HindSight 27

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

EUROCONTROL

COMPETENCY AND EXPERTISE

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ONLINE SUPPLEMENT

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COMPETENCY AND EXPERTISE IN THE NUCLEAR INDUSTRY

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

KEY POINTS

- **It is for each nuclear 'Licensee' to determine what competence they require and to demonstrate that the competence management system is effective.**
- **It is essential to understand the inter-relationships between safety arguments, competence, and training and experience if the claims on human performance are to be realistic and valid.**
- **There is increasing recognition that critical self-awareness of competence is important for compliance.**

The nuclear industry, like other high-hazard industries, relies on human performance to support safety. Whilst the primary reliance is on design and engineering – the integrity of the nuclear containment system, the performance of emergency cooling, the availability of standby power generation – individuals must perform their work effectively. This is no different from aviation, where there is both reliance on the design and integrity of the airframe or the communications systems, and also reliance on the performance of people – the crew on the flight-deck, the maintenance teams, or the controllers within the ATM system.

The hierarchy of risk controls in safety engineering pushes the nuclear industry towards engineered defences – multiple pumps and valves, interlocks to prevent inappropriate actions, etc. Nevertheless, the industry relies on human performance.

What are the foundations of high-reliability human performance? Much of it is around the design of the tasks and ensuring that the demands placed on people match their capability. Staff should undertake well-designed tasks, with good tools and job-aids. At the same time, the procedure that the person must follow needs to be carefully developed to minimise opportunities for error and maximise the ability to detect and recover from errors when they do occur.

But good procedures are not the only element. The person also needs to be competent, and therein lies

the challenge. One can envisage a continuum, where at one extreme there might be highly detailed procedures that foresee every eventuality, and which enable the task to be completed by a novice. At the other extreme one could have an exceptionally highly trained and competent workforce, and a one-page procedure. Reality falls somewhere between the two extremes – but the decision as to where to pitch the procedures and the associated training and competence regime needs careful consideration.

Unsurprisingly, the nuclear industry adopts a structured approach, such as that advocated by the International Atomic Energy Agency (IAEA) (1996), although the manner in which it is applied is for the Licensee to decide (the 'Licensee' is the organisation with a licence to operate – the nuclear equivalent of an ANSP). One of the overarching principles within the UK nuclear industry is that of self-regulation. The regulator (Office for Nuclear Regulation – ONR) licenses an organisation to operate a particular site. It does not license the individuals that operate within that facility. The Licensee must ensure that personnel are competent, and determine what that means and how to deliver it.

Each plant is different, and whilst having broad similarities with other power stations, each plant requires its own safety case and tailored arrangements. The Licensee needs to understand its own safety arguments sufficiently well to be able to define the necessary competences, and then deliver them.

The Office for Nuclear Regulation in the UK sets out the principles that they apply when assessing a Licensee. These Safety Assessment Principles (SAPs) (ONR, 2014) include some that apply to the management system and some that are specific to human factors:

- SAP EHF.8 demands the application of "a systematic approach to the identification and delivery of personnel competence". It expects that such a process would encompass job analysis, identification of competence requirements, training needs analysis, training programme design and implementation, formal assessment of competence, and training programme evaluation. But it is for the licensee to decide what this should look like.
- SAP EHF.9 addresses procedures, and notes that they should "meet the needs of all intended users". This reinforces the link with competence – who are the intended users and what level of competence are they expected to have?

It's also worth noting that the safety assessment principle concerning 'Capable Organisation' expects that "Processes and systems should secure and assure maintenance of appropriate technical and behavioural competence of directors (both executive and non-executive), managers, leaders and all other staff and contractors with safety rules and responsibilities."

This focus on non-technical skills, and on managers and leaders, is important. But what does this mean in terms of the actual arrangements for assuring competence? The industry expends significant effort and investment in developing and sustaining competence. It also faces extensive regulatory scrutiny, driven by the Licencing framework and the specific Licence Condition (LC10) that demands an appropriate focus on training. The ONR Technical Assessment Guide on training (ONR, 2017) provides useful guidance.

Training does not equate to competence. Whilst clearly supported by training, competence is also influenced by prior experience, aptitude, attitudes and behaviours, skills and knowledge. Training affects these in different ways. It's therefore important to understand the following:

- What are the claims being made on human performance? What does the safety case expect, and how are those claims translated into competence requirements? Do we have a clear understanding of the required knowledge, skills, attitudes and behaviours?
- What are the training needs associated with acquiring and maintaining competence? What other factors need to be considered? How much does experience contribute? How should those contributions be controlled?
- What is the appropriate mix of training methods? Is there a sound understanding of the strengths and limitations of classroom-based learning, e-learning, on-the-job training, etc?
- How is competence assessed? Does the assessment really address competence, or is it mainly knowledge and skills-based?
- How is competence maintained? How is the timing of re-assessment and refresher training determined? Is the potential for skill-fade fully understood?

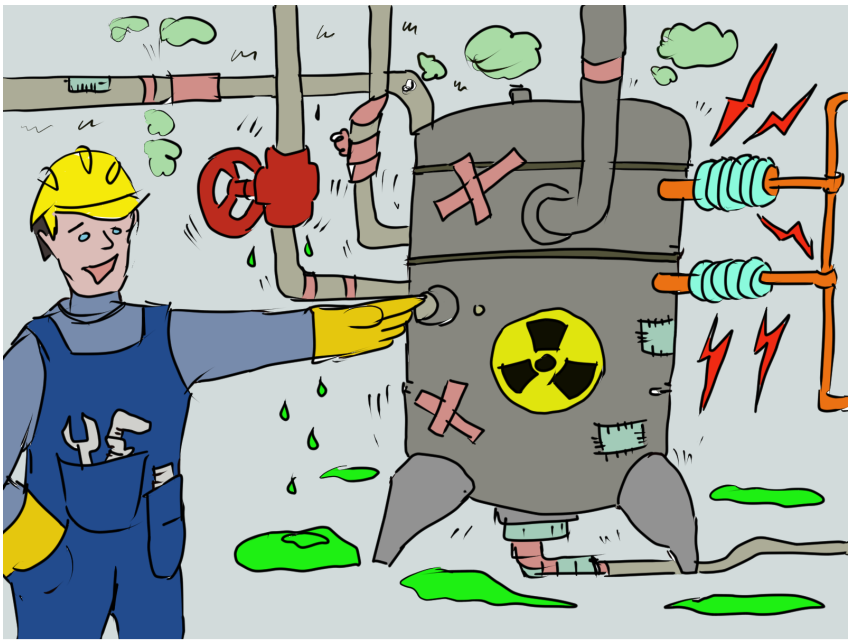
The concept of 'Suitably Qualified and Experienced Person" – SQEP – is widely used regarding qualifications AND relevant experience. Neither is sufficient alone. The notion of SQEP plays an important part in understanding transferability of competence (some of the workforce move around frequently, particularly in the area of maintenance). This is the equivalent of a licence for ATCOs and ATSEPs. There is a thread that runs from the 'claims' being

made concerning safety in a safety case, through the identification of competence requirements to support the claims, to the process for acquiring, assessing and maintaining competence.

Licensees maintain rigorous records of training and competence, but recognise that keeping records does not mean staff are competent. There is a need continuously to reflect on whether the competence management system is actually delivering competent staff.

How does competence influence rule compliance? A good example arose when the regulator was undertaking a routine inspection at a site, observing a front-line worker. The worker undertook a particular activity in a slightly unusual way. On being asked by the Inspector "Is that the way the procedure instructs you to do the task?", the worker replied, "Oh no – when we do this task we don't follow the procedure…". A telling comment. It suggests that the worker was confident they were performing in the manner the organisation expected and hence there was nothing wrong. He was content to tell the regulator that they don't follow the procedure in those circumstances. What does this say about the competence management system? What elements of the training and experience of this worker led them to understand that non-compliance was permissible?

This raises an important aspect of competence: its role in supporting rule compliance. In the nuclear industry, compliance with procedures is more critical than in other more human-centred industries. In recent work on procedural compliance for a Licensee, we identified that a key predictor of non-compliant behaviour was a misplaced perception of one's own level of competence. Erroneously thinking that you are highly competent can 'legitimise' inappropriate non-compliance: "I know what I'm doing, and the risks". People who have genuinely high levels of competence properly understand the risks and the importance of the procedural elements that manage them. People who recognise that their competence is low – perhaps they are newly qualified – tend to be more diligent in complying with the procedures. It is those workers who have a misplaced perception of their own abilities who tend to 'bend the rules' inappropriately. Bear in mind that most men consider that they are above-average drivers… How many competence management systems focus on ensuring an accurate self-perception of competence? How many focus on highlighting ongoing limitations in knowledge and competence? When their teenage children pass their driving tests, parents will try to emphasise that "now is the time when you start to really learn to drive" – even though, worryingly, it tends to fall on deaf ears. Do we do the same with newly 'qualified' workers?



It's nothing a little WD40 and duct tape couldn't fix... trust me! I'm an engineer!

The ability to develop and maintain competence, and to instil an accurate self-perception of competence levels, is an essential element of a good competence management system. The nuclear industry is working towards this.

How far does your competence management system go in making people aware of knowledge and competence gaps? How well do the competencies and their assessment relate to the actual safety claims that are being made? It is the regulatory requirement for the licensee to 'make the case' for the suitability and effectiveness of their competence management system which generates confidence in the high standards within the nuclear industry.

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COMPETENCY IN POWER GENERATION AND DISTRIBUTION: 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 aviation personnel, as **Rob Miles** outlines.

KEY POINTS

1. **Many staff on power generation sites and distribution networks are employed by contractors. This makes competency management more difficult.**
2. **We can define four kinds of knowledge that are relevant and necessary for a job to be completed safely and effectively: task or trade skill, working safely on a site, major accident hazard, and plant history. It is necessary to pay attention to all of these.**
3. **While ATSEPs will relate to these, air traffic controllers and professional pilots may well be able to draw parallels.**

Introduction

While air traffic controllers and (most) pilots are employed directly by ANSPs and airlines, it is now common to find that many staff on power generation sites and distribution networks (the 'duty holder') are employed by one or more contractors. In some cases, the majority of staff will be employed by contractors. There could be a single contractor providing a range of services, a number of specialised contractors, or a lead contractor with a number of sub-contractors.

Contractors can specialise and bring expertise, economies of scale, and provide additional staff at short notice to meet operational needs. However, the success of these arrangements depends on the contractor staff being competent to carry out their contracted tasks safely.

While the competence of duty holder staff (the 'core crew') is addressed through the normal means of selection, training, assessment and development (under the direction of the company Human Resources [HR] department), the situation for contractors is more varied. Larger contractors will have HR departments but many smaller companies do not and so competence is often addressed via procurement contracts.

The engagement of many contractors to operate and maintain a plant, along with the communication and coordination required, presents many challenges. Many workers and supervisors arriving on site are often unfamiliar with the site, the site operator's safety management system (SMS), and site working practices. Competence changes from a procurement issue to an on-site issue, and key elements can get missed in this transition.

It is usually the case that a team, rather than an individual, performs tasks that involve significant health and safety hazards, major accident hazards, or that are complex or high consequence (e.g., in terms of economic risk). Where an individual completes a task alone, they work within a system of procedures, risk assessments, approvals and inspections. This work is supervised and managed. All of these activities and elements have so-called 'knowledge content'. The skill to do a task is included in this 'knowledge', as in 'knowing how to do the job'.

We can define four kinds of knowledge that are relevant and necessary for a job to be completed safely and effectively. In this context, 'safely' means the occupational health and safety of those undertaking the task and major accident hazard safety for the plant being worked on. While these concern engineering work, air traffic controllers, professional pilots, and other readers may be able to translate some of these kinds of knowledge into operational ATC and flying examples.

These four kinds of knowledge concern:
1. task or trade skill
2. working safely on a site
3. major accident hazard
4. plant history.

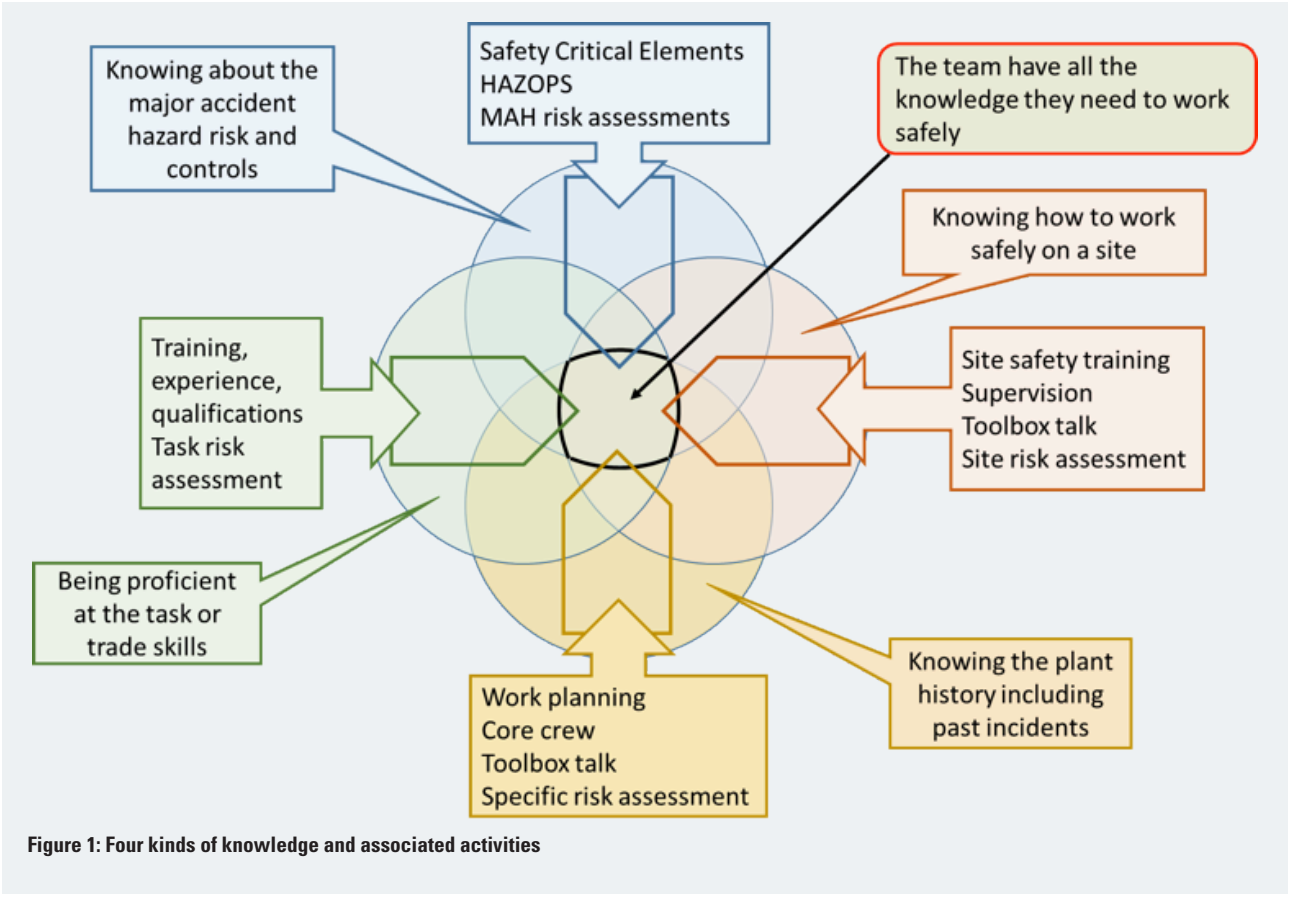

Figure 1: Four kinds of knowledge and associated activities

Knowledge 1: Being proficient at the task or trade skills

This refers to the skills and knowledge to complete the job – trade or professional skills and the knowledge of tools and techniques specific to a trade or area of expertise. Trade and task skills ensure that the person can do the job well and work safety within limits. Examples would be:

- making up bolted joints and flanges
- repairing rotating machinery
- electrical cabling and wiring
- pump overhaul
- pressure pipework repair or installation.

These are a few examples from a very wide range. What they share is a requirement for skills learned through practice and a significant degree of knowledge about the chosen area. These skills are usually externally assessed and validated by trade or technical institutions. The technician must work within their area of competence and their supervisor, manager or client must recognise this.

Knowledge 2: Knowing how to work safely on a site

Safe working practices form part of all basic skills training, and contractor staff must be familiar with relevant health and safety regulations and legal requirements relevant to the task or trade of their direct employer. In addition, the site operator will have company-specific and site-specific health and safety procedures and requirements.

Some examples are:

Company specific:
- permit to work system
- behavioural safety program
- work-safe or 'golden' rules
- company safety rules brought in after incidents or accidents.

Site specific:
- site routes for safe vehicle movements
- site emergency alarm, response and evacuation procedures
- site or equipment specific procedures in response to incidents
- PPE and clothing rules and location of PPE
- hazard zone (e.g., noise) areas
- barrier and exclusion zone procedures.

It cannot be assumed that contractor health and safety training and procedures will cover the full range of health and safety issue required on any specific site to ensure safe working. There can be significant gaps.

Knowledge 3: Knowing about the major accident hazard risk and controls

The term 'major accident hazard' (MAH) is usually associated with major fire and explosion, but it includes any incident capable of causing significant harm to people and the environment and so it includes such events as:

- fire
- explosion
- major release (flammable, toxic, asphyxia)
- pollution of a water course
- large dropped object
- structural collapse during construction
- legionella, norovirus or other disease related to site practices.

Work with a MAH must be properly risk assessed and effective control measures must be put in place before work starts. However, contractors might not have access to the necessary hazard information or the expertise to evaluate it. When this occurs, the contractors' risk assessment will be strongly biased towards occupational safety and may omit completely the MAH risk and controls. This will then carry over into the permit to work (where used) and the 'toolbox talk' or pre-work briefing.

MAH information is typically found in hazard analysis studies, risk assessment studies, and process control diagrams. If the risks from these hazards are to be controlled while the work being done by the contractor takes place, then this makes demands on contractor competency. There are a limited number of ways to ensure MAH is effectively represented in work planning, risk assessments and on site work control (PTW and supervision):

- Make MAH documentation and other information available to the contractors, ensure they are competent to understand and use it, and monitor to ensure that they do.
- Retain ownership of the MAH by thorough planning and control of all the MAH in every task, and define clear boundaries to ensure this control is maintained. This will include early warning when a contractor moves outside their boundary and into the MAH zone.
- Have experienced staff participate in every stage of the work to explain and ensure control of the MAH.

Sometimes, MAH information is intentionally withheld because this can be commercially sensitive and confidential to the operator's senior management team and the relevant regulator. Regulators often treat MAH submissions as 'confidential' and not disclosable to third parties. Many operators would be reluctant to disclose hazards as this may alarm the local community and investors. This kind of disclosure may and require detail that they would view as commercial information that could be exploited by competitors.

Knowledge 4: Knowing the plant history including past incidents

Work on complex plant does not take place in isolation. Regardless of whether it is repair, overhaul, replacement or modification, there will be a history and a reason why changes have to be made. Working on plant without understanding why it needs to be worked on is to be blind to an important part of the job.

The history includes:

- The work method. Why does the work need to be done in this way?
- The equipment history. Why does this work need to be done to this equipment?
- The history of past repairs and reworks. Did they last or fail? Do we know why?
- Accidents that have occurred relating to this task or equipment in the past. What happened? Why did it happen?
- Early service failures after repair. Do we know why and are we about to cause a repeat?

In general, this knowledge is held by the operational and maintenance staff responsible for the equipment. It should be recorded on logs and manuals but often it is not and can only be found in the recollections and experience of core crew (i.e., core staff, not contractors). If the same contractor has always worked on it, they may have the knowledge. In both cases it is clear that handover of experience and long-term involvement are key issues.

The problem with this kind of knowledge is that it is often exposed after an incident, when people come forward with examples of how this has occurred before. The objective is to get this information before things go wrong, not after.

The risk assessment and toolbox talk (briefing) is where this history can most help to prevent an incident. In this context, an experienced person is likely to be more effective than documentary history.

Conclusion

It is necessary to pay attention to all four kinds of knowledge. Air traffic safety electronic personnel (ATSEPs) will probably relate to all four kinds directly, and will also understand some of the issues of contractor management. Air traffic controllers and professional pilots may also be able to draw parallels, and consider where more knowledge may be needed for certain situations and staff.

The work described here is explored in more detail in an up-coming report on contractor competence to be published by the Energy Institute (London) in the course of 2018 (the Figure is adapted from the Energy Institute report).
https://www.energyinst.org

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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 help to provide information to demonstrate the competence requirements for certain tasks. **Gauthier Sturtzer and Eamonn Wylie** explain a methodology called the Task Safety Impact Assessment Technique.

KEY POINTS

- **ATCOs and ATSEPs are currently the only staff with an EU competence regulation in the field of ATM.**
- **The ATM social partners work jointly to inform EASA's decisions with the support of EUROCONTROL.**
- **Jobs are different from one organisation to the next. Regulating a job would therefore be problematic.**
- **Regulating competence is the result of discussions involving all parties.**
- **Licences are not the only appropriate framework to deal with staff competence.**

The legislative obstacle

Through the vision of the Single European Sky and the subsequent entry into force of Regulation (EC) No 1108/2009, the scope of responsibilities of EASA was extended to cover personnel involved in ATM/ANS provision. One of the first steps was to introduce a European licence for air traffic controllers. In addition, air traffic safety electronics personnel (ATSEPs) also see their competence regulated at an EU level.

In conjunction with this extension of EASA's field of competence across ATM, the Agency included in its rulemaking programme tasks to cover all safety-related fields of ATM with both technical requirements but also competence requirements for staff performing various functions (for example MET, AIS, ATS, CNS). This overarching regulation is known as the ATM/ANS Common Requirements (Regulation 2017/373). Annex XIII of this regulation, Part-PERS, was created as a still mostly vacant place to cover any regulation outside the scope of that established in other legislative locations, such as the 2015/340 (ATCO Licensing). Unfortunately, given the lack of safety evidence supporting the need for regulation, implementing those rulemaking tasks proved to be difficult. Therefore, in order to fill this annex in a proper manner, to have an up-to-date knowledge of this developing field of activities, as well as to ensure the most proportionate approach in any possible further related measures, the Agency decided to commission an external study to examine potential development processes and inform future decisions to propose (or not) regulations regarding ATM staff competence.

EASA's initial step

In 2013, EASA commissioned two consulting firms (ECORYS and NLR) to produce a regulatory impact assessment on new rules for training and

competence requirements of ATM/ANS personnel.

First, for each ATM/ANS service, a detailed list of functions was established and a list of jobs associated to these functions was derived. Following this framework of functions and jobs, a definition of safety-related and safety-critical was proposed based on the application of the EUROCONTROL 'accident incident model' (AIM, now known as the IRiS model), commissioned by SESAR.

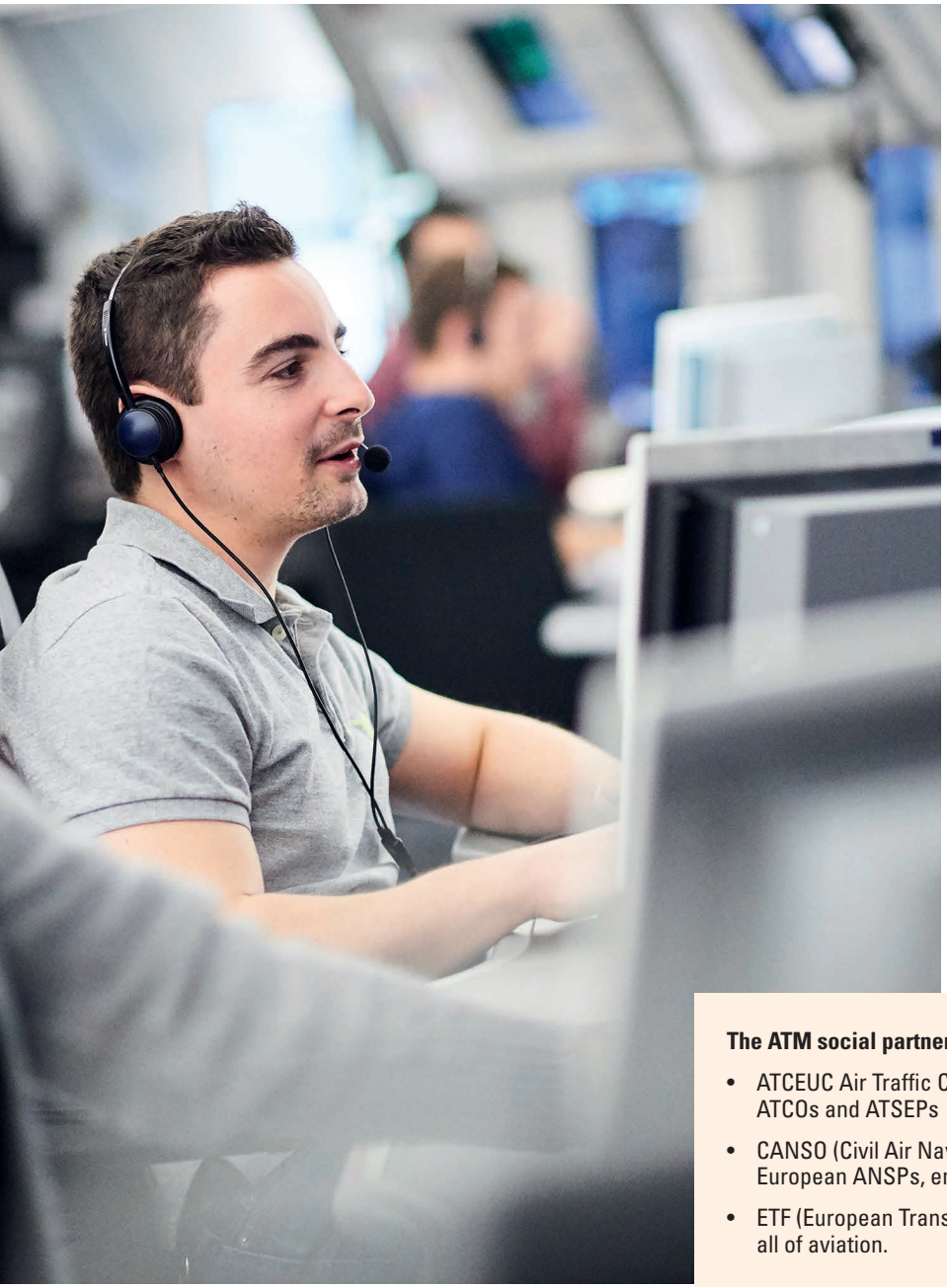
A function is defined as safety-related if a failure of the function would impact safety, using the AIM. A job is defined as safety-related if the job involves performing at least one safety-related function.

A function is safety-critical if a failure of the function would impact safety and no barrier within the ATM/ANS system is found in the model to prevent an accident following the failure of the function. A job is safety-critical if the job involves performing at least one safety-critical function.

Next, the proposed definitions were applied to the list of functions and jobs. The result was a list of safety-related functions and safety-related jobs and a list of safety-critical functions and safety-critical jobs. In total 143 functions and 26 associated jobs were identified and regarded as safety-related, out of which 28 functions and nine associated jobs were identified as safety-critical. These jobs are: air traffic controller (ATCO), various kinds of ATSEPs, AIS officer, navigation data provision officer, and ATM/ANS technical system designer.

The conclusion inferred by the ECORYS assessment was that safety-critical jobs should require the development of associated rules and regulations. The content of the report was considered insufficient to meet its intended purposes for various reasons, but principally because:

- The association between jobs and functions did not fit all ANSPs as there is no standard ANSP structure. Functions could be assigned to any job, giving rise to many job variations. Regulating a job would therefore be problematic.
- There was a lack of rationale supporting the conclusions drawn by distinguishing safety-related functions from safety-critical functions.
- It was a fixed assessment, not considering the possibility of new jobs/functions or new failure modes being identified and integrated in the future.
- The recommended actions were hard to verify. The assessment was based on a perceived correlation between certain jobs/functions and their safety impact, with no proven causality that would lead to a safer system if the jobs would be regulated.
- The recommended actions were rather traditional, missing any innovative approach. It was considered that there were probably better options than training and competency, which we know are seen as 'soft barriers'.



The ATM social partners are:

- ATCEUC Air Traffic Controllers European Unions Coordination representing ATCOs and ATSEPs
- CANSO (Civil Air Navigation Services Organisation) who represent most European ANSPs, employers in the social dialogue context
- ETF (European Transport Workers' Federation), representing staff across all of aviation.

Notwithstanding the above, the report contained valuable roots for the design of the expected evidence, namely the EUROCONTROL Accident Incident Model, or IRiS.

An alternative approach – ASPReT and TSIAT

Following the publication of the report, the ATM social partners (see box) committed to establishing a methodology to support the need for competence requirements for ATM staff with duties affecting safety. This was done by a group of people gathered in a body named ASPReT (the ATM Social Partners Regulatory Taskforce). ASPReT sits under the ATM working group of the European Civil Aviation Social Dialogue Sectoral Committee, the official body for European Social Dialogue run by the European Commission's Directorate-General for Employment (DG EMPL).

Using the latest version of EUROCONTROL safety barrier model, the IRiS model, we developed a methodology called Task Safety Impact Assessment Technique (TSIAT).

TSIAT combines the 'safety-critical' concept, which could be regarded as a measure of severity – inherent to the AIM model, with the failure probability of that task. For the purpose of this methodology a task is expressed as a well-defined, distinct piece of work assigned to, falling to, or expected of a person. A person usually undertakes one or multiple tasks. Operational safety can be impacted to different extents by specific tasks.

A brief look at the TSIAT methodology

TSIAT is a technique that uses as its foundation the EUROCONTROL quantified accident and incident models. The models have been populated with in-service data and reflect how the human tasks protect against ATM/ANS related accidents. It uses these models to understand the extent to which a particular task contributes to the different aircraft incidents and accidents.

The process provides an understanding of both the task effectiveness/performance and the extent of the contribution it makes to reduce the risk of an ATM/ANS related accident for all possible accident outcomes. Based on this understanding and expert analysis and judgement by subject matter experts (SMEs) and safety experts, the TSIAT methodology determines whether there is opportunity for safety improvement for a task using a quantifiable result related to the safety impact of a task.

All decisions and recommendations are recorded, capturing the task that has been reviewed, the personnel involved and the rationale for any recommendations. The final decision both on whether there is opportunity for safety improvement, and the resulting output by EASA regarding that task is deliberately placed in the hands of SMEs and safety experts.

The TSIAT methodology can help to determine whether there is 'opportunity for safety improvement' for a particular task. It goes beyond considering just the contribution a task makes in preventing ATM/ANS accidents but also considers its current effectiveness. Where there may be opportunities for safety improvement, it recommends not just whether it is appropriate to establish competency requirements for the particular task, but whether it might be more appropriate to propose less 'rule-based' alternative solutions, such as safety promotion, training or standardisation.

Test case – Opportunities and stumbling blocks

The TSIAT technique was presented to EASA and EUROCONTROL over the summer of 2017 with positive feedback from both organisations. Subsequently, test cases were run in late 2017, concluding that methodology is likely to deliver the intended advice on the safety relevance of development of competence requirements. Shortcomings within the current structure of the dataset were identified but are not insurmountable.

The IRiS model does not cover the full scope of ATM/ANS tasks since they are focused on the safety of air transport, subject to a separation standard in controlled airspace. For example, there is no IRiS model that captures a commercial aviation aircraft coming into contact with general aviation aircraft outside controlled airspace. Until this is developed, these issues should be considered out of scope of TSIAT.

Similarly, the models are aimed at the identification of causes of accidents to reduce their likelihood. Consequently, the methodology cannot be relevant for tasks associated to dealing with an accident that has happened (mainly the tasks related to an alerting service).

In having identified these stumbling blocks with the technique, the group is already preparing processes and techniques to overcome them. The end result will not be to put an additional cost burden on ANSPs (and ultimately on airlines and travelling passengers) or to have all personnel licensed. Nor should it keep people constrained in their jobs by creating inappropriate hurdles to evolve. The idea, or rather ideal, is to establish relevant requirements enhancing safety and getting people to feel recognised for what they are and what they do.

Going forward

The continued work being conducted by ASPReT will, if successful, provide additional proof that competence requirements for certain tasks are needed. Ultimately it does not answer the next question: which requirements are appropriate? By promoting the preparatory work, the project can get the acknowledgement it deserves so that it may continue to develop and at a pace that fits the importance of the task.

Gauthier Sturtzer is an air traffic controller at Lille aerodrome and approach since 2003. He is a member of the USAC-CGT trade union and has been in charge of international regulatory affairs for 8 years, as well as representing the ETF (European Transport Workers' Federation) in various European bodies, most notably EASA.

Eamonn Wylie has been a tower and approach radar air traffic controller working at Belfast Aldergrove in the UK since 2013. He has recently started training at Heathrow tower. He is a member of Prospect ATCOs' Branch, the trade union representing UK ATCOs, working in the role of Assistant Chair of International and Government Affairs. He also works with ETF, as well as within ASPReT.

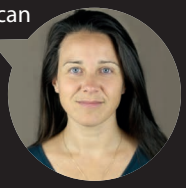
TALKING ABOUT PILOT AND CONTROLLER TRAINING AND COMPETENCIES

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.

KEY POINTS

- **Pilots and controllers have some similar issues. Their training is also quite similar and it may be enriched by learning from one another.**
- **Training of technical skills is necessary but not sufficient for the appropriate current level of safety. Training technical as well as non-technical competencies is essential to improve this.**
- **The Alternative Training and Qualification Program (ATQP) concept shows that a next step is to adapt the training to the trainee.**

Ratings



Florence-Marie: So, can you tell me how a type rating training is done for pilots?

Jérôme: Well, first of all, to acquire technical skills, trainees go through some ground classes where they learn aircraft systems. It lasts a few weeks. They then go to the flight simulator for approximately eight to 10 sessions of four hours each. Here, they perform most of the abnormal procedures (engine failure, emergency descent, hydraulic failures, etc). Instructors then focus on technical skills with a limited operational context: no consideration for passengers or diversions. A positive skill test at this step enables trainees to join the 'real world' by flying a real aircraft. For a first 'liner' rating, they will undertake base training, which comprises six 'touch and go' manoeuvres, at a low traffic airport, on an aircraft with no passengers. For next ratings, these 6 mandatory movements are done in a flight simulator.

Then it's time to face real life and passengers, under supervision of an Instructor. This is called line training. Instructors then focus on operational context. After a certain amount of flights under supervision the future pilot has to pass a 'line check'.

What about you? Do controllers have a kind of 'type rating'?

Florence-Marie: Yes. There are specific ratings depending on the different positions. It all depends on the airport or the area centre, but for instance, here there are three control positions: ground, tower and approach. For each position, you have a specific rating. When trainees arrive at the training department, whether they come from initial school or from another control centre, they start with theoretical courses. Those last a few weeks and at the end their instructor starts working on the position with them. When there's a simulator (for instance, here, there's only an approach simulator), this instructor teaches using simulation, according to their level.

They then see basic radar techniques, emergency stages and technical failures, on aircraft or on tower systems.

Then they enter a team, where they learn to control on real positions, with real traffic. This lasts a few months, up to a year depending on the position: two or three months for ground, three to six months for tower, and five to eleven months for approach. It can be different in other towers and much longer in area control centres. It is also linked to the trainee's background: school, another tower or centre. Each time they complete practical training on a position, when they are ready, they sit exams, before starting another rating theoretical training.

Jérôme: Do they take exams on simulator or on position?

Florence-Marie: On position. When you talk to a controller over a frequency, he or she could be sitting an exam… What about your exams?

Jerôme: Well in fact you could also talk to a pilot on frequency who is taking an exam. Every year, an airline pilot has several assessments: some in a flight simulator, one line check on a regular revenue flight, and one medical check-up. We also have a yearly review of the aircraft systems and company policies performed at the pilot's own pace through a specific learning app on iPad. We talked about skills, but what kind of competencies are you looking for, when training controllers?

Competencies

Florence-Marie: Different competencies are defined by the air navigation service provider. Some are more technical, and some are more non-technical, like decision-making, anticipation, reaction and adaptation, maturity, and cooperation. For each of these competencies, there are positive or negative indicators, based on facts and observations. What about pilots? What competencies are you looking to develop?

Jérôme: Many airlines now use a competency-based model. It evaluates performance of a pilot through technical competencies and non-technical competencies. Technical competencies include hand flying, use of automation, and compliance with procedures. Some airlines also consider knowledge as an integral part of technical competencies. Non-technical competencies include communication skills, decision-making, situation awareness, leadership, and workload management. We use these competencies for initial training as well as for recurrent training.

Continuous and recurrent training

Florence-Marie: Can you tell me about ATQP and TEM?

Jérôme: Well, to maintain an acceptable level of skills and competencies, every pilot performs a set of two simulator sessions every six months. The first is a training session, the second is a test. Should a pilot fail a test, he or she will have to get additional training and sit a new test before returning to line. These tests comply with mandatory items set by the Authority. Because every pilot goes through the same tests (engine failure at take-off, non-precision approach, etc.), one could say that this makes everyone equal, but this system doesn't take into account the fact that every pilot's training needs are different.

To deal with this, some airlines have been granted a new standard called ATQP – alternative training and qualification programme. Now, pilots still have four simulator sessions, but they are divided differently. One 'regular' training session is followed the next day by the test session for licenses revalidation. Six months later, there is an evaluation session where a crew conducts line oriented flight training, or LOFT. The instructor chooses a very realistic scenario, with some technical failures, or some non-technical events, such as a sick passenger. This training may bring to light some particular competencies to work on, so it is followed the next day by a session dedicated to the specific needs of this crew. During this recurrent training, the focus is on crew resource management and compliance with operator policies.

During the debriefing, CRM is emphasised with the threat and error management model. To summarise, instructors will get crew members talking about the following points:

- How accurate were the crew at anticipating or recognising a threat?
- Were they able to mitigate it?
- Did the crew detect and correct the errors made?
- What was strong or weak in a set of tools such as procedures, cross check, monitoring, check lists, airmanship, and so on?

We also have CRM training along with security, fire and rescue, etc., as part of a one-day theoretical training. How about controllers' continuous training?

Florence-Marie: They have two days of continuous training each year: standard procedures class, abnormal procedures, or human factors.

On the standard procedures class, they are taught about instructions, working methods, technical systems, and maintenance, for instance. They also visit other control centres to improve coordination.

Unusual and abnormal procedures are mostly seen in simulators. Here in approach control, there is one day theoretical, and one-day practice in the simulator. Controllers face many challenges, with critical piloting situations or with technical systems: engine, radio, radar failure, fire on board, big thunderstorms, etc.

A human factors session focuses on lessons learned, controllers' environment, and instruction, as here all controllers are on-the-job instructors. The themes change every three years, but examples include fatigue and stress, pilot-controller cooperation, safety/performance balance, groups, monitoring and taking action, learning by errors or by example, etc.

To maintain their rating, they also attend English courses and have English exams. The control exam has multiple choice questions, about working procedures, control theoretical knowledge, etc. Now there are new exam procedures, with recurrent exams on position.

When sharing experience…

Florence-Marie: When you talked about the fact that "every pilot gets the same training", it gives me food for thought about what we do here. Some instructors have built personalised simulations for initial training, but it would be interesting to customise the continuous training simulations. I really like the ATQP concept, where pilots are trained for the specific needs of the crew and the focus on CRM. That's something we could work on. We don't have specific simulations to develop human factors competencies.

Jérôme: It would be good to develop and encourage exchange between pilots and controllers. A few years ago, some controller friends came to our simulations in their own time and played the controller role. Their feedback was very interesting.

Florence-Marie: I've been advocating for these exchanges for a long time. Perhaps in the future, a next step to improve and share competencies will be cross-training between controllers and pilots, between units, and between operators and managers. That would really help to strengthen interfaces.

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.

Jérôme Schimpff started his career in 1998 as a first officer flying B737-200. Then he flew A310 and B747-200 before switching to the left seat in 2007. Now he is a Type Rating Instructor and Senior Examiner on A320. He obtained a Diploma in "Human Factors for the Conception of Human-Machine Systems" at the Paris V René Descartes University. He has been involved in CRM training for many years and is a member of the French Human Factor Reflection Group.

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.

HF TRAINING IN AN AIR NAVIGATION SERVICE PROVIDER

By Florence-Marie Jégoux, HF facilitator, former ATCO, and member of a focus group gathering for pilots and controllers to address flight safety through human factors.

Air traffic controllers have some HF courses during initial training. This mostly covers theoretical knowledge. During unit training, they get one day of HF facilitation about their own training and its issues. Then, in recurrent training, they have HF facilitation about professional daily work issues. This lasts two days and is done every three years.

This training has been mandatory since 2009, although it has been possible for some controllers since 1996. Maintenance engineers also have the possibility to get HF training. However, as it is done on a voluntary basis, only a small percentage of them undertake it.

In simulators, instructors brief and debrief mostly technical competencies. Depending on their willingness, they may also debrief non-technical skills, although they are not trained to do that, and not specifically taught about conflict management with their peers.

As all controllers are instructors, an important improvement in instructors' attitude towards trainees has been noticed along this period of time.
HF probably played a role in that improvement, although many other factors may also have intervened.

HF training for employees other than front line personnel could be developed, starting perhaps with managers, flow managers and safety analysts. These groups and front line personnel may benefit from a non-technical cross-training, based on their needs.

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HF AND CRM TRAINING IN AN AIRLINE

By Erick Hoarau, First Officer, CRM Trainer Examiner and member of a focus group gathering for pilots and controllers to address flight safety through human factors.

For European air operators, the European Aviation Safety Agency (EASA) regulates CRM training. The EASA's official documentation details the acceptable means of compliance (AMC) and guidance material (GM) related to CRM training for air operators in the Part-ORO (Organisation Requirements for Air Operators). ORO.FC.115 details flight crew CRM training and ORO.CC.115 details cabin crew CRM training. The following mainly focuses on flight crew CRM training.

CRM training is conducted both in the non-operational environment (classroom and computer-based) and in the operational environment (flight simulation training device [FSTD] and aircraft).

In classroom training, tools such as group discussions, team task analysis, team task simulation, and feedback can be used. Combined CRM training for flight crew, cabin crew and technical crew may also be used to address effective communication, coordination of tasks and functions. Crew members are thus given the opportunity to interact and communicate in an environment conducive to learning. Computer-based training may be conducted as a complementary training method.

In an operational environment, parts of the flight crew CRM training are conducted during simulator training and check sessions that reproduce a realistic operational environment and permit interaction. This includes, but is not limited to, line-oriented flight training (LOFT) scenarios. The flight crew member's CRM skills are assessed in the operational environment. CRM skill assessment includes debriefing the crew and the individual crew member. It also serves to identify additional training, where needed, for the crew or the individual crew member and is used to improve the CRM training system by evaluating de-identified summaries of all CRM assessments.

Air operators provide CRM training in the following situations:

- Initial operator's CRM training: This typically happens when a flight crew member joins an airline for the first time. Each flight crew member should complete the initial operator's CRM training once.
- Operator conversion course: This course is delivered when a flight crew member undertakes a conversion course with a change of aircraft type or change of operator.
- Annual recurrent CRM training: Flight crew review parts of CRM training elements every year. The whole CRM training syllabus shall be reviewed over a period not exceeding three years.
- Command course: When a first officer undertakes a command course to upgrade to the function of captain, elements of CRM training are integrated into the command course.

The CRM training syllabus is organised so that air operator addresses the following aspects:
Automation and philosophy on the use of automation, monitoring and intervention, resilience development, surprise and startle effect, cultural differences, operator's safety culture and company culture, and case studies (preferably aircraft type-specific case studies, based on the information available within the operator's management system, when available).

HF AND CRM IN DEFENCE

By Jean-Yves Jollans, fighter pilot engineer, human and organisational factors (HOF) consultant in industrial safety and investigator trainer. (Co-author of the book 'Training teams in safety and performance with CRM' / 'Former les équipes à la sécurité et à la performance avec le CRM'. Octares.)

On initial training, HF training is mandatory for ATCOs, for aeronautical technical employees and aircrews in defence. Qualifying HF training is delivered in all courses that require it, as in civil training, e.g. pilot.

For recurrent training, compulsory courses are delivered every two or three years. The first unit training lasts two days, and subsequent courses last one day. Topics are new each time so that operators don't get the same training twice. More than sixty themes have been developed, e.g., social influences, what is a fighter pilot?, facing the unknown and complexity management.

Crew resource management, team resource management and mechanic resource management courses are presented by facilitators. They confront participants with their practices. This leads them to modify their daily practices to improve safety and performance.

For pilots, classroom training is supplemented with specific simulator training. It ensures that HF concepts are implemented and that the benefits are realised.

While not mandatory for submariners, submarine resource management has also been implemented. HF observations in submarine simulators ensure implementation of HF principles in collective practices.

TRM training has also been developed for teams of doctors, nurses and ambulance drivers of the Paris fire service (which also provides emergency medical services in France).

The results are extremely promising. An assessment has been done over the last ten years of around 6500 people trained per year. It shows that:

- 90% say that they became aware of HF impacts
- 92% say that they learnt complementary non-technical knowledge
- 95% say that they had useful discussions
- 84% say that they are going to change their practices.

The criticisms are mainly about HF training being too rare and too short.

SHIP RESOURCE MANAGEMENT ON BOARD MERCHANT SHIPS

By Jean-Pierre Clostermann, Master Mariner, PhD, MNI, Research Regional Coordinator. (Author of 'Merchant ship conduct, Human Factors in a hazardous activity' / 'La conduite du navire marchand, Facteurs Humains dans une activité à risques', Infomer.)

Training in bridge resource management has developed since the 1990s for professional seafarers. Later in this decade, exchanges of good practice took place between airlines, merchant marine, nuclear industry and healthcare personnel. From 2012, Engine-room resource management and ship resource management was developed (in France, students train for deck and engine-room together). Ship resource management is now compulsory for officers, and recurrent training is recommended every five years.

Scandinavian maritime insurers have pushed ship-owners into airline-style CRM training. Most shipping countries have been a little late in understanding HF and CRM training. HF has sometimes been a mere addition of procedures in an attempt to eradicate human error in the same way quality management does with non-compliance.

Today, worldwide, the training is mandatory for an officer position on board, and leads to an official certificate of competence. One might be surprised that deck and engine-room workers (non-officer) do not receive any HF training; being part of very small teams (two operators), their contribution to safety is important.

No specific research study has been done on effectiveness. Nevertheless, considering the four assessment levels of Kirkpatrick:

- 1st level – REACTION: Satisfaction after the training is usually high, except for people who were seeking something else. Satisfaction usually remains high in the long term.
- 2nd level – LEARNING: On the whole, there are changes in perception of the relevance and importance of human factors for safety.
- 3rd level – BEHAVIOUR: The training itself, plus regular discussions afterwards, have brought real changes in some organisations, like the maritime pilots who today will no longer answer their cell phone while piloting a vessel.
- 4th level – RESULTS: There is some evidence of safety improvement in maritime transport, but it is not evenly spread, and little is documented yet. It is difficult to say whether it is specifically the HF training or a general acceptance of procedures on board ships that brought the improvement.

As for the HF training in a rather highly technical school like the French Merchant Marine Academy, all teachers, especially simulation trainers, should be HF trained, in order to correctly debrief an exercise. Today, is it still very difficult for trainers and assessors to determine whether the ship trajectory was due to good (or bad) technical skills, or to good (or bad) non-technical skills and teamwork. Another problem is that simulator instructor stations are not ergonomically designed at all, regardless of the manufacturer.

HUMAN FACTORS IN THE FRENCH NATIONAL RAILWAYS COMPANY

By Christian Neveu and Stella Duvenci-Langa, General Safety Direction, Organisational and Human Factors department, French National Railways Company (SNCF).

After recent accidents (Brétigny 2013; Eckwersheim 2015), the public French Public Railways Group affirmed in 2015 its ambition to consider human and organisational factors (HOF) in safety management. Training managers is one of its biggest projects.

All managers with safety functions (technical system creators, operations supervisors…) were targeted; a total of 8000 individuals in 600 training sessions, in Paris and in the provinces. That was done in about a year. This short period was important to create a rupture in the way safety was considered.

This training has been included into the training catalogue of the group. This training is mandatory and included in new managers' training.

This HOF training lasts a day. The method of training is based on case studies and exchanges. The morning session refers to HOF theoretical knowledge based on the Reason accident model. It is illustrated with a real incident case study, and experience sharing among participants. The afternoon session is a practical study on morning subjects and a presentation of the 'Just and Fair' approach.

Other actions complete and reinforce the effects of this training. These include HOF induction into safety supervision, lessons learned, non-technical competencies development for field experts and managers, and the implementation of HOF competencies.

The results are encouraging: training assessments are very positive, the quality of events analysis has improved, the 'Just and Fair' approach has been implemented for many events, HOF experts are requested to assist managers for change.

Nonetheless, these benefits are fragile. It is important to maintain this commitment on a long-term basis and to accentuate the HOF induction in all training, including technical training for the different professions.

It is also necessary to develop simulation training, which is in an early stage, or yet to begin in some professions, such as maintenance or train manoeuvre.

CREW RESOURCE MANAGEMENT AND HUMAN FACTORS TRAINING IN THE FRENCH HEALTH SYSTEM

SIMULATION AND CRM IN THE FRENCH HEALTH SYSTEM

By Pr JC Granry, Head of Department of Angers University Simulation Training Centre.

CRM and human factors training is essential in health systems, for patients and for professionals. They imply intrinsic factors (physical state, stress, etc) and extrinsic factors (environment, systems, organisation, etc).

During medical and paramedic initial training, intrinsic factors such as physical, physiological and psychological aspects are studied. Nonetheless, cognitive competencies (decision-making processes and influences, like stress, fatigue, addiction…) and extrinsic factors are rarely taken into account.

Recurrent training is not mandatory. Continuous training is sometimes done through simulation. Anaesthetist junior doctors perform three to four simulations a year in our centre. The recent development of simulation has improved initial and continuous training. Non-technical competencies are now studied in Anaesthesia, for instance (from Fletcher, 2003):

Cognitive and mental skills
- Planning and preparing, anticipating
- Prioritising
- Provide and maintain standards
- Identify and use resources
- Gathering information
- Identifying options, balancing risks and selecting options
- Re-evaluating

Interpersonal and social skills
- Coordinating activities with team
- Exchanging information
- Using authority and assertiveness
- Assessing capabilities
- Supporting others

These competencies are linked to methods like checklists, working in pairs, cross-checking, double-checking, interruption management, safe communication, etc. During simulations, HF is part of educational objectives. On each simulation, there is a briefing and debriefing on HF between trainers and trainees. This debriefing is the keystone of the simulation and always suggests improvement.

It has been demonstrated that simulation improves the competencies and behaviours of health professionals. The 'Health High Authority' leads a specific program to improve teamwork, where the study of HF by simulation is an important part. Work on the impact of these programs on patients' safety is still rare, however.

The safety and quality of work conditions of health professionals should also be taken into account. We cannot improve safety and quality for patients if work conditions are poor.

More and more professionals are getting trained using simulation, mostly in surgery and anaesthesia. As a result, less and less 'first time on a patient' scenarios happen. Professionals come back to the simulator more frequently and more happily.

Fletcher, G., Flin, R., McGeorge, P., Glavin, R., Maran, N., & Patey, R. (2003). Anaesthetists' Non-Technical Skills (ANTS): Evaluation of a behavioural marker system. British Journal of Anaesthesia, 90, 580–8.

CRM AND HF TRAINING IN THE HEALTH SYSTEM

By an analyst and CRM trainer

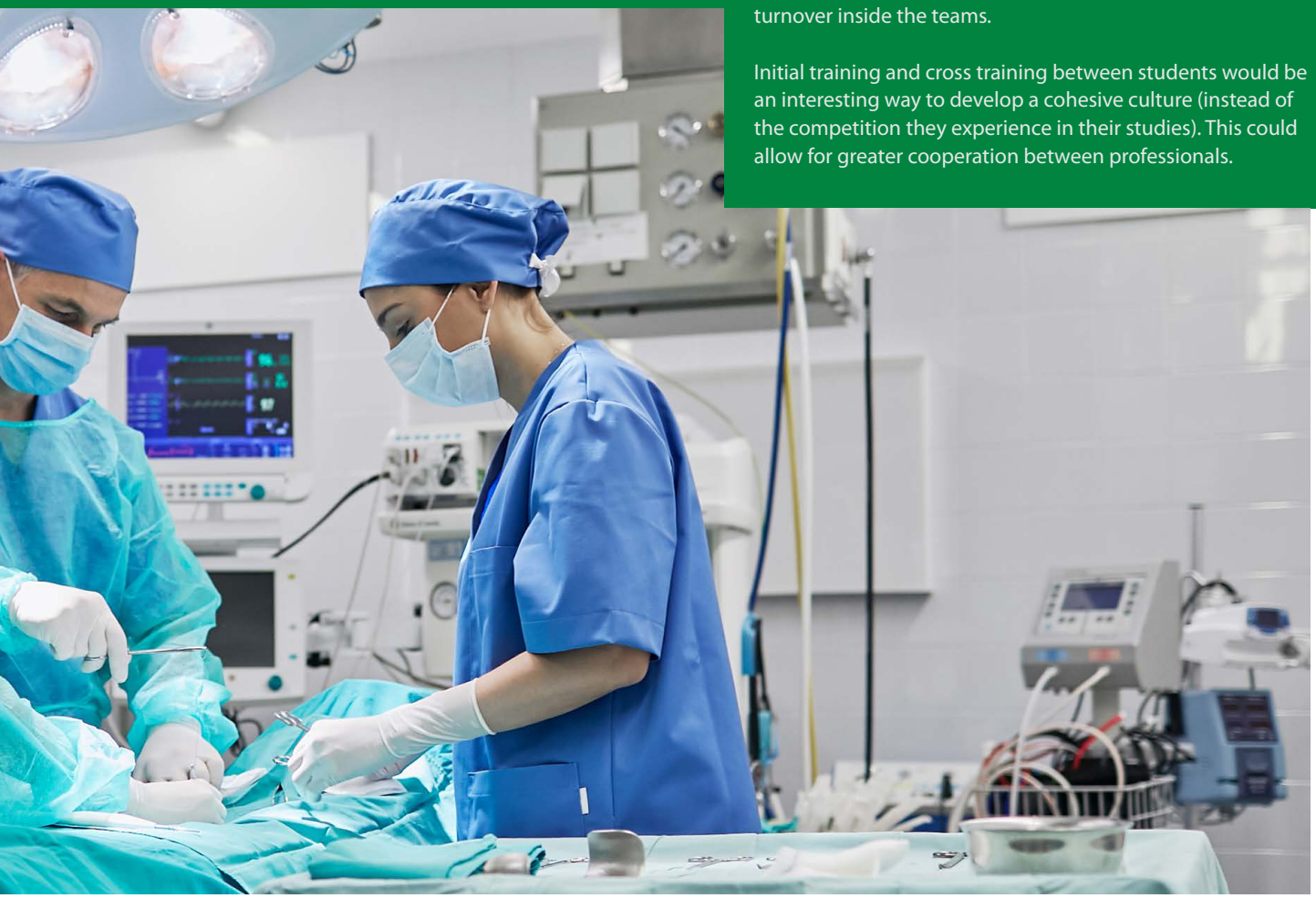
In the French health system, HF training is done on a voluntary basis. A specific program has been developed by the 'Health High Authority': Continuous Improvement Program for Team Work. About 50 teams of doctors, nurses, managers, helpers, cleaners, support services, have experienced this program.

The CRM included in this program is mostly about errors and lessons learned, communication inside the team, with patients and family, leadership, etc. It lasts 3 hours and is done with the whole team. The facilitator helps the team to understand how each profession thinks about others, to soothe the relationships inside the team. The syllabus also includes cooperation, task interruption, stress and fatigue, reporting and leadership.

There is almost no HF training in initial studies, medical or paramedical. Some training centres offer theoretical knowledge on a continuous training basis, but it is rather rare. Experience sharing exists with the analysis of professional practices in some areas, for some teams, usually when there is a specific problem. Safety analysts must now have a specific diploma (university degree, master in risk management) including HF training.

In my experience, CRM has helped people to confront their points of view and realise that they were no different from others. From there on, adjustments can be made. Communication has improved inside teams and CRM is their favourite part of the program, although they said that the allocated time was too short. A limit of the CRM is the turnover inside the teams.

Initial training and cross training between students would be an interesting way to develop a cohesive culture (instead of the competition they experience in their studies). This could allow for greater cooperation between professionals.



HUMAN AND ORGANISATIONAL FACTORS (HOF) TRAINING IN NUCLEAR INDUSTRY: AN EXAMPLE FROM THE FRENCH ATOMIC ENERGY AND ALTERNATIVE ENERGIES COMMISSION (CEA)

By J.-F. Vautier, HOF specialist, coordinator of the HOF expert group of the CEA (French Atomic Energy and Alternative Energies Commission).

At the CEA (the French Atomic Energy and Alternative Energies Commission), HOF training is mainly designed for people working in safety departments or in facilities (like safety officers, field experts who run operations, e.g., the facility manager or a control room shift supervisor). We distinguish HOF training from resource management training. Resource management training include safety culture training, which develops in particular a questioning attitude, and a rigorous and prudent approach and communication from individuals. This training is based on provision of knowledge and experience-sharing among trainees.

Two basic kinds of HOF training may be mentioned:

- External HOF training, like a Masters in Human Factors or Ergonomics, are performed by universities. They are compulsory to become an HOF specialist in the CEA;
- Internal HOF training is mainly performed by the HOF specialists of the CEA. This training lasts from 1,5 hours to 3 days. When the duration is less than one day, it is a module included in a safety training session. When it is more than one day, the training session is only about HOF. The training is dedicated to HOF non-specialists called 'relays'.

The tasks performed by the HOF specialists and non-specialists are not the same. These tasks are indicated by safety policy documents. For example, 'relays' (non-specialists) perform an initial analysis of an unwanted event whilst the HOF specialists perform a more in-depth analysis. Other kinds of studies have to be performed by HOF specialists. For example, an in-depth HOF analysis has to be done for the ten-yearly safety re-examination of the facilities. In this case, the relay who works at the facility will have to explain the benefits of the results of the HOF study to the workers and introduce the HOF results in the safety documents of the facility.

An HOF training, whatever the duration, generally consists of a presentation and illustration of:

- HOF: "factors that influence human performance, such as competences, work environment, task characteristics, and organisation"
- human performance, especially errors and rule compliance behaviour;
- ways of studying HOF: e.g., first identify human performance, next the factors of work situations that may explain human performance, and finally the organisational factors and conditions that affect work situations.

Even if it is difficult to connect an investment such as HOF training to its effects, we have noticed an increased quality of event analysis for the last few years.