

Podcast 013 – Startle Factor

Hello and welcome to this week's 737 talk where we will be looking at startle effect management. We all well know startle and surprise can influence our performance in a variety of detrimental ways and today we will discuss the topic area along with the most recent research into its management. Is it possible to develop techniques to mitigate startle effect and can we be trained for it?

Startle effects can serve as a distraction eroding safety margins and sometimes, more critically, can lead to inappropriate intuitive actions or rapid decision making bringing about responses based on the first thing that comes to mind.

We'll look at a study that was done by EASA, NLR and KLM where techniques were developed that could be applied operationally in an unexpected situation, or, when there was startle or surprise experienced by one or both crew members.

44 KLM line pilots of varying experience including instructors were experimented upon to evaluate both the classroom and simulator sessions through competency test evaluation.

The results of this experiment showed that using the startle effect management techniques developed the pilots were more effective on key behavioural indicators such as "information gathering" after an unexpected event. It also showed it was possible to train pilots in these techniques within the limited time of a recurrent training slot, although repetition over time would be required to increase their effectiveness.

As I'm sure would ring true to all of us it was shown that the combination of classroom time with coaching style training in the simulator was more effective than classroom training alone. The participants themselves also rated the training sessions highly.

The experiment was tailored toward the KLM operational environment and interestingly KLM have further refined the technique for their operation and culture ready for introduction into their recurrent training and operation.

Startle and surprise factors have played a key role in a number of loss of control in flight events as well as in other types of accidents. In other events, the report cites QF32, these factors have been overcome suggesting there are effective methods to manage them, both individually and as a crew leading to that all important positive outcome.

The EU regulatory framework now covers the need to address startle and surprise effects with training programmes and we have seen the development of CRM, EBT and UPRT. However, there is limited knowledge of how to effectively train us pilots to manage these startle and surprise effects.

Startle and surprise involve a multitude of psychological processes such as attention, situation assessment and awareness, stress, fear, problem solving and decision making. Even without the added complexity of the aviation operational environment every one of those processes

could be delved into in great detail. The report however helpfully puts them into an aviation context and summarises for us.

The startle reflex is the initial response to a sudden, intense stimulus. It triggers an involuntary physiological reflex, such as the blinking of the eyes, an increased heart rate and an increased tension of the muscles. This prepares us for the famous fight or flight response. The startle response is accompanied by an emotional component which for a large part influences how a person responds to an unexpected event.

The duration of the startle reflex is short and depends on its severity. It can range from under a second to 1.5 seconds and it is more severe during very low, or very high arousal levels. Startle also inhibits muscular activity making a startled person stop doing what they were doing. This disruption can last up to 3 seconds for simple tasks but potentially up to 10 seconds for more complex motor tasks. I'm sure you can imagine where on this spectrum we often sit on the flight deck.

If we have enough information available to make a rapid assessment our physiological and psychological response fades away. However, in an unclear or ambiguous situation these levels of stresses can persist, possibly leading to non-deliberate muscle activity and decreased cognitive capacity for situation assessment. This happens when the fight or flight response is strong and creates a sense of urgency to take action under perceived time pressure. This action mode inhibits slow, deliberate analysis. This is assumed is what happened to the crew of AF447.

That's startle, now, let's look at surprise. The psychology of surprise is about how people respond to unexpected events. The surprise itself is a result of a disparity between expectations and what is actually perceived. Surprise contrasts with startle as Surprise can be achieved through a lack of a stimuli too, whereas startle is always triggered by a sudden highly intensive stimulus.

The effects of surprise are in part comparable, with similar physiological responses which impair the working memory while focusing the attentional system. This focus can help in evaluating the situation, but people often tend to focus on the most salient information, which may not be the most important at that moment. Also, the combination of this focus along with the impaired working memory can make the carrying out of the individuals' tasks problematic.

Cognitive responses to surprise include confusion and a loss of situational awareness, possibly involving the inability to remember the current operating procedures. You can see things starting to stack up against us here on the flight deck.

In aviation startle alone is very rare whereas startle plus surprise is quite common, for example a lightning strike, but the most common of all is surprise by itself i.e. Expectations don't line up with reality.

As would seem logical to us the study of surprise, looked at by this joint report, states that “regardless of the ultimate outcome of the flight, surprise very often has a worsening effect on the situation.” This however means that surprise may perhaps be occurring more frequently in normal flight but without major, or even minor consequence for the flight’s outcome and therefore, goes unreported.

One of, if not the most important findings of that study was that potentially any factor, or combination of factors can create a surprising or unexpected event that leads to an unwanted outcome. Therefore, if almost anything, at any time can cause a surprise it becomes almost irrelevant to limit surprise-training to a specific flight event. This means an important aspect of training for unexpected events is its applicability beyond the specific event trained.

Now we’ve all heard of the black swan event, which by definition are severe but rare, such as the miracle of the Hudson. Now, we also have a Grey swan event which are less severe but more frequent. Both types have obvious safety implications and coping strategies therefore deserve attention during training.

Research was also done into how domain expertise and judgement abilities influence how we deal with surprise. Domain expertise is the knowledge you already have about the subject at hand whereas judgment ability is defined as the skill a person has in using knowledge to predict the consequences of an event. The study showed high levels of domain knowledge to be far less effective in the simulator events given compared to the significant influences of high levels of good judgement on dealing with unexpected events, even when domain expertise was low.

This suggests those with good judgement skills to be at an advantage and perhaps the domain experts could benefit from enhanced judgement skills in unexpected situations by thwarting cognitive rigidity and the overuse of intuitive decision strategies. You can make your own minds up on that one!

Another interesting one is fear-potentiated startle or surprise. This basically means that if a person has negative emotional memories of a stimulus, they are more likely to classify this stimulus as threatening. Here is where properly thought-out training is required. A practical example here would be, say, if a pilot quickly mastered the Upset recovery training and felt confident in their ability to deal with potential stalls, she or he would then appraise a stall warning with less startle and therefore less interruption to the cognitive processing, more than likely leading to a correct response and safe outcome.

However, if a pilot had a negative experience in training upsets a stall warning may induce a fear potentiated startle/surprise. This is where the trainer is vital to get this pilot up to competence and comfort taking any necessary time.

A culture where learning from mistakes is actively promoted is vital for us to learn from surprise events. Being surprised is not usually caused by a mistake or a lack of knowledge but we may well perceive it as so ourselves, so this is why the open culture mentioned is so important or these events may not be talked about and then nobody learns from them.

We discussed ICAO competencies in a recent podcast. All of these competencies could be affected by distraction which is the immediate effect of startle/surprise. Other effects of surprise such as cognitive impairments, increased stress levels and perceived time pressure will also affect our competencies. As mostly the higher order cognitive functions are impaired the competencies affected the most would be SA and PSD. These are also the competencies that have the greatest effect on operational safety.

As surprising events occur more commonly, and there is no data suggesting startle events to have more serious consequences, the focus of training interventions looks set to be concentrated on surprising events. As was mentioned before, the effects of startle in the longer term ie over 3 seconds are comparable to that of surprise so training in this area will indeed help with startle events too. You can't inhibit the initial startle effects but if you recognise them and correct them timely, they present limited risk to flight safety.

We spoke about judgement skills earlier and how they seem to help in the surprise scenarios. Training interventions to allow pilots to become adaptive experts is one area being looked at. This should give the individual the ability to perform well, outside of their comfort zone. You should then be able to deal with ambiguity and understand how your current beliefs and assumptions may affect your understanding of a situation.

The belief that judgement skills naturally develop with an increase in domain expertise doesn't appear to be supported in research or in studies into accident and incident data. While there is a moderate correlation to an increase in judgement skills with domain expertise with time it doesn't seem to happen automatically for all people.

This difference could be explained by implicit learning for us as pilots. We are fairly isolated from each other as a profession which means as individuals, we don't have the proximity to colleagues for any real time period which is where a lot of informal or implicit learning would take place. This is perhaps only getting worse as a push toward remote learning increases for the cost benefit.

So, training wise it looks like the focus will be on managing distractions and managing stress in an unclear/ambiguous situation. A technique already used widely, TEM is useful here. The threat of startle/surprise is the distraction, and the error is fixation without returning to ongoing activities. Knowing and understanding this as well as recognising when you or your crew member are in this cycle is one of the management techniques.

Scenarios inducing this in the simulator can be used and then correct training intervention pointing to the signs will allow us to recognise when we are getting in to such a situation and should apply across the broad range of surprise/startle events.

Some examples put forward are things such as introducing a sudden tailwind 30 seconds after levelling off at cruise altitude to induce a stall warning or perhaps when the crew are busy briefing or performing another task. Another being an unexpected GPWS in IMC during a brief or when busy with another task.

The report looks at a training experiment in this area at KLM and makes an interesting read on how methods of startle and surprise are integrated through both initial and recurrent training. In summary two general strategies and one more flight-skilled related are sighted.

The first general is CRM which is regarded as a preventative measure by amongst others stressing the importance of building crew situational awareness by effective communication. CRM would also be used to recover from startle and surprise by utilising training of the PSD, WM, SA, COMM and L&T competencies.

The second area was the use of TEM. Again, this was being trained to be used as a preventative measure by anticipating potential threats, and to recover from startle and surprise by suggesting mitigating measures in advance, creating a mental model which can be accessed more easily following an associated startle event.

The flight-skill related strategy was basic flying skills and UPRT training. As a preventative measure this training gives the trainee the ability to recognise possible threatening airplane states. Practising the manual flying core competency gives self-efficacy, which means the individual has belief in their capacity to execute behaviours necessary to produce specific performance attainments. This will promote adequate response to upsets.

KLM is perhaps leading the way in the implementation here but other airlines are catching up and developing new briefings to be compliant with EASA requirements. Airlines questioned in this report indicated that the best safety value would probably be derived from practical training. Those who have implemented startle and surprise training have done so through the UPRT training.

All though are struggling with the constraints of current FSTD's. This is because perceived life threatening situations cannot be provided, we all know it's just a simulator in the back of our minds. Also, we all know as crews that when we go into the simulator we are not going in for a nice day out on the line which eliminates a large part of the element of surprise.

Two other limitations are that sudden high, or sustained G-loading is not possible and then, as we all know, once a couple of crews have been through the new recurrent cycle most of us on the line become informed of what to expect further eroding any surprise element.

Some airlines are attempting to mitigate this last one by allowing trainers a choice of possible events in the LOE element, but still this number tends to be limited and practical problems arise in developing a large number of suitable events.

At the moment all four major airlines who were asked don't address startle and surprise related subjects in instructor training, but they are now developing programmes so that most importantly, knowledge and techniques can be correctly passed down to trainees.

We now get to the report's preliminary recommendations. Firstly, it is recommended to address startle and surprise early in a pilot's career to prevent us having to perhaps unlearn specific behaviours at a later date.

CRM courses should address specifically, what is startle and what is surprise, along with causes and how it affects the individual. Explanation that the emotions that may be experienced in a real-life event are normal human reactions may help take away some of the additional surprise or even perhaps shame a pilot could feel when they are experienced.

Training in specific areas should perhaps become more varied, for example we nearly always train a decompression with an explosive event. This could perhaps be alternated with a subtle or a recoverable event. This should then assist chances of real-life recognition.

As mentioned previously instructor freedom on events in an LOE needs to be developed so to increase the surprise element and therefore the beneficial training. For type conversion it is also recommended that enough opportunity be given to train unexpected events by perhaps not publishing full lesson plans.

The development of active monitoring is another defence enabling crews to detect deviations at an early stage. This training should focus on SA level 1, perception.

Instructor specific training is needed to provide relevant feedback on the process of surprise handling. Also, the training environment needs to be set correctly, it is not a check. Mistakes are acceptable, even desirable, to try again and get more practise at the techniques. The actual outcome of the scenarios is irrelevant when training general startle and surprise mitigation techniques. Airlines need to make this clear to their instructors and we would suggest their crews too as it's a difficult mindset to get yourself into as a line pilot who is used to a jeopardy checking mentality.

A review of company reporting systems is recommended including promoting of a reporting of incidents about to happen, as well as those that did. Cases should be discussed in training and safety publications and the captain's role as a mentor toward first officers should be encouraged. Perhaps some training in this area should be thought of as we all know times when perhaps as first officers, we weren't quite open to the advice in the way it was being given!

The training design that was implemented by KLM involved 1.5 hours classroom and 1.5 hours simulator training. The training goal is to teach pilots to apply a technique that lets them manage their emotions in all surprising situations where some time is available ie no immediate action is required. This is the case in most abnormal situations other than when, the flight path is not under control, for example aircraft upset or terrain and traffic warnings, or, personal safety is at immediate risk as is the case in an explosive decompression.

The surprise management technique can be applied once these exceptional situations are under control through already trained techniques to further manage any on-going surprise reactions.

The training focusses on surprise recovery, not prevention, basically because we are all human and at some point, our expectations are not going to match up with reality. In KLM the term 'Unload, Roll, Power' is used to recover from an aircraft upset and this was decided upon for use in surprise training too in this experiment. Other airlines will be tailoring their training to their culture.

Unload involves four steps. Firstly 'taking physical distance', pilots are instructed to push their backs into the back of the seat, preventing complete focus on one cue avoiding fixation. Instead of focussing on the surprising event, focus should be on managing its effects.

Second is deep breathing. This manages emotions and counter acts the physical fight or flight reaction by focussing on breathing technique. Pilots are instructed to breathe in through the nose using diaphragmatic or deep breathing and out via the mouth.

Third is muscle relaxation. This is achieved by squeezing the upper legs and letting go of the tension in arms and shoulders. Attention to physical relaxation is important because a calm, rational mind does not exist in a stressed, highly activated body.

All three of these steps are well known arousal control strategies and are mentioned in CAP 737 as stress management and coping strategies.

Step four is checking of colleague. We will all experience surprise and its effects at different rates in a different guise so bringing the crew back to working from the same page is very important. This is done preferably by using the person's name and an open question with paying attention to the answer just as important. In extreme cases where no reaction is given, it can be very effective to touch or lightly push the shoulder.

The next letter of URP is R for Roll. This is where the cognitive process is given a start-up. Instead of trying to understand the situation fully at once it's time to gather and verbalise information.

This can be structured by asking the questions. What do I see? What do I hear? What do I feel? and What do I smell? This uses the applicable senses and can provide solid ground having an associated calming effect. It can also give a view of the big picture. An active search for information is helpful to grasp the situation and prevents hasty decision making or performing incorrect and possibly irreversible actions.

Once one pilot has done this the other can correct and/or add their own observations. Level 1 SA, perception, should now be achieved and crews should try to give meaning to the situation and draw conclusions giving level 2 SA. A positive confirmation of the situation, if possible, should be called to ensure the same mental model. Now an assessment of threats together with an assessment of available time and ways to control the situation can take place.

The P stage, or Power involves the asking of three critical questions. Do we miss information? Are there information conflicts or inconsistencies? And are our assumptions correct? Here a projection of the situation into the future is encouraged to try and foresee what mitigating

measures we can take to avoid the erosion of safety margins. This is level 3 situational awareness. It is also a look back at the decision through critical thinking to correct any early process errors.

The main goal of the URP steps is to manage fight or flight responses and assist with structured decision making in a surprise event. It may well also have the secondary effect of increased self-efficacy in dealing with these events thus reducing their impact and helping to prevent fear-potentiated responses.

The 1.5 hours in the classroom is spent looking at the theoretical background of startle and surprise with the URP model introduced. A homework assignment was set so crew could discuss their own experiences, you may remember the implicit learning we talked about earlier. As well as this there was time to practise how URP would be implemented in the simulator with an emphasis on the shortfalls we discussed earlier of using the FFS. The method of self-scoring is discussed encouraging pilots to take ownership of their own learning and progress.

The main goal of the simulator is to practise the URP technique with a focus on the U and R steps, as these are considered the most important and most novel and are the focus of the startle/surprise effect initial management.

The second goal of the simulator is to show that this technique is a broad brush thus being able to be applied to multiple startle/surprise events.

Some examples of events used include an automatic approach with an electronic failure causing PF's PFD and ND to blank, an explosive decompression together with severe engine damage, and, a bird strike on take-off followed by one stalling engine and one engine with high vibration. Please refer to the report if you want to know more of the simulator events.

The scenarios are about practising those startle effect management techniques to a point of self-efficacy maximising the chances of them being use in a real-life event. Instructors will ask trainees if they want to repeat part of the exercise and feedback on the technicalities of the exercise will not be given as this may distract from feedback on the technique.

The structure of the simulator session is to start with a baseline assessment, a training middle, and then a test to finish to evaluate the effectiveness of the training.

The 44 participants of this method were a mixture of 747-400 pilots and 737NG pilots to evaluate any difference between the long haul and short haul side. Also, half were instructors and half line pilots for another interesting comparable. There was a fairly even split between those with over 10,000 hours and those with under.

In addition to this roughly half of the group was given no information on the experiment prior to arrival whereas the other group was sent an electronic questionnaire and classroom training material as preparation roughly two weeks beforehand.

The testing was focussed on the U and R section with the six critical instructor observations being Self-control, Distraction management, Information collection, Physical distance, Deep breathing and checking of colleague.

We will summarise the results here but it's worth a look at the report breakdown for more detail into the specific areas.

Pilots demonstrated progress in applying the startle management technique after both the classroom and simulator sessions. The pilots viewed the training session in startle management techniques as a positive training experience and intended to apply the techniques learned in their daily operation.

The most significant improvement came in the information collection competency. Pilots were rated higher after they had taken the physical distance unload step, and, were more likely to take the breathing moment having taken physical distance. Both of these elements are critical in the management of the cognitive effects of startle and/or surprise so it's very positive the training experiment demonstrated progress in this area.

This technique is designed to be employed across all possible failure and unexpected situations and therefore would be able to be repeated in all recurrent training. Repetition will cement the technique and secure the benefits. Furthermore, if it's introduced at the ab initio phase, as well as being repeated throughout the career, it will become an integral part of dealing with startle and surprise in the cockpit.

A really interesting subject with a lot to take away and think about. We'll put a link to the study below the podcast and across our social media. With EU regulatory framework now covering the need to address startle and surprise effects with training programmes we may well all see something similar coming our way. We hope this background knowledge will help you in starting to think about the sort of techniques necessary to employ to ensure safe operation during such an event.

Thanks again for taking the time with us on this, perhaps slightly longer podcast than normal. If you'd like to keep the talk going, please head over to our various social media pages including Instagram, Facebook and twitter @737Talk. We also have our website www.B737Talk.com where you can sign up for our newsletter giving you information on the podcast ahead of anyone else.