst and the fuel was vaporized into a fog that was ignited by the friction heat from the collision. In the first coach behind the engine of the southbound train some people got caught by debris. At least four of them were burned to

death. The fire brigade resources at the site were insufficient, both regarding water for fire fighting and mechanical equipment for freeing people from debris.

Here we may have another case of a slightly distorted mental model. Luckily enough most distress calls are not about major accidents. So, when a person living nearby the accident site, one minute after the crash called the police and reported a terrible noise, sparks and a smoke cloud from the railway, it may not have generated a mental model of a major accident. Even eight minutes later the police officers at that alarm center were not aware of the fact that it was a collision between two passenger trains. Also, in the next few minutes there were several phone calls between different railway and alarm centers, some of them could roughly be parodied like this: Person A - "There has been a railway accident." Person B - "Yes, we know". End of conversation and person B still unaware of the scale of the accident, which person A knew. In a stressed communication situation this is not uncommon.

A similar story from a Swedish railway accident some 30 years ago shows how insufficient information can create an incorrect mental model. The young deputy chief of the fire department in a Swedish town was on duty one evening. On his way in his command car back from some business he got this message over the communication radio: "Railway accident. Road crossing at Raa church." From this he got the mental model of a railway train colliding with a car. So he called out one rescue vehicle and one ambulance. When he himself, after ten minutes, as the first rescuer came to the accident site he found that two trains had collided resulting in lots of wounded people. Of course he then called out all the resources he had. But they were ten minutes delayed because of the incorrect mental model.

A missed warning

Frequent beeps from your computer can be very annoying. Especially since you in most cases already know you have made a mistake or you can see the error message on the screen. However, in some cases a beep can be vital. An error message on a screen can be spotted when you look at the screen. If you have turned your head away from the screen, it may be missed.

In the accident in Norway a warning message was present on one of the train dispatcher's CRT screens between four and five minutes before it was noticed. Why? The train dispatcher in charge said in a television interview: "If only there had been a beep when the warning came up I would have looked at the screen and could have done something".

This warning that the northbound train had entered the track occupied by the southbound train was indicated at the bottom of a CRT screen in 16 mm high red text. No flashing. And no beep. The screen was the one at the far right hand of a semicircle of four screens. The train dispatcher was busy with a problem on a screen furthest to the left, in a telephone discussion trying to solve a problem on a different railway line.

Not until four minutes later, when the problem is solved, did he take an overview over the rest of the screens and immediately spotted the warning message. There was now between a half and one minute before the trains were to meet, each with a speed of about 90 km/h.

If the railway line had been electrified, as most lines in Norway, the train dispatcher could have turned the power off. Now, however, two diesel driven trains were approaching each other on the same track. If there had been a train radio at this railway line, as on most lines in Norway, he could have called the drivers and at least reduced the consequences.

Now he had to find the numbers of the train drivers' mobile phones. As a routine the drivers called the dispatch center when starting on a route and reported their phone numbers. Unfortunately the earlier dispatcher shift had noted them down on a different place than normally used. When the numbers at last were found, no one answered...

After two similar train accidents earlier in Norway, human factors specialists suggested that acoustic alarms should be installed at the dispatch centers. In 1992 Hamar center got a quotation for installing such an acoustic alarm (beep) at 36 000 NOK (approximately \$3500). Other investments were deemed more important. So the beep that could have saved 19 lives was not installed.