HOW MUCH IS TOO MUCH?

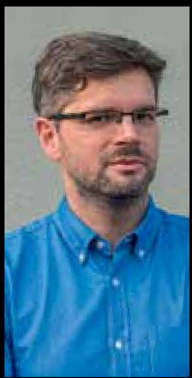
by Adrian Bednarek

I guess it used to be a sort of obligation for every action movie in the 90s to include a breathtaking scene with warning lights and sirens coming on. Red and yellow lights, a timer counting down and a decision which wire should be cut – it was all that simple and straightforward. Whether it was on a flight deck or at a nuclear missile launch site, there always was our hero ready to save the day (or – very often – the whole world). As always, the reality turns out to be much less spectacular and there is no timer to let us know how much time do we have. And our hero – the system operator, a pilot, an air traffic controller, process specialist or launch site commander – usually seems to be both lost and focused at the same time. Plus, there's no background dramatic music to spice things up…

There are places where all those flashing warning lights give us so much contradictory information at the same time that the person operating the system simply doesn't know what to do. Those places include nuclear power plants, chemical plants, operating rooms in hospitals or - when taking aviation into consideration – aircraft cockpits or maintenance facilities. In air traffic control those signals seem to be simpler to process - a warning comes on when aircraft are too close to each other, or they're flying too close to the ground. Actions to be taken also seem to be equally clear - press the button and tell the pilot to turn or change the altitude. Can it get any simpler than that?

In fact, it's a little bit more complicated. Modern ATM systems are much more complex than they used to be. We're not even aware how much data they process every second and how many data sources they use. Let's think about that for a moment - it's not a pure and raw radar signal being transferred to the screen. There is a whole network of those radars and each aircraft position is calculated in real time, based on the information taken from all of them. Then you have all the maps, sectors, borders, areas and their coordinates put into the database your system is using, along with the flight plans and other information processing - each aircraft is expected to be correlated and that information is exchanged with another system located abroad or in another city. When you have all the data combined it's only the programmers' ingenuity that limits what you can do with it. For example, you can decide to use it to warn the controller if he or she is doing something 'wrong', according to the system's logic.

That opens up a whole new range of possibilities for modern warning systems, or safety nets if you prefer to call them that. It's no longer a question of are those two aircraft too close to each other but also if they are flying assigned headings or following their routes properly. Are they properly equipped to enter RVSM airspace? If not, why did you clear them to such a high flight level? Or why is an aircraft flying into a sector which uses 8.33 MHz channel spacing when, according to the flight plan, it will not be able to select the proper frequency? Or maybe you should double check if your last acknowledged instruction was properly received, because it seems that the altitude entered by the crew into their FMC differs from the one entered by you into the system? And hey, you should look at this aircraft which is being transferred to your frequency! Yes, you get my point – warnings popping on your screen try to tell you more than just a simple "it's too close". Every warning message is supposed to be different but they all follow the most recognisable logic in colour coding - green is the normal state, yellow means something's not right and red means something's definitely not right and it's probably very serious. But that wasn't enough so a few other ways of catching your attention came into your life – flashing, bold, boxed or underlined text, an icon, a letter or a digit to let you know what exactly is going on. The whole idea of giving a warning before something bad happens is



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brilliant! And it really works when you're dealing with a single situation going wrong. It's not that easy when your screen is full of alerts and symbols which all look similar but only one of them is really important at that particular moment.

On 12 July 2012, a Boeing 737-300 departed Warsaw airport for its cargo flight to an airport in Western Europe. It wasn't an easy departure – several thunderstorms surrounded the airport and most aircraft were trying to avoid them, flying around in more or less random directions. At the same time a Saab 340 was trying to find its way to the airport and was entering the TMA from the west. As you might be expecting, things went badly and the result was a TCAS encounter with minimum distance being 2.69 nm horizontally and 700 ft vertically. A short-term conflict alert (STCA) was also activated on the controller's screen.

> *At the time immediately preceding the occurrence alerts appeared very frequently on the Controller screen. They were irrelevant to the proper operation of the Controller in his area of responsibility (except for the one concerning the analyzed proximity). For a dozen minutes such alerts were displayed on the screen. Each of these alerts was a piece of information which the Controller had to process and make a decision as to its meaning. For example, during the 10 minutes preceding the occurrence there were numerous STCAs, APWs, STSs and HAND OFFs. Each of these warnings was visualized in a color attracting attention (yellow or red, and SPI – white flashing) which means that at the same time they diverted the Controller's attention from other elements shown on the screen.*[1]

Even the most experienced controller still remains a human being (despite what you may have heard!) and his or her ability to move their attention from one part of the screen to another is limited. Most of us know that feeling of uncontrolled focusing on a small part of the screen where a conflict or another problem is developing (also known as tunnel vision). We don't need additional warning about things going on in that part of our sector but it would be nice to know if there's another place where things might also be starting to go wrong. Flashing warning messages can be a great tool to do that, but too many of them will quickly make them ineffective. Our previous ATM system was a perfect example of such a phenomenon – similar flashing messages were used both for an STCA activation and hand-off information. During busy times, our screens were just filled with such signals. And even when the controller realised that a particular message was a conflict warning, it didn't mean much in our approach control environment – STCA alerts were set to the ACC's minimum of 7 nm separation while we were using 3 nm. It made our approach sector look like a Christmas tree!

It turned out that this performance and fine-tuning problem was not an isolated issue and that it was quite common across Europe. For example, the report on the investigation into a one serious AIRPROX incident in Switzerland in 2012[2] stated that "the air navigation services provider Skyguide defines several STCA "suppressed areas" (SSA) throughout Switzerland, in which the triggering of alarms is suppressed. The reason for this at the location involved was the technical limitation of the ATM system which was not able to filter out nuisance alerts on the radar screens of ACC sectors above class D TMAs.

If you're dealing with limitation like this, you quickly realise that you have only two ways to go – turn the warnings off (like they did in Switzerland) or learn how to subconsciously ignore them (like we did in Poland). Whichever you choose, you have to accept the fact that your safety net is not working and it would be an honest step just to stop pretending that you still have one.

It can take many years to develop a long-term solution to problems like this especially if, as in our case, it was necessary to switch to a completely new ATM system. Of course, it would be naive to believe that it solved all of our problems – in fact, we just limited their severity and moved some of them away from controllers' eyes. The new system introduced additional functions and features which came with new types of warnings attached. New colours (and their combinations) are being used and the number of abbreviations and symbols used has grown dramatically so that now we sometimes find ourselves completely lost when some rarely-seen warning pops up. Just out of personal curiosity, I counted how many different warnings can be related to one aircraft and I found that there could be over dozen of them in a track data block! Taking that into consideration, it's not surprising that a priority system developed to display only a few warnings at any one time. There is simply not enough space to show them all!

It's expected and natural that every computer system working in a dynamic environment will sometimes have to handle erroneous signals. It will receive them as an input from various sensors or from a human operator and, at the same time, it will produce such signals as the result of the computations being done. In case of the safety nets those erroneous output signals result in either unwanted alerts or lack of an alert when it is needed. The former became our biggest issue. It's not difficult for current computer systems to detect (based on current values of aircraft position, speed, rate of descent and heading) that some of the detection thresholds for, say, minimum altitude or separation, will be exceeded. The

1- Extract from Final Report of the State Commission on Aircraft Accidents Investigation on the Serious Incident between a Saab 340 and a Boeing 737 on 12 July 2012 in the Warsaw TMA
http://dlapilota.pl/files/upld/2012_0800_RK_ang.pdf
2- see http://www.skybrary.aero/bookshelf/books/2985.pdf

real problem, especially in a TMA or tower environment, is that the parameters mentioned above are often subject to sudden changes. Aircraft can make a 90 degree turn or reduce speed significantly when turning upwind. The introduction of simple detection and warning safety nets will surely lead us to the problem mentioned before – too many warnings, too many unwanted alerts. The solution is to employ more complex algorithms and to take additional data such as that from mode S or cleared level or heading information manually entered by the controller into consideration. Such data can greatly improve the overall performance of the safety nets system and, in my experience, significantly reduce nuisance alerts. Of course, it's not a perfect world and this strategy comes with its own drawbacks. It relies on additional data, adds significantly to the complexity of the whole system and can have a negative impact on the overall level of safety. For example, a delay in level bust warning which is based on cleared level entered by the controller can be a potential threat for system performance when we realise that this value could have been entered by mistake.

Safety nets have become standard equipment in our ops rooms and I'm sure most of us cannot even imagine an ATM system without them. They have proved their usefulness and they become more and more effective as computing power increases and more useful input data becomes available. But they still have constraints which we have to accept and we always have to consider their ability to interact with human senses and their limitations. Unwanted alerts can become one of the most important issues when it comes to safety nets as their presence quickly erodes the controllers' trust in the system. This can seriously degrade safety and interfere with your perception of risk. That is the reason we should reconsider our approach to safety nets and the role they play. They simply deserve to be properly managed. S