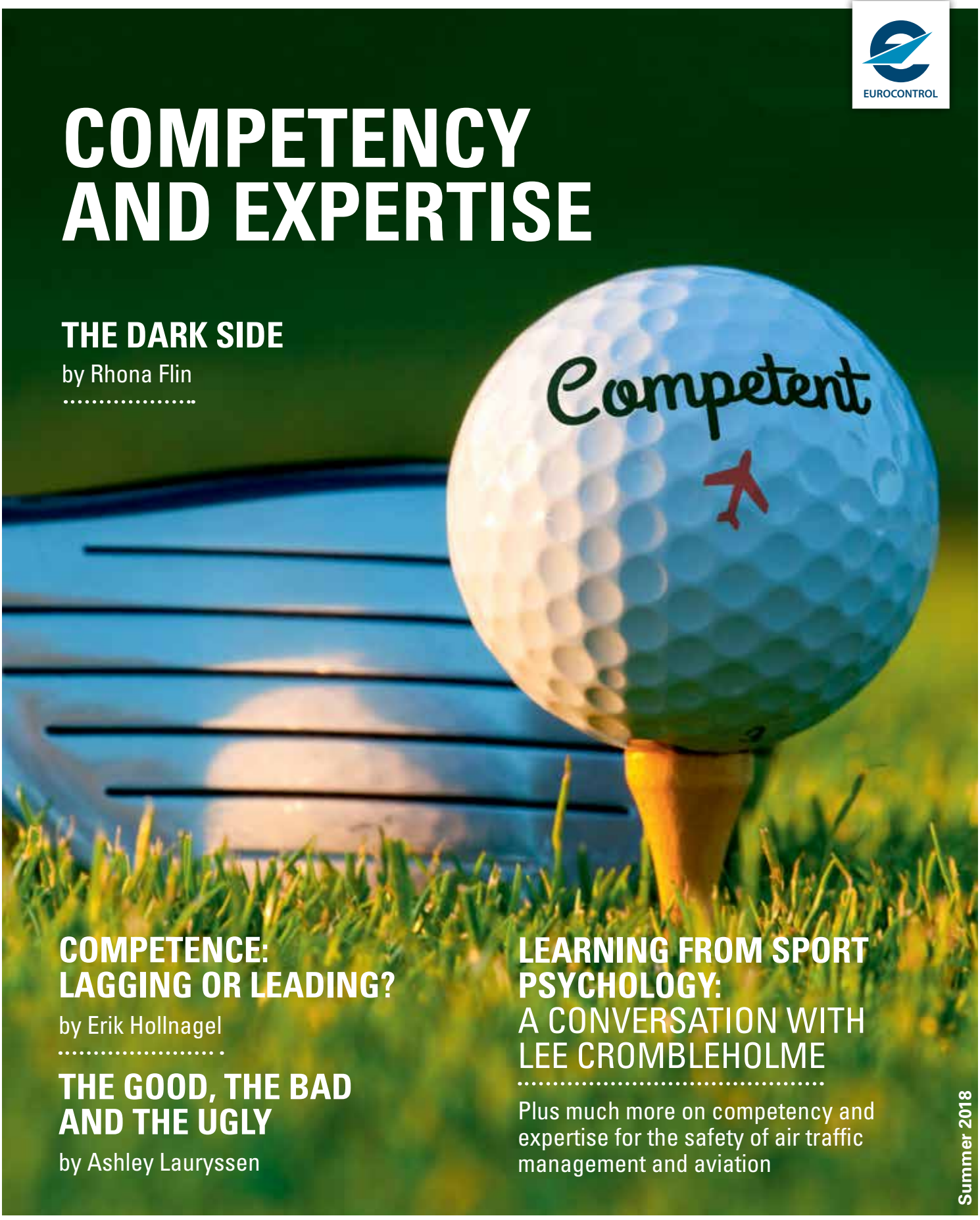
HindSight 27

The ability or opportunity to understand and judge an event or experience after it has occurred

EUROCONTROL

COMPETENCY AND EXPERTISE



THE DARK SIDE
by Rhona Flin

COMPETENCE: LAGGING OR LEADING?
by Erik Hollnagel

THE GOOD, THE BAD AND THE UGLY
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LEARNING FROM SPORT PSYCHOLOGY: A CONVERSATION WITH LEE CROMBLEHOLME

Plus much more on competency and expertise for the safety of air traffic management and aviation

Summer 2018

DG'S FOREWO

Eamonn Brennan was appointed by the 41 Member States of EUROCONTROL to lead the organisation as its Director General from 1 January 2018. Prior to joining EUROCONTROL, he was the Chief Executive of the Irish Aviation Authority (IAA).

Eamonn Brennan has over 35 years' experience working across three continents, in over 25 countries, in both the public and private sector and has held many leading roles in the Air Traffic Management industry during his career.

Dear readers,

This is my first Foreword for HindSight and I am proud to be associated with a publication that does so much for safety. It does this not by taking a political position but by providing a platform for openly and honestly sharing information about things that have gone right (and wrong) and about the challenges that we in aviation face – all at a very practical, down-to-earth level.

In that spirit, I'll start by declaring that Air Traffic Management in Europe needs to change. We are not meeting the needs of our customers – principally the airlines – because we do not have the capacity in place to meet today's demand, let alone the demand forecast in the decades to come.

Our latest forecast (in our Challenges of Growth study) is for an increase of 53% in traffic by 2040. However, there are significant risks associated with this forecast and it may well be that the increase in traffic is as high as 84%.

Airport infrastructure is expected to be a significant constraint on this growth but there are other challenges as well. ATM will not be able to handle these traffic levels safely unless we change the way we do things. Indeed, we will need to make some quite radical changes if we are to avoid the kind of delays we saw twenty years ago. Some of those changes will be technological – coming out of SESAR – but there may also be others, such as financial regulation of air navigation service providers in order to provide the incentives required.

WELCOME

Welcome to Issue 27 of HindSight magazine. The theme of this issue is 'Competency and Expertise'. It is a topic that links to all previous Issues of HindSight.

Our ability to work effectively depends on the competency and expertise front-line practitioners and all involved in the operational, technical, support, and management functions. Safety isn't something that is just 'there' in the aviation system. People actively create safety. But how do we create safety? And what do we need to do to help ensure that we can continue to do so? Competency and expertise is an important part of the answer.

In this issue, we have articles from operational, safety, human factors and psychology specialists. This is part of what makes HindSight unique – it brings together those who do the operational work, those who support operational work in a variety of ways, and those who study operational work to help better understand it. We are proud to give a voice to some of the world's leading academic thinkers, and to operational and support specialists who have stories, experience and practical insights to convey. The key is that the articles are interesting and useful to the primary readers of HindSight: air traffic controllers and professional pilots, and hopefully to others who support operational work. Do we succeed? Let us know!

In this Issue we explore the nature of competency and fundamental applications and implications for operational training, selection, and procedures, including non-technical skills and contingency. We then zoom out to regulatory and future issues. The regular feature on 'Views from Elsewhere' continues with articles from surgery and rail. These articles raise questions for us in aviation, and provide some practical ideas. And in this issue we have articles drawing from the world of sport. HindSight continues online over at SKYbrary with further articles in the online supplement, from aviation and other industries, on the theme of competency and expertise.

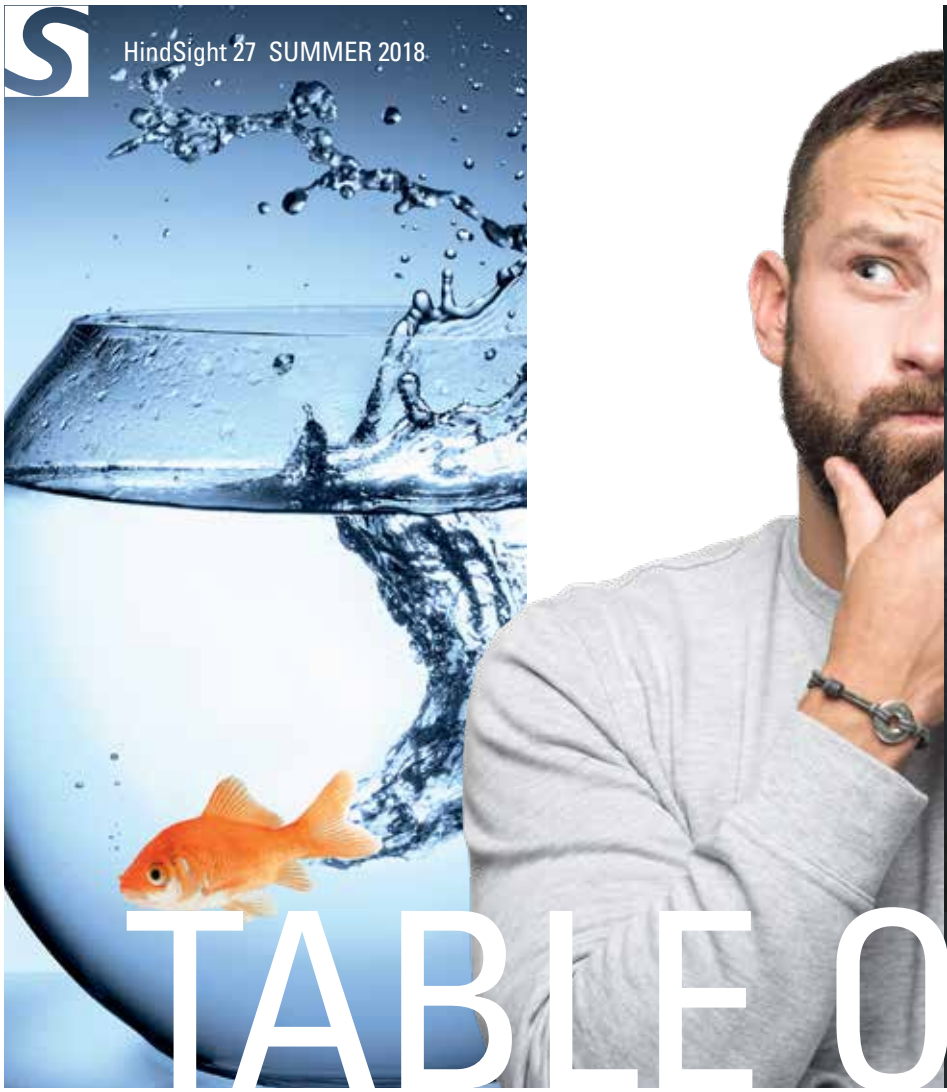
We also have 'What we do' good practice snippets. We'd particularly like to hear from more readers for this section. And this brings me to the next Issue, which will feature articles on 'Change'. All readers have been affected by changes, in procedures, regulations, technology, people, incentives, organisation, etc. The pace of change will only increase. How do we change to adapt to the dynamic world of air traffic management? And how do we as individuals, teams, and organisations adapt to these changes? Let us know, in a few words or more, for your magazine on the safety or air traffic management – HindSight.

At the same time, we will have to respond to other developments, such as cyber threats or the integration of unmanned aircraft into the same airspace as manned aircraft. The rapid growth in the capabilities of drones and their potential uses is set to continue and we need to make sure that this can be handled safely.

So the pressure on the people in the industry to cope and to adapt will be greater than ever before, with challenges for staff, for training departments and also for managers. Competence and expertise will be crucial if the aviation industry is to respond and to meet the demands of the travelling public.

This issue of HindSight provides some fascinating insights into how we as an industry can make sure that our people have the competency and expertise to cope with the challenges we face and the changing nature of ATM. As one article notes, we will have more automation, more use of data, better systems for human-machine interaction and entirely new ways of working with aircraft. We will need all this in order to meet the needs of the decades to come.

Eamonn Brennan
Director General, EUROCONTROL



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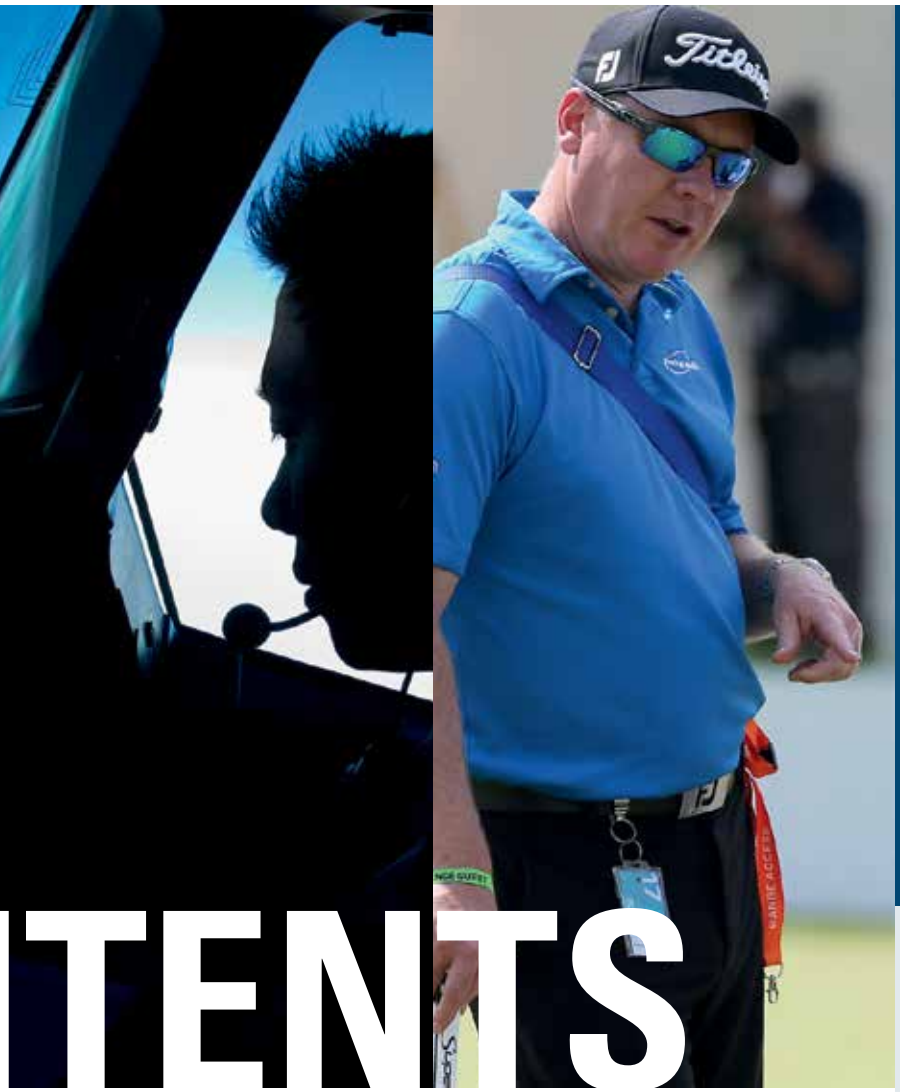

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CONTACT US

HindSight is a magazine on the safety of air traffic services. The success of this publication depends very much on you. We need to know what you think of HindSight.

Are there some improvements you would like to see in its content or layout?

Please tell us what you think – and even more important, please share your experiences with us! We would especially like to hear from current controllers and professional pilots (the main readership) with a talent for writing engaging articles on the safety of air traffic services.

We hope that you will join us in making this publication a success.

Please contact:
steven.shorrock@eurocontrol.int

Or to the postal address:
Rue de la Fusée, 96
B-1130 Brussels

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ACRONYMS

ACC	Area Control Centre
AIM	Aeronautical Information Management
AIS	Aeronautical Information Service
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
APP	Approach Control
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATQP	Alternative Training and Qualification Programme
ATS	Air Traffic Services
ATSEP	Air Traffic Safety Electronics Personnel
CNS	Communication Navigation Surveillance
CRM	Crew Resource Management
EASA	European Aviation Safety Agency
FISO	Flight Information Service Officer
HF	Human Factors
ICAO	International Civil Aviation Organization
IFATCA	International Federation of Air Traffic Controller Associations
ILS	Instrument Landing Systems
LOFT	Line Oriented Flight Training
NTS	Non-Technical Skills
OJT	On the Job Training
OJTI	On the Job Training Instructor
SMS	Safety Management System
STDI	Synthetic Training Device Instructor
TRM	Team Resource Management
TWR	Tower

Steven Shorrock
Editor in Chief of HindSight

VIVE LA COMPÉTENCE!

This summer, we have been entertained by the world's best footballers – experts in the game. And it just so happens that Competency and Expertise is theme of this Issue of HindSight. What might we learn from World Cup 2018? Here are five observations.

1. Past performance does not determine future performance

Some world-leading teams, which were favourites to win, were knocked out early, or didn't qualify. It just goes to show that we can't rely on our record. Past success does not guarantee future success. The same tactics that worked in the past will not necessarily work in the future.

But we humans are creatures of habit. In his famous book *Human Error*, James Reason (1990) described two ways that we rely – or over-rely – on our past experience. The first is similarity matching. When a situation is similar to one experienced previously, we use pattern patching and tend to respond in a similar way to how we did before. The second is frequency gambling. More frequent solutions in roughly similar conditions will tend to prevail. Most of the time, these are efficient ways of working, and efficiency is critical when seconds count. But sometimes, we need to be more thorough, especially when preparing, practising and planning. In any case, we must always adapt to the situation.

Just as past success does not guarantee future success, past failure does not guarantee future failure. Penalties were a case in point. Far from being a lottery that is impossible to rehearse for, or an event for which some teams are 'jinxed', this year showed that extensive physical and psychological preparation for such high-pressure scenarios pays off.

This is something that I am particularly interested in within ANSPs. Front-line safety-critical staff need and deserve world-class training, especially refresher training. This isn't a luxury. It's a necessity, but the sort of necessity that sometimes becomes obvious only in hindsight. The same applies to team resource management training, and other training that integrates lessons from the past. The lessons that stick often come from past failures, but we need to learn those lessons in the right way, in the right context.

2. Teams are more than the sum of their parts…and success runs deep

It became clear in this World Cup that individual expertise does not equal team competence. Teams can suffer through overreliance on star players, but can benefit greatly from teamwork bonded with trust, respect, and an understanding of how each player will respond in a given situation. The same applies in air traffic management. Here, we have procedures to help us predict how others will respond. But procedures do not determine how someone will respond. They do not even apply to all situations, nor prescribe all responses. In this case, trust built from working together helps us to succeed.

In the World Cup, the team is not just the players on the pitch. The best managers set up their teams to win, using all necessary resources, and adapting their style to whatever will bring out the best from each player. Everything is designed and managed for human performance. Hundreds more, including psychologists, dietitians, physiotherapists, etc, help players to perform at their peak. It is similar with ANSPs. While all have similar basic kinds of front-line support staff, some ANSPs have teams of qualified human factors/ergonomics specialists, psychologists, TRM facilitators, CISM peers, educational specialists, etc. Human performance is what we do, but to be sustainably successful, it needs a strong support network.

3. Technology changes the nature of work

The introduction of video assistant referee showed how technology changes the nature of work. Referees now have to use their expertise to decide when to use the technology. Overreliance ruins the spontaneity of play. Underuse may bring criticism that not only did a referee not spot a foul or offside, but that they didn't use a tool that could have shown this: two mistakes, where previously there would have been only one.

In *The ETTO Principle*, Erik Hollnagel discusses a fundamental trade-off that underlies human performance: the efficiency-thoroughness trade-off. Referees must balance efficiency against thoroughness to harmonise fluidity and fairness. Footballers do the same. If there is time to be thorough to set up a shot, then they will. If not, then they need to strike roughly on target. The right balance is clear in hindsight. For controllers, a very thorough approach to flight data recording with an electronic solution may result in too much head-down time. A very efficient approach may result in over-reliance on memory. The efficiency-thoroughness trade-off is a constant balancing act that is fundamental to the development of expertise.

4. Positivity helps (a lot)

Some teams, such as Belgium and Croatia, played with incredible self–belief and confidence. Positivity permeates effective teams, on and off the pitch, even when things are difficult. Having spent hundreds of hours with different fixed ATC teams, and in different units, it is clear that different teams and units develop particular cultures or personalities. For some, fun, friendliness and positivity are hallmarks. This is something one can see and feel, as an outsider. We all know intuitively that working in a positive, joyful environment brings out the best in us. We all need to work on creating joy in work.

5. Respect is an attitude…and a non-technical skill

For me, two of the highlights of the World Cup were about respect. When England Won against Colombia on penalties, Manager Gareth Southgate consoled Colombia's Mateus Uribe, who missed his shot. Southgate was perhaps mindful of the penalty that he missed as an England player. Southgate's overall demeanor was not only respectful, but empathic, supportive, and measured: a great role model for managers.

Respectful people carry their respect with them wherever they go. The Japanese team – consistent with their culture – cleaned their own dressing room, and left a handwritten note of thanks – in Russian. This courtesy is also a sign of pride in work. Even the Japanese fans helped to clean the stadium after their side was knocked out. Perhaps there should be a separate trophy for the most respectful team and supporters. This year, Japan would have won that trophy.

But France won the World Cup after a superb run of matches. Writing this Editorial from France, it was a pleasure to see the French people celebrate their victory, against a strong and dynamic Croatian team.

Perhaps we can learn from the preparation, planning and practice that went into the World Cup, supporting such expert performances. Vive la compétence!

THE DARK SIDE

When we think of competency, we tend to think about the skills, knowledge and attitudes that are desirable for a given job. But there is another side to this coin that most people will be familiar with: undesirable behaviours. In this Op Ed, **Rhona Flin** explores examples from research on the dark side of competency and professionalism, and asks how unwanted behaviours can be considered within competency frameworks.

KEY POINTS

1. **Aside from desirable skills, knowledge and attitudes, there are also less desirable behaviours that perhaps should be considered more explicitly within discussions of competency.**
2. **Rudeness between employees in the workplace is also an issue, and can impact cognitive skills, as well as morale.**
3. **Many scientific papers have been written on 'dark side' characteristics in management and leadership.**
4. **Competency and professional standards documents should mention behaviours that could be detrimental to safety, as well as desired behaviour patterns.**

What makes a controller, a pilot, or a manager competent? For almost all occupations, standards of competence exist that specify the knowledge, skills, attitudes and attributes that a given job requires. These are valuable, but do they present the whole picture? Perhaps it is also necessary to add a little something on what current research tells us about behaviours that could be detrimental to safety. It may be important to acknowledge which behaviours have to be suppressed or inhibited, as well as those that should be enacted.

In the UK, standards of competence for managers have been around for decades. My experience of writing these is limited but in the early 1990s, after Lord Cullen's report on the Piper Alpha North Sea Oil disaster was released. I was part of an oil industry group devising standards of competence for Offshore Installation Managers (OIMs),

especially relating to their emergency command responsibilities (a skill set that appeared to have deficiencies in the three OIMs on duty that night – on Piper and the two connected platforms). This type of management competence framework is written by committees of experts and typically based on job analysis studies. The standards represent best practice and so are important for selection, training, and assessing competence. The contents cover not only the technical skills needed for task accomplishment but also sets of desirable behaviours, such as listening, consulting and mentoring. They do not make for lively reading but that is not their purpose.

More entertaining are the studies of all the other behaviours that humans tend to exhibit in the workplace. Setting aside the sexual activities of notorious film directors, hapless politicians and others named in #MeToo campaigns, and ignoring deliberately malevolent or criminal actions, there are a whole range of interesting behaviours that perhaps should be considered more explicitly within discussions of competency. I've chosen two examples where the safety implications have been examined: rudeness between staff and leadership styles.

Rude behaviours

Social psychologists, Porath and Erez looked at the incidence of rudeness between employees in the workplace and found that it was so frequent that it might be regarded as an epidemic. They began to examine the impact of rudeness on cognitive skills such as memory, by running psychological experiments with students who had been recruited to take cognitive tests.

The students in the experimental group were given directions to the test session, which took them to an office. When they knocked on the door, the person in the office (e.g., a professor) displayed annoyance at being interrupted and spoke to the student very rudely before giving directions to the correct room. The results showed that the students who had been the victims of rudeness performed worse on the tests than those in the control group who had not had this experience. In a second manipulation, students who simply witnessed a rude exchange between a staff member and a student also showed lower cognitive performance than a control group who had not witnessed the exchange.

I was studying behaviours in hospital operating theatres when I read their paper, and was hearing reports of conversations between staff that were less than polite, to put it mildly. There were also survey data showing that aggressive language between operating theatre staff was not uncommon in UK hospitals. Several research teams have now investigated the effects of rudeness – experienced or witnessed – on staff in medical simulations. These teams have reported the same kinds of negative impacts on cognition as found in the student studies. So there is evidence that behaviours such as rudeness, which can be committed thoughtlessly as well as deliberately, can have an impact on critical cognitive tasks and thus on safety. Of course, the organisational culture can foster particular behaviour patterns. To address this, the Royal College of Surgeons of Edinburgh recently launched an anti-bullying and undermining campaign (#LetsRemoveIt). In their membership survey, nearly 40% of respondents reported they had been victims of such behaviour, with the same amount reporting that they had witnessed it.

"There is evidence that behaviours such as rudeness, which can be committed thoughtlessly as well as deliberately, can have an impact on critical cognitive tasks and thus on safety."

In domains beyond healthcare, rude or unpleasant exchanges between staff could have an effect on safety. Readers will probably be familiar with YouTube videos of rude exchanges between air traffic controllers and pilots at some airports. Presenting research findings showing the links between certain social behaviours and impaired cognition in safety-critical tasks can be enlightening for those working in riskier environments. Including this type of evidence in CRM training can result in important insights for busy practitioners who work in stressful, time-pressured conditions, where thoughtful politeness may not always be the norm.

Destructive leadership styles

Some years ago, I heard the American psychologist Robert Hogan – an expert on personality – amusingly describe the dark side of charisma. He had been studying leadership styles and had concluded that managerial incompetence was far from uncommon. In fact, he estimated the base rate to be around 60-75%. He suggested that American managers had learnt their leadership style from watching John Wayne movies, characterised by phrases, such as "Do what I say or I'll kill you".

His findings led him to identify several types of incompetent leaders that could be found in the workplace. The first was 'the empty suit' leader who 'fell upwards' in the organisation, being rapidly promoted, despite a lack of managerial skill, due to competence in navigating selection procedures, such as assessment centres or other 'beauty contests'. The second type left 'scorched earth' in his wake having burnt out his subordinates as he progressed his career. The third was some kind of charming psychopath. (At that time, the majority of managers he studied were male.) ▸▸

Rhona Flin is Professor of Industrial Psychology, Aberdeen Business School, Robert Gordon University and Emeritus Professor of Applied Psychology, University of Aberdeen. She carries out research and consultancy projects on human performance in high risk industries, looking at leadership, culture, team skills and decision making in healthcare, aviation and the energy industries.
r.flin@rgu.ac.uk

"The key intervention is to make managers more aware of their typical styles and to understand the effects that some of their behaviours can have on others."

Almost thirty years later, investigations of undesirable leadership styles are now mainstream for management researchers. Many scientific papers have been written on 'dark side' characteristics, managers who derail, the effects of devious behaviours, and unethical leadership. Studies of destructive leadership styles have tended to examine the effects on employee wellbeing or trust, rather than safety, but there have been reported effects on safety-related behaviours, such as speaking up. Not surprisingly, laissez faire leadership (not paying attention to the task or the team) is related to lower safety performance. A new study by Barling and colleagues of the leadership styles that surgeons use while operating found that unsupportive and over-controlling behaviours were linked to lower measures of team members' ratings of psychological safety.

The key intervention is to make managers more aware of their typical styles and to understand the effects that some of their behaviours can have on others. This requires feedback mechanisms and these detrimental styles of leadership should be openly discussed during training.

What not to do

To recap, while the analysis of competency and the resulting skill sets and professional standards documents are an essential part of occupational development systems, they tend to focus almost exclusively on the desired behaviour patterns. Perhaps there should be some mention of behaviours (which may be typical in a given work environment) that could be detrimental for safety and therefore should be suppressed.

A key component of expertise can be the inhibition of certain actions, such as rushing or becoming distracted. In some of the non-technical skills frameworks, such as NOTECHS for pilots, this kind of information on undesirable behaviours is already included, having been provided by subject matter experts during development. The behavioural markers for each component skill element provide examples of good and poor behaviour patterns. Thus for situation awareness, a negative behavioural marker is, 'Does not set priorities regarding time limits'. For co-operation an example is, 'Ignores suggestions of other crew members'. Similarly in NOTSS for surgeons, markers of poor behaviours include 'Fails to inform team of surgical plan' and 'Needs help from assistant but does not make it clear what assistant is expected to do'. The inclusion of negative markers makes it easier to discuss behaviours that may have a negative impact on task performance.

"For managers, explicit discussion of destructive leadership styles and behaviours that have been shown to increase risk or affect worker wellbeing, could be a useful addition to their training syllabus."

Conclusion

So in discussions of competency, perhaps we should have more up-front consideration of which behaviours may increase risk and should be inhibited. This could also include more advice on what not to do in given situations – i.e. the kind of information that experienced practitioners share informally when they say, 'Don't do that because I did it once and this (negative outcome) happened'. For managers, explicit discussion of destructive leadership styles and behaviours that have been shown to increase risk or affect worker wellbeing, could be a useful addition to their training syllabus and might be included in the appendix to a competency framework.

My experience is not in air traffic management and none of the research mentioned above came from control centres, though some does come from pilots. But are there are behaviour patterns in controllers and their managers that are detrimental for safety, and if so, should they be considered within ATM competency frameworks?

THE GOOD, THE BAD AND THE UGLY

What does it mean to be competent? The answer is: it depends. This makes it impossible to have a fixed syllabus, and so ICAO have developed a set of competencies that may be applied to all air traffic controllers, irrespective of their rating and phase of training. **Ashley Lauryssen** outlines some of the implications and applications of competency-based training.

KEY POINTS

1. **To decide if someone is competent, you first need to define what competent performance is.**
2. **Fixed syllabi for air traffic controllers create problems for training organisations if the syllabi cannot be updated regularly.**
3. **ICAO ATCO Competency Frameworks are suitable for all ratings and phases of training, and are transferable across tasks and in all contexts.**
4. **A controller who consistently demonstrates the behaviours defined in the local competency model may be considered competent.**
5. **ICAO is also developing an ATCO on-the-job training instructor competency framework.**

If I were to make a Spaghetti Western about air traffic control, then Clint Eastwood (the younger version) would play the good controller and Lee Van Cleef (also the younger version) would play the bad controller. Since there are no ugly controllers, I would have a dilemma coming up with a punchy title for my film. Maybe this is why I have never made it! But is there really such a thing as a good controller or a bad controller? This article considers what it means to be a good or bad controller.

Jon is a trainee air traffic controller who is undertaking his on-the-job training ▸▸

at an approach surveillance unit. How does the training manager know when Jon is able to do the job on his own? Is it because Jon has completed 50 hours of simulation and 200 hours of on-the-job training, and has passed all the required theory exams? Is it because, in the collective opinion of the instructors, Jon is now able to do the job?

"To decide if someone is competent, you first need to define what competent performance is."

This question about how to determine whether Jon is able to do the job on his own, leads us to a fundamental aspect of competency-based training and assessment. To decide if someone is competent, you first need to define what competent performance is. This begs the question, how do you define competent performance?

And this is where ICAO and their Air Traffic Controller Competency Framework come into the picture. ICAO has developed a set of competencies that may be applied to all air traffic controllers, irrespective of their rating and may be used during any phase of training. These competencies have been published in the ICAO PANS – Training document and became applicable in November 2016. This framework has been developed in such a way that it is adaptable to any air traffic controller environment taking into account the local regulatory, technical, operational and organisational requirements.

For any air traffic control instructor who's been around for the last 10 to 30 years, you are likely to remember the old ICAO 05 series of ATC training syllabi. I still have a few on my shelves. Every once in a while, I take them down and flick through them – they're relics from the past, complete with a musty smell, yellowed pages and typewriter text. The Area (Airways) Control – Radar Syllabus (Series 056) was last published in May 1979 when cathode ray tubes were modern technology and Automatic Dependent Surveillance was unheard of in ATC centres. Even though these syllabi were withdrawn from publication by ICAO many years ago (and not replaced), they live on in many parts of the world. Training academies still offer 05 series training courses and one can only hope that the content has been updated and made relevant for today's air traffic controllers.

ICAO was right to withdraw these syllabi from circulation. Fixed syllabi for air traffic controllers create problems for training organisations if they cannot be updated regularly. In Europe we have been fortunate to have the EUROCONTROL ATCO Common Core Content (CCC) training syllabi to work with. These started as guidelines 25 years ago and were the result of collaboration between many European ANSPs and training organisations who sought to harmonise ATC training in Europe. The CCC syllabi have been regularly updated. Today, these syllabi live on in EU regulations and continue to be updated and relevant.

However, even if ICAO had been able to keep the 05 Series syllabi up-to-date, it would have been nearly impossible to develop comprehensive training objectives that would be relevant for all air traffic controllers irrespective of where they worked. One size does not fit all. And this is where the notion of competencies comes to the rescue!

To illustrate this point, let's go back to Jon again. When he eventually qualifies, he will provide an approach surveillance service to an extremely busy aerodrome that operates a parallel runway system and is located in a semi-desert region where the terrain is flat and the visibility is CAVOK for most of the year. His best friend Natalie is also a trainee approach surveillance controller, but when she qualifies she will be providing approach surveillance services to a quiet aerodrome that is located in a remote mountainous region that provides an entry point for mountaineers who wish to scale some of the peaks. The airfield is often covered in snow and reduced visibility is a weekly occurrence. The airfield is also the base for the local helicopter rescue unit.

Do both Jon and Natalie need the same competencies to do their respective jobs? Well, they both need to be able to manage their traffic situation, communicate and coordinate effectively, maintain situational awareness, manage their workloads and so on. For Jon to perform competently, he will carry out a fairly limited number of sequencing and separation tasks, but in a highly complex environment where the standards for efficiency will be extremely demanding. Natalie is pretty much out there on her on, so for her to perform competently she will need to carry out a much wider range of tasks, but the standards for efficiency may be less demanding. And for sure, some of Natalie tasks are going to be significantly different to Jon's because Natalie is working in a climatically challenging environment.

"An ICAO competency consists of the competency unit itself, a description, and observable behaviours that are associated with that competency."

So clearly, Jon's and Natalie's unit training won't be the same because the conditions that they are operating under and the tasks they are performing are not the same, and the standards they need to achieve are different. But to be declared competent, they will both have to demonstrate the achievement of the same competencies.

An ICAO competency consists of the competency unit itself (e.g., communication, workload management), a description, and observable behaviours that are associated with that competency (see Table 1). For each competency the training organisation determines:

- which of the behaviours are applicable in their environment
- if any of the behaviours should be modified, deleted or added
- the likely conditions and standards under which those behaviours should be demonstrated.

Competency-based training contains some elements of task-based training because the performance of a task is one of the building blocks of competency. However, acquisition of the basic knowledge and skills required to perform a task in a sterile environment is not enough. Tasks

Competency	Definition	OB no.	Observable behaviour
Separation and conflict resolution	Manage potential traffic conflicts and maintain separation	OB 3.1	- Detects potential traffic conflicts
		OB 3.2	- Selects appropriate separation method
		OB 3.3	- Applies appropriate separation and spacing
		OB 3.4	- Issues clearances and instructions that ensure separation is mantained
		OB 3.5	- Issues clearances and instructions that resolve conflicts
		OB 3.6	- Resolves conflicts through coordination with adjacent sectors or units
		OB 3.7	- Monitors the execution of separation actions
		OB 3.8	- Adjusts control actions, when necessary, to maintain separation
		OB 3.9	- Takes corrective action to restore appropriate separation as soon as possible below minima

Table 1: Example of one competency with description and observable behaviours

need to be performed in dynamic and changing conditions, and there is no training programme in existence today that could expose an ATC trainee to all the possible conditions and combinations of conditions that they may encounter as an operational ATCO. Consequently, when an assessor or instructor is working with a trainee, they observe the trainee performing their tasks, but at the same time they are looking for evidence that demonstrates that the appropriate competencies have been acquired. If they are able to see evidence of these competencies being performed during repeated sessions, then there is reasonable certainty that the trainee will be able to call on these competencies to manage their tasks, no matter which conditions or context they are working in.

And so returning to Jon one last time. One of his main tasks is to establish and manage the arrival sequence. To do this, he may use established arrival procedures and a combination of vectors and speed control. However, this task is not performed in isolation. He carries out a number of other tasks, such as managing the departing aircraft until they are transferred to area. To determine if Jon is competent, the instructor will observe Jon managing his arrival sequence and other tasks, but will be looking for evidence of behaviours that demonstrate that he is maintaining situational awareness, managing his workload, performing as a team member, solving traffic problems, communicating effectively and on. If Jon consistently shows evidence of these required behaviours, he may be considered competent.

"Your training programme can only be effective if the instructors who carry out the teaching and implement the programme are capable and effective."

Since the publication of the ATC Competency Framework and the associated Manual, the role of instructors has often been discussed. ICAO has recognised that no matter how well defined your training programme might be (competency-based or otherwise), it can only be effective if the instructors who carry out the teaching and implement the programme are capable and effective. As a result, ICAO is developing an ATCO on-the-job training instructor competency framework that recognises that for an instructor to be competent, there is a need to demonstrate competencies that take into account:

- teaching and instructing
- mentoring and coaching
- maintaining safety and efficiency
- collaborating and demonstrating ethics and integrity.

This framework should be published in the ICAO PANS-Training during 2019.

So, when I get around to making my air traffic control movie, Clint can still be cast as the good guy and Lee can still be the bad guy, but they can't be controllers because controllers are neither good nor bad, they are just 'competent'. The movie will have to be called 'The Good, the Bad and the Competent' (cue Ennio Morricone).

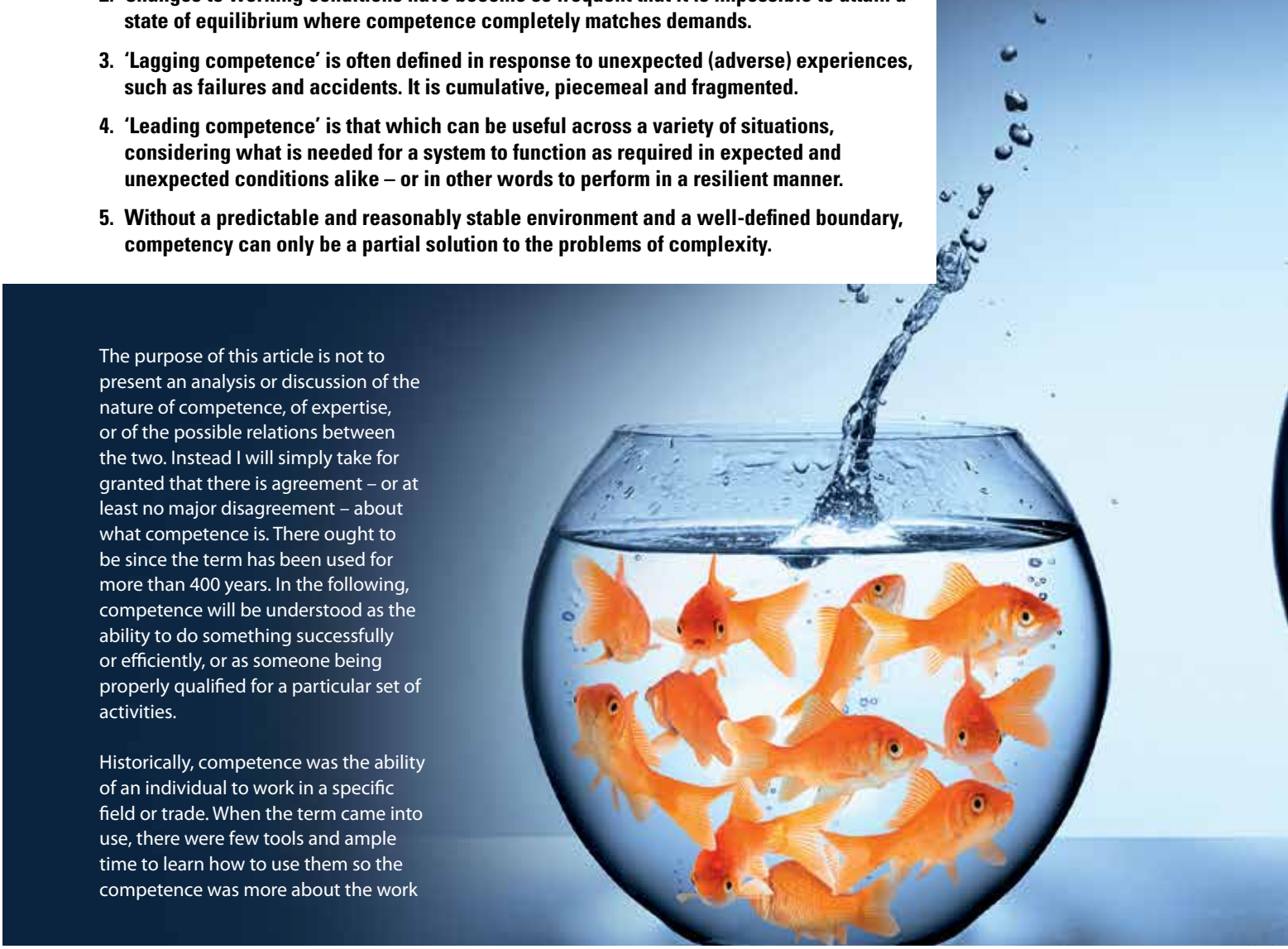
Ashley Lauryssen is a Senior Training Expert at EUROCONTORL IANS. Since 2013 she has been involved in various ICAO working arrangements for the development of competency-based training and assessment concepts and frameworks.

COMPETENCE
LAGGING OR LEADING?

The accelerating changes in technology and the environment of aviation place new demands on competency, such that it is becoming ever harder to prescribe specific competencies based on irregular situations. **Erik Hollnagel** makes a distinction between two kinds of competence – lagging and leading – and argues that there are limits to work-as-imagined and work-as-prescribed when it comes to competence.

KEY POINTS

1. **Work now requires the mastery of rapidly evolving and increasingly complicated technologies, with increased demands on competence both to manage the technology and how to compensate for its limitations.**
2. **Changes to working conditions have become so frequent that it is impossible to attain a state of equilibrium where competence completely matches demands.**
3. **'Lagging competence' is often defined in response to unexpected (adverse) experiences, such as failures and accidents. It is cumulative, piecemeal and fragmented.**
4. **'Leading competence' is that which can be useful across a variety of situations, considering what is needed for a system to function as required in expected and unexpected conditions alike – or in other words to perform in a resilient manner.**
5. **Without a predictable and reasonably stable environment and a well-defined boundary, competency can only be a partial solution to the problems of complexity.**



The purpose of this article is not to present an analysis or discussion of the nature of competence, of expertise, or of the possible relations between the two. Instead I will simply take for granted that there is agreement – or at least no major disagreement – about what competence is. There ought to be since the term has been used for more than 400 years. In the following, competence will be understood as the ability to do something successfully or efficiently, or as someone being properly qualified for a particular set of activities.

Historically, competence was the ability of an individual to work in a specific field or trade. When the term came into use, there were few tools and ample time to learn how to use them so the competence was more about the work

than the tools. Working conditions were also very stable in the sense that changes – due to new tools or methods, for instance – were few and far between. Competence could therefore be acquired in a natural manner and was not the problem that it is today.

All this came to an end around the middle of the 20th century when computers and information technology radically changed the nature of work. To make a long story short, work required the mastery of rapidly evolving and increasingly complicated technologies and the role of competence therefore became more conspicuous. Since work no longer could be done without the use of technology, one consequence was that demands on competence grew to include both how to manage the technology and how to compensate for its limitations. Another consequence was that changes to working conditions became so frequent that it became impossible to attain a state of equilibrium where competence completely matched demands.

Defining competence as the ability to do something successfully means that it must refer to a description of what it is that needs to be done. The basis for competence used to be the codified work experience such as that required for apprentices to become journeymen and finally master craftsmen. But today, competence must also include knowledge about how work systems and technological artefacts have been designed and are intended to function. This can be seen as a combination of Work-as-Imagined (WAI) and Work-as-Prescribed (WAP).

"In view of the ever growing importance of safety, reliability, and productivity, competence must now also include the ability to recover from potentially harmful or dangerous situations – as well as to avoid getting into them in the first place."

WAI comprises a specification of the skills and competence that are needed to ensure that the system can accomplish its purpose – that it will work as intended. WAI is both how we imagine others do, or should do, their work and how we imagine what work will be in the future. WAP is the formalisation or specification of work as it is found in, e.g., regulations, procedures, standards, and job descriptions. In the world of today, the basis for competence is therefore a combination of collective experiences and anticipated needs. In view of the ever growing importance of safety, reliability, and productivity, competence must now also include the ability to recover from potentially harmful or dangerous situations – as well as to avoid getting into them in the first place.

Lagging competence

Competence should in principle cover the whole range of possible situations from the trivial to the non-trivial. In a discussion of resilience engineering, Westrum (2006) proposed a distinction between three types of threats based on how expected – or unexpected – they were: regular threats, irregular threats, and unexampled events. The two first categories, but not the third, make sense in relation to work situations and competence.

Regular situations happen so often that most people in an organisation have experienced them, directly or indirectly. It is therefore possible to specify the competence that is needed to manage them and to carry out work in a satisfactory manner. While competence initially can be based on WAI/WAP, unexpected situations or conditions will occur sooner or later. They can be due to improvements and redesign – such as new technology – but more importantly also due to malfunctions, failures, or even accidents. Indeed, an almost universal response to failures and accidents is to analyse them in order to identify the competence that would have prevented them. In that way the competence increases, but retroactively: it is lagging. Competence is furthermore cumulative and based on unexpected (adverse) experiences, hence piecemeal and fragmented. The advantage is that the associated costs can be justified because they refer to something that has happened – although the probability that it may happen again is rather low, which detracts from the value. The disadvantage is that lagging competence only increases the curriculum, since new cases are simply added to the existing ones rather than being seen in a larger context.

Leading competence

Although some part of competence must be lagging, it would clearly be interesting and useful if competence also could be leading. That would among other things mean that there would be fewer situations where a lack of competence could lead to losses. The downside is that preparing competence ahead of time, without knowing for certain whether it will ever be needed, is costly both in terms of establishing it and in terms of maintaining and verifying it.

Yet leading competence is essential for irregular situations since they, by definition, happen rarely. Irregular situations are so infrequent that an organisation may never have encountered them, hence has no experience to refer to, although people may know about them from the general lore or shared war stories. Since irregular situations go beyond the design base there is little help to be found in WAI and WAP either. Although each irregular situation by itself may be imaginable, their number is so large that it is impossible to think of, let alone establish, specific competence. Even if the required competence could be specified, it will not be cost-effective to prepare and maintain it. An alternative solution is to consider the generic competence that can be useful across a variety of situations.

> "Leading competence is essential for irregular situations since they, by definition, happen rarely."

One way is to rely on risk assessment and a risk matrix to specify what is needed to compensate for the most serious cases. A complementary and more constructive approach is to consider what is needed for a system to function as required in expected and unexpected conditions alike – or in other words to perform in a resilient manner. This can be called the requisite competence, in analogy with the concept of requisite variety as used by control engineering and cybernetics. The requisite competence could, for instance, be derived from the set of cognitive and interpersonal skills that are the focus of CRM – such as communication, decision making, and leadership. It could include the abilities to handle time stress and uncertainty, to guard against well-known fallacies in judgement and decision making, etc.

This can, however, not be done without explicitly considering how competence depends on the boundaries of the system. The demands on competence change as the boundaries expand horizontally, vertically, and temporally. The attractiveness of routines and standardisation, and therefore of WAP, is that these make it possible to define the required competence – at least as long as the situation can be controlled and stable working conditions can be maintained. Competence cannot be prescribed, assessed, or verified unless there is a well-defined boundary and unless the environment is reasonably stable and predictable. Yet an understanding of competence, lagging as well as leading, must accept that working environments today – and actually since the early 1980s – are characterised by tightly coupled functions that defy linear cause-consequence reasoning about how they should be managed. A failure to recognise that will lead to unreasonable and unacceptable limitations and constraints on system performance in terms of safety, productivity, sustainability, stakeholder interests and customer satisfaction. Competence is a challenge, but it is not a silver bullet.

References

Westrum, R. (2006). A typology of resilience situations. In: E. Hollnagel, D. D. Woods and N. Leveson (eds). Resilience engineering: concepts and precepts. Aldershot, UK: Ashgate.

Erik Hollnagel is a senior professor of Patient Safety at Jönköping University (Sweden), Adjunct Professor, Central Queensland University (Australia), Visiting Professorial Fellow, Macquarie University (Australia), and Visiting Fellow, Institute for Advanced Study, Technische Universität München (Germany). Erik's professional interests include industrial safety, resilience engineering, patient safety, accident investigation, and modeling large-scale socio-technical systems. He is the author/editor of 24 books, as well as a large number of papers and book chapters.
hollnagel.erik@gmail.com

COMPETENCY BASED TRAINING: VISIBLE AND INVISIBLE COMPETENCIES

Competency isn't only about what we can see. It's also about what we can't see. In this article, **Katrien Peeters** outlines the structure of competency and some implications for selection and training.

KEY POINTS

- **Skills and knowledge are sometimes called visible or surface competencies. Skills may be cognitive or psychomotor. Knowledge may be explicit or tacit. Skills and knowledge are basically teachable.**
- **Attitudes are not directly visible but have a strong influence on someone's competence. They are more or less constant, or else change very slowly.**
- **This has implications for selection, training design, and assessment.**

Over the last few decades, organisations have been confronted with continual changes in different domains such as technology, the social and cultural environment, and the economy. This has put increasing focus on continuous training and development, especially in knowledge-based industries. Investing in competency is a prerequisite to survive and achieve success.

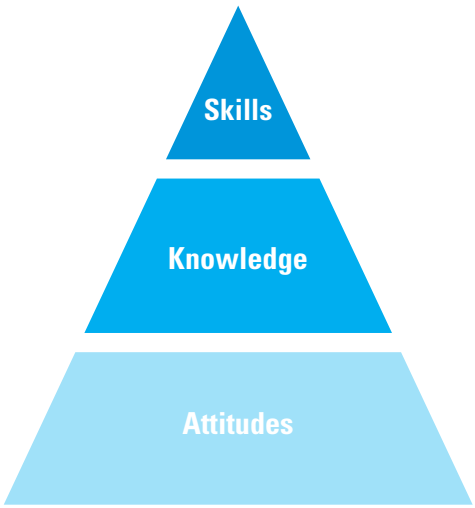


Figure 1: The more and less visible aspects of competency

If you compare the amount and type of information presented to an air traffic controller today with even only 15 years ago, the difference is significant. Technology, procedures and route networks are expanding, resulting in different and more complex working methods, and with little margin for error.

"Competency-based training helps to bridge the gap between what is taught in training and what tasks will be performed 'on the job'."

According to ICAO, competence may be described as a person's ability to act in a self-organised manner and to be creative in situations not previously encountered. ICAO encourages the development of competency-based training for air traffic controllers. Competency-based training helps to bridge the gap between what is taught in training and what tasks will be performed 'on the job'.

As described in DOC 9868 PANS-TRNG, competency-based training makes use of a systematic approach whereby the air traffic controllers' competencies and their performance criteria are defined. Competencies are learned one by one and only when a competency or combination of competencies is mastered, the training will move on to the next learning block. If a student has been trained and masters all different competencies, he or she will be able to perform as an air traffic controller, and can be called a competent air traffic controller.

It is a student-centred training approach, focusing on what the trainee must be able to do after completing the training. Each component of a competency based training is designed, monitored and adjusted as deemed necessary, while bearing one thing in mind: the result. Training plans are therefore developed based on clearly defined learning results, including observable behaviour derived from an analysis of the learner's tasks. Personal judgement and subjectivity are minimised, creating a more positive learning environment.

But we must pay attention to the structure of competency. Some elements of competency are easy to see, and so are easier to train and assess or evaluate. Other elements are hard to see, but we must pay attention to them.

The visible: Skills and knowledge

Skills and knowledge are sometimes called visible or surface competencies. Skills are activities that are mastered well and are often teachable. A skill

is the ability to do something well and may be acquired through the application of knowledge, practice and experience. Skills are developed over time and with practice. Often, complex tasks that are new to the controller are initially seen as cognitively demanding. However, as they become more practised, some of these cognitive processes become 'automatised' and so the skills require less effort to perform. In terms of ATC, this gives the controller the capability and the capacity to find solutions to more difficult situations.

Skills can be divided into cognitive and psychomotor skills. Cognitive skills are thinking skills that are needed to carry out any tasks from the simplest to the most complex. These skills have more to do with how we learn, remember, problem-solve and pay attention rather than the knowledge itself. Psychomotor skills are those that enable a person to make coordinated movements, perform manual tasks and carry out physical activities.

Knowledge on the other hand is information that is acquired through experience and/or education, and is also basically teachable. Knowledge could be divided into explicit and tacit knowledge. Explicit knowledge is formalised and codified and is sometimes referred to as 'know-what', e.g., ATCO rules and regulations. Tacit knowledge refers to knowledge that is largely experience-based and is sometimes referred to as the 'know-how', e.g., making an efficient sequence.

Katrien Peeters has worked in the operational environment as assistant, TWR and ACC controller at Brussels Airport and Canac. During her work as deputy flow manager she came into contact with the training environment as a theoretical instructor. Until recently, Katrien worked as Training and Human Performance Manager at Belgocontrol. She will shortly take up a position within the EUROCONTROL Maastricht unit training team.
katrien.peeters@eurocontrol.int

The invisible: Attitudes

Attitude is the state of mind of a person towards different issues. It describes a person's predisposition such as values, tendencies or orientation. Attitudes are not directly visible but have a strong influence on someone's competence. They are more or less constant, or else change very slowly.

For ATCOs, attitudes towards issues such as safety, adherence to regulations, working with others and responsibility is a significant factor in the achievement of competence and the safety of air traffic.

Implications for selection and training

This structure of human competence must be kept in mind when starting to think about developing training and certainly also during the selection procedure.

Ensure that attitudes are covered by the selection procedure
Since attitudes are more difficult to change and develop, candidates with the required attitude and personality traits must be identified during the selection process. This will affect the success rate and cost-efficiency. Candidates must have the ability to study the relevant theory and develop the associated practical skills. But the invisible part must be adequate in order to start training.

Training design must integrate skills, knowledge and attitudes
Training must be designed in such a way that those three levels of learning and development are covered. ICAO states:

"Although individual tasks can be broken down into a list of observable performance criteria, competence is only achieved when the controller successfully integrates the skills, knowledge and attitude required into an overall performance." (ICAO 2014)

Use pre-tests
On some occasions it can be a great help to measure the present level of knowledge or skills from trainees by using a pre-test. The results help you define where to focus in the training.

Use learning blocks to build training
By dividing the practical training into learning blocks with relevant tasks and milestones, skills with a strong foundation will be built. The risk of having gaps in the training is reduced when describing overall objectives, specific objectives and its associated performance criteria in advance.

Be transparent about the training trajectory
Transparency about the training trajectory and the student's learning curve will enable the student to be more prepared before a training session, boosting his/her motivation.

Focus on expecting the unexpected
Trainees must be able to perform in a safe and adequate manner as well when confronted with unfamiliar situations. They must be able to use their competencies and common sense at all times, and not freeze when an unexpected situation arises.

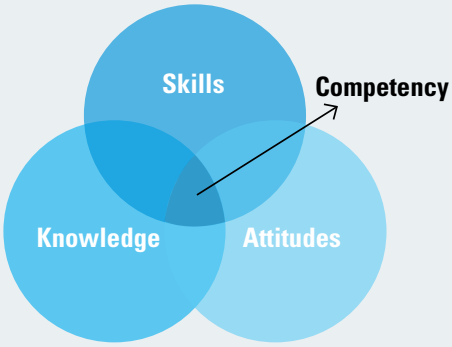
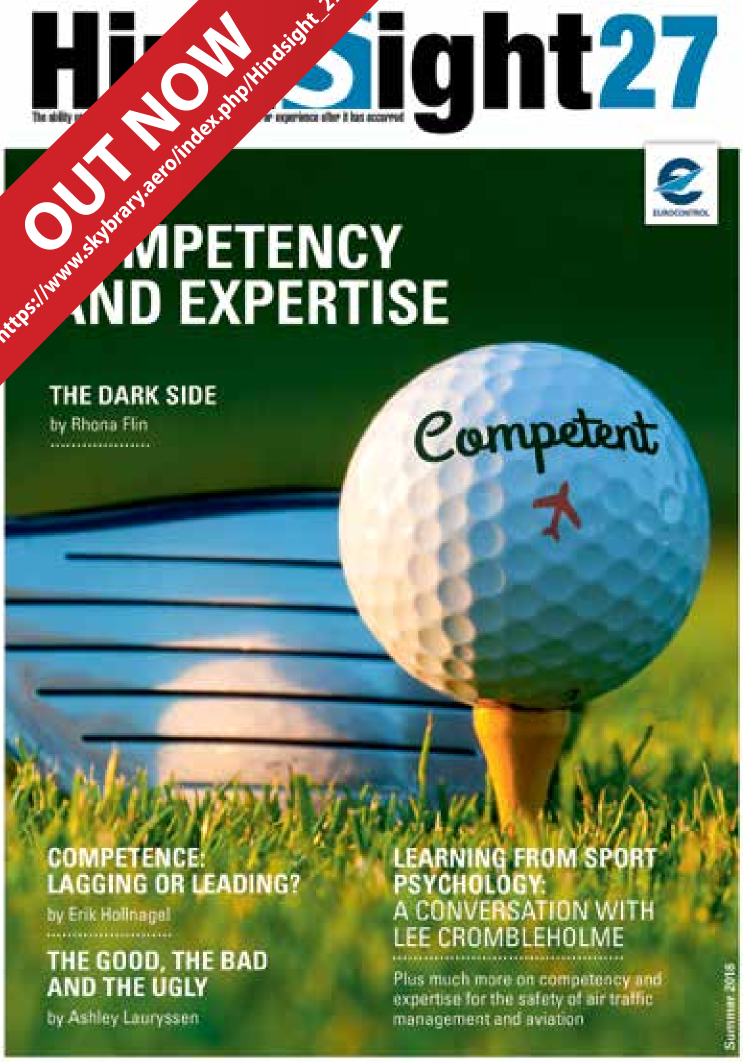
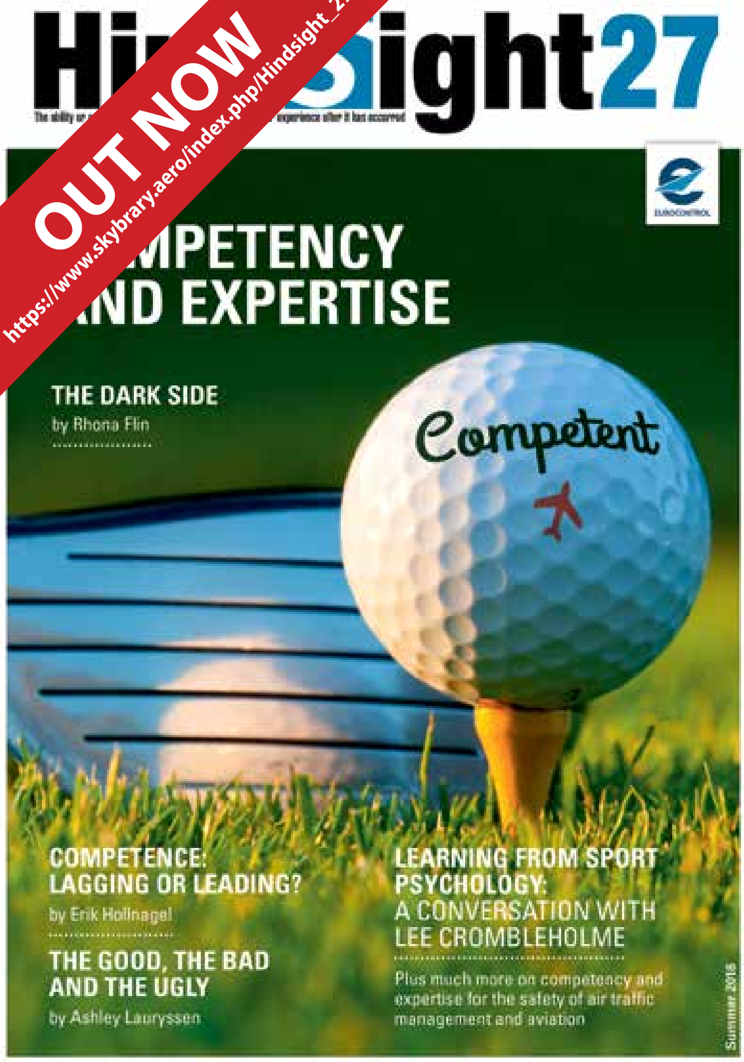


Figure 2: Competency emerges from the combination of skills, knowledge and attitudes

As ICAO stipulates:
"Competency includes the ability of a person to formulate solutions for complex and/or difficult situations, including those situations that they are experiencing for the first time. For the air traffic controllers, they need to be able to deal with these situations effectively and at the same time ensure that it is done in a safe and secure manner." (ICAO 2014)

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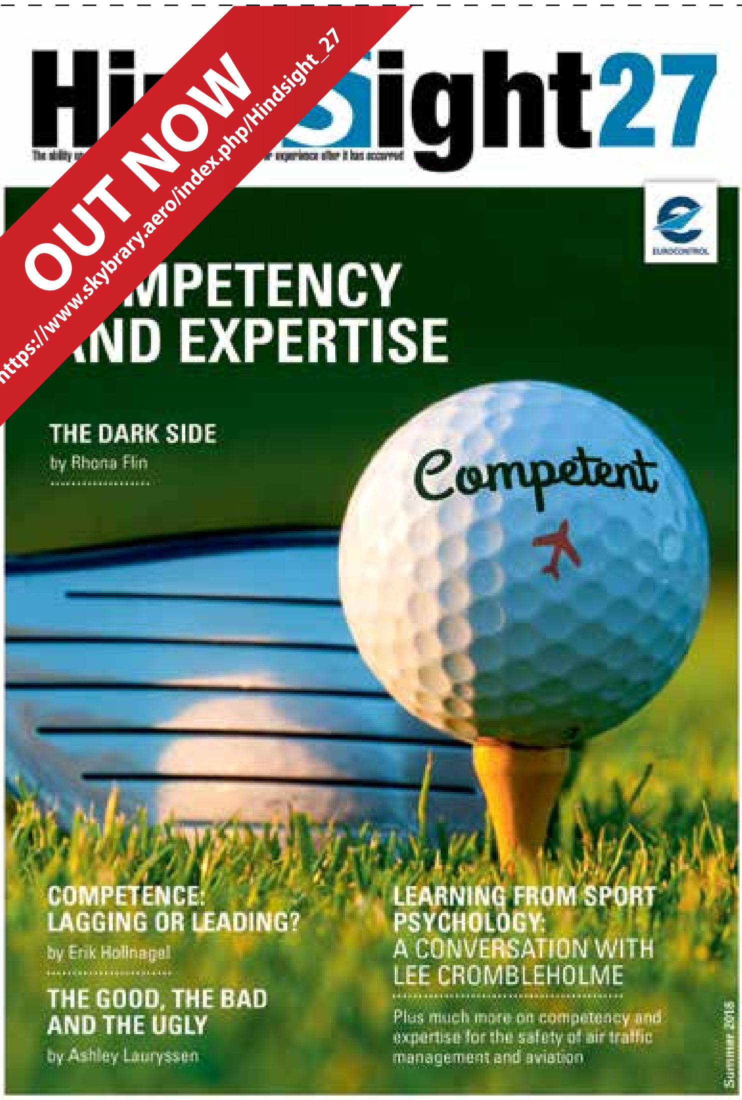
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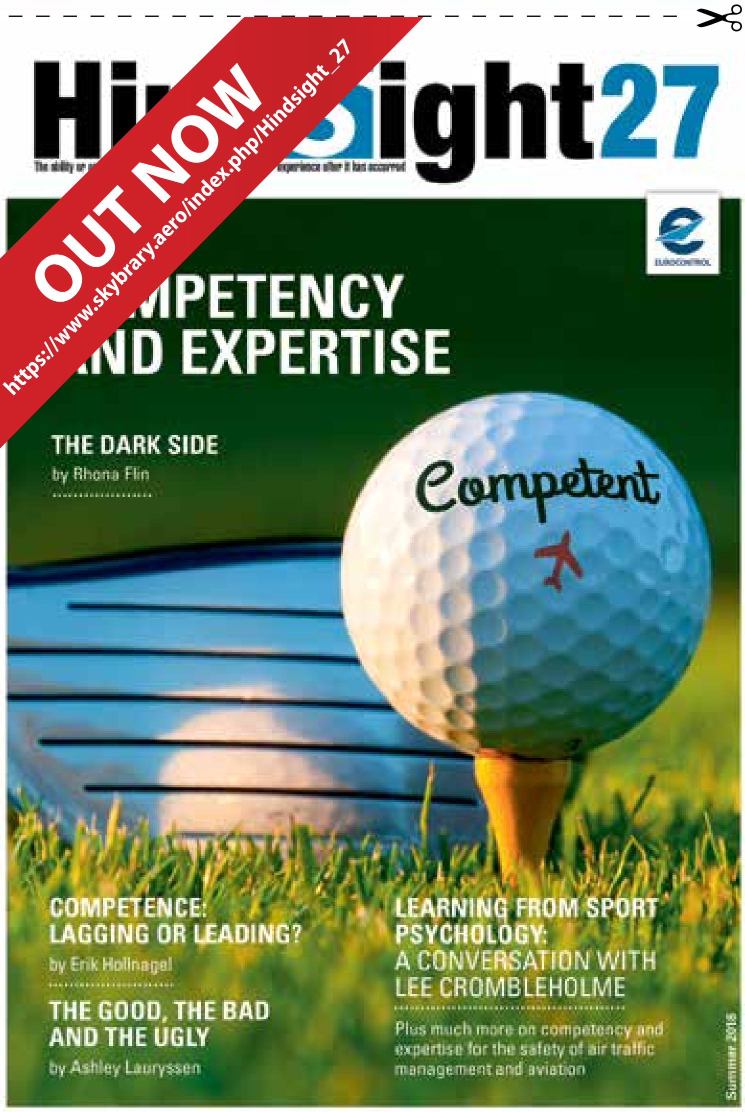
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DEVELOPING NON-TECHNICAL SKILLS

Non-technical skills training is one aspect of Human Factors in operations that has become an important part of developing competency and expertise in aviation. It helps to focus on aspects of operational work that help to create safety, but that we often don't pay much attention to. In this article, **Florence-Marie Jégoux** reflects on her time as a Human Factors trainer, and explains what she has learned along the way.

KEY POINTS

- **We cannot train experts and teach non-technical skills in a traditional way.**
- **Non-technical knowledge needs to be instilled into non-technical skills.**
- **Creative teaching methods may help, especially facilitation, like in team resource management.**
- **Ultimately, Resource Management must spread through and between organisations.**

How can we develop non-technical skills among operational staff? What helps and what hinders? In this article, I reflect on my practical experience as a Human Factors trainer and specialist, and share the lessons that I have learned in almost 10 years of practice.

Lesson 1: We cannot train professionals the way we teach students

Teaching HF in a lecture from a 'know-it-all' position results in resistance: "Yes, but… It's not possible the way we work", "we can't do that because…" HF 'lectures' may be counter-productive: "You want to tell me how I am supposed to work?" Resistance needs to be addressed by encouraging free speech. Protests and disagreements should be expressed instead of being kept politely silent.

Trainers get resistance when they put the professional expertise of operational experts at stake. The participants can feel like they are being re-assessed or infantilised. They are experts, and their expertise first needs to be recognised.

Lesson 2: We have to be realistic about what can be achieved by CRM/TRM training

Technical competencies are the high level competencies that have been traditionally taught to professionals. Non-technical skills are more linked to our personality, our emotional intelligence, our values, our behavioural patterns, and our professional identity.

When developing non-technical skills, two pitfalls should be avoided. One is a mindset that, "we can change every attitude". This may provoke clashes during a CRM/TRM session. It may bring about disillusionment. The other pitfall is its contrary: "we cannot change anything or anyone". We often hear, "that's the human factor, we can't do anything about that. We can't change people". The aim is not about changing people. It is about helping them to get insight and change working behaviour.

A good incentive is the collective opinion: when a growing number of people change their behaviour, at some point ▸▸

Physiology	Stress, fatigue, sleep, …
Cognitive psychology	Decision-making, attention, situational awareness, priorities, cognitive biases, errors, …
Social psychology	Teamwork, communication, leadership, conflict management, group biases, conformity, …
Teaching methods	Teaching skills, teaching biases, monitoring, intervening, …
Sociology, systems theory	Cultures, regulation, authority, hierarchy, organization, …
Management	Role of managers, risk management system, priorities, …
Safety culture	Experience report, experience sharing, …
Selection and training	Selection, initial, recurrent, continuous training, examinations, …

Table 1: Non-technical factors: A non-exhaustive list

they reach a critical mass. This turning point can lead the remaining individuals to changing their behaviour, too. For instance, when many newcomers arrive in a control centre or tower, sooner or later, they change some habits to fit into the team (going to the restaurant with colleagues, using new working methods, etc).

For safety behaviours, we often need forerunners. Forerunners may sometimes be the trainers themselves. They may be the best ambassadors. By implementing non-technical skills into their daily operational practices, they inspire their peers. The best lessons may come not from the classroom, but from behaviour at work generally.

Lesson 3: HF knowledge is not enough

Knowledge and skills are different. If HF knowledge were sufficient, CRM or TRM trainers or experts would have excellent decision-making and communication. As we are also human, we sometimes make mistakes and do not communicate effectively. A lack of coherence between what is said and what is seen in training sessions and in our daily behaviour can decrease credibility and legitimacy. Therefore, the selection and training of trainers is critical.

Turning knowledge into competencies is not easy. Take sleep, for instance. Many doctors have detailed knowledge about sleep and good 'sleep hygiene'. Yet their initial training and work conditions do not help them to transfer this knowledge into their own practice.

In order to turn knowledge into skills, we need some creative learning methods to overcome the mental blocks that may arise.

Lesson 4: Creative teaching methods are needed

Different kinds of methods may be used to develop NTS. But creative methods are needed to improve our understanding about our thinking, our ability to learn from experience, and our capacity to adapt to unknown situations. TRM training requires several active learning methods: case studies, short videos, games, role-playing games, simulation, etc. Their aim is not about having fun (although recent studies made it clear that fun fosters memorising), but rather bringing about insights and debate. Then, the facilitator's role is to enable participants to transpose what they experience in the activity to the ops room by asking specific questions, like:

- What were the problems?
- How did you solve them?
- How can it be used in daily work?

Seeing different situations from different perspectives is therefore a way to enhance their capacity to produce new solutions to recurrent problems. From a Safety-II perspective, "understand how things usually go right" (EUROCONTROL, 2013) is as essential as identifying what goes wrong (and indeed is "a basis for explaining how things occasionally go wrong" (p. 21). Understanding what works also helps to improve motivation and quality of work life.

With fighter pilots, mindfulness has also been shown to be useful in dealing with unforeseen events. Mindfulness may be seen as the capacity not to judge a situation according to our positive or negative feelings. The French Army Biomedical Research Institute explored the problem solving skills of Mirage 2000 pilots (from failure simulations). It was found that performance was linked to mindfulness and openness (or curiosity), although the number of years of professional experience was of no help (Dechy et al, 2016).

Lesson 5: Give food for thought, not 'the right answers'

In using creative methods, there is an essential point about 'posture'. Instead of trying to convey 'the right answer' (which probably makes them wrong…and who likes that?), or delivering moralistic messages, we need to debate with openness and just give experts food for thought. Sometimes there are no 'right answers'. Sometimes they do not see the point during a course but perhaps, a few weeks later, they will think it over and change their point of view. It requires trainers' humility and trust in the process.

We all know that we make mistakes, but experiencing them for ourselves can help us to stop feeling ashamed of making mistakes. It also helps to have a briefing that normalises the fact that we all make mistakes (see Moneypenny, 2017), along with a sensitive and funny debriefing.

Lesson 6: Facilitation and debate is critical for skill learning

Facilitation is a method to encourage debates and reflective activities, which enables people to get understanding and perspective, and transpose what is seen in training into daily life. It is a method that puts ideas to the 'reality test' regarding:

- professionals and their own practice: we can become aware of the pros and cons of our practice
- professionals and their peers: different opinions cross-fertilise and enable field experts to complete their own toolbox with their colleagues' tools and tricks
- individuals/teams and their taboos: they may look at implicit rules and taboos, question them and create a space for discussion
- facilitators and professionals to HF theories and knowledge: are these theories realistic? What can be put into practice?

For instance, CRM and TRM include many debates on professional issues. TRM is a program that enables "operational questions, doubts and uncertainties to surface and receive appropriate attention before they become an irreversible situation" (Bunjevac, 2011). This experience sharing among experts is a key to improve non-technical skills.

Lesson 7: Ultimately, resource management must spread through the organisation

These methods are very useful but they usually affect only operational personnel. Others at the upper levels of organisations also have competencies and may develop or inhibit them. The decision-making process occurs over a longer time frame, and is scattered across multiple departments and individuals. The feedback from their errors also occurs over a much longer timeframe, sometimes in years – if at all. But is there any specific reporting for organisational lessons learned, as there is for operational staff? Or is this rather informal?

In some airlines, Crew Resource Management became Company Resource Management, with people from different departments attending the CRM courses, instead of working in silos. But also looking outside of the organisation, we may work on two axes:

- **a horizontal axis:** with different operational jobs and activities that are related: Operational Resource Management.
- **a vertical axis:** with different hierarchy levels, both bottom up and top down: Organisational Resource Management.

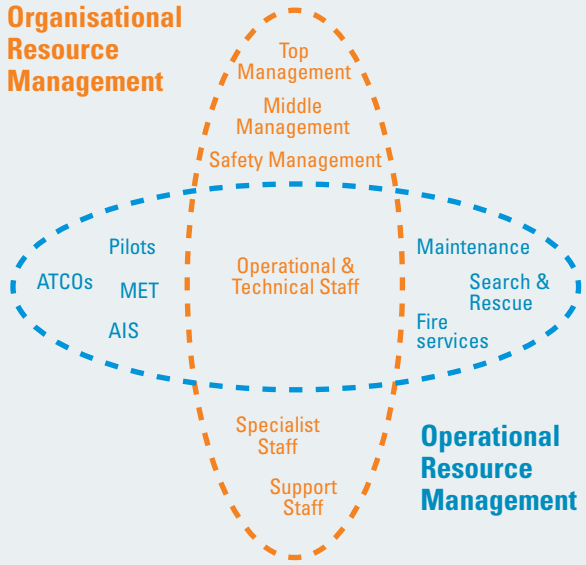


Figure 1: Operational and Organisational Resource Management

Paying attention to these two axes will help to ensure that resource management is for the many, and not just the few.

References

Bunjevac, S. (2011). The emperor's new clothes…or what exactly is TRM? *HindSight Issue 14: Training for Safety.* Brussels: EUROCONTROL.

Dechy, N. et al (2016). Explorer « l'imprévisible » : comment et jusqu'où? [Exploring the "unpredictable": how and how far?] *20th Congrès de Maitrise des risques et de sûreté de fonctionnement*, Saint Malo, 2-5 October 2016, Institut de Maitrise des Risques.

Moneypenny, M. (2017). Imagining work-as-done in simulation: Lessons from healthcare. *HindSight Issue 25: Work-as-Imagined and Work-as-Done.* Brussels : EUROCONTROL.

Florence-Marie Jégoux became a private pilot in 2000, a certified air traffic controller in 2004, and an HF facilitator in 2009. She is also a coach and is trained in systems theory. She now works for an ANSP in their training department as a Human Factors facilitator and specialist. She passed an HF University Degree in 2017 in the National Polytechnic Institute of Bordeaux.
dvtsystemiquehumain@gmail.com

THE TYRE

How often do you look back on your time and reflect on what you have done that has really made a difference, that someone really appreciated? Perhaps there are specific instances that come to mind, and that others would remember too. In this article, **Svetlana Bunjevac** recalls one such event and asks whether we should take more time to reflect and discuss when a colleague on the ground or in the air has said thank you…and really meant it.

KEY POINTS

1. **Repetition of the training methods that are used to develop competencies will give similar results.**
2. **This is reliable to maintain the required competencies but not sufficient to grow expertise.**
3. **No amount of regulation will compensate for a lack of critical thinking.**
4. **The purpose of lifelong professional training for aviation staff is to cultivate critical and creative thinking.**

It is early afternoon in the true South Balkan type of summer. B737 is at RWY 16 ready to roll: "Cleared for take-off, wind calm". And off it goes. A very long roll, fortunately still within the available runway length. But not all seems quite right.

I am not sure if it is the hot air dancing above the tarmac. Or did a small part of the tyre get separated from one of the wheels that I saw flickering in that radiating heat? Was it anything at all? The crew is quiet; they seem quite content with their take off. Should I send the car to check the runway? Should I say something to the crew? What would you do?

Less patient back then, I spoke: "ABC123 it seems that a part of one of your gears got detached. Am unsure about this and am sending a car to check the runway for the debris. Will get back to you."
The car went for the check and found nothing. There were some skid marks on the tarmac but this is not unusual in that type of heat.

There was no physical proof to support the transmission I just made.
What would you say to the crew now?

Option 1:
"We found nothing on the runway. Contact 123.4 and have a safe flight."

The aircraft continued. It was a very short flight (25 min). It crash-landed at destination, caught fire and the crew were caught by surprise. It was missing a part of a tyre.

Option 2:
"We found nothing on the runway. Contact 123.4 and have a safe flight."
The aircraft landed with no issues whatsoever.

Option 3:
"We found nothing on the runway but the gear part could still be somewhere on the side."
"Roger."
"Contact 123.4 and have a safe flight."

The pilot declared and performed an emergency landing, foam on the landing runway. The crew was ready to act. A hard but safe landing. No fire.

Option 4:
"We found nothing on the runway but the gear part could still be somewhere on the side."
"Roger."
"Contact 123.4 and have a safe flight."
The pilot did not declare an emergency landing. They landed with all the gears down, locked and complete.

Which one is it?

▸▸

The road to getting above the 'thin red line' of competence is detailed in various places, including the

- Common Core Content document
- Unit Training Plan
- Unit Competence Scheme
- Operational Manual
- ICAO 10 Competences.

It all starts with good recruitment and selection, and classroom and objective based training levels. Common Core Content Levels 0, 1, 2 and 3 (page 20, para 6.5.2) take you through the theory and basic applications to the simulators. Objectives level 3, 4 and 5 take you through the job simulations to the on the job competences. Research shows that the six levels of learning are arranged hierarchically by the level of mental complexity involved (Bloom et al, 1956; Anderson et al, 2001). Then ICAO's 10 competencies take over, providing a description of ATCO competencies (ICAO Doc 10056, Appendix B to Chapter 2).

"No amount of regulation will compensate for a lack of critical thinking."

Once we get there, the aim is to remain competent – but how? The answer is by providing good classroom training, simulator refresher training, e-learning and assessments to fortify what we have and need. And repeat. But there is a part missing, the 'create' part (see Figure 1). By repeating the class-sim-assess cycle the big five below are taken care of. But if we want to go higher we need a 'breakthrough' – a different approach and recognition of the developmental nature of competence.

No amount of regulation will compensate for a lack of critical thinking. The ultimate purpose of lifelong professional training for aviation staff is to cultivate critical and creative thinking. One should be able to evaluate that no procedure, rule, regulation exists for that one situation, and create a safe yet new solution, on the spot. Competence is having ready-made solutions for clear-cut problems and emergencies. But more so it is about creating solutions when one is not readily available. Expertise means recognising the danger of relying only on prescribed procedures.

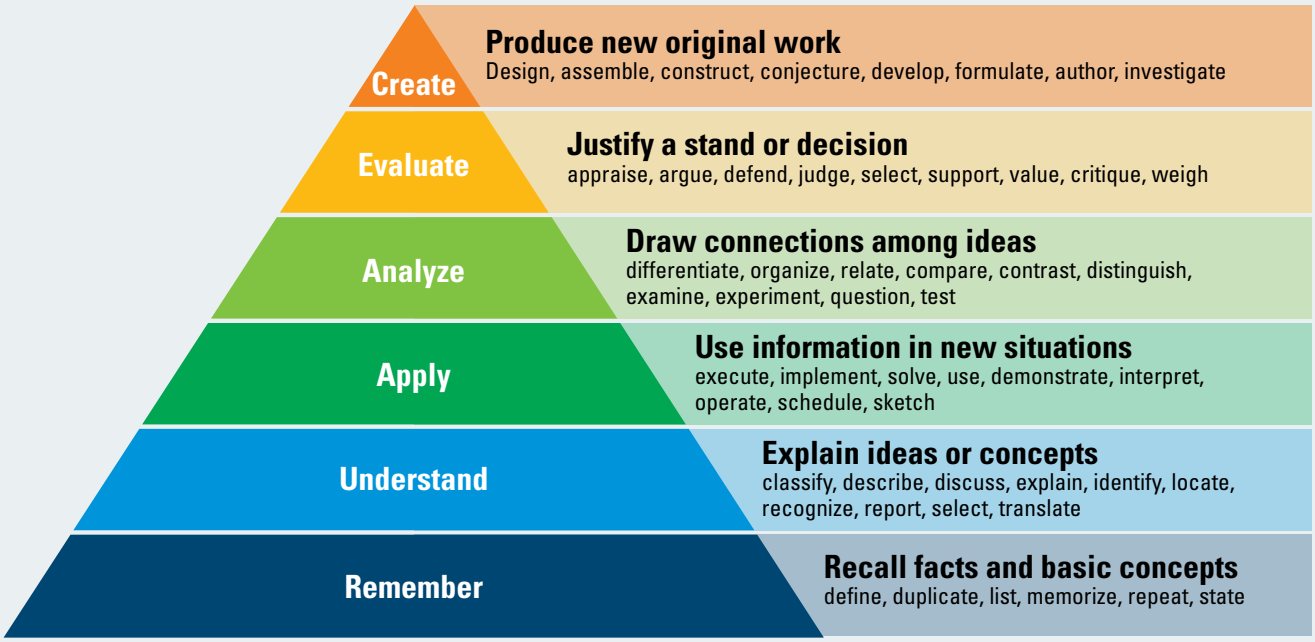


Figure 1: Bloom's (2001) revised taxonomy (Vanderbilt University Center for Teaching CC BY 2.0)

Using facilitation in peer-to-peer learning events provides controllers with the opportunity to achieve the highest levels of mastery: analysis, evaluation, and most importantly creation, in the continuation training stage.

This is a very powerful way of unlocking capacity for creation and exchange of experience. It is TRM that brought the method of facilitation into our learning structures many years ago, although through very small doors at times. But it is here. Our Spanish colleagues and ENAIRE have 150 facilitators today and are spreading this way of assisted learning and exchange throughout the 10 ATCO competencies. Of course, simulations and classrooms remain. The additional element is sharing and learning from the unwritten case studies that everyone carries with them.

What happened with my B737, though? "I think you lost a part of the wheel", I said. While it felt so uncomfortable, as a young controller, the heavy feeling didn't last too long. I got a phone call about an hour after the take-off. It was the captain, and I have kept these words in my head for the last 29 years: "One of our wheels was incomplete but we are all safe and the plane can be used again. Thank you."

It was Option 3.

In our work, significant events happen that do not always find their way to 'breaking news', but could make their way into our continuation training content. Support for the growth of expertise requires more than presentations, e-learning, and simulations of known scenarios. It needs exposure to the unknown, and not solely while in the working position. One possibility is to exchange our experiences of unknown situations. There ought to be more possibilities, though. Can we put our heads together to support the growth of expertise and critical and creative thinking, creating more engaging continuation training events? That is what I wish for.

Ceca (Svetlana) Bunjevac is senior human performance expert at EUROCONTROL. Ceca provides human factors training and improvement support to the aviation community and coordinates HUM training domain of the Luxembourg Institute's portfolio of courses. She contributes to the EUROCONTROL Network Manager Safety Unit, EUROCONTROL Diversity Group and to EASA HF Collaborative Analysis Group. Her ATCO background is TWR, TMA, En-route (civil and military), on-the-job-training instructor, competency assessor, and shift supervisor.
svetlana.bunjevac@eurocontrol.int

References

Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: a revision of bloom's taxonomy of educational objectives.* New York: Pearson, Allyn & Bacon.

Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives, Handbook I: The cognitive domain*. New York: David McKay Co Inc.

EUROCONTROL (2015). *Specification ATCO common core content initial training specification* (Edition: 2.0; Edition date: 02/04/2015; Reference Number: EUROCONTROL-SPEC-157). Brussels: EUROCONTROL.

ICAO Doc (2017). *Manual on air traffic controller competency-based training and assessment.* First Edition. ICAO Doc 10056. Montreal: ICAO.

Illeris, K. (2011). *The fundamentals of workplace learning: Understanding how people learn in working life*. London: Routledge.

QUESTIONING FOR COMPETENCY ASSESSMENT

We all think about our performance in some way, in routine work and when undertaking training and assessments. But how do we do this? Questioning is a tool that can be used by trainees and instructors to help give insight into our own performance, as **Emmanuelle Gravalon, Caroline Fauquembergue, Julie Baltet, and Sylvain Dumousset** explain.

KEY POINTS

- **Competency is mainly a non-observable process. The only observable parts of a competency are actions and results.**
- **Practising questioning makes it possible to verbalise some mental processes and become aware of how we understand a situation, form strategies, and evaluate performance and learn.**
- **Questioning can be used by instructors and trainees to help reflect on and improve performance.**

A competency is a combination of theoretical and procedural knowledge *(savoir)*, the ability to implement this knowledge in various situations *(savoir-faire)*, and behaviours adapted to the situations encountered *(savoir-être)*. However, competency is mainly a non-observable process: one can't read someone else's mind, one can't hear someone else's thoughts, and one can't feel someone else emotions. The only observable parts of a competency are actions and results. For both instructor and apprentice, this non-observable part of competency is an obstacle to competency assessment. The ability to reproduce successfully a competency and the expected result creates performance.

Assessment and validation of competencies are often mixed-up with an instantaneous measure of performance, thus highlighting the difficulty of describing a competency. The French Human Factors Team for ATCOs uses 'questioning' to support instructors and trainees in this skill building process. Practising questioning makes it possible to verbalise some mental processes and become aware of how we practise:

- I recorded the elements of the situation. I understand how I did it.
- I am able to explain my choices, my actions and the elements to watch out for, so that everything runs smoothly.
- The result allows me to validate the actions implemented, or to plan improvements for the next attempt.

When the student knows how they achieved the result, they will be able to reproduce that combination, and amend it when the circumstances vary.

Some examples of questions are below. These can be adapted to fulfil each objective.

1) Understanding: What are the characteristics of the situation?

- What did I see and hear, which helps me in building my mental picture of the situation?
- What is my knowledge related to this situation?
- What is my goal for this situation?
- What is my concrete general objective? What is my underlying personal goal?
- What personal and external resources are needed? Which of these are available?

Objective:

For both instructor and trainee, check the relevance of information gathering, and compare their mental pictures of the situation, and their objectives.

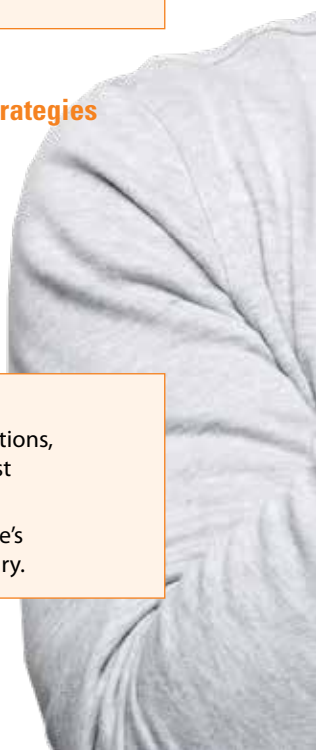
2) Strategies: What are the possible strategies to achieve the objectives?

- Do I imagine several solutions?
- What is the expected result for each?
- What obstacles have been identified and considered for each?
- Which one do I know best?
- What is my action plan?

Objectives:

Enable the trainee to verbalise different options, and the selection criteria for them (e.g., past success, available resources).

Enable the instructor to discover the trainee's 'library of strategies' and to enrich this library.



3) Evaluation and learning: How did it go?

- Did I roll out my action plan as planned?
- Which adjustments or corrections were necessary and useful? What feedback indicated this?
- Did the result fit my predictions?
- Which personal and external resources contributed to this outcome?
- What adjustments should be made for the next time?

Objectives:

Enable the instructor and the trainee to compare objectives and results.

Evaluate the competency.

Plan improvements for future situations.

Practising this kind of questioning helps to become aware that, for the same performance, each controller has constructed his or her own combination of knowledge, technical skills, and non-technical skills.

Questioning can be used by an instructor when debriefing as a tool for feedback. The debriefing becomes more factual and work-oriented. It helps to explain another way of dealing with such a situation. Questioning can be used by a trainee to reflect on their own performance (e.g., to compare intention to outcome) and to question what they observe (e.g., situation resolution that he or she witnessed), in order to reproduce or improve it. Questioning is however time-consuming, and so obviously cannot be implemented in real time during intense traffic.

When the instructor and trainee use questioning together, they can compare their own way of dealing a situation, 'speaking the same language' through the three stages of understanding, strategy, and evaluation and learning.

Emmanuelle Gravalon has been working as an air traffic controller for the last 30 years. Formerly in Limoges airport, she is currently working in Basel-Mulhouse International airport as an approach controller. She became an HF facilitator for controllers in 2008, and graduated in Ergonomics & HF Basics from Paris Descartes University in 2011. She recently led the creation group of the TRM course for trainees, and is responsible for its implementation in her ANSP.

Caroline Fauquembergue has been working as an air traffic controller for the last 25 years. She started her career as an en-route ATCO in Reims ACC, but is currently working in Nantes-Atlantique airport, as an approach controller. She became a TRM facilitator for controllers in 2001, and has participated in creating HF training courses since 2002.

Julie Baltet has been working as an air traffic controller in Reims ACC since 2006. Feeling the need to learn more about HF, she became an HF facilitator for controllers in 2011. She joined the French HF team recently.

Sylvain Dumousset is the TRM National Co-ordinator, and manages the HF team. He's been involved in many different HF projects, and stands in the National Safety Commission. He's still an active approach controller in Clermont-Ferrand.

gncr.team@gmail.com

TEAM RESOURCE MANAGEMENT: IMPLEMENTATION SURVEY 2017

TRM has matured in recent years and is now an acceptable means of compliance to Regulation EU 2015/340. But how is it implemented? This article by **Anthony Seychell and Svetlana Bunjevac** reports on a survey performed by EUROCONTROL to help ANSPs learn from each other.

KEY POINTS

1. **Around 70% of the ANSPs surveyed have implemented TRM. It is expected that nearly half of the ANSPs who have not yet implemented TRM are planning to do so in the near future.**
2. **TRM is mostly applied to ATCOs. Some ANSPs have extended the programme to cover also ATSEPs, AIM/AIS personnel, FISOs and FMP staff. A few ANSPs hold joint sessions with management, adjacent units, and pilots.**
3. **The topics for the TRM sessions are mostly taken from internal reports although a substantial number of ANSPs use EUROCONTROL TRM prototype material.**
4. **TRM is delivered using various learning tools, the most common being ATC case studies, internal investigation reports, and videos.**
5. **TRM sessions typically last one day, have 10-12 participants with two facilitators. Facilitators usually have about two days of preparation prior to the session.**

Anthony Seychell is a senior safety expert at EUROCONTROL. He is a former controller, OJTI, competency assessor and safety manager at Malta Air Traffic Services.
anthony.seychell@eurocontrol.int

Ceca (Svetlana) Bunjevac is senior human performance expert at EUROCONTROL. Ceca provides human factors training and improvement support to the aviation community and coordinates HUM training domain of the Luxembourg Institute's portfolio of courses. She contributes to the EUROCONTROL Network Manager Safety Unit, EUROCONTROL Diversity Group and to EASA HF Collaborative Analysis Group. Her ATCO background is TWR, TMA, aEn-route (civil and military), on-the-job-training instructor, competency assessor, and shift supervisor.
svetlana.bunjevac@eurocontrol.int

What is the background and purpose of TRM?

Team resource management (TRM) is defined as: Strategies for the best use of all available resources - information, equipment and people - to optimise the safety and efficiency of air traffic services. Like crew resource management, TRM is based on the recognition that many operational incidents relate to issues with human performance and teamwork. TRM is therefore especially designed to improve the functioning of air traffic control teams. It does this by increasing the awareness and understanding of interpersonal behaviour and human capabilities that may affect operational safety.

The main benefits of TRM are considered to be:

- reduced teamwork-related incidents
- enhanced task efficiency
- improved use of staff resources
- enhanced continuity and stability of team work in ATM
- enhanced sense of working as a part of a larger and more efficient team
- increased job satisfaction.

Team resource management programmes are operational human performance enhancement programmes recognised by European transport legislation as an acceptable means of compliance to Regulation EU 2015/340.

Surveys on TRM implementation are conducted every three years or so to study the evolution of TRM Implementation over the years. This article reports on the survey performed in 2017.

How did we do the survey?

A questionnaire was prepared and distributed to members of EUROCONTROL's Safety Team, Safety Human Performance Sub-Group and TRM focal points.

Who has implemented TRM?

The responses indicate that around 70% of the ANSPs surveyed have implemented TRM, while it is expected that nearly half of the ANSPs who have not yet implemented TRM are planning to do so in the near future.

What is the scope of TRM programmes?

Most TRM programmes address only ATCOs. Some ANSPs have expanded the programme to include other ATM professionals and others are ready to do so. The professions included in the 'other' category were FISO, FISOs assistants, flight data and flow management assistants. Two ANSPs indicated that they plan to extend TRM to the ATSEPs, while another ANSP is planning to include AIS/AIM personnel in the TRM programme.

What kind of staff take part?

ATCOs were the main participants in all ANSPs, but ANSPs also perform joint sessions between:

- ATCOs and their operational managers (the most common type of joint session)
- ATCOs from different units
- ATCOs with different ratings and/or endorsements
- civilian ATCOs and military ATCOs
- ATCOs and pilots (civil, airline and military)
- ATCOs and FISOs
- FISO and/or AIS, flight data and flow management
- non-technical and technical personnel.

The survey probed the advantages and disadvantages of joint sessions. The general feeling was that the joint sessions were very fruitful experiences. The advantages can be summarised as better awareness of the overall organisation as a coherent system, awareness of other areas activities, and improved coordination.

A small number of disadvantages of joint sessions were mentioned. The primary disadvantages identified were that people can get uncomfortable and stop sharing. There can also be planning problems. The important factor noted was to run joint sessions in a neutral environment.

A few respondents gave reasons why joint sessions are not held in their organisation. The main common response was the lack of resources to properly organise such sessions. A lack of support from management for such activities was also mentioned a few times.

Who is responsible for TRM?

The responses indicate that the responsibility for TRM rests mainly with the training unit. But often, responsibility is shared with other units. In three organisations, it was indicated that responsibility is shared with other directorates and departments.

The 2017 responses to the question about responsibility contrast with those of the previous surveys. In the past two surveys, the responses indicated that it was the Unit Managers who were responsible for TRM.

A possible explanation for the transfer of responsibility could be that, during the early implementation phase, TRM was an experiment in only a few units. The responsibility may have transferred to the training unit once the TRM programme matured.

The transfer of responsibility from unit management to the training unit could be also due to the inclusion of TRM as an acceptable means of compliance (AMC) to operational HF training during unit and continuation training of ATCOs. When TRM was declared an AMC to EU 2015/340, this changed its status to a 'soft' law and perhaps the service providers felt a need to centralise the programme to harmonise and standardise it, because it became part of the ATCO training certification requirements.

Who is briefed about TRM, and how?

Most ANSPs provided briefings to the operational and technical staff concerned, and various layers of management, from unit management through to senior management.

What are the topics for the TRM sessions and campaigns?

ANSPs indicated that they use information from internal reports (17 ANSPs), EUROCONTROL prototype material (11 ANSPs), external reports (10 ANSPs), new regulatory requirements (8 ANSPs), and other sources, including:

- training needs, detected in the ops room through observation, over the shoulder techniques, interviews and focus groups, and during training sessions
- input from the unit/training manager, based on daily impressions and identified issues
- ATCO assessor reports
- changes (technology, team dynamics, adaptation to change, etc.)
- identified skill requirements.

What kind of modules are delivered?

EUROCONTROL prototype modules delivered included:

- teamwork
- team-roles
- communication
- situational awareness
- decision making
- stress.

Seventeen out of 20 ANSPs responding reported that they have also delivered their own modules dealing with a wide variety of topics such as:

- local issues
- error management
- drift into failure/bending the rules
- aging (getting older as an ATCO)
- new technology and automation
- change of working style between planner and executive controller after switch to new system
- fatigue
- conflict management
- leadership
- attitudes
- communication
- resilience
- supervision
- adaptation to change
- workload dynamics.

Where are TRM sessions conducted?

Sessions were held in units (13 ANSPs), in an outside location (11), in the training centre (9), or in the HQ (1).

The learning materials and activities are shown this Figure. Some indicated that they also use:

- a room escape exercise
- psychological techniques of self-development
- case studies via drama
- lecture about psychological processes in human performance
- games.

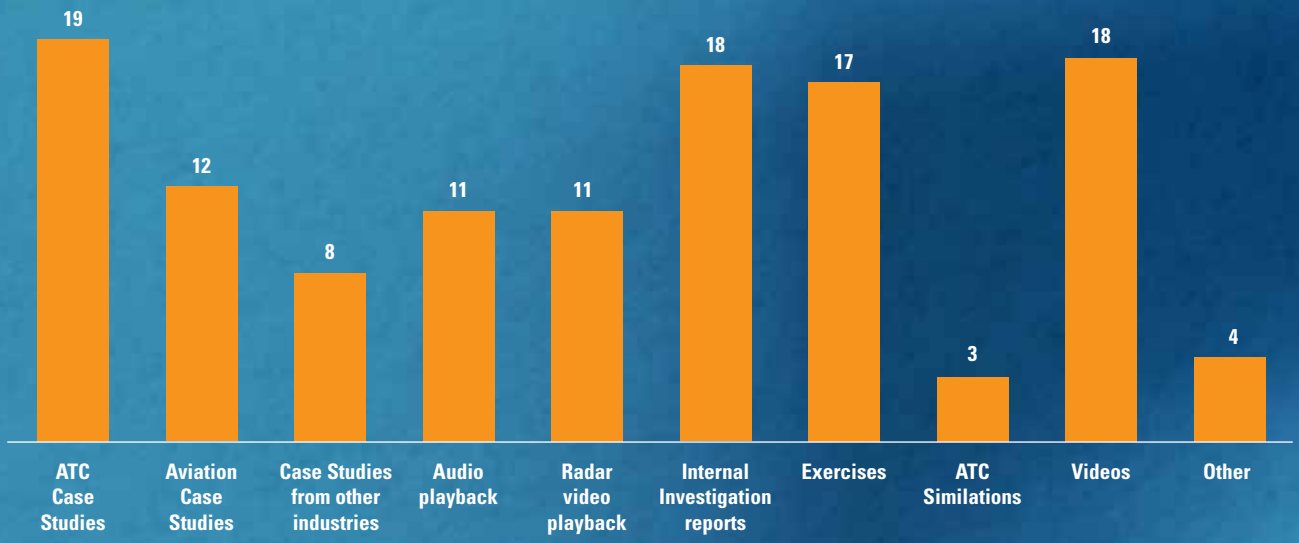


Figure 1: TRM learning activities

How long do TRM sessions last?

Most TRM sessions last between 1 and 3 days (see Table 1).

Duration	0.5 day	1 day	1.5 day	2 days	3 days	More
ANSPs	3	11	1	7	6	3

Table 1: Duration of TRM sessions

How many participants and facilitators are there in TRM sessions?

Most TRM sessions range between 7 and 12 participants and use two facilitators (see Tables 2 and 3).

Number of Participants	4 - 6	7 - 9	10 -12	13 - 15	More	Other
ANSPs	3	10	13	4	3	1

Table 2: Number of participants in TRM sessions.

Number of Falicitators	1	2	3	More
ANSPs	5	19	4	2

Table 3: Number of facilitators per TRM session.

What kind of feedback is received?

Most ANSPs use a written template to gain feedback on TRM, and feedback is provided to facilitators. In some other cases, feedback is provided to other people an units such as management, the training unit, the chief training instructor, the head of training, TRM coordinator, directorate of safety, human factors specialists, and the human performance unit. In most cases, feedback results in new TRM activities and topics. Other issues included preparation time, length of sessions, time spent on theory vs practice, location, and the number, type, and mix of participants.

What is reported to management?

Most ANSPs give a report to management after each campaign or periodically, e.g., annually. This is important for future campaigns. More than 10 ANSPs' reports included:

- main points from participants' feedback
- number of sessions
- topics addressed
- number of participants
- recommendations for the next campaign
- main points from facilitators' feedback.

ATC SIMULATION: A CONTROLLER-LED APPROACH

Does ATC simulation need to be as realistic as possible, with large-scale simulators? Or is it better to be as realistic as necessary, but continually adapted and adjusted around user needs? **Juan Antonio Lombo Moruno** describes a lighter approach to ATC simulation that retains the operational benefits, plus some other benefits.

KEY POINTS

- **Flexibility in simulation design and development is as important as cutting-edge technological features.**
- **ATCOs must be involved in simulation design and development from the beginning to create a system tailored to their actual training needs.**
- **The ATC Training Division at ENAIRE has been responsible for creating a new training system called Gammasim.**
- **Gammasim was designed and developed with and by controllers to provide an easy and flexible software solution to cope with unit training, refresher training, and conversion training remotely, for tower, en-route, and approach simulation environments.**
- **The approach allows adaptation to feedback from all stakeholders.**

One of the challenges for any ANSP in ATC training is to cope with the increasing simulation demand for:

- unit training
- refresher training for ATCOs
- conversion training (new ATC tools, airspace and procedure changes).

Simulation is an essential part of this training. There are benefits for the learning process, before, during and after on-the-job-training (OJT), and it gives students more self-confidence. As an instructor, observing students in simulated conditions means that you can test different scenarios for specific traffic, weather, or special circumstances. Additionally, since the simulator instructor is not responsible for the operational working position in a live traffic situation (unlike the OJTI), it is possible to focus on monitoring competency.

Besides practising ATC technical skills (phraseology, separations, vectors, clearances), ATC simulation is mainly about the non-technical skills, because the key part of the learning process is how we interact with pilots and colleagues. Simulation design needs be able to control the development of training sessions regarding interaction among people (instructors, trainees, and pseudopilots), the definition of exercises, and conditions for adequate observation of trainee competency.

The trouble with ATC simulation systems is that major investments are usually required. This is not only for the acquisition of new devices but also for the technical support needed for maintenance, implementation of new scenarios or features, as well as airspace and procedure updates. Furthermore, when you are dependent on a technological supplier, it is difficult to adapt your system to your evolving needs.

So we must assess the benefits and drawbacks of selecting either a high-fidelity system (full-replica hardware and software), or a flexible software solution. It might be more effective to focus on the objectives by creating a sense of realism, instead of searching for the perfect re-creation of the system hardware and features.

"Controllers led the design and development of the simulator from the outset to create a system that fits their training needs."

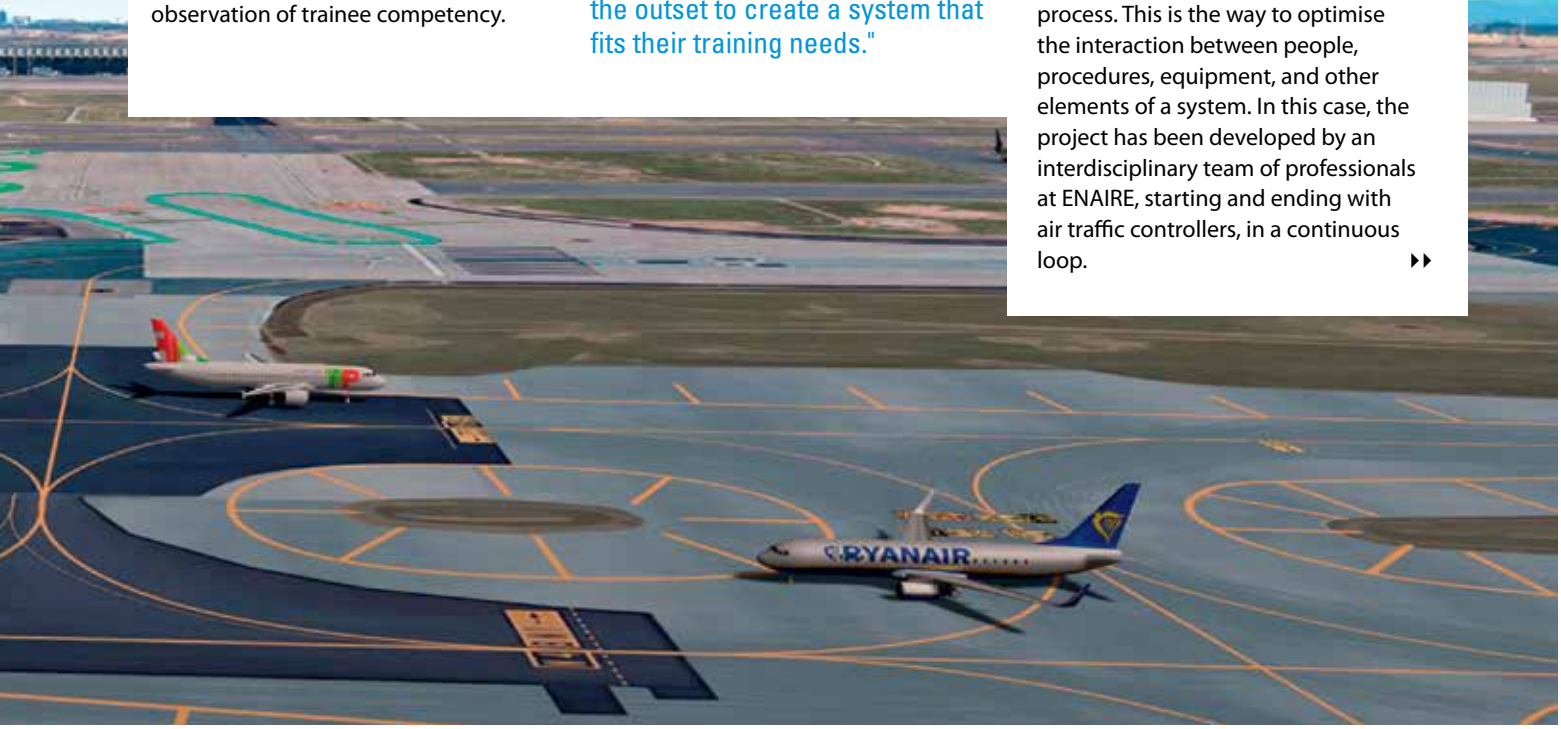
User-led design

ENAIRE has faced the challenge of this increasing demand for simulation from a new perspective: controllers led the design and development of the simulator from the outset to create a system that fits their training needs.

We have started this project with controllers as a cornerstone because they are the ones who really understand:

- the most important aspects of the training objectives
- what actually works at each stage of training
- the necessary features to be developed
- the effectiveness of the exercises
- controllers´ feedback.

Human factors in design (ergonomics) has long emphasised the need for users to be at the centre of a design process. This is the way to optimise the interaction between people, procedures, equipment, and other elements of a system. In this case, the project has been developed by an interdisciplinary team of professionals at ENAIRE, starting and ending with air traffic controllers, in a continuous loop. ▸▸



Gammasim

The ATC Training Division at ENAIRE has been responsible for creating a new training system called Gammasim, where all these concepts have been applied.

The main objectives for the simulator were:

- quality tower, en-route, and approach simulation
- an easy to use and flexible system to cope with training needs
- focus on unit training, refresher training, and conversion training
- software solution, enabling remote use
- quick scenario implementation.

After some months of research and development, Gammasim became a reality. It is currently implemented in several units such as LEMD or LEBL, where it is being used for unit, refresher, and conversion training.

GAMMASIM FEATURES

The main features in the last updated version are:

- easy operation
- controllers and pilots can join the simulation from any location with a computer connected to the web
- one tool serves all ratings: independent or simultaneous tower, approach and en-route simulations
- realistic 3D scenarios based on an efficient development using aerial photographs and animated 3D models of all aircraft types (airliners, general aviation, helicopters, military) and vehicles
- visual effects (engine fire, different weather conditions, propeller movements…)
- virtual tower systems
- electronic flight strips or advanced flight progression management without flight strips
- voice over internet protocol communications
- simulation of degraded modes of operation
- user-friendly pseudopilot interface.

GammaSim

The stakeholders

The system is in a continuous development cycle involving several stakeholders.

This simulator has been developed by controllers with previous computing and engineering experience. The rest of the support team consists of engineers, computing staff and pseudopilots.

The team is located at the headquarters and is led by an operational ATCO who developed the first software version of the simulator. Additional ATCOs are involved in design, exercise development and training management.

Engineers and computing staff are in charge of maintenance, feature updates, scenarios and exercise computing.

Pseudopilots have received training designed by ATCOs, and they are permanently in contact with the development team, influencing the design as users of the system.

ATCOs and instructors are the main users of the tool, and provide feedback to the heads of local training

departments, who send the feedback to the team at HQ, thus closing the loop.

Besides pure training uses, the system can also be used by airspace designers and incident investigation users (ATCOs and engineers), who also give feedback for improvement.

Benefits

By operating the new system, we have achieved the following benefits:

- internal development by ATCOs, engineers, computer staff and virtual pilots
- no external acquisition costs or support contract
- technological autonomy and immediate operational scalability for further development and features
- internal support (maintenance, updates, exercises, scenarios)
- total adaptability and quick response to feedback request
- high performance focused on the controllers' training needs
- additional uses besides training, such as airspace design and incident investigation.

It is widely recognised by controllers as a useful training aid, providing successful operational results, and is economically sustainable.

Juan Antonio Lombo Moruno is currently working at ENAIRE's Headquarters ATC Training Department as an expert for human factors. He is in charge of TRM training and CISM program implementation, and also assisting with the simulation department. His aeronautical operational background encompasses both ATC and pilot functions. Besides the operational side as a TWR and currently ACC ATCO, he was a former fighter pilot in the SAF (Spanish Air Force) for 15 years.
jalombo@enaire.es

INTERLAB: SUPPORTING NON-TECHNICAL SKILLS TRAINING

EUROCONTROL is now able to support training in non-technical skills via a simulation platform called INTERLAB.

The simulation platform is based on an unfamiliar activity so that everyone will be on equal ground. It reproduces the main components of air traffic control and piloting, including communication, team management, task coordination, and workload management. The operational environment is not ATC, but it does include some of the same constraints: complexity, fuzzy data, imperfect procedures, emerging situations, and time pressure.

With the INTERLAB platform, important interpersonal skills are analysed and trained under the various constraints. You and your team work out your own goals, plans, and strategies in a challenging but energising context. Problem solving is improved via multiple perspectives.

The INTERLAB sessions mix simulations with interactive classes, behavioural measurement, feedback sessions, and group discussions. INTERLAB requires a facilitator that acts as a trainer, observer and coach to generate self-reflection and discussion. Through engaging and fun simulations, participants learn about themselves, and how they work in teams.

Mutual trust is exercised and strengthened. Different personalities are integrated. The participants leave the INTERLAB session with field-tested behaviour they can implement immediately in operations

Demonstrations and sessions can be planned in ANSP premises.

For further information, contact Fabrice Drogoul at **fabrice.drogoul@eurocontrol.int**

HELPING TRAINEE CONTROLLERS ACHIEVE THEIR DREAMS

Becoming a controller or professional pilot is a long and expensive process. If it goes wrong, there are consequences for the individual and the organisation. But if a person fails their final validation, does that have to mean the end of the line? In this article, **Neil May** outlines a training and coaching programme to help trainee controllers be more confident and resilient when under pressure, to the benefit of everyone.

KEY POINTS

- **Resilient individuals have confidence, a strong social network, adaptability and purposefulness.**
- **It is essential for the trainee to understand their internal motivation for becoming a controller, and to keep motivated and focused when times get tough.**
- **Trainees must maintain confidence and project confidence. They must have a performance and learning mind-set.**
- **It's OK for a trainee to make mistakes, so long as they learn from them.**
- **Quality of practice is far more important than quantity of practice. It is essential that Instructors and Training Managers learn and practise the skills of how to identify and support struggling trainees.**

In the autumn of 2014, the training team at NATS' Swanwick Area Control Centre had a problem. Over a matter of weeks, four trainee controllers had all failed their final validation assessments. The instructors were mystified. They believed that all four trainees had the necessary technical skills to pass the assessment and to be good, competent controllers. But for some reason, they didn't perform on the day. The hopes and dreams of four trainee controllers were on the line.

The Swanwick training team asked the Human Factors team in NATS for help. By the time of the final validation assessment, a trainee controller has spent around three years in training. A lot of time, money, energy and emotion has been invested by both the trainee and the organisation. Failing an assessment is bad for the organisation and bad for the individual.

Occupational psychologists from the HF team interviewed both trainee and experienced controllers and found a number of common themes. Successful trainees had confidence in themselves, they performed well under pressure, and had the ability to accept and bounce back quickly from setbacks and negative feedback. Non-technical skills were just as important to success as technical skills.

A training and coaching programme was put together to help trainee controllers be more confident and resilient when under pressure. This was built around a model of resilience which had been developed and applied very successfully in elite sports. There are four key elements:

- **Confidence** – Individuals feel more resilient when they feel competent and effective in coping with stressful situations. Strong self-esteem is important.
- **Social Support** – Having good relationships with others and seeking support helps individuals to overcome adverse situations. This is especially important for trainees who may be away from home in a new environment.
- **Adaptability** – Flexibility and being able to adapt to changing situations that are beyond our control are essential to maintaining resilience. Resilient individuals can cope well with change and their recovery from its impact tends to be quicker.
- **Purposefulness** – Having a clear sense of purpose, clear values, drive and direction helps individuals to persist and achieve in the face of setbacks.

Today, soon after their arrival in NATS, all trainee controllers attend a series of non-technical skill training sessions to help them to prepare for the pressures that they will face. Most trainees have been very successful before joining NATS, and know that they have done better than many hundreds of other applicants to get a place on the controller training course. At this stage, many new trainees are unaware of, or do not recognise, how challenging the training might be for them. They are unprepared to deal with the pressure that they will face.

The confidence and resilience sessions cover eight modules and are supported by workbooks and tools to help the trainees throughout their three years of controller training. A key focus of the training is providing practical tools and techniques to encourage the trainees to develop a proactive approach to learning. Right from the start of their training, they need to learn a lot of information in a short period of time and are quickly working under pressure. Trainees are taught study techniques to help absorb the vast amount of information. This includes building their social support network by working in groups with other trainees and making sure that they proactively ask questions of the instructors where unsure.

"The confidence and resilience sessions cover eight modules and are supported by workbooks and tools to help the trainees throughout their three years of controller training."

Another key element is the diary that trainees have to complete after every training session. This asks the trainee to identify five things that they did really well during the session and no more than three things that they could improve on. This reinforces the message that the trainee is encouraged to take control of their learning in an active way. Ultimately, the trainee should aim to build upon the positive behaviours and eradicate the areas to improve upon.

Role models for trainees are discussed and these are generally previous trainees who have gone on to successfully validate, family members, or people who have achieved great success in the fields of sports, music and politics, often overcoming adversity along the way. Tips for success are provided and case studies discussed to provide trainees with suggestions that they could apply to themselves.

Recognising the signs of stress in oneself is extremely important. Each of us has different mental, physical and ▸▸

behavioural symptoms that tell us we are feeling stressed. If we recognise these symptoms, we can do something about them. If they are ignored, they can easily be a distraction from the training being imparted. Again, tips for success are provided from previous trainees who have dealt effectively with stress.

"Trainees are helped to identify their internal motivations for becoming a controller and to ensure that they keep motivated when times get tough."

It is well known that motivation is an important key to success. Trainees are helped to identify their internal motivations for becoming a controller and to ensure that they keep motivated when times get tough. This also requires trainees to remain focused on their goals and, in line with elite sports, to visualise what success looks like for them. As Michael Jordan, the US basketball player, said, *"I don't do things half-heartedly because I know that if I do, I can expect half-hearted results."*

Maintaining confidence is important but projecting confidence is just as important. The way in which the trainee is perceived by their instructors and their future fellow controllers has a psychological effect on how they are treated. A trainee might be extremely motivated to succeed but if they come across as not being motivated to learn, to listen or to improve, then this is likely to affect the help and support that they will receive.

"Trainees must have a performance and a learning mindset. They must demonstrate positivity, and accept and bounce back quickly from setbacks and negative feedback. A key part of learning is making mistakes."

Motivation and confidence can be eroded rapidly during training, maybe through poor performance on practical exercises, exam failure or making mistakes during on-the-job training. The negative feelings can be even more difficult to cope with in trainees who, before starting controller training, seldom or never experienced failure.

Trainees must have a performance and a learning mindset. They must demonstrate positivity, and accept and bounce back quickly from setbacks and negative feedback. A key part of learning is making mistakes. As Winston Churchill said, *"Success is going from failure to failure without losing enthusiasm."* A successful trainee in NATS said, *"I think sometimes I needed to make the mistakes to realise what I needed help on. I was a bit scared to make mistakes but it's fine to make mistakes, just make sure you learn from them and remember them and watch what other people do right and wrong, and learn from that too."*

For most of us, success doesn't come without a lot of hard work and practice. In elite sports, it is often cited that 10,000 hours of purposeful practice is required to become expert. Tiger Woods and the Williams sisters all started practising their sports at a very early age. Trainee controllers cannot be provided with 10,000 hours of practice before their validation assessment, nor can they start training at three years of age. It is essential therefore that every hour they get is focused on achieving their goals. Quality of practice is far more important than quantity of practice. It is important to break down the goal of becoming a controller into shorter, meaningful goals that can be measured, achieved and recognised.

As said earlier, many trainees do not recognise how difficult and stressful the training might be for them on first arrival. One-to-one coaching is therefore provided throughout their live 'on-the-job' period of training, which is focused on the specific confidence and resilience issues that the trainee is facing. The challenges that trainees face are diverse and can include building an effective visual scan, team resource management, and maximising performance under pressure. It is only when faced with setbacks during this critical phase of their training working with real aircraft that trainees fully recognise the importance of the confidence and resilience support available to them.

The non-technical skills programme is constantly evolving and being cascaded more broadly into the organisation. Non-technical skills training modules are built into instructor and training manager programmes. These key people are taught the importance of effective feedback to maximise trainee performance and how to recognise and support struggling trainees to ensure that confidence issues are caught quickly. One Training Manager said, *"when a trainee's confidence drops, it drops quickly like falling off a cliff and it can be hard to turn it around. My job is to catch them before they fall."*

The need to address confidence and resilience issues arose because four trainees at Swanwick failed their final validation assessments over a short period. As a direct result of the support provided through the confidence and resilience programme, three of these trainees subsequently passed and became valid controllers. One of them said, *"The board day went very smoothly, and where normally I'm a bag of nerves before a practical assessment, I didn't feel anything all day. I just felt comfortable and I'm obviously delighted."* Four years on, they continue to be successful controllers. The confidence and resilience programme helped them to achieve their dreams.

Neil May is the Head of Human Factors at NATS leading a team of 28 Human Factors specialists who work to maximise human performance and minimise human risk within the Air Traffic Control operation. Neil leads NATS' work on human performance which focuses on providing controllers with the right tools and the right capabilities to do their jobs while working within the right organisational environment. He co-chairs CANSO's Human Performance Management Task Force.
neil.may@nats.co.uk

COMPETENCY AND MORAL DILEMMAS: "WHAT WOULD YOU DO?"

Sometimes in our working lives, we have to make decisions that involve a kind of competency that we don't teach or even talk about: moral and ethical decision-making. Most of us face situations where we feel uncomfortable with the possible choices, because none is clearly preferable. As part of the EUROCONTROL safety culture programme, 'moral dilemmas' have been developed based on realistic situations. These dilemmas have been used in workshops to uncover assumptions, values, beliefs and decision processes. We share some of the dilemmas with you hoping that similar sorts of dilemmas become part of your own professional discussions. You may have to wear shoes that you have never worn...

Steven Shorrock, Anna Wennerberg, and Tony Licu. ▸▸

1 You are controller with both TWR and APP ratings – one of the few in the unit with dual ratings. There is an ongoing clash between TWR and APP controllers, following a serious incident. One group blamed the other for the outcome, and a serious dispute followed. The formal and informal relationships that existed were severely affected. Even coordination became 'unhelpful'. You know that a few controllers in TWR and APP are willing to build bridges, but some of the older union leaders are against this. By intervening, you put yourself in a risky situation, potentially splitting two groups into three.
What would you do?

2 You work in an ANSP where the working language is supposed to be one language, but staff come from different nationalities and speak different languages. Some staff (who are mostly in their 50's) struggle to speak the 'official' language, and they speak limited (operational) English. They prefer to speak in their native language. Many of these people were promoted to supervisors to reduce misunderstandings in coordination. Now there are communication problems relating to supervision. Staff get by, including via translation by those who are fluent in both languages. But misunderstandings happen. People feel uncomfortable to raise this language issue and there is no clear answer. What would you do?

3 You are the safety manager of an ANSP. Senior management is very proud of the ANSP's safety achievements. The maturity of the safety management system (SMS) has been rated independently as high, based on your responses to questions about the SMS. However, based upon updated guidance material, the self-assessment of the 'safety maturity' of your SMS could result in a drop in your ANSP's rating, even though the SMS is no different to how it was during the last assessment. In some areas it has even improved during the last year. Knowing that a drop in your scores will be very awkward for you as safety manager in front of the top management, what approach would you choose? On the one hand, you want to give honest answers, but on the other, having to explain to your senior management could affect your relationship and even your career prospects. Would you rather ensure that your previous scores are unchanged (since the SMS is the same), or reduce the values of your self-assessment in line with the new guidance?
What would you do?

4 You are a young ACC controller who works part time in a safety department. You notice a conflict between the safety department and the controllers. The ACC controllers see the safety department as trying to impose restrictions. The safety department sees the ACC staff as rejecting any ideas for improvement, and keeping safety staff out, making it hard for them to do their work. Both see the other as a constraint. You get on with both groups of staff, and enjoy both safety and operational work, but the controllers are starting to perceive you differently. You think they are keeping you out of some discussions. The easiest route would be to stop the safety work, but this would make the division even worse.
What would you do?

5 You are a new technician and are uncomfortable with local practice regarding the maintenance of a high voltage (3000V) circuit. Work is done on the circuit using gloves and boots that are certified up to 1000V. Working in this way is forbidden by the organisation, but the other technicians say that they don't have enough time for full isolation, and there has never been an accident. But when you have tried to highlight and discuss the risk with the others, this was unwelcome. By raising this issue outside the group, you think you will be excluded from the close-knit group, and this will severely affect your working life. What would you do?

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6 You are an ACC controller. Several of your colleagues work far away from the centre. In order to maximise their personal time, some work two or three double shifts, with eight hours off in between. This is permissible within your regulations exceptionally, but has become more routine. Of course, during the night, they get some rest when possible. But the controllers are using coffee and stimulant drinks in an attempt to remain alert. You think that you notice some effects in their performance, but can't be sure. By raising the issue, you may start a chain of events that prohibits this working schedule, which will directly affect their personal lives.
What would you do?

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7 You work as a safety specialist on a major new tower project at a busy airport. The safety assessments have been conducted as usual and all risks have been deemed acceptable, or are due to be accepted or signed off by the Unit Manager or Safety Director, as appropriate. The project is critical for airport capacity and is due to be opened within two months, with a transfer from the old tower to the new one. On time delivery at the planned O' date will be seen as a great success for the ANSP, airport and all staff involved. There is much media attention and public figures have visits planned. Everyone involved in the project has incentives (including cash bonuses) attached to a timely O' date, including you, your colleagues (who are now friends), and the Unit Manager. During training, you decide to observe the controllers in the simulator. This is the first time that anyone other than training specialists has done this. You notice that many can use the new equipment, and so are being signed off as competent, but they can't do the job. Some are clearly frustrated and upset and several can't maintain 'the picture' of the traffic. If you raise this to the Director, the Director will not sign off the 'residual risk' from the risk assessment without your assurance. If you tell the Director about what you saw in the simulator, the whole project could be put on hold. But it feels very uncomfortable to ignore it. What would you do?

8 You work as an operational expert on a major project. You have helped to conduct safety assessments, including quantification of the risks involved. Shortly, prior to sending the risk assessment for approval, you find that a miscalculation, resulting in values that are significantly incorrect, and different to those that are deemed acceptable. However, you feel strongly that the risk controls that are in place, and the monitoring arrangements, are robust, and you know that safety assessment is not an exact science. The project will be of significant help to operations. What would you do?

9 You are the Operational Division Director and still keep your ATCO licence valid. This means that once a week you are on duty. A young ATCO from the unit complains to you that some supervisors don´t use a fair approach in putting the controller on the position during shifts. Supervisors put the ATCO behind the radar screen for two hours duty, followed by 30 minutes break. Other ATCOs, who are friends of supervisor, are put on the position for one hour duty and one hour off. You as the Director of this Division have this issue officially on the table. But you are keeping in your mind that you are coming to the shift as ATCO as well and you need to have good relations with supervisors. What would you do?

d you do?"

10 You are a supervisor in an ANSP that has recently published a 'league table' of supervisors based on delay statistics. The aim was to introduce some competition, influence behaviour and improve efficiency. But you notice that you are near the bottom of the list. When faced with a decision to divert flows of traffic in bad weather, you realise that this will increase delay and you feel embarrassed at your place on the list. You think it is safe not to divert, but if it were not for the list, you would probably divert. What would you do?

11 You are a controller in a regional unit. The new procedures for your unit were designed in head office, far away from your unit, by someone who has never worked in your unit. If you follow the procedures, you believe that an incident is likely. If you use your own judgement, you are comfortable that the traffic is safe. But if something does go wrong, you know that you will be blamed for not following procedures. You have raised the problem with the procedures with the procedure writer, to no effect. What would you do?

12 You are a Unit Manager in a unit with quite a lot of traffic. The employees take pride in being part of delivering a 'no delay' service to the customers. In daily work, some of your colleagues feel high pressure to achieve targets on capacity and efficiency. You have noticed that there is a tendency to use rather thin buffers. The result is that there are regular losses of separation. These are rarely serious, and most of the time they are marginal losses. Many ATCOs, including supervisors, have no problem with operating this way. Higher management questions the losses of separation, but at the same time there is praise for handling the traffic so efficiently, both from your immediate and higher management, and from airport management. What would you do?

13 You see a colleague and close friend on your shift make a mistake with safety implications, and you know that this colleague has no intention to report it. The error cannot be captured by any monitoring that is in place, so it is unlikely to be known unless you report it. No aircraft was in jeopardy but the error could potentially be seen as a symptom of a deeper trouble with the working methods that are in place, and someone else might make a similar mistake. What would you do?

Do these sorts of examples bring any moral dilemmas to mind? You are likely to have encountered problematic situations where there is no clearly preferable solution, or perhaps you can imagine some realistic scenarios. Would you be willing to share a moral dilemma, so that others might use them in learning and discussion? If so – and if you have any feedback on your use of moral dilemmas – please contact **steven.shorrock@eurocontrol.int.**

Steven Shorrock works in the EUROCONTROL Network Manager Safety Unit, where he leads the European safety culture programme and is Editor in Chief of HindSight. He is a Chartered Psychologist and Chartered Ergonomist & Human Factors Specialist with experience in various safety-critical industries. Steven is Adjunct Associate Professor at The University of the Sunshine Coast, Centre for Human Factors & Sociotechnical Systems. He recently co-edited Human Factors & Ergonomics in Practice.
steven.shorrock@eurocontrol.int

Anna Wennerberg is an airport expert at EUROCONTROL. She started her career in Air Traffic Control and moved on to work first in Airport Operations at Stockholm-Arlanda airport and later in strategic Airside capacity and safety . She has a vast experience in all operational aspects of an airport. At EUROCONTROL she has participated in the creation of numerous airport related concepts and contributed in validation activities such as prototyping and real time simulations. Anna has also been a devoted member of the EUROCONTROL Safety Culture program for several years.

Tony Licu is Head of the Safety Unit within the Network Manager Directorate of EUROCONTROL. He leads the deployment of safety management and human factors programmes of EUROCONTROL. He has extensive ATC operational and engineering background, and holds a Masters degree in Avionics.
antonio.licu@eurocontrol.int

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.

Anders Ellerstrand works as a Watch Supervisor at the Malmö ATC Centre in southern Sweden. He has been working as an ATCO in Sweden for over 30 years but also in ICAO Projects in African countries. He is a safety assessment specialist for the Malmö Centre and is presently studying for an MSc Human Factors in Aviation with Coventry University.
anders.ellerstrand@gmail.com

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.

EXPERTISE AND COMPETENCY FOR CONTINGENCY

When ATC centres suffer outages, contingency planning comes into play. In this article, **Önder Toydemir and Arife Aycan Mutlu** outline the contingency arrangements in Turkey, which were put to the test during a total loss of ATC data.

KEY POINTS

- **Effective human resources planning is essential to benefit fully from employees' expertise and competency.**
- **Listing 'key personnel' with the necessary competency and expertise before passing through to contingency mode is critical.**
- **Promotion of competency and expertise is needed for communication about contingency operations, dissemination of lessons learnt, and to enable continuous improvement of the process.**
- **A training policy for contingency operations requires a variety of training methods, including briefings, simulations and joint exercises.**

Contingency Planning in the Turkish Air Traffic Control Centre

There is today only one Area Control Centre in Turkey, located in Ankara. This is a result of a modernisation project known as 'SMART' (Systematic Modernization of ATM Resources Turkey). SMART ATC systems have been in operation since 7 July 2015, and involved the transfer of Istanbul ACC and Izmir ACC sectors to Ankara ACC. There are also a number of APP services in Istanbul, Antalya, Adnan Menderes, Dalaman and Bodrum.

In the event of a disaster or any other event that makes air traffic and supporting services partially or totally unavailable, contingency planning is put to the test. In Turkey, the Turkish Civil ANSP (DHMI, General Directorate of State Airports Authority) activates the contingency plan. This outlines the arrangements to be introduced to permit flights to transit, land and take off without significant disruption. In the event that one of Turkey's approach units becomes inoperable, an auxiliary facility within the Turkish Air Traffic Control Centre (THTKM) in Ankara becomes responsible for the provision of these air traffic services.

The contingency plan was developed in close co-operation and collaboration with Directorate General of Civil Aviation (SHGM), with the civil aviation authorities responsible for the adjacent FIRs, and also in a consultation of Turkish military authorities. Turkey has a huge, strategically important airspace, at the crossroads between Europe, the Middle-East, Africa and Asia. This comprises 66,930 kilometres of controlled air routes and 982,286 square kilometres of controlled airspace over Europe and Asia. So many adjacent States, FIRs and ACCs are directly affected by the Contingency Plan.

Under the plan, air traffic operations move safely and swiftly from the units to the auxiliary facility, and vice versa, with no loss of data or technical system performance. Flight information from the regions is securely transferred, along with communications between controllers and pilots, airlines and airports. During this interim period, flight operations in the Turkish FIR would be restricted, to a degree.

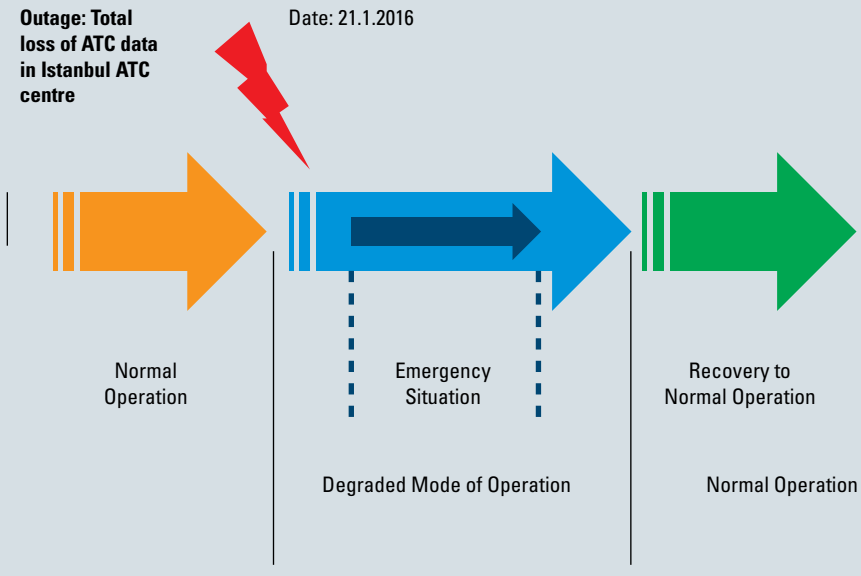


Figure 1: Contingency Life Cycle on 21/01/2016 in Turkish FIR

Expertise and competency in the contingency life cycle

There are five different stages in the 'contingency life cycle':

1. normal operations
2. emergency situations
3. degraded modes of operation
4. service continuity, and
5. recovery to normal operations, and again back to normal operations.

This life cycle provides a framework for the more detailed plans that each service provider must develop within their local context of operation. Each of these plans depends on competency in the provision of safe ATC using current back-up systems. This, in turn requires effective human performance, including controller decision-making expertise.

By competency, we mean the ability to do something successfully or efficiently, and by expertise, we mean a high level of knowledge or skill, requiring lots of practice and exposure. But if it is a contingency situation, that means a rare and an unusual case. So what is the role of competency and expertise when dealing and struggling with a difficult and challenging situation? Here is an example.

Emergency: Total loss of ATC data

Until January 2016, air traffic services in Turkey had been provided under the new SMART system without any emergency situation. The whole ACC service had been provided in the new centre for about a year.

As a result of the human resource planning process, ATCOs in the Istanbul ACC and APP service for Atatürk and Sabiha Gökçen Airports had been transferred to THTKM in Ankara and distributed to the ATCO teams. Atatürk Airport is the 5th airport in Europe, providing services to 63,854,109 passengers in 2017, according to the Airports Council International.

Up to this time, the ATCOs, having no experience in İstanbul ACC and APP sectors before the SMART project, had been educated in the training and simulation facilities. Training for contingency operations had been carried out by a variety of means, including briefings, simulations and joint exercises. All these actions were put into practice in the 'normal operation' stage of the contingency life cycle.

But on January 21, 2016 there was a total loss of ATC data (voice, radar, network, phone, meteorology, others FIR's) in İstanbul APP sector. The air traffic and supporting services, normally undertaken by İstanbul ATC sector, were totally unavailable. This outage and the degraded modes of operation is technically described as follows: *"a reduced level of service invoked by equipment outage or malfunction, staff shortage or procedures becoming inadequate as a knock-on effect of one or several deficient system elements".*

Before passing to the 'emergency situation' (see Figure 1), the contingency plan was put into practice. All landings and departure traffic from İstanbul and to İstanbul from other airports were cancelled by the team, consisting of the controller, ATC supervisor and technical supervisor in the İstanbul APP sector. Approximately 55 landing and take-offs – just for Atatürk Airport – were affected in the first second of the contingency plan, and this number was going to increase steadily. The number of aircraft for Atatürk Airport was regulated immediately and the hourly capacity for the airport was decreased, first zero-rate, then 12, and afterwards 20 aircraft.

It took one or two minutes to transfer air traffic operations from İstanbul APP sector to Ankara ACC. In this time interval the supervisors and team members of Ankara ACC decided to decrease the lower divisions of the İstanbul Lower ACC sector to cover APP levels, while the technical team were trying to transfer air traffic information, including voice, surveillance, flight plans, meteorological information, aeronautical and auxiliary data to SMART radar display systems and voice communication systems. There was no interruption of ATC services, and the 'emergency situation' started. All subsequent actions were performed according to the contingency plan by the ATCOs and supervisors.

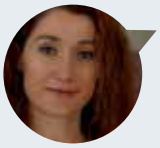
The elapsed time of emergency situation was 2 hours 47 minutes, after which the ATC service recovered to normal operation in İstanbul APP.

Return back to normal situation

In the 'normal operation' stage, the team handling the contingency operations on that day was honoured and their success – and associated competency and expertise – was announced to the organisation. This raised awareness of contingency, disseminated lessons learnt, and enabled continuous improvement of the process.

The FL decrease was introduced to the contingency plans and checklists. These plans have been reviewed and continually improved. Supervision has been enhanced; in a contingency situation, a supervisor observes and reminds controllers of relevant procedures. Finally, training for contingency now includes real case analysis and scenarios, such as simulation of the contingency mode of Antalya APP service.

Önder Toydemir is Air Traffic Manager of Turkish Air Traffic Control Centre. He graduated from Anadolu University Faculty of Aeronautics and Astronautics in Eskisehir in 1994 and attended General Directorate of State Airports Authority (DHMI) in the same year. He worked as approach and area controller, OJTI and shift supervisor for nineteen years. Between 2008 - 2013, he was the manager of TATCA Ankara Branch. He has been working as the Air Traffic Manager since 2013 in Turkish Air Traffic Control Centre (SMART Project).



Arife Aycan Mutlu is an Air Traffic Controller in Turkish Air Traffic Control Centre, THTKM. She has been working as an en-route and approach controller for eight years in General Directorate of State Airports Authority (DHMI). She has been a board member of TATCA Ankara Branch from 2017. Her undergraduate degree is in management engineering from Istanbul Technical University. Her master degree is in economics from Koc University, and she received her PhD degree in Management from Gazi University in 2017.

ArifeAycan.KASAP@dhmi.gov.tr

SUPPORTING PILOT COMPETENCE

Competency issues sometimes emerge from accident investigations. Where this is the case, it is usually associated with training and monitoring, and the design and implementation of SOPs. Understanding the reasons for SOPs is critical for judgement and decision-making, as **Captain Ed Pooley** explains.

KEY POINTS

- **Pilots must be individually competent for their role before release from supervision.**
- **Competence is achieved by delivering task-appropriate training to carefully selected individuals.**
- **Pilots are necessarily specialists from the start, but expertise comes – in varying degrees – from experience. The acquisition of 'expert' status is neither a given nor a necessity.**
- **Competence includes procedural compliance driven by understanding rather than solely by directive.**
- **Effective monitoring of actions taken is the primary defence against omissions and unintended or inappropriate actions. Monitoring by humans is not 100% reliable and so the process must fully embrace the opportunities provided by system automation.**

I'm going to start with a very brief discussion about how I believe competence and expertise apply to pilots in two-pilot fixed wing aircraft. I'm then going to look at some real events where competence has failed to deliver safe outcomes, and suggest why. I'll conclude by proposing ways we could improve the extent to which competence is delivered more reliably. Some of this should read across to controllers, too. Like pilots, controllers are first trained to obtain a licence and then task-trained for a specific use of that licence.

Self-evidently, task competence is essential. Contrary to the usual mantra of 'knowledge, skills and attitudes', I prefer the variation 'aptitude, knowledge and skills' – in that order. Aptitude and the ability to absorb knowledge ought to be part of any selection process. And any training regime must be explicitly focussed on the skill-based competence it seeks to establish. Recurrent training, whether in the classroom, in a simulator or during supervised flying, must involve sufficient training to revalidate competence rather than just be a hoop to be jumped through. This is particularly important to revalidate competencies that may, in today's age of automated reliability, rarely if ever be needed.

Once a licence holder has gained some initial relevant experience, the build up of expertise will have begun. Useful expertise will not automatically accumulate at the same rate for everyone, and this will affect the career path that follows. Clearly an aircraft commander will need to have demonstrated sufficient relevant expertise as a First Officer before being considered for such a position. And for appointment as a Training Captain, the evidence of skill based on expertise and on consistent demonstration of competency will need to be very carefully considered alongside the particular aptitude and the extensive knowledge required for this role.

That's the theory. But human performance is inevitably imperfect.

This is relevant in selection for training, in the design of training regimes, and in the assessment of competence for our actual performance on the front line. Whilst I am absolutely not discounting what we can learn from what goes well, especially when the unexpected presents itself, I'm now going to offer a few cases where things have gone wrong on the front line. These have been independently (and competently – still unfortunately far from a global achievement) investigated in order to remind ourselves of ways that this can happen. I have deliberately chosen cases where the aircraft operator involved can be characterised as an established and reasonably large business that actively seeks to achieve safety. Such operators will invariably recognise, to varying degrees, that the safety they seek depends on a great deal more than regulatory compliance, which for them serves merely as a baseline rather than the goal. But we should bear in mind that such an approach is still a very long way from being universal.

The order in which the events below are presented is of no significance. Although in a few cases, the aircraft involved may have been destroyed, no occupant fatalities resulted nor, in many cases, any risk of it. I have mostly avoided using more than one example from any particular airline. Note also that the selection made is not predicated on the potential seriousness of the outcome but on the effect of competency problems, and how these might have come about.

It is not suggested that these competency problems were the fault of the individuals, nor that competency was the only issue. In most cases, problems of competency are associated with training or monitoring, or both, and coexist with problems in the design and implementation of SOPs. Rather, the cases are presented as examples where aspects of competency, and the implications for training and procedures, must be considered in order to learn.

An A340-300 arriving at **Paris CDG** in 2012 continued descent on an ILS Cat 3 approach when so far above the glideslope that eventually, when 2 miles from the runway and still 2500 feet above it, it pitched up abruptly as the false glideslope upper lobe was captured and in the resultant confusion, control was almost lost before recovery was achieved. The formal conclusion of the investigation noted (1) inadequate monitoring of the aeroplane's flight path by the controller and by the crew during the CAT III precision approach and (2) the crew's decision to continue the approach after the FAP when the aeroplane was above the glide path. The report also observed that the Cat 3 SOP did not include any operational limits for its use. Ref. 2.

A Boeing 767-300 made a belly landing at **Warsaw** in 2011 when the crew were not able to lock the landing gear down using either the alternate or free fall procedures after earlier loss of a single hydraulic system. The reason for this was that a tripped circuit breaker controlling all emergency electrical circuits was not noticed and reset. This meant that the electrical release of the landing gear up locks, which is common to both alternate and free fall gear deployment procedures, was prevented. Ref. 5.

A Boeing 767-300 was in the cruise eastbound over **Atlantic** in 2011 when the First Officer awoke from an abnormally long period of 'controlled rest'. After a startle response (reportedly based on mistaking the planet Venus for the lights of an opposite direction aircraft at the same level), the First Officer put the aircraft into a steep dive towards an opposite direction aircraft 1000 feet below, causing multiple passenger injuries. The Captain took control and recovered the aircraft. Sleep inertia after excessive 'controlled rest' was considered likely to have been contributory. The procedure for 'controlled rest' was examined and it was found that the rest taken prior to the excursion did not comply with it in a number of respects. Ref. 6.

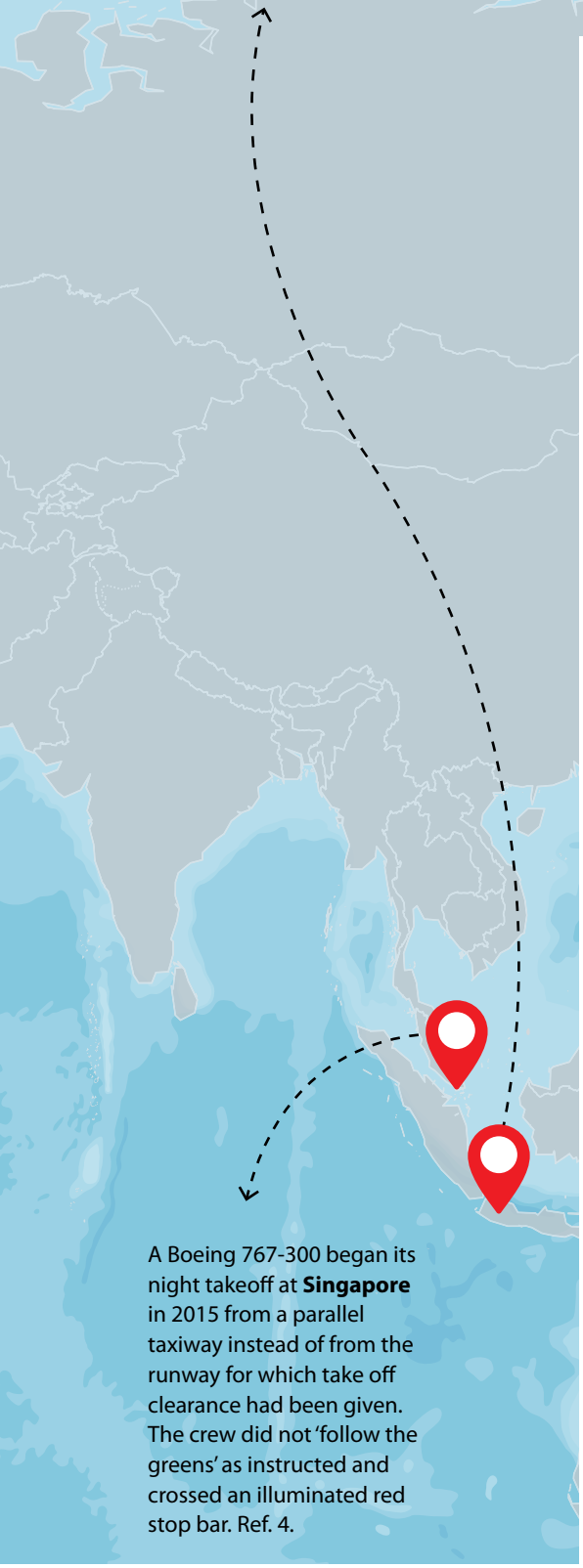
An A319 departing **Ibiza** in 2016 did not follow the previously trouble-free procedure to taxi off the gate using a clearly marked sharp left turn, and the right wingtip struck the air bridge, where it became lodged. One engine taxi departures (OETD) are a discretionary fuel saving technique described in the Operations Manual. The procedures explicitly require consideration of the direction and degree of turn away after pushback and during taxi, but presume that engine 1 will be started first. By omission, the Operations Manual effectively assumes that pilots will understand that it would be ineffective to attempt to follow a taxi line that requires a significant and sustained turn in a confined space using the engine on the inside of the turn. Ref. 1.

A Boeing 777-300 began a go around from the runway at **Dubai** in 2016 after touching down late, but its initiation was attempted by selecting TO/GA thrust on the switches (the airborne go around procedure) instead of advancing the thrust levers to the TO/GA position as the SOP requires for a rejected landing. The aircraft reached 85 feet above the runway with thrust at idle before descending onto it – all occupants escaped before the destruction of the aircraft was completed by fire. Ref. 3.

Captain Ed Pooley is an Air Operations Safety Adviser with over 30 years experience as an airline pilot including significant periods as a Check/Training Captain and as an Accident/Incident Investigator. He was Head of Safety Oversight for a large short haul airline operation for over 10 years where his team was responsible for independent monitoring of all aspects of operational safety. Ed has been an active contributor to SKYbrary and HindSight magazine for many years and is a member of the Flight Safety Foundation's European Advisory Committee.

An Airbus A330-200 left the landing runway at **Jakarta** in 2013 after the final stages of the daylight approach were continued after the Captain, as Pilot Flying, had lost his previously acquired visual reference in heavy rain. The First Officer reported that he had not intervened because he could still see the runway. The aircraft touched down with the right main landing gear on the grass and continued like this for 500 metres before regaining the runway, sustaining damage that precluded taxiing in. Prevailing SOPs clearly required that a go around should have been flown. It was considered that the Captain's failure to do so "might have been the result of his insufficient intuitive decision making to cope with the situation". Ref. 7.

"SOPs must be properly documented and trained, and finally that this training must include *an appreciation of why they exist.*"



A Boeing 767-300 began its night takeoff at **Singapore** in 2015 from a parallel taxiway instead of from the runway for which take off clearance had been given. The crew did not 'follow the greens' as instructed and crossed an illuminated red stop bar. Ref. 4.

What can we learn from these few selected events? Compliance with SOPs is clearly important but SOPs need to be supported by an appropriate context. That context includes recognition that the SOPs must exist where appropriate, must be properly documented and trained, and finally that this training must include an appreciation of why they exist. The importance of the last of these, which can be described as 'background knowledge', is frequently ignored in favour of a 'just do it' approach. More classroom training of pilots in this area would be beneficial.

Interestingly, explaining what underlies SOPs is also likely to improve the quality of judgement and decision making, which is needed when what happens is not entirely addressed by them. This could be because the response to a situation is either seen as a matter of licence-level awareness of the operation of a generic aircraft. It could also be because the circumstances that are encountered are unanticipated or are so rare that they are not the subject of an entirely SOP-based response.

Of course, this leaves unintended non-compliance with appropriately constructed SOPs still reliant on monitoring one's own actions or monitoring by the other pilot. This monitoring is heavily relied upon to support compliance, but is not fully effective given that pilots, however competent, will still make mistakes. It also ignores the risks that can follow the actions of a pilot who is 'startled' and then suddenly acts contrary to training. This is an area where we have so far been rather slow to embrace all the opportunities that modern aircraft systems have given us to introduce automated gross error monitoring. We could start with pilot FMS inputs but that could be just the beginning. A comprehensive in-depth assessment of this area could be made but I am not sure that one has yet been published. If this is so, it is overdue and we do not need to wait for more fatal accidents. The opportunity to enhance operational safety performance by leveraging automated systems in this way is clear, and it would constitute a realistic support for competence.

References

1. A319, Ibiza Spain, 2016. https://www.skybrary.aero/index.php/A319,_Ibiza_Spain,_2016
2. A343, vicinity Paris CDG France, 2012. https://www.skybrary.aero/index.php/A343,_vicinity_Paris_CDG_France,_2012
3. B773, Dubai UAE, 2016. https://www.skybrary.aero/index.php/B773,_Dubai_UAE,_2016
4. B763, Singapore, 2015. https://www.skybrary.aero/index.php/B763,_Singapore,_2015
5. B763, Warsaw Poland, 2011 https://www.skybrary.aero/index.php/B763,_Warsaw_Poland,_2011
6. B763, en-route, mid North Atlantic, 2011. https://www.skybrary.aero/index.php/B763,_en-route,_mid_North_Atlantic,_2011
7. A332, Jakarta Indonesia, 2013. https://www.skybrary.aero/index.php/A332,_Jakarta_Indonesia,_2013

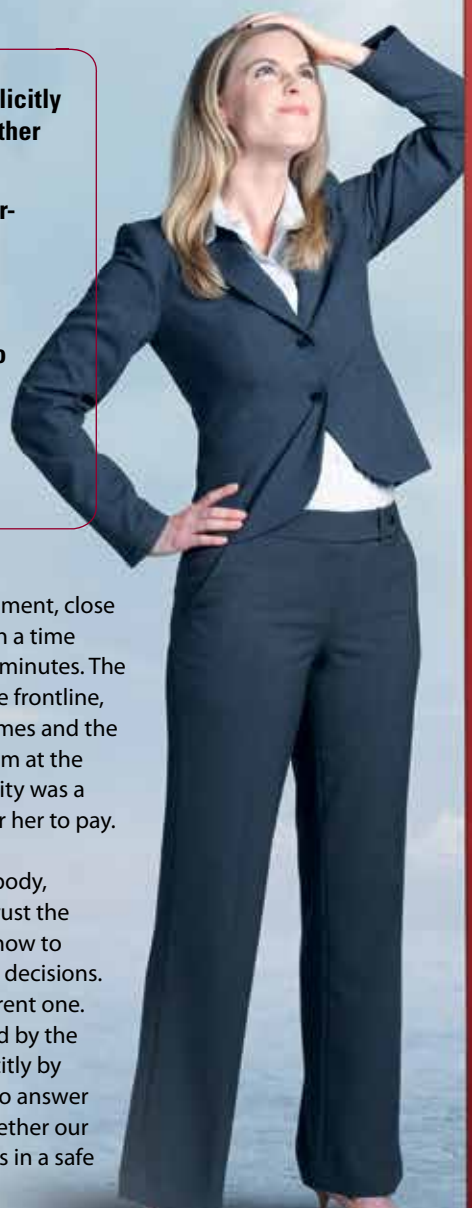
REGULATORY AND OVERSIGHT COMPETENCY:

THE LADDER OF ABSTRACTION

The focus of competency and expertise is often on front line staff. What about others, further away from the front line but whose decisions affect operational performance? They too need competency and expertise, but of a different nature, as **Stefano Oberti** explains.

KEY POINTS

- **Oversight bodies are mandated by the State (and implicitly by the public opinion) to answer the question of whether industry operates in a safe way.**
- **This requires competencies and expertise, both different and complementary from those of frontline staff.**
- **Oversight staff need competency and expertise to work on different levels of abstraction, to both understand the concrete work of frontline staff and to follow the more abstract reflections at the regulatory level.**
- **Oversight bodies need your help, as controllers, pilots and other readers, to do this.**



It is December 2011. I am sitting in my office together with a young ANS inspector to review the mandatory trial period for new staff. She recently joined the team, after some years spent as an ACC controller. She already produced good quality work with us. It was an easy decision for me, but I did not foresee her reaction, when I told her that she finally got the job. "I'm not quite sure this is the right job for me", she replied. "I'd like to extend the trial period".

In the next months, I closely followed her work and we regularly shared our views. Eventually, we both concluded that it was indeed not the right job. As an ACC controller, she used to work in a dynamic environment, close to pilots and with a time horizon of a few minutes. The distance from the frontline, the long timeframes and the missing dynamism at the oversight authority was a price too high for her to pay.

As an oversight body, we rely on and trust the frontline's knowhow to take appropriate decisions. Our job is a different one. We are mandated by the State (and implicitly by public opinion) to answer the question whether our industry operates in a safe

way, avoiding unacceptable safety risks for staff, passengers and the population on ground. This requires competencies and expertise, both different and complementary from those of frontline staff.

We are expected to understand how work is done at the sharp end and at the managerial level of the ANSP, and to judge whether this corresponds to the intention of the regulator. We must be able to evaluate how much of what front staff discloses about their work, matches with what they really do. If necessary, we request that their management takes action.

Inspectors are required to master interview techniques and risk assessment methods. They need to be able to question the answers they receive. Empathy and assertiveness are two essential character traits. Perseverance is of good help to cope with the long time frames, e.g., to see corrective actions being implemented.

We focus on the aviation system as a whole; our decisions are taken based on impact analysis of the entire system, not on a single actor. This requires the ability to shift from the detail to the 'big picture'. Finally, we report our observations to the regulator in order to complement their view on the way work is done. We are the trait d'union between the sharp-end and the blunt-end, between the frontline operators and the abstract government level. We need sufficient knowledge about the operations and technology subject to our oversight. At the same time, we have to speak the regulator's language.

Oversight professionals are required to be able to work on different abstraction levels, moving along an imaginary 'ladder of abstraction'. We need to be able to verify the match between four 'varieties of human work' (Shorrock, 2016): what front-line operators disclose about their work (work-as-disclosed); what they really do (work-as-done); the more abstract intentions of the rule maker (work-as-imagined, in the future); and the written rules (work-as-prescribed). We then report observations in the appropriate language.

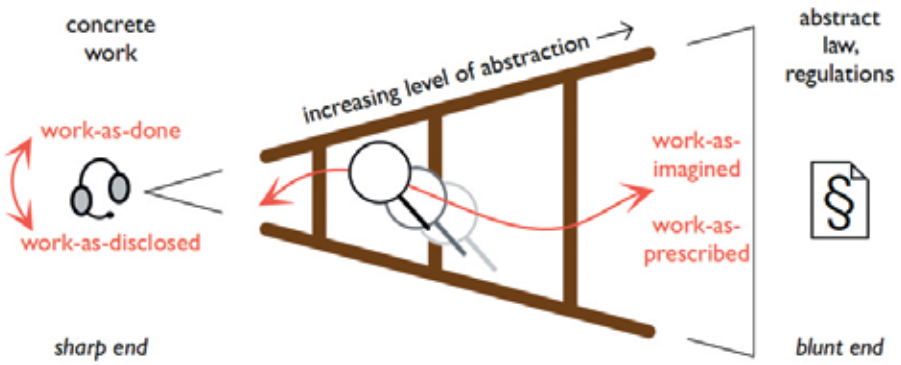


Figure 1: The ladder of abstraction

In order to get this expertise, we have adopted the following approaches in Switzerland.

First, our inspectors spend a few days per year in an ATC unit as observers. In these on-the-job-visits, they get an insight into the daily operations. In turn, controllers get to know them without the 'inspector's hat', fostering trust and communication.

Second, we 'train the trainer': we offer a team member tailored training and task him or her to give it further. Once per year, in a two-day workshop, one expert leads us in a discussion on a subject, where we draw conclusions for our work. We started in 2015 with socio-technical systems, supported by the system thinking learning cards by EUROCONTROL (EUROCONTROL, 2015), and by examples from EUROCONTROL 'ES2 – Experience Sharing to Enhance Safety'. In 2016, human factors and human performance was on the agenda, and in 2017 we deepened our expertise in meteorology and ATFCM.

The 'safety reminder of the week' remains one of my preferred tools to foster my inspector's expertise. I email them with 'food for thought': quotes, articles, videos – sometimes provocative – taken from various sources, like humanisticsystems.com, HindSight magazine, literature from aviation and other disciplines. Recently I have posted a TED Talk by Lera Boroditsky on 'How language shapes the way we think'.

In summary: oversight staff need competency and expertise to work on different level of abstraction, to both understand the concrete work of frontline staff and to follow the more abstract reflections at the regulatory level. It is like inspectors are asked to move along an imaginary ladder of abstraction. And we need your help, as controllers, pilots and other readers, to do this.

References

EUROCONTROL. (2014) *Systems thinking learning cards*: Moving towards Safety-II. Brussels: EUROCONTROL. Retrieved from http://www.skybrary.aero/bookshelf/books/3380.pdf

Shorrock, S. (2016, December 5). *The varieties of human work* [Blog post]. Retrieved from bit.ly/HSTVOHW

Dr Stefano Oberti is Head of Section Air Navigation Services at the Federal Office of Civil Aviation (FOCA), in Bern, Switzerland. He leads the inspectors' and field experts' team conducting safety oversight on air navigation services, licensing, performing technical verification of IFR procedures, coordinating the publication of aeronautical information, conducting the approval and oversight of air displays, and supervising search and rescue activities.

THE EVOLUTION OF COMPETENCY: FROM INDIVIDUAL EXPERTISE TO GROUP COMPETENCY

Competency may be seen as something to do with individuals, but we work in a social context, belonging often to several groups. Group can resist new ideas, but given the right environment, individual expertise can also spread. **Ludovic Mieusset** and **Sébastien Follet** discuss how individual expertise can be transformed into new group competencies.

KEY POINTS

- **Controllers and other front line specialists have common competencies and individual expertise.**
- **Good practice procedures may meet resistance among operational peers.**
- **By developing freedom of speech, some groups allow each member to share his or her past experience for the benefit of the group.**
- **The informal leader of a group, and the connectors that help to connect groups, have special roles in expanding the boundary of the expertise, and spreading good practice.**
- **In the right environment, individual expertise can be transformed into new group competency.**

A twin-engine airplane encountered a technical problem on one engine on initial climb.

The crew declared a PAN-PAN.

The first controller acknowledged and immediately asked the nature of the problem: the fuel endurance, the intentions of the crew, the number of people on board, the need for emergency services deployment on landing… In the cockpit, the crew started to go through the emergency checklist. But the controller repeatedly interrupted the task. This was uncomfortable for the crew, but the controller was following his own checklist, which he had been trained for when facing unusual situations.

The second controller had the same competencies, learned and rated all along her initial and continuous training. But she had already faced this type of situation. In this particular case, she knew that the standard procedures were not the best choice. So, after acknowledging the PAN-PAN message, she decided to apply another tool a colleague had shown her: the ASSIST procedure.

This procedure, implemented in more and more ANSPs across Europe, gives ATCOs important information they will relay to emergency services for a safe recovery. In that particular case, the controller will try not to interfere too often with the crew; only at specific moments. Her past experience had given her a certain level of expertise in dealing with PAN-PAN situations. This locally non-standard procedure might be considered effective by her colleagues. But, despite this recognition, there was a real reluctance to change the procedures, and transform this expertise into a new shared competence.

The third controller had the same high level of competency as the other two. But he was more independent. An open-minded individual, he explored widely all areas linked to aviation activity. In particular, he tried to exchange as often as he could with pilots, firefighters, ground handling staff, and others. Once, a pilot told him about the NITS procedure, a procedure implemented by airlines with multi-national crews. On several occasions, he experimented with this tool, and had the opportunity to evaluate its benefits after debriefing with the crew involved in the incident. He developed a certain level of expertise, and could be considered an expert, meeting both ATC and pilot needs effectively. But he was on the edge of the two groups and so might also be considered an outsider to each group. In this situation, the controller's action was not considered legitimate by his fellow workers.

This could have been the story of 'the three little pigs', and the incident might have been the wolf. In fact, it is not. None of the three controllers is lazy or inconsistent. All of them are highly competent and did the job correctly to ensure a safe return of the plane. But regarding their expertise, they each deal with it in a different way.

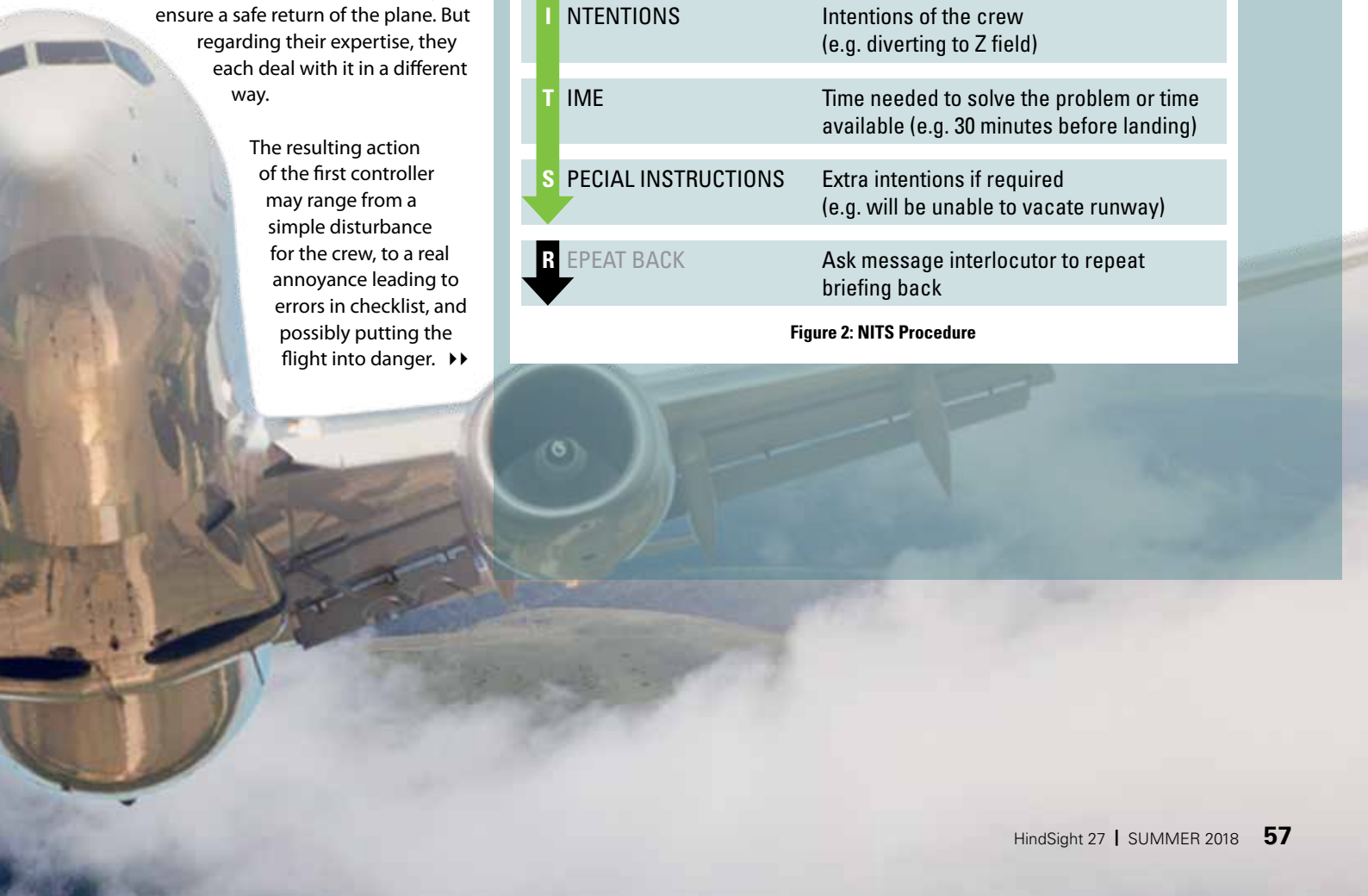
The resulting action of the first controller may range from a simple disturbance for the crew, to a real annoyance leading to errors in checklist, and possibly putting the flight into danger. ▸▸

EMERGENCY	
A CKNOWLEDGE	Make sure you understood the nature of emergency and acknowledge accordingly
S EPARATE	Don't forget to establish/maintain separation!
S ILENCE	Impose silence on your control frequency if necessary. Don't disturb urgent cockpit actions by unnecessary transmissions!
I NFORM	Inform your supervisor and other sectors/units concerned
S UPPORT	Give maximum support to pilot and crew
T IME	Allow pilots sufficient time to work on their problem

Figure 1: ASSIST Procedure

EMERGENCY	
N ATURE OF THE PROBLEM	Give a quick overview of the situation (e.g. slat problems)
I NTENTIONS	Intentions of the crew (e.g. diverting to Z field)
T IME	Time needed to solve the problem or time available (e.g. 30 minutes before landing)
S PECIAL INSTRUCTIONS	Extra intentions if required (e.g. will be unable to vacate runway)
R EPEAT BACK	Ask message interlocutor to repeat briefing back

Figure 2: NITS Procedure



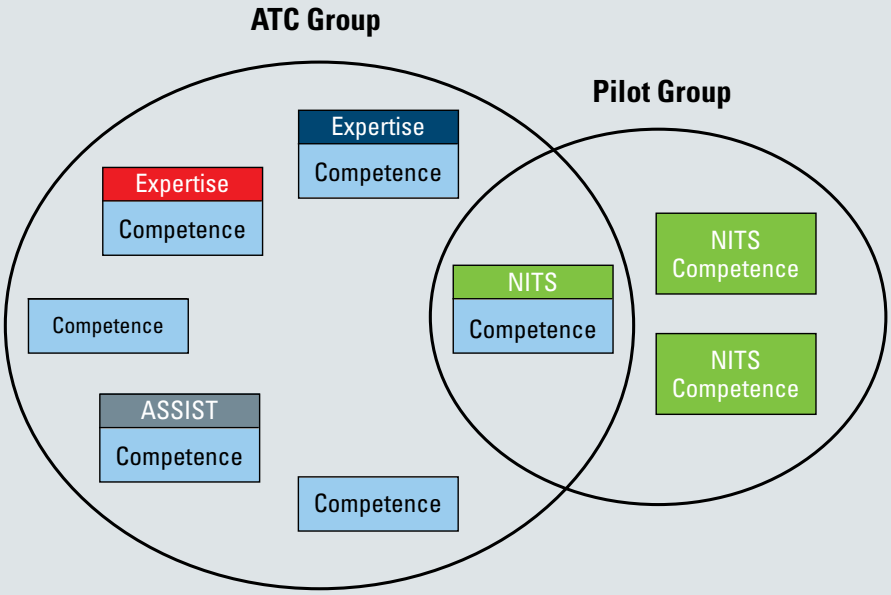


Figure 3: Emergency procedure: Group competence and individual expertise

The ATC-oriented procedure implemented by the second controller gives headlines, but she has to ask for information, without clearly knowing when to ask. With the NITS procedure, the third controller waits for the pilots to give him the needed information. ASSIST and NITS seems to bring progress, so why aren't they implemented as new competences?

These three controllers could be found in any team or group. Each one shares common and standard competencies, but has also developed his or her own expertise, based on personal experience. Does the sum of individual expertise develop the group's expertise?

This example, inspired by a real-life situation, shows that within the same group of controllers, an aircraft technical problem may be dealt very differently; more or less efficiently. To be part of the group, we have to respect the rules of the group, but we also have to show that we are competent. In order to fulfill some of our human needs such as group integration, group recognition, and a sense of belonging, we are very keen to show our individual skills and abilities when facing an unusual situation. This is certainly one of many reasons why it is so difficult to waive our own expertise in favour of another's. We'll question our practice only if the group decides to give credit to specific expertise. In this situation, we'll conform to the new practices out of allegiance to the group.

This conformity comes naturally. The group, giving credit to the experience of one of its members, transforms this individual expertise into new competencies, which will become a new standard for the group.

How can a group transform individual expertise into new competence?

First of all, the group needs to be able to identify the group boundaries and other related groups. We are all part of various overlapping groups, from small to very large. Each group has its own rules. Belonging means understanding and accepting and respecting these rules. Working as an ATCO means we apply European good practice and rules as members of EUROCONTROL and EASA, national rules as member of our ANSP group and national regulator, local rules as members of our control unit group, and team rules as a member of our work-group. But we're also part of transversal group, such as our special workshop group.

Let's concentrate on an ATC team. In some groups, competencies never evolve, and pilots confront a different practice according to the controller on duty. On the ATC side, it's very comfortable, but may fail to adapt to a constant changing world. From the cockpit, the situation may look a little bit muddled, and the crew does not really know what to expect.

Other groups are able to identify the competencies of each member of the

group. By developing freedom of speech, they allow each member to share his or her past experience. This expertise is recognised, and the group is able to refer to the most appropriate expertise. This implies some special principles.

Some groups naturally fulfill all these characteristics. This is partly thanks to an informal leader – a member of the group, chosen by the group, and who defends the group. He or she is central in the group communication, sharing information and knowledge inside the group. The leader upholds the group rules and is also emotionally intelligent, aware of human factors aspects for individuals and for groups. Unfortunately, there is confusion between leader and chief – a chief may have his or her own preference for solutions, and often decides regarding the chief's own constraints, discouraging others' opinions.

"Even with a very efficient group, it's difficult to transform expertise into new competencies. The main problem lies in the resistance to change."

But even with a very efficient group, it's difficult to transform expertise into new competencies. The main problem lies in the resistance to change. Individually and collectively, we are reluctant to change. The group's need to defend its common practices and provides some stability. We all know of situations where changes have led to group conflict or separation. Changing means abandoning well-established practices, and adopting new practices, and learning to apply them correctly. It is an effort, and the effort remains each time we have to apply them, until they become automatic.

The same influence is at work for the third controller in our earlier example. This expert is an outsider and by his connection to both sides and might be seen as a danger to the group. Which language does he or she speak: pilot or controller language? Being at the junction of two groups might signify belonging to none of them. And that is an enormous loss, because the expertise of the third controller is built on two different groups. This person is a link, a connector (see HindSight 25 and HindSight 26). The connector knows the rules of the two groups, and can bring expertise to the two groups. Special attention should be given to this particular member and role.

"Learning from individual expertise to gain some new and more efficient competencies, is a way to progress everyday safety."

Transforming expertise into new competencies might be an odd idea, but this is a way to implement Safety-II, as described by Professor Erik Hollnagel (see HindSight 25). Everyday work – good and bad experiences – give every controller some expertise. Learning from individual expertise to gain some new and more efficient competencies, is a way to progress everyday safety. This progress relies on us. The key is to develop collective intelligence into our groups of all sizes following the sorts of principles outlined above.

Principles for freedom of speech

- Limit hierarchy effects to reduce fear of the consequences of speaking up.
- Limit extreme differences in expertise level, to avoid the fear of comparison.
- Give confidence to the members of the group by team-building or team training activities, in order to create some shared experience, to better know each other, and to develop interpersonal relationships.
- Don't relay on individual members who are more willing to speak up 'for the group'.
- Set some rules or guidelines on how the group works. These might include the absence of judgment and the duty to listen to everyone, even a solitary and discordant voice.

Ludovic Mieusset has been an Air Traffic Controller for the last 26 years. He began as a French Air Force ATC on a fighter jet Air Base. After 11 years, he joined a civil ANSP and became a Tower Controller in 2 different busy General Aviation airfields. This aviation enthusiast is now an ATCO and HF Facilitator in a regional approach control center. **ludovic.mieusset@thehumantree.com**

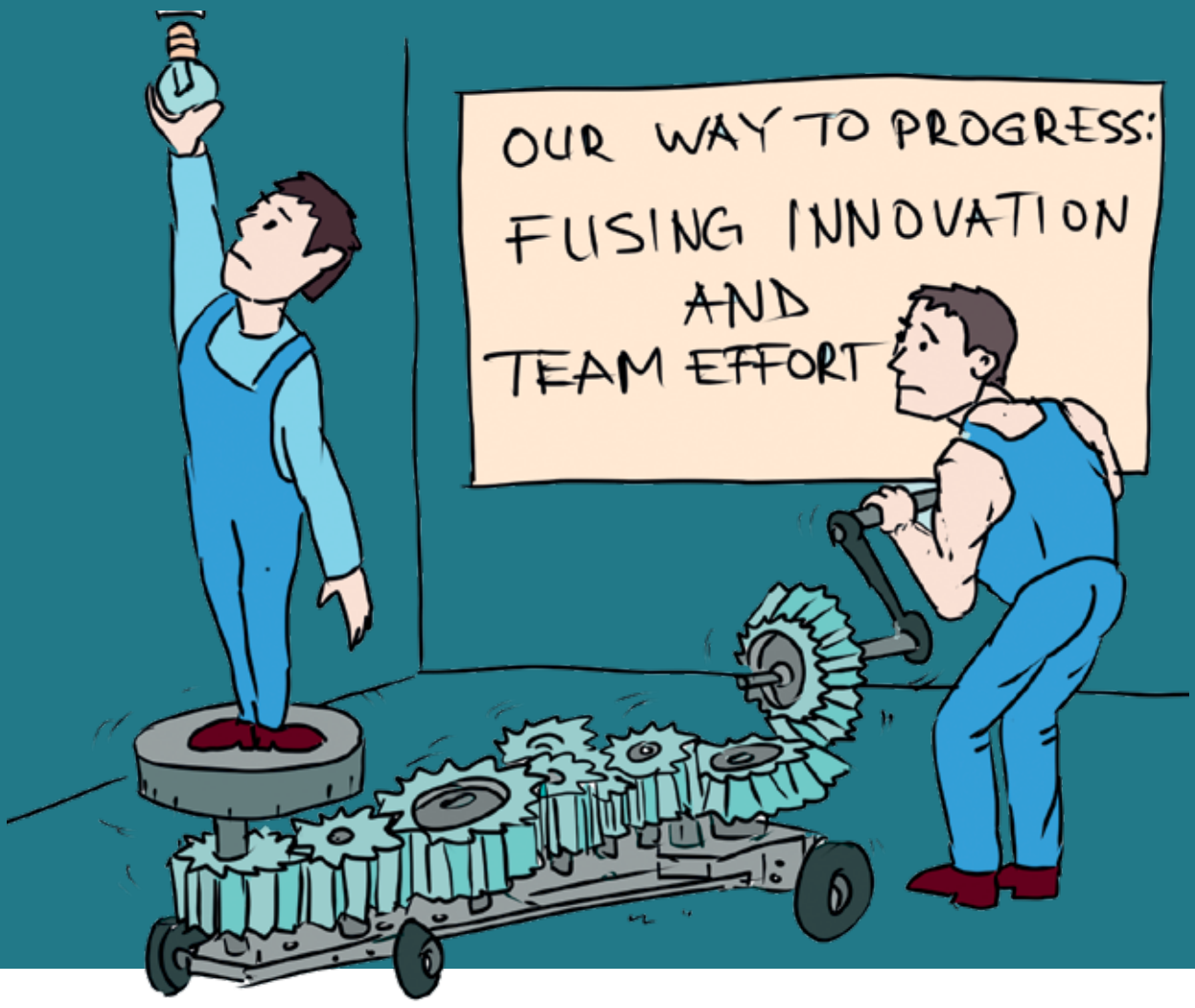
Sébastien Follet has been working as an Air Traffic Controller for the last 16 years. He has been a HF facilitator for controllers for the last 10 years and is currently instructor for controllers in his ATC center. Formerly, he has also worked on various safety studies to implement new equipment. He has a degree in Ergonomics & HF Basics from Paris Descartes University. This aviation enthusiast has been a private pilot for 17 years. **sebastien.follet@thehumantree.com**

COMPETENCY AND EXPERTISE FOR THE FUTURE OF ATM

As we move into the future of aviation, changes in society and technology will affect the competency and expertise required of front-line and other staff. In this article, **Linda Napoletano** outlines some of the future trends and the changing nature of work, along with some of the implications for competency.

KEY POINTS

- **Trends and innovation will change the nature of ATM. The challenge is ensuring that today's workers have the competencies, expertise and support needed.**
- **New technologies and innovations require thinking in terms of human-machine partnerships.**
- **Future competencies needed in ATM may include abilities to work with data, knowledge of ICT and robotics, and new non-technical skills relating to problem solving and decision-making.**
- **ATM is starting to discuss how to define future competencies. We need to compare current competencies with future needs to prepare for the changes in the ATM work.**



Mobility4EU is a Horizon 2020 project aiming to deliver a vision for the European transport system in 2030 and an Action Plan that aims to implement that vision. This vision and action plan will focus on user-centeredness and cross-modality anad include the transport of passengers and freight (see https://www.mobility4eu.eu/).

STRESS is a Horizon 2020 project in the frame of SESAR Research and Innovation action to support the transition to higher automation levels in aviation, by addressing, analysing and mitigating its impact on the Human Performance aspects associated to the future role of Air Traffic Controllers (see http://www.stressproject.eu/).

MOTO is a Horizon 2020 project in the frame of SESAR Research and Innovation to identify the key multimodal stimuli required on remote tower platforms to enhance the sense of presence experienced by air traffic controllers (see http://www.moto-project.eu/).

KAAT (Knowledge Alliance in Air Transport) is an Erasmus+ project developing competency frameworks in ATM (see http://www.kaat.upb.ro/).

Introduction

For the past 10 years, the unemployment of the European labour force aged 15 to 24 years has been between 18%-20%. Beside the recent economic crisis, an important reason for young people being held back from the labour market is a lack of skills relevant to the workplace. The skills shortage sends alarming signals to both the European aerospace industry and to educational institutions. The European aerospace sector has always required a highly qualified and innovative workforce, and it is estimated that in Europe in 2014, 2.5 million jobs belonged to the aerospace sector (Air Transport Action Group, 2018). There is a need to identify the new skills, knowledge and attitudes to maintain competitiveness and to keep attracting and retaining highly skilled staff.

Future trends

In the next 20 years, mobility will dramatically change (Mobility4EU, 2018). Digitalisation, the Internet of Things and Big Data will allow different transportation modes to communicate with each other and with the environment. This will pave the way to integrated and inter-modal transport solutions.

Automation will increase for all tasks, changing the nature and the role of the humans in the system. Digital analytics, for airline and airport operations, will improve the strategic planning of traffic flows in both optimisation and deconflicting (NATS, 2017). Travelling will be more seamless. Unmanned aerial systems (UAS) will be populating our urban areas, performing many more applications.

"Automation will increase for all tasks, changing the nature and the role of the humans in the system."

Additionally, growing awareness of environmental concerns will require sustainable flying for policy makers, industry and end users.

The changing nature of work

Currently, there are two extreme perspectives on the implications of these trends. On the one hand, the impact of technology on the employment rates would be catastrophic. On the other hand, technological innovations are seen as the solution for all social and environmental problems.

A recent report (IFDT, 2017), suggests a third way, which is to frame the human-machines interaction in terms of partnership. This begins to build capacity in machines to improve their understanding of humans, and in people and organisations to engage meaningfully with robotics and new technologies. The versatility, creativity and ability of humans to solve problems would combine with the precision and repeatability of robots.

When applying a human-machine partnership framework to ATM, we can still see the future air traffic controller as an "active decision-maker" (as Andrew Beadle, IFATCA Executive Vice President, said in 2010), delegating to automation the execution of repetitive tasks. Once relieved from routine tasks, the pilots and controllers could dedicate more time to other activities such as training, collaborating with colleagues, complex planning and problem solving.

A number of technological innovations will change the way operators currently interact with machines in ATM. Some occupations will be modified, others will disappear, and new ones will be created. We can expect the following:

1. Airspace will be dynamic, with airspace boundaries changing to suit traffic flows, even in the terminal area, and in response to the ATM services needed. Operational differences between areas, like terminal and en-route, will become more blurred. More than one service provider could work in a given airspace block and controllers may be responsible for a set of aircraft (CANSO & IFATCA, 2010). In such a vision, **augmented reality** offers inline instructions to operators that can be quickly reassigned to new working positions with training being focused mainly on problem solving and decision making.

2. Higher levels of automation will be required. **Big data** will be collected at all levels of the system, including from operators. This will allow for performance-based operations, more accurate predictions, and on-time adaptation to unexpected changes. In the SESAR exploratory research project 'STRESS', air traffic controllers wear devices to monitor their levels of stress, workload and fatigue. 'Adaptive automation' is used to help both controller wellbeing and system performance.

3. New concepts for ATM will appear, such as remote towers, which centralise services for multiple airports. What will happen to situational awareness and decision-making of tower controllers, once they are no

longer physically there? Remote towers can be equipped with **augmented and virtual reality** to recreate a sense of presence, and haptic wearable devices to enhance the controlling experience and overall safety (see MOTO project).

4 In the coming years, the commercial use of drones is expected to grow across industries and for many applications. Extensive **drone operations** will call for new competencies and jobs, from unmanned aircraft designs, to trained drone pilots, to the technology and regulations required to ensure that such aircraft are operated safely in the commercial airspace (SESAR, 2016).

Competencies

By looking at the few examples of the changing nature of the work in ATM, we can see that the skills and knowledge required for working in the ATM sector will change.

- Increasingly, the future controller (supported by automation) will manage traffic flows and trajectories. Active tactical intervention will be the exception, and the human will remain in the loop to make sure that the system meets performance targets.
- Using big data to diagnose future problems will require a new level of teamwork. To detect deviations and promptly intervene, machines will analyse and build patterns among large sets of data, and humans will interpret the results and understand how they connect to the actual operational scenarios. Future controllers will need competencies in strategic decision making and problem solving, as well as skills and abilities to read big data analytics and thus be able to manage the system, even when less directly involved in the operations.
- New 'natural interfaces' (e.g., gestural, voice/conversational) will enter ATM. Operators will need new technical and operational competencies.
- Where old tasks are fully delegated to automation, it may not be possible for the controller to understand how automation is offering a specific outcome, but operators may need competencies to take back control in some situations.

Additional technical and non-technical competencies will be required at all levels: operational, technical, support, specialist, and management.

An additional challenge for ATM will be to facilitate the adoption of a new 'mindset' concerning change. ATM has to plan for this now, by involving staff in the development of future ATM (Zizi, 2010).

"We need to understand how new technology, new procedures and new concepts will change competency requirements."

Challenges

The current competency framework must be compared with short- and mid-term needs. The current workforce must be trained to meet these needs. To contribute constructively to changes and adoptions to the surrounding world, ATM needs a new competency framework (see KAAT project). We need to understand how new technology, new procedures and new concepts will change competency requirements. We also need to assess what part of future employment demand can be met by retraining existing workers versus hiring new ones.

Linda Napoletano holds a Ph.D. in Human Computer Interaction. Since 2008 she has worked as a human factors, validation, dissemination and training expert for Deep Blue, a SME specialised in research and consultancy with a focus on ATM. Linda is currently researching on the future of mobility and the impact on competences and skills needed within the transportation sector. She is member of the ACARE WG5 Research, Infrastructure, Education & Workforce.
linda.napoletano@dblue.it

References

Air Transport Action Group (2018) Aviation beyond borders. https://aviationbenefits.org/around-the-world/europe/

CANSO & IFATCA (2010). The next generation aviation professional. http://bit.ly/2Lc5gMO

IFDT (2017). The next era of human | machine partnerships. New report explores emerging technologies' impact on society & work in 2030. http://www.iftf.org/humanmachinepartnerships/

Mobility4EU (2018). Vision for 2030 map. https://www.mobility4eu.eu

NATS (2017). Harnessing big data for flight operations. http://bit.ly/2ITVmot

SESAR (2016) European drones outlook study: Unlocking the value for Europe. http://bit.ly/2u7PhJ9

Zizi, F. (2010). Ways and ideas to train aviation professionals for today and tomorrow. NGAP Symposium, ICAO, Montreal, 1-4 March 2010. www.bit.ly/2kFPKhk

Read more about the 'ironies automation' and competency

Bainbridge, L. (1982). Ironies of automation. Automatica, 19, 775-780. http://www.bainbrdg.demon.co.uk/Papers/Ironies.html

Gordon Baxter, G., Rooksby, J., Wang, Y., & Khajeh-Hosseini, A. The ironies of automation ... still going strong at 30? Proceedings of ECCE 2012 Conference, 29th-31st August, Edinburgh, North Britain 65 Copyright is held by the authors / owners http://johnrooksby.org/papers/ECCE2012_baxter_ironies.pdf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TRAINING FOR COMPETENCY AND EXPERTISE

EUROCONTROL IANS COURSES

The EUROCONTROL Institute of Air Navigation Services (IANS), located in Luxembourg, develops and delivers Air Traffic Management Training, Services and Tools for Air Navigation Service Providers, Airlines, Training Organisations and Civil and Military State Authorities worldwide.

Building on over 45 years of expertise, the Institute provides a wide range of training courses, services and tools – from general introduction courses on ATM concepts through to advanced operational training.

Here are four courses that may be of interest to air traffic controller readers looking to enhance their own competency and expertise.

Theoretical Training Instructor Skills [HUM-TTI]

Training is a vital part of ensuring that everybody involved in ATM is competent for the tasks that they are asked to undertake. Training can take many forms, but to be effective it is important that the trainer understands the fundamental elements involved in transferring knowledge during a lesson. This course is designed to help those who are asked to produce and deliver classroom training material or to deliver work related presentations - to do it in the most effective way. Although mostly focused on a classroom-based training environment and ATCO training, the principles covered by this course are equally applicable to many other training situations (ATSEP, AIS/AIM, etc).

Objectives
With this course we aim at supporting you in tailoring your work presentations and lessons. After completing this course, participants will have hands-on experience of delivering short theoretical training in lesson format. You will be asked to prepare and design, develop and deliver two lessons lasting up to 30 min each, together with designing one written test. Participant's sessions are debriefed, based on set guidelines.

Audience
This course is appropriate for colleagues who will be asked to design, develop and deliver theoretical training for ATM staff and/or presentation on ATM related events. It aims at fulfilling criteria from Acceptable Means of Compliance to Part-ATCO, subpart C, Section 1 (Instructors) for Commission Regulation (EU) 2015/340.

Design of ATC Simulation Exercises and Courses [HUM-SIM]

The current European ATM regulatory framework requires all staff undertaking safety-related tasks to be appropriately trained and competent. Such training is often carried out using a combination of practical skills training and classroom-based training. Practical skills training for air traffic controllers is carried out using simulators. In order to be of value, it is important that this training is designed according to specific objectives. Our course includes both theoretical and practical work to achieve meaningful training for the creation of ATC simulation exercises for ACS/APS based on predefined training objectives. The topics covered include the fundamental principles and parameters of simulation exercise design, workload evaluation and evaluation of a simulation course.

Objectives
After completing the course, participants will have an understanding of the necessary elements in ATC simulation exercise and course design and will have gained practical experience in designing such exercises.

Audience
This course is designed for ATC instructors who are, or will be, involved in simulation courses and developing ATC simulation courses.

Practical Training Instructor skills for OJTI and STDI [HUM-OJTI]

The Training Programme for On-the-Job Training Instructors (OJTI) and Synthetic Training Device Instructors (STDI) provides theoretical knowledge and practical skills for ATC controllers who will undertake OJTI/STDI duties. The course uses various teaching methods such as role plays, videos, document study and discussions. The majority of the course comprises practical exercises in training techniques, coupled with extensive feedback from course instructors. The practical exercises are carried out on radar simulators. This is an assessed course, which includes examinations/assessments in both theory and practical OJTI/STDI skills.

Objectives
After completing the course, future On-the-Job Training and Synthetic Training Device Instructors will have the skills necessary to help student controllers and trainees to progress toward a successful conclusion of their operational or simulator training.

Audience
This course is designed for air traffic controllers holding (or who have held) a surveillance rating who will be undertaking OJTI/STDI duties.

Controller Competency Assessor [HUM-CCA]

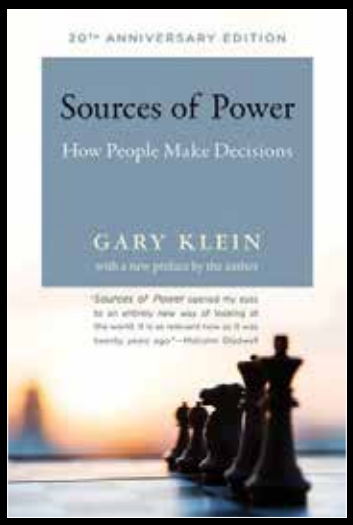
A key element of assuring the safety of air traffic services is ensuring that controllers are competent to perform their tasks safely. Because of this, both the EC Single European Sky regulatory framework and EUROCONTROL Guidelines Material include obligations to ensure that a controller is assessed as competent before being granted an air traffic controller licence. This course deals with the processes used within a formal competence scheme to evaluate the competence of air traffic controllers for the first operational competency and for continuing competence. The course supports the use of both practical and oral assessment as tools to determine the initial operational competency of a controller and provides participants with the rationale, knowledge, techniques and practical skills needed to undertake the role Competence Assessor. In addition, the use of dedicated checks and continuous assessment are covered as methods to evaluate the continuing competence of air traffic controllers.

Objectives
After completing this regulated course, participants will have been assessed on practical and pedagogical skills of competence assessment and will have an understanding of the current European controller competence regulations and the principles of competence checking. In addition, participants will have an appreciation of competence assessment techniques and 'best practice' to prepare them to take on the role of Competence Assessor.

Audience
This course is designed for controllers who will carry out the certification of competence of other controllers for either the issue of new qualifications or the renewal of existing qualifications.

Check the prerequisites and dates for each course, and register at EUROCONTROL Training Zone.
https://trainingzone.eurocontrol.int/

If you want to read more about some of the issues raised in this Issue of HindSight, then these books might be of interest.



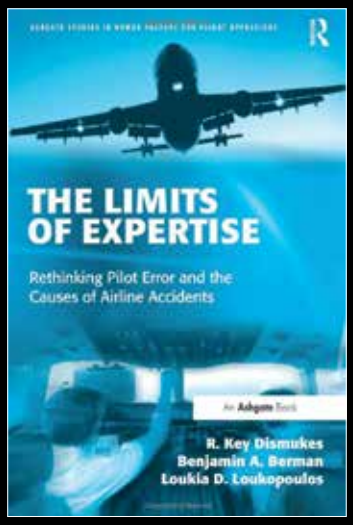
Sources of Power: How People Make Decisions,
by Gary A Klein (2017)

From the publisher: "Anyone who watches the television news has seen images of firefighters rescuing people from burning buildings and paramedics treating bombing victims. How do these individuals make the split-second decisions that save lives?

Most studies of decision making, based on artificial tasks assigned in laboratory settings, view people as biased and unskilled. Gary Klein is one of the developers of the naturalistic decision making approach, which views people as inherently skilled and experienced. It documents human strengths and capabilities that so far have been downplayed or ignored.

Since 1985, Klein has conducted fieldwork to find out how people tackle challenges in difficult, nonroutine situations. Sources of Power is based on observations of humans acting under such real-life constraints as time pressure, high stakes, personal responsibility, and shifting conditions."

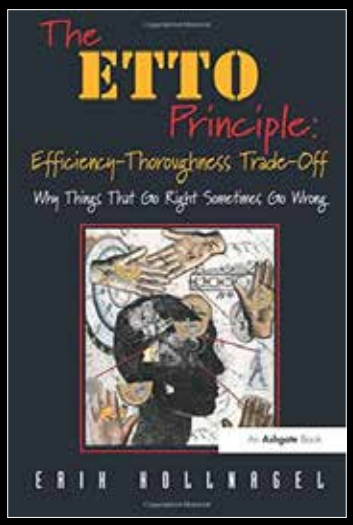
> *"Sources of Power is without a doubt one of the finest works on decision making. A must for anyone responsible for training command and control personnel." (Hugh E. Wood, Program Chair, Emergency Incident Policy and Analysis, National Fire Academy)*



The Limits of Expertise: Rethinking Pilot Error and the Causes of Airline Accidents,
by R. Key Dismukes, Benjamin A. Berman, and Loukia Loukopoulos (2007)

From the publisher: "The Limits of Expertise' reports a study of the 19 major U.S. airline accidents from 1991-2000 in which the National Transportation Safety Board (NTSB) found crew error to be a causal factor. Each accident is reported in a separate chapter that examines events and crew actions and explores the cognitive processes in play at each step. The majority of all aviation accidents are attributed to human error, but this is often misinterpreted as evidence of lack of skill, vigilance, or conscientiousness of the pilots. Why would highly skilled, well-trained pilots make errors performing tasks they had successfully executed many thousands of times in previous flights? The approach is guided by extensive evidence from cognitive psychology that human skill and error are opposite sides of the same coin. The book examines the ways in which competing task demands, ambiguity and organizational pressures interact with cognitive processes to make all experts vulnerable to characteristic forms of error."

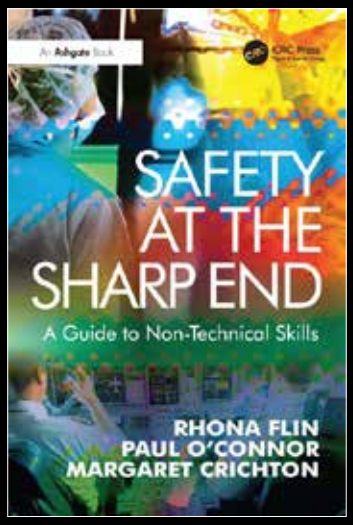
> *"The authors argue that human error should be seen as an indication of "system vulnerability" rather than pilot inadequacy. Fortunately there are many ways in which managers and regulators can improve the system to help avoid future accidents. The book is packed with techniques by which individual pilots can reduce their vulnerability to error and thereby improve their chances of reaching retirement unscathed. A fascinating read for pilots, managers, regulators and anyone interested in operations at the limits of human expertise.' (The Log, BALPA, 2008.)*



The ETTO Principle: Efficiency-Thoroughness Trade-Off,
by Erik Hollnagel (2009)

From the publisher: "Accident investigation and risk assessment have for decades focused on the human factor, particularly 'human error'. Countless books and papers have been written about how to identify, classify, eliminate, prevent and compensate for it. This bias towards the study of performance failures, leads to a neglect of normal or 'error-free' performance and the assumption that as failures and successes have different origins there is little to be gained from studying them together. Erik Hollnagel believes this assumption is false and that safety cannot be attained only by eliminating risks and failures. The ETTO Principle looks at the common trait of people at work to adjust what they do to match the conditions - to what has happened, to what happens, and to what may happen. It proposes that this efficiency-thoroughness trade-off (ETTO) - usually sacrificing thoroughness for efficiency - is normal. While in some cases the adjustments may lead to adverse outcomes, these are due to the very same processes that produce successes, rather than to errors and malfunctions. The ETTO Principle removes the need for specialised theories and models of failure and 'human error' and offers a viable basis for effective and just approaches to both reactive and proactive safety management."

"This is an impressive book, simultaneously bold and reasonable. Hollnagel, in his highly readable style, lays out a simple but profound principle - the tradeoff between thoroughness and efficiency - and uses it to cut through all kinds of sterile debates in order to provide valuable insights about human behavior."
(Gary Klein, author of Sources of Power: How People Make Decisions)



Safety at the Sharp End: A Guide to Non-Technical Skills,
by Rhona Flin (2008)

From the publisher: "Many 21st century operations are characterised by teams of workers dealing with significant risks and complex technology, in competitive, commercially-driven environments. Informed managers in such sectors have realised the necessity of understanding the human dimension to their operations if they hope to improve production and safety performance. While organisational safety culture is a key determinant of workplace safety, it is also essential to focus on the non-technical skills of the system operators based at the 'sharp end' of the organisation. These skills are the cognitive and social skills required for efficient and safe operations, often termed Crew Resource Management (CRM) skills. In industries such as civil aviation, it has long been appreciated that the majority of accidents could have been prevented if better non-technical skills had been demonstrated by personnel operating and maintaining the system. As a result, the aviation industry has pioneered the development of CRM training. Many other organisations are now introducing non-technical skills training, most notably within the healthcare sector." Safety at the Sharp End" is a general guide to the theory and practice of non-technical skills for safety. It covers the identification, training and evaluation of non-technical skills and has been written for use by individuals who are studying or training these skills on CRM and other safety or human factors courses."

"The text is lively and well illustrated with relevant figures and tables. Very interesting, informative and exploratory, it manages to balance the strictly technical and the non-technical with a welcome sense of humour and a refreshing degree of caring sensitivity to human rights and behaviour. Another Ashgate book which opens doors for new solutions to old and new safety problems."
(The RoSPA Occupational Safety & Health Journal, May 2008)

COMPETENCE IN SURGERY: FROM ME TO US

Surgery is a job that is unlike any other. As patients, we probably think only of operating skill, but surgeon competency affects patients from the first meeting before the operation, through to the monitoring of recovery. In this article, **Craig McIlhenny** goes further to consider team competency, including other surgeons, anaesthetists, junior doctors, technicians, nurses, and administrators, working together to ensure the best possible outcome for the patient.

KEY POINTS

- **Competence is not a set construct and can change with time and the situation.**
- **The competence of surgical trainees in the UK is assessed in the workplace performing actual work.**
- **Competence assessment is performed by multiple assessors, over many observations, with different tools, to build a valid and reliable representation of performance.**
- **Our concept of competence in surgery is very much based on the individual surgeon, and we should look to assess the competence of both the surgical team and the system in the future.**

"He was six foot two, and operated in a bottle-green coat with wellington boots. He sprung across the blood-stained boards upon his swooning, sweating, strapped-down patient like a duellist, calling, 'Time me gentleman, time me!' to students craning with pocket watches from the iron-railinged galleries. Everyone swore that the first flash of his knife was followed so swiftly by the rasp of the saw on bone that sight and sound seemed simultaneous. To free both hands, he would clasp the bloody knife between his teeth."

This vivid and visceral description is of Sir Robert Liston, a pioneering Scottish surgeon, performing an amputation in the late 19th century. Liston was widely lauded for being amongst the best surgeons of his day. He operated in a time before anaesthesia and antisepsis, when swifter surgery meant less risk of infection and death, and so sheer speed was seen as the main barometer of competence in a surgeon. And Liston was the fastest.

In his most (in)famous operation, he removed a patient's leg in under two and a half minutes. Unfortunately, the patient died afterwards from gangrene, which was very common in those days before antibiotics. During the operation, Liston managed to amputate the fingers of his young assistant, who died afterwards from infection as well. He also slashed through the coat tails of a distinguished surgical spectator, who was so terrified that the knife had

pierced his genitals that he dropped dead on the spot from fright. This remains the only surgical operation in history with a three-hundred percent mortality rate.

If, heaven forbid, you required a surgical procedure today, you would want this to be performed by a competent surgeon, in the same way that when I fly as a passenger I want, and indeed expect, to be flown by competent flight crew aided by competent controllers. However, when you find yourself in the hospital, more than a little nervous, trying to protect your modesty in one of those awkward backless gowns, the million dollar question you want to ask your surgeon is unlikely to be "what is the fastest time you have performed this operation in?"

It appears fairly obvious then that what constitutes competence changes over time, sometimes radically. Indeed, in Liston's day, there was no formal definition of what a competent surgeon was; no set of standards existed that surgeons were tested against before being allowed to practise their art on the general public. So, if we can no longer rely on the ticking of a silver pocketwatch to define how good our surgeons are, how do we define and indeed measure competence today?

For many years in surgery we struggled with this very question. There was always an informal assessment of competence from your mentor, and if you were known to have a 'safe pair of hands' you were allowed to progress. We then moved to try to reliably assess prospective surgeons with various exams, which were thought to give a more reproducible and defensible 'score' of competence measurement. Professor Ronald Harden, a distinguished professor of medical education, pointed out the fallacy inherent in this approach to competence assessment with reference to your humble footwear: *"In many places they would ask the students to write an essay on the origin of the word shoelace, or design multiple choice questions on the design of shoelaces, or even ask them to describe the steps involved in tying a shoelace. Whereas really the only way of doing it is showing you can tie an actual shoelace."*

"The main way we measure and assess the competence of our trainee surgeons is by directly observing their performance."

So, this is how we now define and measure competence, in terms of performance. Yes, we still do have examinations and tests of knowledge, but the main way we measure and assess the competence of our trainee surgeons is by directly observing their performance. We continuously use a variety of workplace-based assessment tools, each designed to assess a different aspect of performance, or performance in a specific setting, such as the hospital ward, or the emergency department or the outpatient clinic. We utilise multiple different observers over multiple observations to increase the validity of these observations and ensure that we construct an accurate picture of how that surgeon performs doing the actual job we want them to do. Typically, our trainees carry out between fifty and eighty of these 'on the job' assessments each year.

As surgeons, one of our main tasks is to operate on patients, and so the most commonly used tool is a procedure-based assessment. This looks at all the steps involved in performing a safe operation, and is divided into five domains. It starts from the pre-operative planning process, through the actual technical performance of the operation itself, to the post-operative instructions and care given. Each of the sections is assessed separately, with feedback given on performance in that section and whether that performance was competent. In addition, the trainer assigns a global score to the overall performance of the whole operation and benchmarks it against the level expected of a fully trained and independent surgeon. At the end of a training attachment all of these assessments are reviewed by a committee of trainers, including a senior trainer from outside the region, and a lay member of the public. This committee then decides if the trainee is competent to proceed to the next stage of training, or be awarded a certificate of completion of training if they have reached the end of their training programme.

So, as a surgeon who trains other surgeons, and who also supervises surgeons training other surgeons, I feel we have a good system – a safe system – for training and assessing competence. However, lately I must admit to a certain feeling of unease. At times I can almost hear the ticking of the pocket watches, and the ring of steel and rasp of saw on bone from when Robert Liston stood alone and measured his competence in terms of swiftness.

Although surgeons no longer operate wearing a blood encrusted 'bottle-green coat' (I do still wear wellington boots), my training, and that of all surgeons today, still has a faint echo of that manner in which Sir Robert Liston trained; the culture of training remains very much the training of an individual. We still view competence as a quality possessed by that single individual. Our entire surgical training pathway is rooted in this individualist paradigm; we select prospective medical students based on individual grades at school, we grade their medical school performance on individual academic achievements, and even in our current advanced competency-based training schemes, we largely assess our future surgeons on their individual knowledge and their individual technical ability to carry out an operation.

Surgical care in the 21st century, however, is not delivered by individuals but by multi-professional teams within complex systems. So, is our current, individualistic model of competence still fit for purpose? Civil aviation has clearly pronounced on this topic: *"The question should not be whether a particular pilot is performing well, but whether or not the*

system that is composed of the pilot, the co-pilot and the technology of the cockpit is performing well. It is the performance of that system, not the skills of the individual pilot, that determines whether you live or die" (Hutchins and Klausen, 1998, p.16).

If we translate this concept to the operating theatre, one surgeon's individual competence is insufficient for the optimal completion of a surgical operation. To achieve the highest levels of performance and safety, the whole operating theatre team need to have a shared body of knowledge about both the procedure and the system, a shared mental model of the plan, and a shared expectation that will come together to deliver a set of coordinated actions during the many tasks required to complete the operation. This co-ordination made possible by distributed cognition is a good representation of collective 'team' competence.

The concept of competence as an individual possession also deflects our attention from systems thinking in healthcare. Rene Amalberti and colleagues (2005) wrote that of the five main constraints to an ultra-safe healthcare system, three of them are related to medicine's culture of individualism. The other side of the coin of the individualistic view of competence is that incompetence is also the fault of an individual. Healthcare very much takes the view that patient harm can be blamed on individual incompetence and can be corrected by taking that 'faulty' individual out of the system, ignoring local rationality, degraded systems and unsafe working environments.

I now perform surgery using tiny instruments and a laser instead of a scalpel. Sir Robert Liston was of another era and would hardly recognise this as surgery. The concept of competence as the skill inherent in a single individual probably belongs more in his era than in this current age, and I hope that we surgeons can embrace the brave new world of competence in teams and systems.

Craig McIlhenny is a consultant urological surgeon working in NHS Forth Valley in Scotland. He has a special interest in human factors, patient safety, surgical education, simulation and training. He is a trained team resource management instructor and has provided human factors, non-technical skills for surgeons (NOTSS) training, and team training. He is currently Surgical Director of the Faculty of Surgical Trainers at the Royal College of Surgeons of Edinburgh, and sits on the Scottish Surgical Simulation Collaborative.

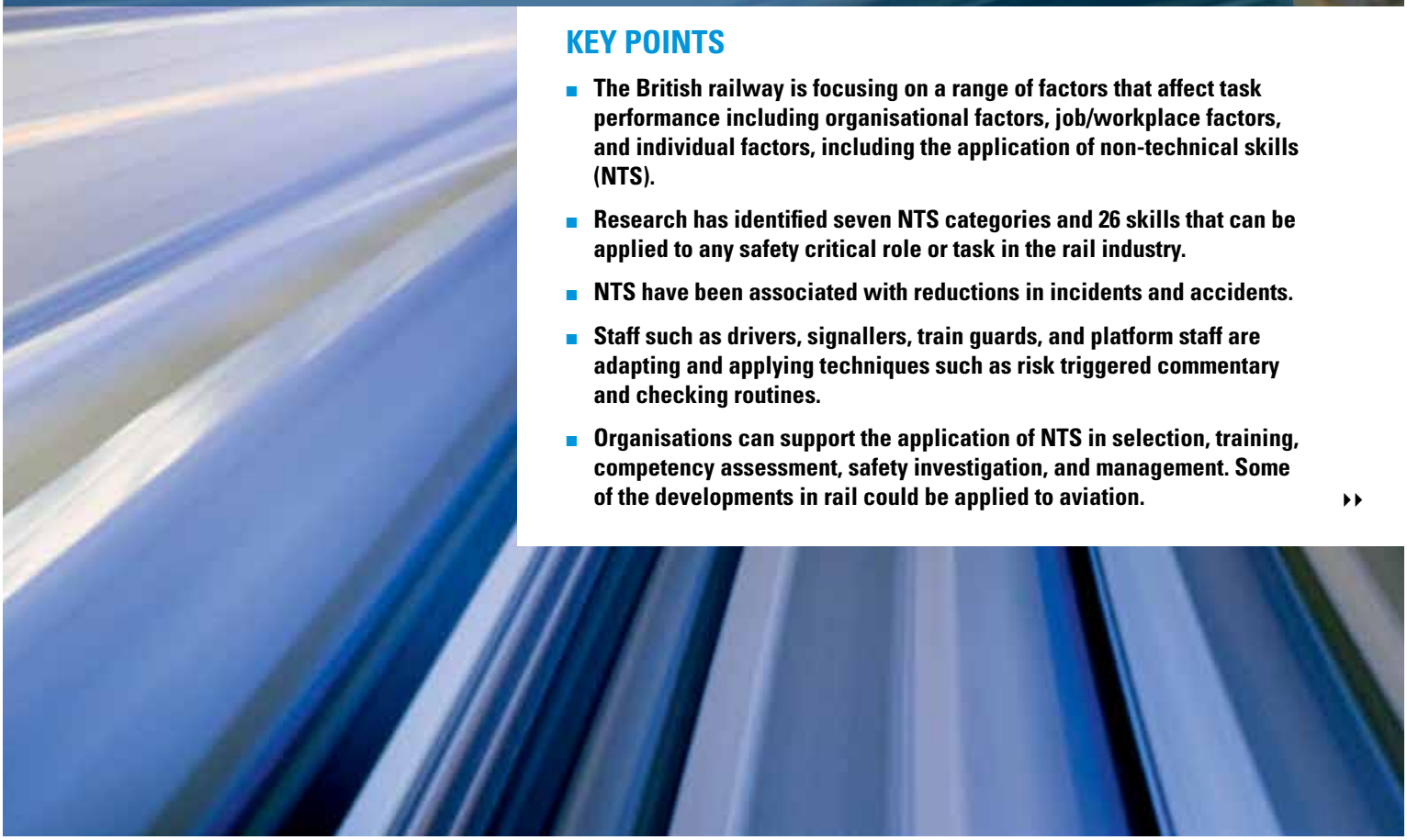
References

Amalberti, R., Auroy, Y., Berwick, D., & Barach, P. (2005). Five system barriers to achieving ultrasafe health care. *Annals of Internal Medicine*, 142(9), 756-764.

Hutchins, E. & Klausen, T. (1998). Distributed cognition in an airline cockpit. In Y. Engestrom & D. Middleton (Eds.), *Cognition and communication at work*. Cambridge: Cambridge University Press.

Following a series of accidents in the 1980s and 1990s, the British rail industry made major advances in human factors and safety. It is now among the safest in Europe, and rail is the safest conventional mode of transport in Great Britain. In this article, **Paul Leach and Philippa Murphy** describe the use of non-technical skills to help achieve marginal gains in performance.

ACHIEVING EXPERTISE THROUGH MARGINAL GAINS: A RAIL PERSPECTIVE



KEY POINTS

- **The British railway is focusing on a range of factors that affect task performance including organisational factors, job/workplace factors, and individual factors, including the application of non-technical skills (NTS).**
- **Research has identified seven NTS categories and 26 skills that can be applied to any safety critical role or task in the rail industry.**
- **NTS have been associated with reductions in incidents and accidents.**
- **Staff such as drivers, signallers, train guards, and platform staff are adapting and applying techniques such as risk triggered commentary and checking routines.**
- **Organisations can support the application of NTS in selection, training, competency assessment, safety investigation, and management. Some of the developments in rail could be applied to aviation.**

Britain's railway is vast and heavily utilised. We have 21,000 miles (about 33,600km) of track, 10,000 route miles (16,000km), 2,500 stations, 4,000 trains and roughly 216,000 employees. Demand for rail services is increasing; commuting by train has increased by 73% since 2002. There are 4,000 more services a day than in the mid-1990s and passenger journey growth since 1997/98 has outstripped that of France, Germany and Spain (Rail Delivery Group, 2017).

It is also very safe. No passengers or workers have died as a result of a mainline train accident for the last ten years (Department for Transport, 2017; RSSB, 2017).

This level of performance relies heavily on our people, especially those who work and operate the train (drivers and train crew – analogous to pilots and aircrew) and those who control the movements of trains (signallers and traffic managers – analogous to air traffic controllers). They must be able to perform safely and consistently across different scenarios, such as normal operations where tasks can be routine and repetitive, to degraded and novel situations were normal operating procedures may not easily apply.

Developing expertise is essential to achieve this level of performance and the rail industry continues to look for different ways to improve. One such approach is using non-technical skills to help achieve marginal gains in performance over time.

What are marginal gains and what is the role of non-technical skills (NTS)?

The term 'non-technical skills' (typically incorporated into crew resource management in aviation) is now common in many safety-critical industries. NTS combine cognitive and behavioural aptitudes and skills to describe how a person undertakes a task. A pilot or air traffic controller has procedures and checklists detailing the tasks and actions they need to undertake. The related NTS for these helps explain how a pilot or air traffic controller carries out those tasks. For example, how do they maintain situational awareness? What information do they consider when making decisions? How do they manage periods of high and low workload? What strategies can/do they use? When there is equal emphasis on how a task is carried out, as much as what the task is, learning, development and performance can improve.

NTS Category		NTS Skill
1	Situational awareness	Attention to detail
		Overall awareness
		Maintain concentration
		Retain information (during shift)
		Anticipation of risk
2	Conscientiousness	Systematic and thorugh approach
		Checking
		Positive attitude towards rules and procedures
3	Communication	Listening (people not stimuli)
		Clarity
		Assertiveness
		Sharing information
4	Decision making and action	Effective decisions
		Timely decisions
		Diagnosing and solving problems
5	Cooperation and working with others	Considering other's needs
		Supporting others
		Treating others with respect
		Dealing with conflict / aggressive behaviour
6	Workload management	Multi-tasking and selective attention
		Priorotising
		Calm under pressure
7	Self-management	Motivation
		Confidence and initiative
		Maintain and develop skill and knowledge
		Prepared and organised

Table 1: RSSB NTS list

Through our research we have identified seven NTS categories and 26 skills that can be applied to any safety critical role or task in our industry (Table 1).

The aim is to help staff and the organisations they work for understand human performance, the factors that affect performance and the techniques that can be applied to enhance performance. This increased level of awareness means people are better able to identify opportunities for performance improvement through 'marginal gains', which is an approach often used in sports, such as athletic cycling. Small, focussed, and incremental improvements over time add up to an aggregated, significant improvement.

For example, Team Sky spearheaded the concept of marginal gains in cycling, looking at the different aspects of cycling that could be improved – bike, technology, training, diet, rest, and cognitive factors. Our railway is adopting a similar philosophy by focusing on a range of factors that affect task performance.

What's the benefit?

The benefits of understanding and applying NTS are well known. On Britain's railway, NTS has been associated with reductions in red signals passed by drivers, incidents and accidents and errors during line blockages (RSSB, 2016). This is similar to some of the benefits seen in aviation. However, there are a number of factors that can affect our ability to apply NTS.

What affects our ability to apply NTS?

Based on our experiences working with rail organisations and looking at relevant rail incidents and accidents, a common set of factors seems to affect someone's ability to apply NTS effectively.

These include:

- individual factors (such as memory capacity, assumptions, distractions, workload, attention and perception)
- job/workplace factors (such as equipment design and usability of procedures)
- organisational factors (such as leadership, culture, and change management).

Our work on NTS therefore tends to focus on two areas:

1. techniques that individuals can apply to help them address the factors above, improve their application of NTS and achieve marginal gains in performance, and
2. approaches that organisations can take to increase the integration of NTS into their business, and help individuals identify and apply their techniques.

Figure 1: Model of risk-triggered commentary

What techniques can staff apply to make marginal gains?

There is no one approach that everyone can apply to achieve marginal gains. However, there are a couple of techniques that staff such as drivers, signallers, train guards and platform staff are adapting and applying.

One example is risk-triggered commentary (Figure 1). This technique helps focus our memory so that critical information relating to risk for a given situation and/or task is maintained at the forefront of our mind. Risk triggered commentary involves recognising a risk and then speaking it aloud, along with the actions to take to mitigate the risk. The technique helps someone to 'sense check' what they are doing, and plan do to and can help to combat the effects of auto-pilot, low or high workload, distraction and incomplete or incorrect assumptions. The verbalisation is based on risks, identified through risk assessment and incident and accident investigation, so that it does not become a running commentary of each decision and action undertaken.

Another example is the short journey concept. This is a technique used by drivers to break down their route. Rather than conceptualising their route as one journey, they break it down into short journeys, typically station to station. For each short journey they focus on three areas – signal, speed and station stop (i.e., length of train and the platform stopping position). This approach can help to focus attention, manage working memory and reduce the possibility of distraction. The technique can also be used by any role where it is beneficial to break procedures or processes down into smaller chunks to help focus attention and concentration.

Staff have also developed their own checking routines to focus attention and combat the effects of assumptions, distractions, and 'auto-pilot' attention. For example, some people visually check monitors and screens from top left to bottom right (z scan). Others use 'point and call' when checking and scanning to help them remember important information and indications, especially when such information or indications suggest something unusual or abnormal may be occurring.

"Rail organisations are also starting to explore the concept of storytelling, where people's experiences are collected and turned into stories so others can learn from them."

What can organisations do?

There are a number of things that organisations can do to support the application of NTS and RSSB has developed resources to help rail organisations adopt these approaches (RSSB, 2016). For example:

- Critical NTS can be part of the staff selection criteria, with suitable tests selected to assess these.
- NTS can be fully integrated into technical training, competence standards and competence assessments, making it easier for staff to understand how these skills relate and enhance their technical skills and knowledge and the technical tasks they undertake.
- Incident and accident investigation can explore where a failure in NTS was a contributing factor, along with the factors that contributed to this failure.
- Leaders, managers, supervisors, trainer, assessors, and incident investigators can all be trained in NTS so they are better able to explain, promote and demonstrate these skills.

Rail organisations are also starting to explore the concept of storytelling, where people's experiences are collected and turned into stories so others can learn from them. For example, Network Rail collects stories from signallers who have had an incident. Each story describes how the incident occurred, how the person felt, the reason for the incident, the techniques they now use to help them apply NTS better and the benefits this has brought them. RSSB has also recently been exploring the use of storytelling for route learning. This is where routes drivers need to learn are depicted in story format to help them understand and memorise the route and determine the specific hazards and risks associated with a route.

What does the all mean for aviation?

Although NTS is already used within aviation, pilots, aircrew, air traffic controllers, and safety professionals can consult the RSSB NTS list to see if there are NTS that could be of use to help enhance performance. For instance:

- Staff and organisations could consider the factors that can affect someone's ability to apply NTS to determine the extent to which these are addressed within training, development and the techniques that staff already apply.
- Risk-triggered commentary could be applied to a range of aviation roles to help manage situations where tasks can be routine and repetitive, causing cognitive underload and degraded, and novel situations were cognitive workload can increase rapidly.
- Aviation organisations can check their selection, training, assessment, and incident and accident investigations to understand if NTS is being fully integrated into these areas and the extent to which organisational, job and workplace factors are considered and addressed to support human performance.
- Storytelling could be used in initial and refresher training as well as during development days, safety days and team/crew briefings.

There is no 'silver bullet' when it comes to safety management and improvement. But improvements at the individual, job, workplace and organisational level can help to achieve marginal gains in performance.

RSSB has a wealth of expertise, products and services that could be applied in aviation so please feel free to visit our website for more information and get in touch with us if you want to find out how to access them – www.rssb.co.uk.

References

Rail Delivery Group (2017). *In partnership for Britain's prosperity: The rail industry's plan to secure growth across our country.* Available at: https://www.britainrunsonrail.co.uk/files/docs/one-plan.pdf

Department for Transport (2017). *Rail factsheet*. November 2017. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/663116/rail-factsheet-2017.pdf

RSSB (2017). *Annual safety performance report 2016/17.*

RSSB (2016). *A good practice guide to integrating non-technical skills into rail safety critical roles.* Available at: https://www.rssb.co.uk/Library/improving-industry-performance/2016-07-non-technical-skills-integration-good-practice-guide.pdf

Paul Leach is a Chartered Occupational Psychologist working for RSSB. For over 12 years he has been applying his expertise across a range of safety critical industries, including rail, nuclear, oil and gas. Paul's expertise covers Human Factors analysis, safety culture, technical and non-technical skills training, behavioural and organisational change, leadership, management development, supervision, procedural compliance, emergency response, accident and incident investigation and competence management and assessment.
Paul.Leach@rssb.co.uk

Philippa Murphy is a Principal Human Factors Specialist working for RSSB. She has spent the majority of her career in the rail sector working on various human factors and behavioural safety projects and research for Railtrack, Network Rail and as a freelance consultant. Her areas of expertise at RSSB are in Non-Technical Skills training, development and integration, accident investigation and improving operational decision making.
Philippa.Murphy@rssb.co.uk

"In Naviair we have a training-philosophy basically saying that all students are colleagues and that we continue training as long as progress is seen over time. It's a declared goal to strive for a 100% success rate. You can only appreciate such a goal in a time where number of applicants are dropping and the need for ATCOs is rising. But the notion "over time" is the really tricky part. We've just succeeded with the longest OJT process that I've seen in my 14 years of being an OJTI – a job well done from both OJTIs and the newly appointed ATCO himself. However, it took a lot of courage from the OJTIs involved to stand their ground and continue their argumentation opposite ATCO colleagues, who had lost faith in the project. My point is that no matter how good a training philosophy a training organisation can come up with it all comes down to the single OJTI involved and the effort and courage they show towards their new colleague. And I'm beginning to see our training-philosophy actually pay off. "

Louise G. Degner
ATCO & Head of Training, Naviair, Denmark

"In our training we have had a tendency to make our simulator-exercises too complicated and with a learning curve that is too steep. The consequence has been that the students find learning too hard and the course loses momentum until the students catch up.

To change the situation, we started with an analysis of what basic methods our students really needed. Each block of training was then initiated with very basic exercises. These are less complicated to let the students focus on the basics. The purpose is to really drill basic methods, to give the students a solid ground by defining basic methodology. An example from tower training is an exercise where the entire exercise consists of aircraft just requesting taxi. This could sound boring, but it has actually proven to be a great way of learning the basics before adding complexity and traffic volume."

Petter Bylander, Head of Training
Military ATM, LFV Training Department, Sweden

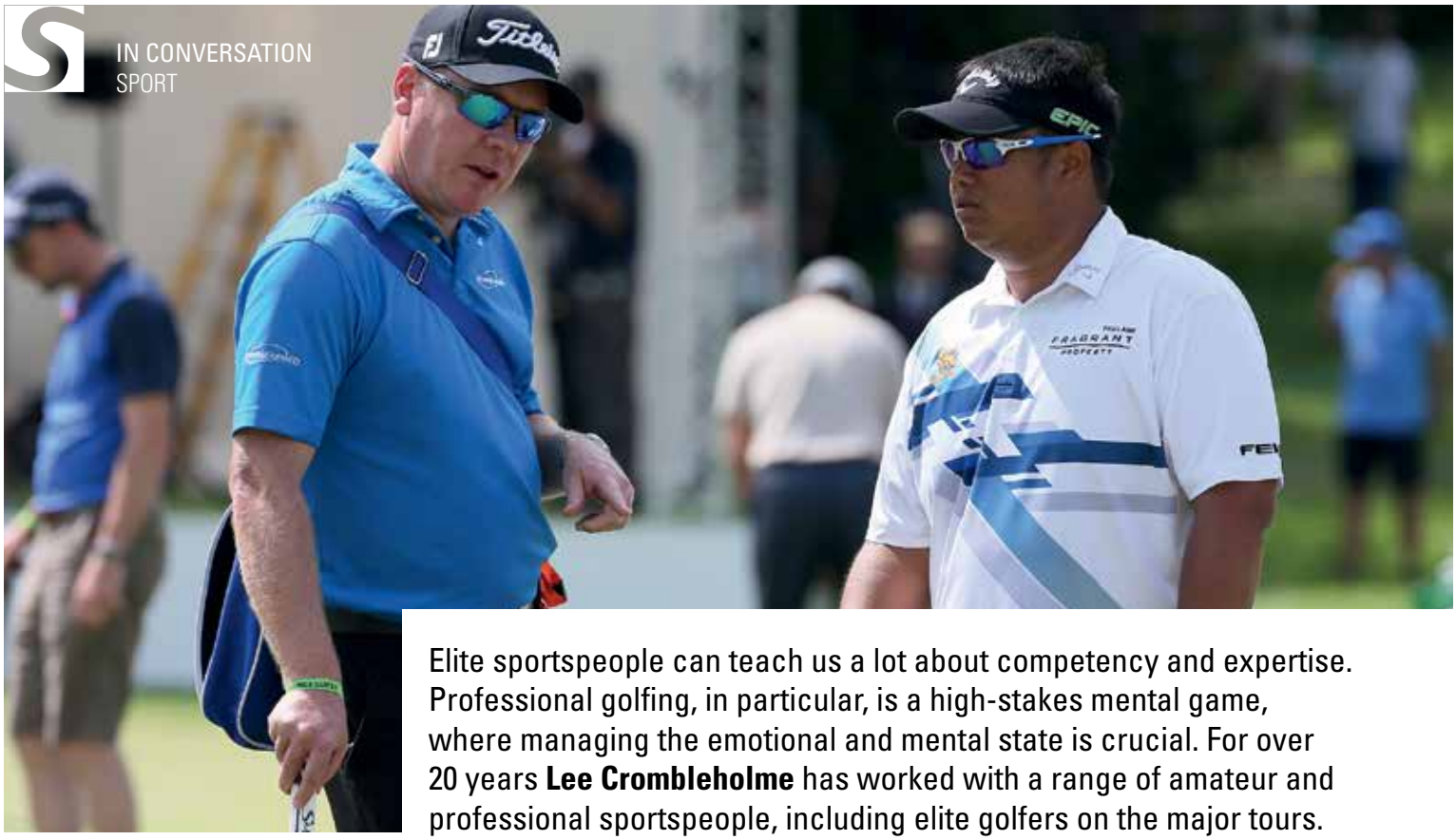
"A very basic way of developing competency is to get people to start discussing a topic you want to address. I have found the EURCONTROL Safety Culture Discussion Cards very helpful for this purpose. I have used them to train ANS inspectors in Windhoek, Namibia; to promote safety discussions at the Inter-Operator Safety Meetings at Eros airport in Namibia; to facilitate safety communication between safety managers in Lagos, Nigeria and to assist ICAO Experts working with the Somalia Project in Nairobi, Kenya.

I have used them like this: In a small group, have someone pick a card randomly. Read the text and then have a short discussion on the subject. Not to determine any absolute truth but rather to start a discussion and thinking on the subject. Frequently, what was being discussed can come back a few days later. The cards are available via SKYbrary at **www.bit.ly/SCCARDS.**

Axel Rydin, ATCO
at Stockholm Terminal Control, Sweden

Do you and your colleagues do something that other operational readers might be interested in?

Send your short examples of good practice relating to 'Change' for Issue 28 (200 words maximum) to steven.shorrock@eurocontrol.int



Elite sportspeople can teach us a lot about competency and expertise. Professional golfing, in particular, is a high-stakes mental game, where managing the emotional and mental state is crucial. For over 20 years **Lee Crombleholme** has worked with a range of amateur and professional sportspeople, including elite golfers on the major tours.

LEARNING FROM SPORT PSYCHOLOGY:
A CONVERSATION WITH LEE CROMBLEHOLME

KEY POINTS

1. **Elite players are not only more technically competent. They are a lot clearer, with a quieter mind, and are better able to manage their emotions.**
2. **Elite golfers keep the direction of their thoughts more 'towards'. They focus on what they want to do as opposed what they don't want to do. Asking 'effective questions' helps a player to focus on what they want to achieve.**
3. **Turning attention from frustration to what's going well, even if not completely successfully, helps to build confidence and manage arousal.**
4. **People naturally like to practise what they are already good at, and need psychologically safe environment to practise what they need to improve on.**
5. **Leaders help to set up the team for success, bringing players together to support each other and adapting the approach to each individual.**
6. **We need to pay attention to our biological state, attitudes, and behaviours.**

Steven Shorrock (SS): *Lee Crombleholme, thank you for joining me. Could you please introduce yourself and tell us a little bit about your background and what it is that you do.*

Lee Crombleholme (LC): I'm a registered sport psychologist. I work predominantly in golf now. Historically, I went to university and studied psychology and sports science, and then started working with golfers and other people in other sports, right up to the European Tour. I'm in America at the moment for one of the big events on the US tour. I've also worked at a Ryder Cup. I currently work with about eight of the top European tour players. I help them to stay focused and deal with pressure. This week at the Players' Championship in the States, I think the

winner takes home nearly two million dollars. There's a lot of pressure. So, it's making sure they are motivated, in the correct way, and for the right reasons. Making sure that they practise and in a way that will help build confidence, getting into the zone.

SS: *So one question I have is, what is the difference between a very good pro golfer and the elite golfers that you work with today?*

The Quiet Mind

LC: It's multifaceted in sport. But golf is quite a technical, physical movement. So they have to be very competent in their basic golf swing, or the way that they chip the ball, or the way that they putt. They are constantly tweaking and changing their technique. And the more elite the player is, the more competent they are from a technical, physical point of view. But from a mental point of view the difference between a top 20 player in the world and someone who is 500th in the world would be that they would be a lot clearer. They would have a much quieter mind. Things are more subconscious, more automatic. They have a better ability, generally, to manage their emotions, sometimes their expectations. But from a mental point of view, one of the key things is they have quieter minds. They are thinking less about the technique because they are more competent with that. They just stay focused on things that are relevant. And they keep the direction of their thoughts more 'towards'. So they focus on things that they want to do as opposed what they don't want to do, if that makes sense.

"They keep the direction of their thoughts more 'towards'. So they focus on things that they want to do as opposed what they don't want to do."

SS: *That makes a lot of sense. If as an air traffic controller you are thinking about a flight level not to use, then there is a risk you actually instruct an aircraft to fly to a level or altitude that is actually blocked. Because you're actually thinking about the wrong thing, rather than thinking about what you should do. How would that would translate to a golfer?*

Asking effective questions

LC: If they're on a tough tee shot where there might be water down the left-hand side and out of bounds down the right, and if they start saying "don't hit it into the water", the brain pictures very quickly and creates an image of hitting into the water. Now there is a good chance that they might hit it left into the water, or overcompensate and hit it right, into the out of bounds or into the trees. So I get golfers to ask effective questions. Rather than come up with statements, which would be "OK I want to hit there", I get them to ask questions: "what would a really good shot look like here?" If you ask an effective question, then 99 times out of 100 they might create a positive image. But also in asking an effective question it gets the subconscious to answer. So asking effective questions would get a player to really focus on what it is that they want to achieve. That doesn't guarantee that shot but we are loading the dice in their favour.

SS: *Right, what would an effective question look like?*

An effective question on putting would be, "where do I want to start it to hole it?" On a chip shot around the green, "where do I want to land the ball in order for it to go in the hole?" Asking those questions creates the more positive, 'towards', directional image and answer. So it's not only creating the image. It's also a loaded question because you are getting the player to focus on holing the putt, as opposed to missing the putt – that would be an avoidant goal, trying not to miss the putt. And even good golfers can think like that.

SS: *What else do golfers do in practice? How do they practise physically as well mentally?*

Practice

LC: We create drills, challenges, games. We bring some competitiveness into the practice days and into the warm-ups. Set little challenges, how close you can get, a certain number of chip shots, and measuring those. So there is something at stake. You can't create the same pressure as high-level competitive golf in practice but you can create an intention. These guys are so competitive that if I set a challenge they will want to meet the challenge. It is very difficult to replicate the pressure of coming down the last hole of a major championship because the heart rate is going, the emotions can be all over the place. They can be thinking avoidance, you know, "don't mess this up, if I win a major it can be worth 10 million". So you're not going to be able to create that kind of pressure but you can facilitate that need to achieve. I set them quite strong challenges; ones that if they work really well and perform really well, they can reach, and their confidence goes up.

SS: *So what would be quite a tough challenge that you might set to try to recreate, obviously nowhere near the kind of pressure of an actual game, but to recreate some of the conditions?*

LC: With the technical coach they will just hit and repeat, repeat, repeat, repeat. I'll mix it up, so they might drive a shot towards the target and then change it to different club towards another target. And the better they get I will make those target areas smaller. The other day with one of my players here, we set up a 15 foot, a 30 foot putt and then a 45 foot putt. The 30 footer was taking a long time and I can see the frustration building in this player because he kept just missing. After 10-15 minutes I went over and said, "Look, we need to be focusing on the good things you are doing with the ball. If you shift your focus away from the frustration of missing, to actually appreciating the fact that you might have really good speed on that putt, even though it missed, or you started it on line." There's always something, some positive that you can pick out, unless it's a real disaster.

I've got in my mind the image of a spotlight that was previously on his frustration and on his annoyance, which I guess is going to raise his arousal in a bad way, and you have tried to get him to move that spotlight to examining what went well and how can I keep that, and build on that. And again that's something that air traffic controllers and pilots can use in their training to focus on what has gone well.

Even if you do fail but you learn from it, then it becomes a very valuable experience. In sport, you know you can't win all the time, especially in golf. When Tiger Woods was at his absolute best I think his his win percentage at tournaments was something like 25%, which is phenomenal. So even Tiger Woods was losing 75% of the time. If you can constructively reflect on failure then you are always learning.

SS: *So I think what you've touched on is the difference between technical skills, which is how you putt, and your posture, and so on, and non-technical skills, which you might call mental skills, which are more about decision-making, situation awareness, managing stress, fatigue, arousal, and those kinds of things.*

"If you can constructively reflect on failure then you are always learning."

LC: Absolutely. But also, a golfer will tend to practise things that they do really well all the time. If they are not very good at chipping then they might avoid practising chipping, which seems absolutely crazy. But it's just human nature. They want to stand there on the range and hit their iron shots and boom the driver down there because it makes them feel good and boosts their ego. But if they're not very good at the chipping aspect around the greens, they might avoid that because they don't want their confidence to get knocked. So I make sure that they work on these things and they manage their mental state effectively in order to be able to build confidence in those areas. People always say I want to build my confidence and I ask a question, is it confidence that we need to build or is it the mind that we need to quieten down? There is quite a distinction there. Someone who lacks confidence will generally have a busy mind.

SS: *But I think the insight about us as human beings, we like to practise what we're good at. I guess practising something that you are not good needs a psychological safe environment, which means that you will make mistakes and that's fine. We're here to learn from them. No-one's going to judge you for them. So how do you create that psychological safety with someone who is actually one of the world experts in their field – in your case in golfing?*

LC: You start off with the easy stuff. If you use chipping as an example, you start off with a simple basic chip shot, just get that within 5 feet or something like that – a nice, simple, basic task. And gradually make it more challenging.

Competency and Teams

SS: *Right, so we've covered quite a bit of ground, and a lot of that relates to the individual golfer I suppose so we've talked about arousal, preparation and practice. And we've talked about effective questions, and the quiet mind. But what about the Ryder Cup, the team tournaments?*

LC: A lot of the Americans were individuals. They never used to mix with each other off the golf course. The Europeans, even though our world rankings weren't as high as the Americans, we went on a run of winning Ryder Cups. A lot of that was put down to the fact that the Europeans were friends. They would go out for dinner together. But with the Americans, there was a running joke where all you see in a hotel corridor was empty plates from room service. But now the Americans socialise a lot more, especially young guys. And I think that's why they picked up their game in the Ryder Cup. I was at Hazeltine at a Ryder Cup with one of my clients. In the team room, everyone was encouraging everyone else. Everyone put their individual rivalries to the side, just working for the team. They'll bring motivation speakers in. Alex Ferguson came to one. And communication is vital. Honesty is vital. But positive reinforcement within the team is essential. If someone already won or lost the match they will go and support the other matches. They don't just go into the clubhouse and sit there and have some lunch. Everyone is out on the golf course.

Leadership

I read about Colin Montgomery's team in this book called Superteams and a couple sentences here describe that kind of environment. "He won the 2010 Ryder Cup with 12 players who in a straight match up with their American counterparts were the inferior team on paper without playing a shot. But he'd create an environment where the team was meticulously set up for success, choreographing its members to maximise the benefits of collaboration empowering leaders throughout the playing order and supporting his charges with the vital personal coaching at the most critical moments." So that kind of thing that you've just been describing.

LC: They call it 'synergy', when the power of the team exceeds its individual components. Colin Montgomery created an amazing environment. They had artwork on the walls – very positive and energetic – so there were constant subconscious reminders about how well this team could perform. And they played fantastic. The captain's role in the Ryder Cup is huge. You can see the energy in the teams when they are directed into that kind of peak performance.

"They call it 'synergy', when the power of the team exceeds its individual components."

SS: *And obviously in aviation we have captains on the flight deck. But from an air traffic control point of view, it's a little bit different, because each traffic controller in a way is a captain of their sector or position, but there are also supervisors. Are some of the captains from the golfing world using some of the same kinds of approaches that are you might use? Or is it something really quite different that they're doing?*

LC: There's certain players that you want to rev up, and certain players that you want to calm down. And a good captain will know. So someone like Ian Poulter is a player who needs to be revved up. He needs to be energised, and when he does that, then he is unbelievable, and his Ryder Cup record is phenomenal. The polar opposite of that would be someone like Victor Dubuisson, who is a very talented French golfer. He's very introverted.

SS: *So you can bend human nature to a degree but with someone who is very introverted , you can't change that too much. So you've got to work with their nature rather than work against it.*

LC: The sign of a good captain, or a good manager, if you look at some of the great football managers like Bill Shankly or Sir Alex Ferguson, is they get the best out of each individual player. They will talk to them completely differently. I'll have completely different approach with Player A to Player B depending on personality. And a good manager in a traffic control would do exactly the same thing.

SS: *So they'd have to have good emotional intelligence. They'd have to be well attuned to the different individuals and have that level of empathy, to understand what their needs are, and what strengths are. You'll know over time certain people will respond in different ways.*

That's right, absolutely. Whether to put their arm around them and nurture them that way, or to give them an earful!

SS: *What that means then though, is that as a captain, or at any level of management, you've got to spend enough time with the frontline people – the golfers, the pilots, the controllers, the footballers – to know them, to know their strengths, to know how they will respond under pressure, or in different situations. To know, well, how are you going to tailor your approach as a captain, or as a supervisor, or as a manager? As a sport psychologist, if you were to spend some time with air traffic controllers or with pilots, what might you do with them to help them to get their best performance?*

LC: I would explain the framework that I work around. It's a three level framework. Level three is the top level – the behaviours and processes. With a golfer it might be their course management, decision-making, pre-shot routines, effective questions. But in order for level three to function level two needs to function, and I call that the attitude level. Within that you've got different types of motivation, whether it's mastery or ego. A mastery motivated individual would be into learning about the nuances the game. It would be me versus me, me versus the golf course. The money side, and playing against other competitors, would be the ego side. And within the attitude level we've got the 'towards' goals and the avoidance goals. So with air-traffic controllers I would guess we need to be more 'towards', more 'mastery', focusing on the task. Then we go into level one, which I call biological level, because it's about how the blood is flowing around the brain, so it's more the emotional management. So with air traffic controllers, generally you would want them to be emotionally calm, clear, a nice quiet mind, so they can make the right decisions. If you can get all three levels functioning really nicely, that's when you get that peak flow state. That's almost when the behaviours on level three just happen automatically.

I think that's really a nice simple framework that any air traffic controller or pilot can probably remember and relate to.

LC: And it works from the bottom up. You can be the best golfer in the world technically, from a golf swing point of view, but if level one isn't functioning well – if they are an emotional wreck – then they're not going to be able to swing a golf club under pressure or perform to their ability. We see amazing golfers on the practice range who just can't do it on the golf course because they are getting too emotional or they focus on where they don't want to hit the ball. They never get down the top 500 in the world.

Lee Crombleholme studied Psychology and Sport Science at undergraduate and postgraduate level. He has over 20 years experience helping golfers from club level up to International amateurs and European Tour professionals. Lee travels around the World working with sports people and conducting Mental Coaching Seminars to all levels of players. Lee is the founder of Winning Golf Mind.

Web: www.winninggolfmind.com
Email: info@winninggolfmind.com
Twitter: @winninggolfmind

A link to the audio conversation and the full transcript is on SKYbrary for HindSight 27 under 'Online Supplement'.

The HindSight Online Supplement includes articles not featured in the paper magazine, including those that may be more relevant to more specific readers, such as training specialists. Here is a summary of these articles for HindSight 27, which are available to download at SKYbrary.

READ MORE IN THE ONLINE SU

TALKING ABOUT PILOT AND CONTROLLER TRAINING AND COMPETENCIES

Pilot and air traffic controller training specialists rarely come together to learn from one another, but the competencies have similarities and differences that may be of interest. In this article, **Florence-Marie Jégoux and Jérôme Schimpff** talk about their two worlds.

HUMAN FACTORS AND RESOURCE MANAGEMENT TRAINING: VIEWS FROM LAND, AIR AND SEA

From the beginning of crew resource management in aviation, the concepts and practices have spread throughout many safety-critical industries. In this article, a number of authors from different industries provide an overview of human factors and resource management training for operational and other specialists in France. By **Florence-Marie Jégoux** and colleagues.

PPLEMENT

COMPETENCY AND EXPERTISE IN THE NUCLEAR INDUSTRY

The nuclear industry recognises the importance of competence. How does it know what competences are required, and whether personnel can demonstrate appropriate levels of those competences? **Jon Berman** discusses how the industry approaches this issue, and how it provides confidence that competence is being managed effectively.

REGULATING THE COMPETENCE OF ATM STAFF

Over the last few years, EUROCONTROL has been developing quantified models of accident and incident risk, mostly to support SESAR safety assessments. These models could potentially help to provide information to demonstrate the competence requirements for certain tasks are needed. **Gauthier Sturtzer and Eamonn Wylie** explain a methodology called the Task Safety Impact Assessment Technique.

FOUR KINDS OF KNOWLEDGE

Competence is a key issue for power generation and distribution, where core staff and contract staff work on sites where they or others could be injured, or where there could be a major accident. There are four kinds of knowledge that need to be understood in this setting, which may well apply to aviat on personnel, as **Rob Miles** outlines.

Would you like to write for HindSight magazine?

HindSight is a magazine aimed primarily at air traffic controllers and professional pilots, on the safety of air traffic management and air traffic safety.

As such, we especially welcome articles from air traffic controllers and professional pilots, as well as others involved in supporting them.

Here are some tips on writing articles that readers appreciate.

1. Articles can be around 1500 words (maximum), around 1000 words, or around 500 words in length. You can also share your local good practice on what works well for you and your colleagues, on the theme of each Issue, in up to 200 words (for the 'What we do' section).

2. Practical articles that are widely applicable work well. Writing from experience often helps to create articles that others can relate to.

3. Readers appreciate simple and straightforward language, short sentences, and concepts that are familiar or can be explained easily.

4. Use a clear structure. This could be a story of something that you have experienced. It helps to write the 'key points' before writing the article.

5. Consider both positive and negative influences on safety, concerning day-to-day work and unusual circumstances, sharp-end and blunt-end.

If you have an idea for an article that might be of benefit to others, we would like to hear from you.
Please write to **steven.shorrock@eurocontrol.int**

HindSight

The ability or opportunity to understand and judge an event or experience after it has occurred

The theme for HindSight 28 will be

CHANGE: CHANGING TO ADAPT AND ADAPTING TO CHANGE

HindSight is an aviation safety magazine for air traffic controllers and professional pilots on the safety of air traffic management.

We welcome articles and short good practice examples by **Friday 2 November 2018**. We especially welcome articles written by or with front-line controllers and professional pilots. Some suggested subject areas include:

- Reasons for and impact of changes in procedures, regulations, technology, people, incentives, organisation, etc
- Work-as-imagined, work-as-prescribed and work-as-done, including unforeseen and unintended consequences
- Human-centred design and the use of operational expertise in change
- Training, instruction and communication for change
- Stories of how individuals, teams and organisations adapted to changes
- Handling multiple and frequent changes
- Assessing and investigating the safety impacts of change

Draft articles (1500 words maximum, but may be around 1000 or 500 words) and short examples of good practice ('What we do' – something that may be helpful to other readers) (200 words maximum) should:

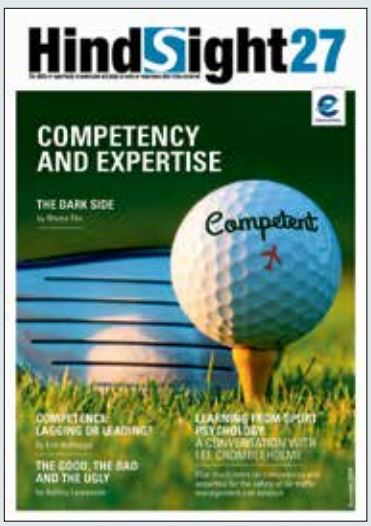
- be relevant to the safety of air traffic management
- be presented in 'light language' keeping in mind that most readers are air traffic controllers and professional pilots
- be useful and practical.

Please contact
steven.shorrock@eurocontrol.int
if you intend to submit an article,
to facilitate the process.

If you are interested in downloading back issues of the **HindSight collection**
http://www.skybrary.aero/index.php/HindSight_-_EUROCONTROL

In the next issue of HindSight:

"Change: Changing to Adapt and Adapting to Change"



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Putting Safety First in Air Traffic Management

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