PREPARING FOR THE UNEXPECTED

New levels of complexity in aviation bring reduced predictability. People can't be trained for every situation. We must therefore focus more on resilience: our ability to sustain required operations under both expected and unexpected conditions. In this article, **Anders Ellerstrand** outlines an EU funded research project to help expect the unexpected and know how to respond: DARWIN.

KEY POINTS

- **Roles and responsibilities must be clear. The organisation must also support and maintain a clear and legitimate space of manoeuvre relative to plans and procedures, to adapt to unusual (unanticipated) circumstances.**
- **Staff must be trained to handle the usual and unexpected situations. Keep in mind that what you train for will probably not be exactly what will happen.**
- **Plans and resource allocation must have buffers. Never plan for a situation that will eliminate the room for manoeuvring. Know in advance where extra resources are available and how you call them in.**
- **Know your neighbours. Maintain relations through regular meetings with other stakeholders that could be a resource in a crisis. Learn about their abilities and who to contact.**

Reducing unwanted variation

Walter Andrew Shewhart was an American physicist, engineer and statistician. In 1924 he prepared a paper that was to be the beginning of what we know today as process quality control. Shewhart understood the importance of reducing variation in a manufacturing process. His ideas were important when the United States entered World War II. Bullets and rifles were made in many different states but by controlling variation in manufacturing any bullet could fit any rifle.

Quality management still has a focus on controlling and reducing variation. If you look at Quality and safety management systems, you will find many similarities, and it is an ICAO recommendation to integrate organisational management systems such as QMS and SMS. If quality is improved by reducing variation, it seems reasonable to assume that safety is also improved by reducing variation.

In 'Managing the risks of organizational accidents', James Reason (1997) wrote: "All organizations suffer a tension between the natural variability of human behaviour and the system's needs for a high degree of regularity in the activities of its members. The managers of hazardous systems must try to restrict human actions to pathways that are not only efficient and productive, but also safe."

In aviation we work to achieve that restriction in human actions, through selection, training, technology and documented procedures. By reducing variation, we hope to increase safety.

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Qantas Flight 32

On 4 November 2010, Qantas Flight 32 was on a flight from London to Sydney with a scheduled refuelling stop in Singapore. When climbing out from Singapore and passing 7400ft, an inboard engine exploded. Engine parts cut through control systems and fuel tanks. Most aircraft systems, including roll control, were affected.

Of course, the crew were trained for emergency scenarios. In the simulator they had been exposed to different failures, sometimes even two or three simultaneous failures. But now they had to deal with more than 50 simultaneous failures and more than 100 alarms.

The captain, Richard de Crespigny and his crew did a fantastic job. They had to work outside and even contrary to standard operating procedures but managed to land the severely damaged aircraft in Singapore without any person being hurt.

This is just one of many examples where the quality principle of reduced variation is not the solution to every problem. Competency is not only to follow documented procedures, but also an ability to adjust to the situation.

Resilience

This type of competency can be called resilience. Erik Hollnagel states that, "A system is resilient if it can adjust its functioning prior to, during, or following events (changes, disturbances, and opportunities), and thereby sustain required operations under both expected and unexpected conditions."

To achieve resilient performance, Hollnagel suggests four basic potentials:

- **The potential to respond.** This requires a special kind of knowledge or competence. We need to either activate prepared actions or adjust the way we work.
- **The potential to monitor.** We need to be able to discover changes, within the organisation or in the environment, that can seriously affect the system's performance.
- **The potential to learn.** We must be able to learn from experience.
- **The potential to anticipate.** We must be able to understand developments, to foresee the possible disruptions and anticipate opportunities.

Resilience calls upon competencies that require a very different kind of training compared to the training that aims to reduce variation. But we don't have to start from scratch. We all recognise the four abilities because they are already part of how we do things. Perhaps we can build on them.

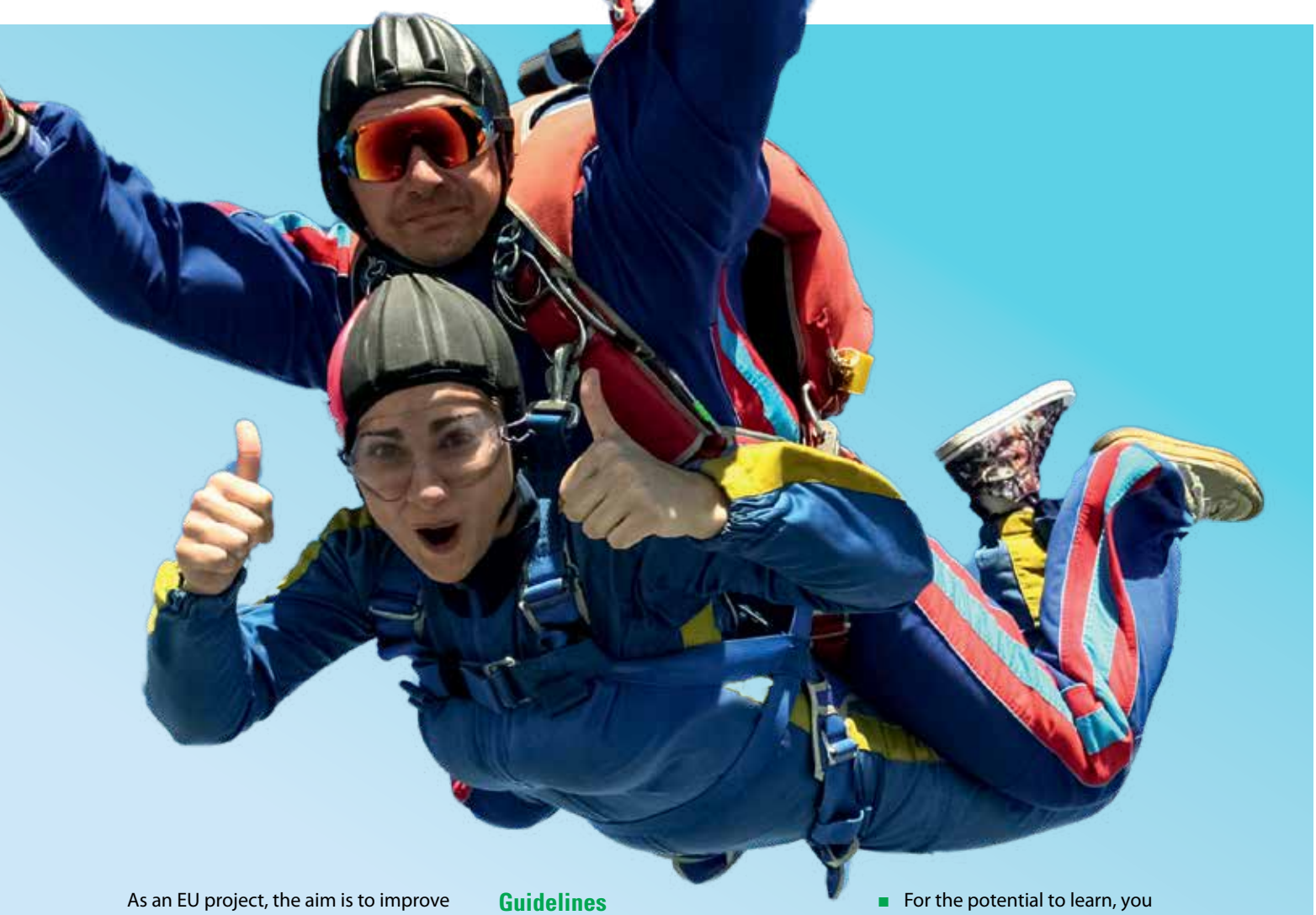
DARWIN Project: Expect the unexpected and know how to respond

One attempt to address the need for resilience is the DARWIN Project. DARWIN is an EU funded research project under the EU Horizon 2020 research programme. The project name is of course inspired by Charles Darwin, whose famous theory of evolution is based on the observation that species must 'adapt to survive'. The project was launched in June 2015 and it will run through to September 2018 with the slogan "Expect the unexpected and know how to respond".

On the project website (https://h2020darwin.eu/) you will find the nine European experts/partners involved in the project. There is also a DARWIN Community of Practitioners with 160 members from 23 countries. I have been one of them and am fortunate to have attended two workshops and one pilot exercise.

The work within the project has gone through four steps:

1. **Review**. A review and interviews of different resilience concepts and approaches.
2. **Development.** Guidelines were developed, including specific interventions to enhance resilience.
3. **Testing.** Focusing on two safety critical domain (ATM and healthcare), a series of pilot exercises were used for testing the usability of the guidelines.
4. **Practice.** To assist in the implementation, DARWIN has developed training materials, simulation and gaming tools.



As an EU project, the aim is to improve resilience of the European community. This is done by developing guidelines known as DARWIN Resilience Management Guidelines. These guidelines are not prescriptive and are not intended to replace the guidelines or procedures that are already in place. They propose interventions and are intended for different levels in an organisation: policy makers, decision makers and managers, but they will of course affect indirectly front-line operators.

Pilot exercises

The usability of the guidelines has been tested in four pilot exercises:

- Rome, 12 June and 4 July 2017. The scenario was a disease outbreak during an incoming flight.
- Rome, 22 June and 30 oct 2017. The scenario was an aircraft crashing in urban area close to a major Italian airport shortly after taking off.
- Linköping, 30 May – 20 Sep 2017. The scenario was a collision between an oil tanker and a passenger ferry leaving Gotland island.
- Rome, 29 November 2017. The scenario was a total loss of radar information at Rome ACC.

Guidelines

The complete set of guidelines will be made available as the project is finalised later this year. It will be possible for organisations to use any part of these to assist in increasing resilience performance. Here are just a few examples:

- For the potential to respond, make sure you know in advance who will be in charge. That person needs to be prepared and trained. Also make sure you have put buffers in your plans and in your resource allocation, or that you know how to mobilise extra resources. You may need collaboration with other organisations and this needs to be prepared in advance. The front-line operators and managers might have the best knowledge of the situation and ability to act. Make sure they are trained and given the authority to act.
- For the potential to monitor, you need to identify problem areas. The opposite of resilience is brittleness and it is typically found in situations of goal conflicts. Brittleness can also be found when comparing work-as-done with work-as-imagined (see HindSight 25). This could reveal how the system might be operating in a way that is riskier than expected.
- For the potential to learn, you must investigate how you handle expected and unexpected conditions. Often there is at least as much to gain in learning from what went well. Different stakeholders must know what resources, plans, experiences and expertise they have. There is also the need for insight into other actors' responsibilities and capabilities. Such knowledge can help to identify and close gaps.
- For the potential to anticipate, managers must be trained to recognise when unexpected events occur that could challenge the current organisational structure and processes. You need to establish what variables and data are monitored to assess whether there is a crisis or an opportunity.

The DARWIN project is also developing serious games, where a team of several players can solve problems in exercises related to crises management.

The DARWIN guidelines can help any organisation that wants to improve resilience, increasing the likelihood of us being able to expect the unexpected and to know how to respond.