Competence Assessment of Air Traffic Controllers: A transition from Safety-I to Safety-II

Thesis/Project work submitted in partial fulfillment of the requirements for the MSc in Human Factors and System Safety

Anne-Mette Petri

Lund University
Sweden

Date of submission: 2015-09-24

COMPETENCE ASSESSMENT OF AIR TRAFFIC CONTROLLERS: A TRANSITION FROM SAFETY-I TO SAFETY-II

Anne-Mette Petri

Under supervision of Björn Erik Besserudhagen
and
Dr Anthony Smoker

ABSTRACT

The reality in terms of operational competence has changed. The past tradition of assessing procedural compliance of the individual Air Traffic Controller is today challenged in a dynamic and intractable socio-technical system like Air Traffic Management. Changes in technology and complex system interdependencies, call for an enhanced understanding of the interaction and coupling between the human operator and the system. As the skill sets change, new competencies emerge and the assessment or measurement of these must follow.

A study, using the framework of Grounded Theory, was conducted to explore the existing practice of the yearly competence assessment of Air Traffic Controllers. The purpose of this research was to examine if the compulsory competence assessment can be utilised as a means of transitioning from the individual centric approach that characterises today's competence assessment, towards a system centric view where the interaction between the Air Traffic Controller and the wider system is incorporated.

Sixteen semi-structured interviews, four of which were conducted as small focus group interviews, provided qualitative data for this research.

The study found a need for calibrating the traditional view of competence to encompass the many new functions of normal work. An enhanced six stage competence model was derived from the research data to ensure an augmented emphasis on understanding the daily activities of work. The six elements of the competence model are:

- Skill-based competence
- Knowledge-based competence
- Experience-based competence
- Adaptive competence
- Service-driven competence
- Social competence

The competence model represents a synthesis of individual and systemic based competence elements, as both approaches need to coexist within the concept of competence assessment.

This study advocates the importance of recognising Air Traffic Controllers as system informants to gain a comprehensive picture of the complexity of operational work. Assessment of competence is only meaningful if one understands the contextual parameters and practices of normal work.

PAGE LEFT INTENTIONALLY BLANK

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

ABBREVIATIONS

ANSP:	Air Navigation Service Provider
APP:	Approach
ATC:	Air Traffic Control
ATCO:	Air Traffic Controller
ATCC:	Air Traffic Control Center
ATM:	Air Traffic Management
EATMP:	European Air Traffic Management Programme
ECAC:	European Civil Aviation Conference
ESARR:	Eurocontrol Safety Regulatory Requirement
OSAR:	Operational Safety Request
OJTI:	On the Job Training Instructor
TWR:	Tower

1. INTRODUCTION

In April 2006, competence assessment of Air Traffic Controllers (ATCOs) became compulsory within the ECAC[1] area. ESARR 5[2] was enacted from previously being a recommendation made in 2003 to a mandatory EU Directive (2006/23/EC). All member states, as well as their operational ATC units, had to implement and follow ESARR 5. It became a requirement to have;

> Approved procedures to ensure the ongoing competence of their air traffic controllers, including a mechanism, based on operational experience or a competence checking system, or a combination of both, whereby controllers are monitored or regularly tested to ensure they maintain their competence (EUROCONTROL, 2002, p.11)

In many countries and for numerous Air Navigation Service Providers (ANSPs), competence assessment was, and still is today, approached in the traditional way of observing procedure and rule compliance to ensure desired performance by the individual ATCO. Focus is predominantly placed on monitoring and identifying non-standard performance due to errors in techniques, mainly technical or judgmental (Bosk, 2003). Failure to perform competently as a professional, a.k.a. competence in doubt, will preclude the privileges associated with the license from being exercised, and the ATCO will consequently be suspended from carrying out operational work.

The assessment of operational ATCO competence is commonly performed through the utilisation of either a *dedicated check* or as *continuous assessment* (EUROCONTROL, 2005). The dedicated check is a planned observation of the ATCO working with live traffic, in normal and representative traffic levels and complexity. The check is generally performed once a year and the monitoring timeframe varies from one hour up to several hours, depending upon traffic amount and unit work practices. Assessment can also run as a continuous assessment program, which entails assessing at regular intervals that are unknown to the ATCO. The continuous assessment can take place at any time and is in most cases conducted by a colleague, holding an assessor endorsement, who is also part of the normal working shift.

The two approaches are not only very different in the way they are conducted; they are also problematic in comparison hence the philosophies are not the same. These approaches are characteristic of the classical safety paradigm where strict rule compliance is used as a way of ensuring organisational control. Weichbrodt defines it as a behaviourist approach to organisational safety (2015). There is however an alternative safety paradigm that suggest a change in focus from stringent compliance to understanding the reality of the real world.

The purpose of this thesis is to investigate if competence assessment can be utilised as a method, to enable the transition from the traditional Safety-I approach of constraining performance variability and adaptation, into monitoring, understanding and managing both as intended in the Safety-II philosophy. These reflections form the basis of the thesis and research question:

Can competence assessment of air traffic controllers enable or facilitate a transition from Safety-I to Safety-II by recognising performance variability and adaptation?

---

[1] ECAC's mission is promotion of the continued development of a safe, efficient and sustainable European air transport system. ECAC seeks to harmonise civil aviation policies and practices amongst its 44 Member States.

[2] ESARR 5 sets out the general safety requirements for all ATM services' personnel responsible for safety related tasks within the provision of ATM services across the ECAC area

2. LITERATURE REVIEW

2.1 Competence in Air Traffic Control

The meaning and concept of competence is described elusively in ESARR 5 as "the required level of *knowledge, skills, experience* and where required, proficiency in English, to permit the safe and efficient provision of ATM services" (EUROCONTROL, 2002, p.8 – emphasis added).

Assessment of *knowledge*, declarative memory, is commonly done through a theoretical test. It can be a written or computer based test, or alternatively as a constructed scenario interview. The purpose of the scenario interview is to confirm understanding of all key objectives, as well as target areas which were not observed during the practical part of the assessment.

Skills, procedural memory, is assessed by monitoring the ATCO while working in position. The competence assessor is primarily observing the ATCO's skill- and rule-based performance (Rasmussen, 1983) in situations ranging from routine to familiar, and with a cognitive attention spanning from automatic to conscious. The knowledge-based performance as described by Rasmussen arises during "unfamiliar situations, faced with an environment for which no know-how or rules for control are available from previous encounters, the control of performance must move to a higher conceptual level, in which performance is goal-controlled and knowledge-based" (p.259). In the event that an emergency occurs, or if the situation is deemed unfamiliar or unusual to such an extent that the competence assessor decides to assist in handling the traffic, the assessment is officially cancelled. Assessment of skill should only be conducted in traffic complexity considered normal or representative for the unit.

ATCO operational experience is maintained in terms of competence by the following provisions within ESARR 5;

> The provider of air traffic services at its ATC unit(s) shall ensure that unit(s) have approved competence schemes to satisfy the requirement that controllers must maintain operational competence and experience. These procedures shall include requirements for controllers to:
>
> a) Complete a specified minimum number of controlling hours within a specified period on the sectors or operational positions for which they hold valid ratings;
> b) Be subject to an assessment of their continuing competence;
> c) Undertake periodical refresher and emergency training;
> d) Ensure operational competence after returning from extended periods of absence; (EUROCONTROL, 2002, p.13)

These four procedures are created to ensure that operational competence and experience is maintained. It is however difficult to generalise and quantify experience as something that is retained in these terms. The quality of the four procedures can vary and ultimately depend upon the focus, emphasis and purposefulness of the training or assessment.

Hutton & Klein (1999) presented a clear linkage between experience and the nature of expertise. They argued that developing expertise is experience dependent; "expertise is gained through participating in and experiencing many different situations" (p.35). They furthermore claim that;

> Experience allows the expert to visualize how a course of events is likely to unfold, so that s/he can form expectancies from the beginning. Experience allows

> one to notice when these expectancies are being violated, when something that was expected did not occur. Experience provides one with the ability to make finer perceptual discriminations, and to focus in on the relevant information while tuning out the noise, irrelevant, or unfruitful information and subsequent possible courses of action. (p.43)

Expectancy or expectation is a factor that is particularly relevant as it is connected to mental readiness. According to Weick & Sutcliffe (2007), every deliberate action is based on assumptions about how the environment will react and these assumptions will ultimately guide our behavioural choices. Expectations will suggest the probable course of event through attention guidance. Within competence assessment the notion of expectation could take various forms dependent upon the contextual setting of the assessment itself. ATCO actions and choices in the setting of a dedicated check will most likely be affected by the fact that the ATCO is being monitored and the performance is being assessed as well as measured against a standardised performance criteria. This additional awareness based upon assumptions related to the conditions of the assessment will be less dominant in a continuous assessment setting.

Another aspect examined by Hutton & Klein (1999) was the connection between skilled performance and the characteristics and development of expertise. They identified expert performance or expertise as;

- Vast domain-specific knowledge
- Understanding of large meaningful patterns and the ability of seeing "the invisible"
- Efficient and consistent performance due to skill automaticity
- Superior short-, long-term memory along with being attuned to the goal-relevant constraints in the environment
- Problem-solving at a deeper contextual level
- Strong self-monitoring skills
- Refined perceptual abilities, seeing;
    - Typicality
    - Distinctions
    - Antecedents and consequences

This development of expertise in a skill is contextualized by Hutton & Klein in the previously mentioned Rasmussen model. They maintain that "the acquisition of expertise can be described as a progression through these levels of conscious control with skill-based control characterizing the performance of an expert" (p.36).

Monitoring this type of expert performance would almost be meaningless if the sole purpose was to assess rule and procedure compliance. Another purpose which can be served by this form of monitoring of expert performance, is the understanding of everyday performance through the experience and expertise of the ATCO. This is by far more valuable and will offer greater organisational insight. Competence can take many forms and it is by no means a static skill set which can easily be monitored and measured. As technology advances and human-system integration increases, the skill pattern and nature of work will change and lead to an alteration in the patterns of expertise.

Ensuring a safe and efficient service provision is not based on compliance alone. The ability to anticipate and adapt is essential to ensure resilience within a socio-technical system like ATM. Branlat & Woods argue that "the resilience of a system corresponds to its adaptive capacity tuned to the future" (2010, p.30). It is therefore critical to include aspects like adaptive capacity in

competence assessment to foresee future challenges. Applying a Safety-II perspective could provide important information regarding performance variability, adaptation, performance adjustments and emergence. All of which are key elements in understanding normal work. (Hollnagel, 2014).

2.2 Safety-I and Safety-II

In "A Tale of Two Safeties" (Hollnagel, 2013a), the concept of two diverse safety management approaches, Safety-I and Safety-II, is introduced. Hollnagel argues that safety cannot be managed solely by applying a reactive approach, a mere response to failure. Today's tightly coupled systems require an enhanced focus on proactively ensuring that things go right.

Safety-I, according to Hollnagel, is epitomised by the traditional portrayal of safety as a state where the number of adverse outcomes is as low as possible. Attention is mainly placed on adverse outcomes and unacceptable risks that are assumed to have bimodal and identifiable causes. The human is predominantly viewed as fallible and liable. Hollnagel claims that;

> According to the logic of Safety-I, the goal - the coveted state of safety - can be achieved by constraining all kinds of performance variability. Examples of frequently used constraints are selection, strict training, barriers of various kinds, procedures, standardization, rules, and regulations (Hollnagel, 2013a, p.6)

Acceptable outcomes and a low number of adverse events are, in Safety-I, seen as the product of procedure compliance. Success is attained by conforming to the detailed description of Work-As-Imagined (Hollnagel, 2014).

Safety-II is defined as a condition where the number of successful outcomes is as high as possible. Focus is placed on ensuring things go right instead of preventing them from going wrong (Hollnagel, 2014). Outcomes are emergent rather than resultant and achieved through performance adjustments by the human operator. Performance variability is a key concept of system performance in Safety-II, and the human is recognized as an important asset to ensure system flexibility and resilience (Hollnagel, 2013a). Safety-II has its heart in the principle of equivalence i.e. success and failures as originate from the same set of actions taken within the system. Understanding emergent behaviours does not rely upon Work-As-Imagined i.e. procedures and rules, but on Work-As-Done.

Exploring the gap between Work-As-Imagined and Work-As-Done is essential to comprehend the complexity of normal work. Dekker argues that "For progress on safety, organizations must monitor and understand the reasons behind the gap between procedures and practice. Additionally, organizations must develop ways that support people's skill at judging when and how to adapt" (Dekker, 2003, p.235).

Kontogiannis & Malakis (2012) state that "Practitioners consider adaptation and interpretation of procedures to be an integral part of their work" (p.8). They furthermore suggest that the professional norms of the practitioner:

> … tend to value judgment rather than compliance to rules, confidence in their abilities to solve problems and reliance on teamwork to promote safety. Adaptation of rules and procedures is also affected by the social context of work and professional cultures (p.8)

Competence assessment, whether it is done as a dedicated check or as continuous assessment, is meant to identify the potential gap between procedures and practice. Identifying, however, does not include gaining an understanding of the context of the gap and the goal conflicts which frequently lead to rule violation. (Weichbrodt, 2015). The mind-set by which the competence assessment is conducted, determines if understanding and learning from discretionary judgements and adaptations are seen as core elements.

Adaptation and efficiency versus thoroughness aspects of individual judgment is described in Hollnagel's ETTO principle (Efficiency-Thoroughness Trade-Off). Hollnagel claims that "making such trade-offs is not only normal for humans and organisations, it is actually necessary" (Hollnagel, 2009, p.62). When people stop making trade-offs and work strictly according to all procedures, every rule and regulation, the organization will experience a loss of efficiency. "In extreme cases, 'work-to-rule' is referred to as malicious compliance" (Hollnagel, 2009, p.62).

Efficiency is related to getting the work done, accomplishing a task and ensuring productivity. Time, money and effort are critical factors in determining the amount of resources required to get the work done. Effectiveness, on the other hand, is primarily concerned with the quality output of the work and making sure that the right things are getting done. "Moving toward Safety-II means moving toward effectiveness rather than simply away from failure. By understanding effectiveness more holistically and clearly, it is possible to derive benefits beyond safety "(Shorrock, 2013). The aim of competence assessment is to assure the quality output of the work as well as understanding effectiveness. But in order to comprehend effectiveness, light must be shed on the principle of approximate adjustments (Hollnagel, 2014). Daily constraints and the underspecification of normal work necessitates performance variability and creates a precondition for approximate adjustments.

Rankin, Lundberg, Woltjer, Rollenhagen & Hollnagel (2013) point out that; "models and methods for systematically gathering knowledge regarding necessary adaptation are rarely seen in organizations today" (p.4). They claim an increased awareness of the adaptive strategies is necessary "to strengthen the organization's abilities to anticipate and monitor change" (p.5). They furthermore point out that "knowledge about performance variability is not commonly recognized as an asset, and informal solutions to systemic problems often go unnoticed by organizations" (p.4). Hollnagel exemplifies the connection between event probability and ease of perception in a distribution curve that can be viewed below in Figure 1.

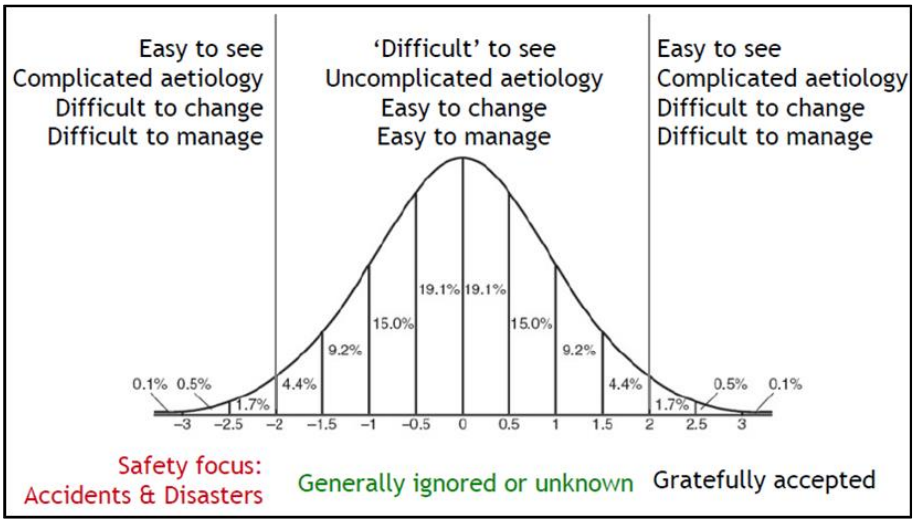


Figure 1. Relationship between event probability and ease of perception. Reprinted with permission (Hollnagel, 2015)

Traditionally the focus of competence assessment has been placed at the left tail of the distribution curve in Figure 1, where performance with a negative or non-standard outcome is commented upon and to a certain point also corrected. This embodies a Safety-I mind-set where procedural compliance takes precedence of appreciating the variability of normal work. A transition towards Safety-II within competence assessment would entail a shift in attention to also embrace the middle section of the distribution curve in Figure 1, as it represents the typical adjustments of performance needed to ensure effectiveness. Looking at performance as a whole, rather than solely searching for examples of non-compliance, will enhance the understanding of the everyday activities of normal work. Yet in order to be able to monitor the middle distribution, the ATCOs must feel confident and assured, that the management accept and support the intricate findings of normal work. Displaying Work-As-Done instead of a temporary version of Work-As-Imagined during a competence assessment, requires organisational willingness, openness and trust. Building organisational trust to ensure employee openness can be facilitated through a shift in focus, from exclusively monitoring and assessing the individual, to include a systems perspective.

In August 2014, a White Paper was issued by EUROCONTROL with the purpose of moving towards Safety-II. The aim was to increase and promote systems thinking through ten key principles. Understanding the nature of the interactions between the elements of the socio-technical system and the ten principles is seen as vital in terms of improving system performance. These principles can be divided further into four categories based on a system focus;

- People as part of the system
- System conditions
- System dynamics
- System outcomes

When referring to *system dynamics* in this thesis, it incorporates the notion of interactions between people, equipment and procedures along with the flow of work through the system. An additional aspect is the trade-offs made, in order to resolve goal conflicts and balance efficiency with thoroughness. Lastly the principle of performance variability is included to understand the variability of system conditions, demands and behaviour (EUROCONTROL, 2014).

The ten principles can be viewed below in Figure 2.

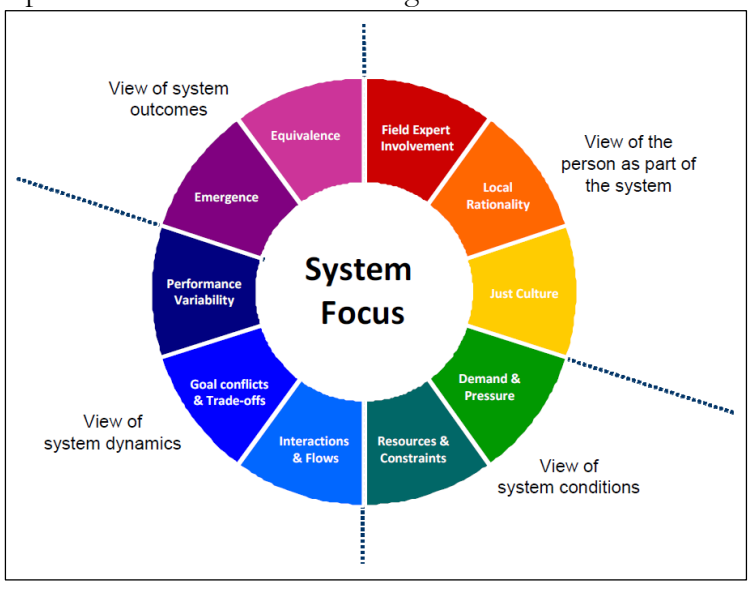


Figure 2. Ten principles of systems thinking. Reprinted with permission (Licu et al., 2013)

2.3 Why the need for a transition from Safety-I to Safety-II in competence assessment?

Competence assessment as seen from a Safety-I perspective is concerned with standardisation of the individual against the described procedures of Work-As-Imagined. The main purpose is to ensure the performance of the ATCO will not impose an unacceptable risk or potential hazard. In EUROCONTROL's Guidelines for Competence Assessment it is stated that;

> Competence assessment of controllers must be a genuine test of a controller's operational skill and knowledge. Although failure during competence assessment is expected to be a rare occurrence, the actual assessment must be seen by controllers as one in which they will not automatically be assessed as competent in respect of their performance. (EUROCONTROL, 2005, p.8)

This statement represents a view of work as it is described and proscribed in operations manuals, rules, procedures etc. It characterises Work-As-Imagined and is a static and formalised view or idea of what is expected in operational practices (Hollnagel, 2015). Placing focus on the individual in preference to understanding the systemic or procedural difficulties and daily trade-offs is counterproductive, and will never help in understanding Work-As-Done. Real world operational practice will almost certainly differ from the perspective of Work-As-Imagined as it relate to the availability of resources, serviceability of technical systems and constraints embedded in the system. Work-As-Done reflects the daily practice in a constantly changing work environment that constitute the features of normal work. Understanding everyday activities and the reason for their successful outcome is an essential aspect of Safety-II.

Safety-II as defined by Hollnagel (2014) focuses on performance variability and the principle of approximate adjustments which are common features of a complex socio-technical system such as Air Traffic Management (ATM). These features are ever present in the normal work of practitioners who frequently adjust their performance to match the conditions when time or resources are limited or underspecified. Since performance variability, performance adjustments and adaptation are typical structures of normal work, they are unquestionably worth exploring in order to gain a deeper awareness and understanding of how they manifests themselves in today's operation.

To date most of the literature concerning Safety-II is presented in the context of safety management. The Safety-II principles are however just as well-suited for competence assessment. Operationalising the Safety-II concept in the mandatory competence assessment scheme, would give accountable managers and the safety department access to a vast amount of information on how work is currently being carried out. Analysing data from incidents and accidents will undeniably still be of great importance to a safety department and exceedingly more useful, given this is consistent with the Safety-II philosophy. An example of this could be a combined parallel process of including competence assessors to monitor and gather information on how similar situations are being solved every day. With this kind of information, the organisation might begin to understand the context of the ATCOs performance adjustments. The ATCOs are daily using and navigating the system's adaptive capacity to ensure that things go right, therefore they should be seen and recognised as a resource to ensure flexibility within the system.

Hollnagel argues that performance variability is a strength rather than a liability, and that it is the humans' ability to overcome problems, that is the reason why socio-technical organisations function well in terms of both safety and productivity. He reasons that; "Since human performance can both enhance and detract from system safety (and quality), assessment methods must be able to address this duality" (Hollnagel, 2012, p.25). This supports the demand of

expanding the current assessment method to include new skills and explore the dynamic patterns of expertise. The structure of what to look for is essential and should include aspects like adaptive strategies and performance variability. The prevailing approach in many countries is exclusively based upon Safety-I and requires a further development as it is reactive only. It is similarly important to understand that the suggested approach will be different from traditional observational techniques like; Normal Operation Safety Survey (NOSS) and Day to Day Safety Survey (D2D), as the philosophy will not be a framework of threat and error management as encompassed in the EUROCONTROL white paper of Observational Safety Surveys (EUROCONTROL, 2011).

Observing normal work could be a wide-ranging and very costly approach, unless it is possible to utilise a method or platform which is already in place. The compulsory competence assessment of ATCOs could provide such a framework if appropriately adapted to the Safety-II philosophy. With the purpose of understanding necessary performance adjustments in an intractable system, with fluctuating production pressures, varying demands and frequent goal-conflicts, it is increasingly important to place focus on the system as a whole, and not solely on the performance of the individual practitioner acting within the system. Exploring how and why ATCOs adjust their performance is essential if an organisation is interested in, and attentive towards the complexity of normal work. An organisational benefit of increasing the attentiveness towards the intricacy of normal work or Work-As-Done, is the potential to sustain or even increase the effectiveness of the system as a whole.

Developing a Competence Assessment Scheme that is able to both monitor successes and failures of normal work, in addition to the constantly changing delta between Wok-As-Imagined and Work-As-Done, would unquestionably improve the organisation's ability to succeed under varying conditions. Broadening the target of competence assessment from individual depth to a systemic breadth could facilitate the transition from Safety-I towards a Safety-II perspective. Investigating how to respectfully combine Safety-I &-II thinking in assessment, could perchance assist in understanding the gap between procedures and practice. The competence assessment could represent a method or a model for systematically gathering knowledge regarding necessary adaptations and performance variability, as called upon by Dekker (2003) & Rankin et al. (2013). The findings may possibly help us comprehend how adaptation of rules and procedures is affected by the social context of work and professional cultures as suggested by Kontogiannis & Malakis (2012) and Weichbrodt (2015).

Six important features of Safety-II were identified as a result of this literature review:

- Why things go right
- Work-As-Done
- Approximate adjustments
- Performance variability
- People as a resource to ensure flexibility
- Trade-offs

In the following Result & Analysis section, the aim is to enhance understanding of these six features as viewed in the context of competence assessment of ATCOs.

3. METHOD

3.1 Designing the research approach

This qualitative study used the framework of Grounded theory to allow a consistent comparative analysis (Glaser & Strauss, 1967) throughout the data collection process. The aim was to closely examine the current practice of the yearly competence assessment of Air Traffic Controllers, both as a concept and an operational process. According to Strauss & Corbin (1998), theory development and explaining practice is grounded in data from informants who have experienced the process themselves.

The purpose of the research was to examine to what extent Safety-II is incorporated in today's competence assessment through the specific perspective of performance variability and adaptation. Triangulation of data collected from three European ATC units, with different assessment approaches, methods and philosophies, provided a basis from which it was possible to explore the complexity of competence assessment and the research question of this thesis.

3.2 ATC units and their assessment methodology

The ATC units were carefully selected to represent three diverse approaches to competence assessment and to ensure breadth in the data. In addition to the imperative variance in assessment philosophy, the chosen units correspondingly represented three different types and sizes of organisations. An overview of the units and their characteristics are presented in Table 1. The units are:

- Vienna Approach, part of Austro Control
- Malmö ATCC, a NUAC upper area center in Sweden
- Inverness Tower, part of the HIAL group in Scotland

All three organisations are following and complying with the Competence Assessment Scheme recommendations issued by Eurocontrol.

Table 1. Unit characteristics pertaining to competence assessment

	Vienna Approach	**Malmö ATCC**	**Inverness TWR**
Unit size	Medium (50 ATCOs)	Big (180 ATCOs)	Small (13 ATCOs)
Assessment methodology	Continuous assessment (Was introduced February 2014)	Dedicated check	A combination of dedicated check and continuous assessment
Method enactment	Unit assessors are working as ATCOs and are a normal part of the shift. There are no targeted days for observation, it is a holistic impression of the ATCO's work.	One yearly dedicated check (2 times 1 hour working in position covering the executive and planner position)	One yearly dedicated check and a monthly check either monitoring in position or pulling a sample from R/T and radar readouts.
Briefing	No	Yes	Yes, preceding the dedicated check. Not in conjunction with the monthly sampling
Debriefing	No (Unless the assessor has observed something that needs to be discussed)	Yes	Yes, after the dedicated check. A written feedback form is generated after the monthly sampling.

3.3 Informants

The informants of this study were at the time of the thesis research all directly or indirectly involved in the Competence Assessment Scheme and were thus selected to represent the following four categories from each of the three ATC units;

- Air Traffic Controllers (ATCOs)
- Competence Assessors
- Management
- Safety Manager(s)

The structure of using informants from these four diverse groupings was designed so in order to comprehend the concept of competence assessment as it is perceived by not only each individual but also the group as a whole. Group demography in terms of gender and experience can be viewed in Table 2.

Table 2. Informant group demography on gender and experience

	Total number	Female	Male	Experience span within ATC
ATCOs	9	2	7	From 4 – 25 years
Assessors	4	1	3	From 22 – 20 years
Managers	5	0	4	From 16 – 35 years
Safety Managers	2	0	4	From 19 – 24 years

3.4 Data collection

16 semi-structured interviews were conducted in order to obtain qualitative data. The format of semi-structured interviews provided a framework that allowed an almost identical set of questions to all informants as well as enabling the coding process (Stake, 2010). The flexible structure and the use of open-ended questions, facilitated exploration in areas of particular interest for the interviewee(s). To obtain affirmation or exclusion of certain essential research topics, this researcher included a number of closed questions to ensure reliability of the data. All closed questions had follow up question to guarantee an elaborated or in depth answer.

Four of the interviews were conducted as small focus group interviews, with two informants, to create a safe experience and accommodate individuals who could prefer to discuss issues within a group (Blaxter, Hughes & Tight, 2010). In order to be able to determine how strongly my informants hold an opinion, meaning the relative emphasis on an issue, it was decided not to mix the four group categories. An additional reason was the importance of ensuring good group dynamics when discussing sensitive group specific matters. The 16 interviews were divided between the three units and the four group categories as indicated in table 3. In total this study included and interviewed 20 informants.

Table 3. Interview overview

Unit	Competence Assessors	ATCOs	Management	Safety Managers
Malmö ATCC	1 (FG)	1 (FG)	2 (II)	N/A[2]
Vienna APP	1 (II)	2 (FG)	1 (II)	1 (II)
Inverness TWR[1]	1 (II)	3 (II)	2 (II)	1 (II)

II = Individual Interview, FG = Focus group, N/A = Not applicable.

[1]Note: In Inverness it was not possible to conduct focus group interviews due to staff shortage.

[2]Note: In Malmö the function of the Safety Manager is fulfilled by the Manager Operations ATCC Malmö.

3.5 Interviews

All interviews were conducted on site in each of the three countries between September 17th and November 12th 2014. Prior to commencing the interview the participants were informed of the aim and scope of the research project. The structure of the interview was explained and acceptance for voice recording was given. Their willingness to participate was confirmed and an informed consent form was signed. An example of the informed consent form can be found in Appendix 1.

The duration of the interviews ranged between 1 to 1½ hours. All interviews were recorded by the use of a Dictaphone and later transcribed and categorised using an Excel spreadsheet for each of the informant categories. Three of the four Swedish interviews were translated into English as a number of informants preferred to conduct the interview in their own mother tongue.

A standardised interview guide (Brinkmann & Kvale, 2015) was created to cater all four informant categories. The content of this uniform questionnaire covered;

- The introduction of the research project
- Informant background
- Generic questions which were applicable for all informants
- Closing remarks

Unit and category specific questions were added to cover significant domain themes and perspectives. The interview guides were updated and revised in between field visits to avoid collecting useless data or to ensure the right questions were being asked. This is in line with Czarniawska (2014), and recommended practice for interviews based upon Grounded theory. All interview guides can be found in Appendix 2 – 12.

Two pictures were included and used as part of the interview guide. The first picture titled "The boxes" was used to investigate the informant's perception of the unit's competence assessment approach or methodology. The data collected during this discussion is presented in depth in the result & analysis section (4.2 Competence assessment as of today).

The second picture titled "The assessment environment" was meant to explore the perceived purpose of Competence Assessment and place it in context with different approaches to competence assessment. The data obtained during the discussions did not indicate any specific patterns or themes and consequently the question was not pursued any further. Both pictures can be found in Appendix 13 and 14.

3.6 Ethical considerations

The research of this study was facilitated by the management of all three units as they showed a real interest and provided access to staff and relevant documentation. Acceptance and approval were given to publish the findings in the format required by Lund's University.

Participation in the study was voluntarily and all interviews were performed during the informants working hours. The informants was informed of the purpose and nature of the interview as well as the contextual use of their involvement. It was explained that statements and quotes will be anonymized to ensure confidentiality. Within certain group categories, the sample size was too small to ensure anonymity, hence an agreement was made with the informant to review and approve the quote or statement. All informants were presented with and signed an

informed consent form adhering to the layout and guidelines issued by Lund's University (Appendix 1). The investigator of this study co-signed the consent forms and a copy of each is stored with all the research data.

3.7 Coding and data analysis

The coding and analysis of data were influenced by Grounded Theory (Glaser & Strauss, 1967), (Strauss & Corbin, 1998) and (Corbin & Strauss, 2008). The analysis process commenced with *open coding* of the data to find the main categories of information. The data was investigated thoroughly and codes representing various themes, were generated to catalogue the embedded messages in the data.

The following phase consisted of *axial coding* where the concept and view of competence emerged as a core phenomenon in accordance with Creswell's depiction (2007). During the axial coding, three main themes related to competence were identified as essential categories closely connected to the core phenomenon of competence. The three themes are; Competence - a versatile concept, Competence Assessment as of today and Competence Assessment in consonance with Safety-II. These themes are all related to, or affected by what Creswell (2007) describe as;

- Causal conditions; *what factors caused the core phenomenon*
- Strategies; *actions taken in response to the core phenomenon*
- Contextual & Intervening conditions; *broad and specific situational factors that influence the strategies*
- Consequences; *outcome of strategies* (p.64 & 65)

The three competence themes are analysed and viewed through Safety-I and Safety-II strategies, conditions and consequences in the Result & Analysis section.

The third and the last phase was the *selection coding*. This process consisted of verifying and identifying relationships and patterns across different subsets of data. The findings resulted in an enhanced competence model based on a synthesis of Safety-I and Safety-II principles.

3.8 Validity

The thesis research used a set of data collected from three ATC units, representing different ANSPs in three European countries. There are undeniably many more ATC units and ANSPs in Europe, which could add more detail and variety to the investigation of today's competence assessment methods and approaches. However, in order to keep this research within the framework of a thesis, the number of units were deliberately set to three to cater for the three well-know and accepted assessment methods;

- Dedicated check
- Continuous assessment
- A combination of dedicated check and continuous assessment

The ANSPs and units were cautiously selected to represent a reliable cross section of ANSPs in Europe.

4. RESULTS & ANALYSIS

Inspired by Grounded Theory and the use of Open coding (Corbin & Strauss, 2008) and Axial coding (Creswell, 2007), three main themes were identified as relevant for the exploration of the thesis question:

- Competence - a versatile concept
- Competence Assessment as of today
- Competence and competence assessment in consonance with Safety-II

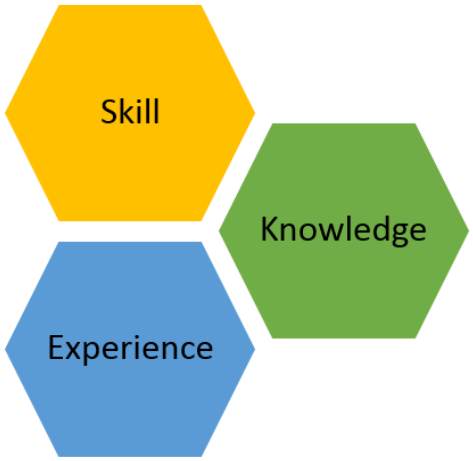
The properties and dimensions of these three themes were closely examined by the use of exploratory questions, some of which were derived from the interview guide, others emerged during the open coding process of the 16 transcripts. The conception of the themes emerged from the statements of the 20 participants. Each of these themes will be explored and analysed in depth.

4.1 Competence - a versatile concept

In order to comprehend competence both as a concept and as something which can be measured, the word in itself had to be defined by the informants. It was critical to understand competence as seen through their lens of interpretation. The intention was to investigate if there would be a clear and common view of competence, and to examine if essential elements are absent in the existing definition of competence.

All informants were asked to define or describe competence, along with the means of measurement. The statements were sorted according to group category before being coded and analysed. During the coding process, the informants' view of competence was examined and initially categorised according to the traditional ESARR 5 (2002) classification of Skill, Knowledge and Experience.

Figure 3. Competence model according to ESARR 5



These three elements of competence were given a colour code to facilitate the coding and analysis process. Statements covering Skill-based competence were underlined in yellow, Knowledge-based in green and Experience-based in blue. Despite an emerging pattern among the statements, numerous descriptions and definitions of competence were still not compatible with any of the above.

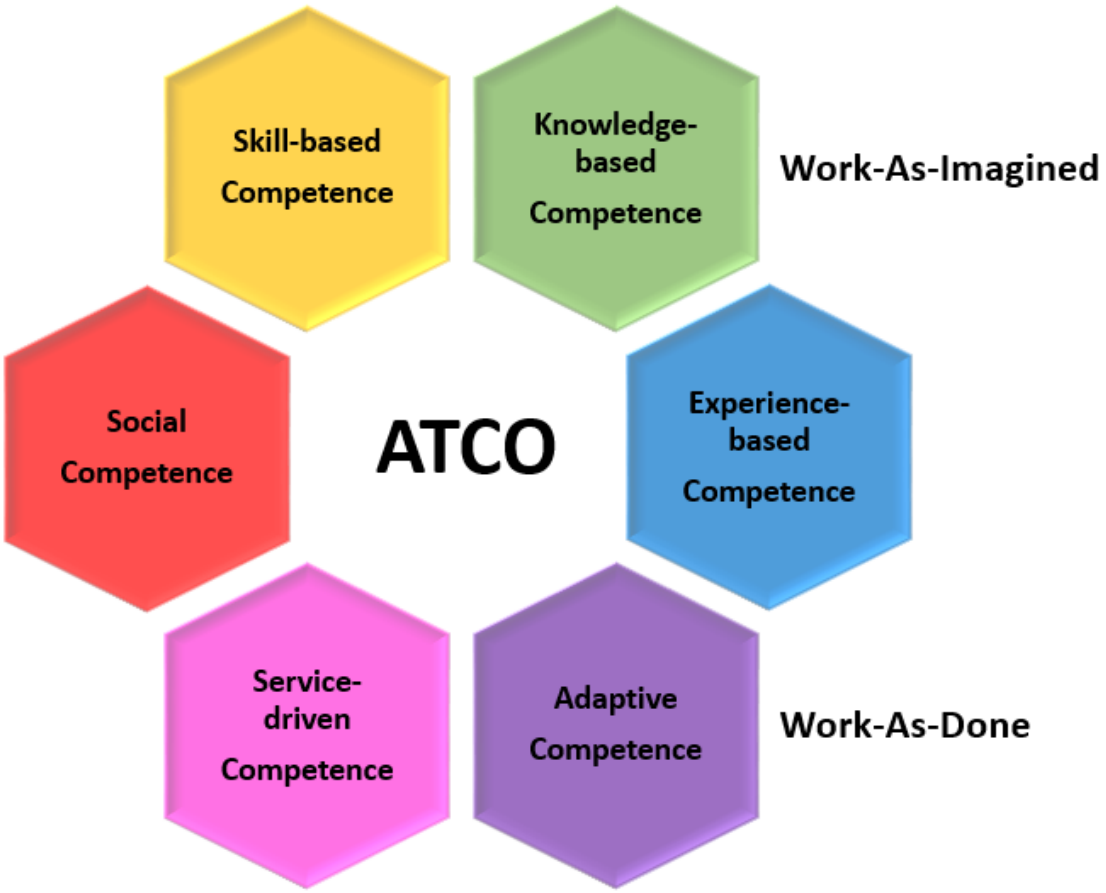
The next and the fourth element of competence to be recognised, was the need for Social competence. The associated comments advocating social skills and team work, were given the colour red.

A theme that emerged from the informants' statements, was the significance of flexibility and the ability to adapt. This theme included workarounds and adapting to unusual circumstances. Though these might feature in the experience and skill element of the competence model, the weight the informants gave to these aspects, justified consideration of a separate category of its own. For that reason it was decided to include a fifth competence element, namely *Adaptive* competence.

There still remained a body of informant responses which could not be categorised. Many of the statements were found to be linked to the features of the operational environment, e.g. the requirement of providing a high level of service, supporting flight efficiency or being able to work at a 'normal' speed. A sixth element labelled *Service-driven* competence was therfore created to accommodate the emphasis placed on service and efficiency as being an important part of ATCO competence.

The data analysis resulted in an expanded competence model with six elements. Three new elements emerged from the statements of the informants. The six stage competence model represents a synthesis of the ESARR 5 definition of competence and the data provided by the informants. The new model was adapted to also include a view where Work-As-Imagined and Work-As-Done has relevance.

Figure 4. The six stage competence model



Coding the data according to the six stage model revealed a far more complicated picture of what competence involves than the traditional approach to competence. The colour coded data used to define the six stage competence model can be found in appendix 15 "Competence – coding of data".

4.1.1 Skill-based competence

The ATCOs' depiction of skill-based competence is mainly concerned with the aptitude of doing the craft you have been trained and tasked to do. It is the hands-on aspect of operational work. One of the ATCO informants noted that the individual ATCO bears responsibility to "ensure that you are equipped to do so" (Informant 4, ATCO). An interesting remark made by another informant was that one "should obey the rules where it is necessary and know when to break a rule" (Informant 1, ATCO). The skill-based competence in this example is not the knowledge part of the rule, but the enactment of complying and deviating when needed. In the current competence assessment scheme the Skill-based competence is being measured according to compliance. However the statement provided by the ATCO informant disclose that compliance is only seen as one part of Skill-based competence.

When analysing the statements from the assessor informants the notion of skill was only described in very general terms such as "the ability to do the work in a safe and in a good way" (Informant 7, Assessor), or "the ability to undertake one's chosen role to an acceptable standard" (Informant 9, Assessor).

The management informants referred to skill-based competence as the ability to perform a function. This was exemplified as working with the procedures and converting theory into practice. A manager added a thought-provoking statement regarding his role in assuring a suitable environment;

> That I as a manager has created an environment where I have ensured that his workspace and the development I have given him, the people he works with, the equipment he uses all comes together where he can apply his skills (Informant 13, Management).

Seen from a two dimensional angle the skill-based competence is not only personified in the ATCO, the management play an important role in facilitating the enactment of the ATCOs' skills.

The statements of the safety managers which related to skill were a mixture of tangible examples like; phraseology, application of procedures and management of de-conflicting minima. As well as a generalised view of "acting and delivering in exactly the same way as you've been trained to do" (Informant 16, Safety Manager). This viewpoint may well signpost a Safety-I aka Work-As-Imagined interpretation of required ATCO competence.

4.1.2 Knowledge-based competence

When describing competence, many of the ATCOs associate it with theoretical knowledge and the regulatory requirements. Knowing, as well as complying with the rules and procedures is seen as a way of ensuring standardisation. Knowledge is similarly referred to as "knowing where the boundaries lie – pushing to the boundaries, but never exceeding them" (Informant 6, ATCO). An aspect which was linked to the knowledge-based competence, was the requirement of ensuring that one is up-to-date with any changes going on.

The numerous changes within the governing framework was mentioned by the assessors as an add-on to the complexity of the operational environment. They recognise theoretical knowledge as being an essential part of competence, still it was also stated that "it is not just the new rules you need to keep up with" (Informant 8, Assessor). Knowing the rules is not sufficient, the application of the rules is essential for competence. This statement is further elaborated in the section describing Adaptive competence.

The Management concur in terms of knowing and working in accordance with the requirements of the legislation. They correspondingly lay emphasis on the necessity of being "well-prepared and well-read within the required subject matters" (Informant 12, Management).

One of the statements given by a safety manager could be associated with knowledge-based competence, as this pertain to the correctness of performing the previously described examples of skill-based competence; "Correct R/T phraseology, correct application of procedures" (Informant 16, Safety Manager).

4.1.3 Experience-based competence

Competence was labelled by one ATCO as "the ability to use previous experience to safely manage any given situation to the best possible outcome for that situation" (Informant 6, ATCO). Another informant stated that "you must have enough experience" (Informant 2, ATCO). This statement is fascinating, as it can be seen as supporting the previous quote by stressing the significance of using experience to safely navigate the operational environment. The same ATCO revealed that "The first year is very hard. You are often afraid since you do not know how to manage difficult traffic situations. You don't have the experience and you don't really know how it works" (Informant 2, ATCO).

The assessors recognise the impact of experience and relates this with working part-time, along with the importance of feeling "comfortable and confident while working" (Informant 8, Assessor).

One of the management informants talks about the "background to interpret" information laid out in procedures (Informant 14, Management). Having a background to interpret can only come from experience and thereby confirm the relevance. It furthermore point towards underspecification of procedures, which is a core characteristic of complex systems. This comment combined with the ATCO statements provide insight into the way that knowledge and experience is treated in the competence assessment scheme and there is evidence that it goes beyond a compliance based system.

A safety manager described competence as; "you will get more competent with more routine, with more experience. Competence is an ongoing process it never stops" (Informant 15, Safety Manager).

4.1.4 Social competence

Social competence stands out from the original ESARR 5 derived competence elements, as something needed to be added to categorise the informants' responses.

When defining competence, an insinuation of social aptitude materialised in all informant groups. Cooperation, teamwork, helpfulness and social skills were mentioned by the ATCO informants.

"It is also about cooperation and teamwork, that you help each other" (Informant 3, ATCO). "You need to get on with people you work with" (Informant 5, ATCO).

Personality, rapport and fitting into the team were added by the assessors. "You have to fit in socially and be able to adapt since you work with many different colleagues" (Informant 8, Assessor).

Management equally saw the social part and team interaction as being important. A manager characterised the cooperation between the ATCOs and the management as being a core competence; "being able to interact with the management of the unit and feel open and honest in relation to incident and accident investigation" (Informant 14, Management).

4.1.5 Adaptive competence

This competence element was added on account of the informants' emphasis on the capabilities of flexibility and adapting to workarounds or unusual circumstances. The addition of this category was supported not only by the statements unfolding competence, it was reinforced by data pertaining to the operational environment and questions connected to performance adjustments and adaptations. Adaptive competence is particularly interesting as it is currently not present in any of the reviewed competence assessment schemes. Consequently the element of Adaptive competence will be explored more in depth and quotes belonging to the operational environment will be included to illustrate the influence the operational environment has upon competence.

Flexibility and the ability to adapt were described by the ATCO informants as core competencies. This was expressed both in regard to the regulatory framework and the quickly changing circumstances of ATC, such as an unusual situation or an emergency. Rule compliance was by an ATCO contrasted with rule breaking or rule adaptation to gain potential safety benefits; "you should know when to break a rule. Don't misunderstand me but you should know when you have to do something to adapt the rules if there is a benefit for safety" (Informant 1, ATCO). Safety is seen as the hard target, adapting the rules to ensure safety appears to belong to the ATCO's discretionary space.

The Assessor informants added the perspective of adaptability in terms of working with different colleagues and unofficial workarounds or best practices; "it is not just the new rules you need to keep up with, there can also be workarounds and best practices to make it smoother and this might not be written down anywhere" (Informant 8, Assessor).

The statements provided by management are very much aligned with the ATCOs. Flexibility, the ability to adapt and dealing with unusual circumstances were correspondingly defined as core competencies required when handling traffic.

There is an importance of this element that brings new understanding to what competence means and entails. What follows is a more in depth discussion to clarify the relationship to the operational environment.

When exploring the operational environment the ATCOs work in, there were several aspects which came into play. One of these was the perception of the operational environment in terms of stability and improvisation. All ATCOs described the environment as being stable and mostly routine except during special weather phenomenon like thunderstorms or for the period of busy summer traffic. One of the ATCOs described it in the following way; "It seems like it is a little of

both (stable and need for improvisation). You build everything upon experience and routine, still you need to adapt your decisions" (Informant 3, ATCO).

Two assessors defined the operational environment as: "Challenging at times but mostly routine. The challenges are similar and quite repetitive. People are seeing these situations regularly, they can be momentarily challenging, but they are fairly predictable and with experience quite manageable" (Informant 9, Assessor).

"Mostly routine, however the traffic situations vary everyday so you may need to come up with different solutions" (Informant 8, Assessor).

Seen from a management perspective the environment can to some degree be defined as stable, however the need for flexibility can create situations of instability;

> It's pretty stable. Air traffic control always demands a certain degree of flexibility and unforeseen situations, but for the most times it's fairly stable. *You can say we are in a stable condition of instability*. With that I mean that we now have free route airspace. We drive traffic direct exit points from the area of responsibility (or neighbours area of responsibility) and we have these different agreements how we handle this traffic. So we have during the last five years created traffic patterns so they are not flying airways anymore, they are flying direct everywhere. So we have created an unstable traffic picture and that is ordinary work for us - that is an ordinary day. It is a new way of working, you almost work in the upper sector as you do in the lower sector, even in the TMAs. You are working more actively with the traffic" (Informant 11, Management, emphasis added).

In Inverness the nearby location of one of the main UK RAF airbases (Lossiemouth) is described by management as an additional operational challenge;

> We have a very busy military airfield adjacent to us here, there's a lot of activity and very fast moving aircraft, and in fact our own radar can't even cope with it sometimes. So controllers do have to stay sharp (Informant 14, Management).

Additional aspects which are central in understanding the operational environment, and the notion of normal work, is the frequency of performance adjustments and adaptations. The ATCO group were in agreement that adjustments and adaptations occur regularly; "Daily I would say. On every shift you have an element of that" (Informant 4, ATCO).

"We do adjustments every day. It can be small changes which are used to get the traffic more expeditiously and fluently, so these are adjustments and we only do them when we have time to do them" (Informant 1, ATCO).

"Daily, - it is rather complex. It seems like it is very often, especially due to the military activity" (Informant 3, ATCO)

The group of assessors agree that adjustments and adaptations take place every day;

> You adapt every day and every situation is unique in some way. They are of course similar otherwise you could not handle them, but I would say that you need to adjust on a daily basis, there is always something that is a little bit different (Informant 7, Assessor).

In addition to this confirmation the assessor informants add the perspective of flexibility both within and outside the procedural framework during a competence assessment;

> I think it is still quite efficient and flexible despite following the rules. However if you are being assessed, and you need to do some adjustments which are outside the procedures, then they would comment and explain why they have chosen to do so. I generally think it works really well, and it is seldom we need to bypass the rules. Yet we do see different solutions and variations (Informant 8, Assessor).

Management consistently confirmed the frequency of performance adjustments and adaptations. An interesting holistic perspective was added as several of the managers showed acceptance and understanding of;

- Adaptations which at times disregard procedures, if safety is ensured
- System adaptations
- Adaptability as the core of the ATC profession

> It happens on a daily basis. Some procedures are quite strict, they have to be. You have to know what you are allowed /not allowed to do. I think adaptations are part of a common way to work and no one would criticise that, not even the assessor would blame the colleague, since you know it is a common way, you know it is against procedures, but it is safe (Informant 10, Management).

> I think it happens daily. It's both the traffic situations and then again if you adapt one day to a certain thing, then it's added to your experience-bank and then you know how to handle the situation. Maybe there are not new events every day, but they have to judge things from a non-structural traffic pattern. But what they have to adapt to in an even greater extend is how the system is running. They have to adapt towards which functions you have in the system and which functions aren't working, or how it was supposed to work. We call that workarounds and we have quite a few of those (Informant 11, Management).

"It's part of normal work to adapt to the current situation! You of course have a regulatory platform which both can serve as support and hindrance. Adaptability is the profession of air traffic control. You do this daily" (Informant 12, Management).

The last aspect which is essential when exploring the operational environment is the ability to anticipate or foresee situations which will demand some kind of adjustment, customisation or adaptation. The ATCO informants mention *experience* as a key element in developing a bag or a kit of tools to cope with the needed adjustments and adaptations:

> With experience you get to know what options that are available to you. Maybe you don't know what option you are going to use until the last minute, but with experience you'll have a bag of tools. The need for adjusting the performance is usually due to expedition, of course within the realms of safety (Informant 4, ATCO).

> There are no answers. As long as you have the complete kit of tools, then you can adapt to every situation. But there are no, or very few definitive answers in air traffic. That is always one of the issues with trainees. You get trainees who are able to adapt and you get trainees that want the solution. The ones that want a solution are never going to make it as controllers, because there is not a solution.

> You can't write down what to do in that situation because that situation, with those exact timings is never ever going to happen again and the answer is different if anyone factor changes at all (Informant 6, ATCO).

An assessor adds that: "Sometimes they are very predictable and sometimes you cannot prepare like emergency situations or various weather situations" (Informant 7, Assessor).

Management concur regarding the relationship between predictability and experience and refers to it as being proportional; "The longer you work with it, the more predictable it gets. You tend to know what the routes are for the fast jets etc. They are not written anywhere, but experience tells you" (Informant 13, Management).

One of the management informants adds an interesting perspective regarding the ATCOs necessity for adjusting or adapting to a specific situation, and the drawback this may hold; "The systematic ones you can prepare for by learning new methods and so on. But the amount of workarounds is keeping back a capacity increase I would think. It is manageable, but there are quite a few" (Informant 11, Management).

It was essential to triangulate the data regarding the operational environment as the informant groups view it from different angles and with dissimilar goals to be achieved. The data did however display a shared understanding of the current challenges entrenched in the operational environment. All informants describe the environment as being stable and mainly routine, though a need for improvisation is emphasised as the everyday variation demands a difference in solutions. Experience and routine facilitates the predictability, the adaptation and handling of challenging events. A management informant exemplifies an operational challenge with fast moving aircraft, as something the radar can't cope with – so the ATCO has to stay sharp. Coping with this kind of complexity requires adaptation and flexibility. The effects and consequences of flexibility was mentioned by another manager as a potential source for creating not only instability, but a "stable condition of instability" (Informant 11, Management). Having an unstable traffic picture was described as ordinary work, on an ordinary day and accentuates the need for performance adjustments and adaptations.

All informant categories confirmed adjustments and adaptations as a daily and vital part of operational work. If adjustments and adaptations are considered an accepted practice, then a fundamental query would be to explore whether we presently accommodate this in the competence assessment scheme. The quest will most likely end up empty-handed as the traditional competence assessment scheme is created from a safety-I perspective of compliance and procedural adherence. According to Hollnagel, Safety-I regards the role of performance variability to be harmful and should be prevented as far as possible. Safety-II on the other hand sees it as inevitable but also useful, it is something which should be monitored and managed (2014). The only way to monitor and understand adjustments and adaptations is if they can be seen as required constituents in a model used to encompass competence. In the six stage competence model this capability was included and labelled: *Adaptive competence.*

4.1.6 Service-driven competence

Service-driven competence was added due to the informants' weight on capabilities additional to the aspect of working safely. Being service oriented and delivering a high level of service appeared to be the driver for working efficient and expeditiously. As with Adaptive competence, the Service-driven competence element was correspondingly supported by data extracted from

statements belonging to inquiries on operational trade-offs. Quotes are added from this area to ensure a thorough data analysis of this new element of competence.

"Competence is not only to work safe, though safe is very important in our job. For competence it is also necessary to work in a normal speed" (Informant 2, ATCO). This statement was expressed by an ATCO and it specifies, that working safe is only one element of ATCO competency.

An assessor informant raised the same issue and added the dimension of working too fast and expeditiously or too slow:

> On one side I have the impression that competence in our unit is to work fast and expeditiously. But that doesn't necessarily mean that you are competent. Because if it's fast and expeditious it's possible that it's not safe. On the other side if someone is working according to the book, according to the rules but not fast enough, then he's incompetent because he's slowing down the whole process" (Informant 7, Assessor).

This of course characterise the outer parameters of acceptable performance, nevertheless it supports a statement made by another assessor that there are best practices for making things smoother.

Service related competence was by management termed as a "common way to work" (Informant 10, Management), "service that has a continuous high standard rather than peaks" (Informant 13, Management) and a consistent "level of service provision" (Informant 14, Management).

An important aspect associated with Work-As-Done is the trade-off between efficiency and thoroughness. Hollnagel argues that "for a recurrent work situation most people will naturally choose the more efficient mode of operation as long as it, in their experience, is just as safe as the alternative" (2009, p.15). The question is whether this is perceived by the informants to be true or not. If it is so, then to what extent would the ATCOs use a trade-off during a competence assessment?

The following quotes from the informants are their words and views on the operational reality of working with trade-off whilst sustaining service delivery:

> I would rate myself more at the efficient way, safe but rather efficient than to obey every rule till the end. If you turn an aircraft 5 nm before your sector boundary, where you know 99%, I can turn this aircraft without release from my colleague, then I will do it because it is a shortcut, it's more efficient and we are service orientated here. If we are not obeying to the rules exactly, then it is just to get it more efficient, nothing else. Whether I would do the same during an assessment, it would depend on who is sitting beside me (Informant 1, ATCO).

"When we have a bad weather situation we are not efficient, we try to work safe" (Informant 2, ATCO).

> One situation which I think is quite typical, and I think most do this - is when an aircraft checks in on your frequency and it has not crossed the boundary yet, but you turn it directly so you don't have to get back to it later. You save a lot of time

and it prevents you from forgetting it. It varies whether you would do this during an assessment, it depends (Informant 3, ATCO).

That is the point of the hotspot (feeder/director position) which came from the management. I think it is very often that people tend to make the most efficient spacing and the line-ups are not so good anymore. I often observe in bad weather situations like tricky wind situations and during lots of rain and so on, that only to fulfil the minimum distance, they turn them in much too early and much too high and much too fast. That is the problem we have identified. We are drilled to handle as much traffic as possible but there are times where it is better to be more thorough (Informant 7, Assessor).

It doesn't happen too often, but where you might see it is on radar if you have a sequence of inbound traffic where they can overload the R/T and add instructions to be efficient. The pilots might not pick up everything, so you have lost the efficiency (Informant 9, Assessor).

Going from low to high traffic flow, can make the assesse forget that we are there. It is noticeable that they increase their pace and that is of course very positive. That is probably the best example of going from thorough to efficient. Certain weather situations like thunderstorms and CBs will make everything much more difficult. It is however stated that we shall conduct the assessment during normal traffic, so we can stop and cancel the assessment if we deem it to be outside the parameters of what constitutes as normal traffic (Informant 8, Assessor).

On the subject of actually making a trade-off whilst undertaking an operational competence assessment, the informants said;

"They would have to do some adaptions. But they would not break/bend procedures or rules on a dedicated check" (Informant 7, Assessor).

Mostly yes actually, and this is where I like to think the sampling we have got is contributing to this. People are very aware that if they are not consistent in their actions and correct, then this will be picked up (Informant 9, Assessor).

When we are talking about balancing safety with expedition, at the end of the day we are running a business. So every aircraft on the ground and off the ground on schedule and on time paints a good image of the airport, therefore it enhances the business opportunities. But I do not think procedures are stretched to allow this to happen. Because it's a unique environment, everyone is a civil servant. All airports are subsidised as part of the socio development of the community. The controllers are not as worried if for safety reasons somebody goes into the hold and does four rounds in the hold. The airports will never close and nobody will ever be made redundant (Informant 13, Management).

As a manager of the unit I need to have an efficient service provision. Sometimes you'll have very efficient controllers but you have to be careful from efficiency to being slick. All controllers get by sometimes on slickness, they have the old fox angle and they can work a procedure to make it fit. However the risk is that the Swiss cheese holes lines up somewhere else down the road and the slickness bites you on the butt (Informant 14, Management).

> I think so, they have very high standards. Those trade-offs and workarounds they do, I don't think any of those are consciously or deliberately outside the requirements of what they should be. However I'm sure (like everywhere) that there are some amount of normalised risk, whereby normalised deviance where they don't even know they are doing little things. I don't think they would do it any differently under a dedicated assessment than under continuous assessment, except that they are completely switched on, because they are being scrutinised – "I'm going back to the books. I'm going to do absolutely everything rigidly here by the books". (Pause…..) I'm thinking as I'm talking to you. I would say that the ongoing assessment has the ability to pick up normalised deviance and normalised risk a lot better than the single one (Informant 13, Management).

> There are differences. At a dedicated check they will not do that, just because I get checked and I don't do it (the aircraft will have to fly some miles more, to follow procedures) I will not be as flexible as I could be. Today they work normally when working with the competence assessor. The assessor will see and accept these adjustments and adaptation until a certain line and if something crosses that line he would feedback them and be active (Informant 10, Management).

Adjusting work according to existing conditions was well recognised by all informants. Interestingly enough very few perceived this adjustment as being an efficiency/thoroughness trade-off. Adjusting their performance to match time constraints or limited resources was something they did without referring it to a loss of thoroughness. The data collected from the ATCO informants show that they distinguish themselves as being efficient and service-oriented. Efficiency is perceived as being more important than strict rule compliance. This clearly supports Hollnagel's argument that people will choose the more efficient mode of operation, as long as it is perceived to be safe. An ATCO informant stated that during "a bad weather situation we are not efficient, we try to work safe" (Informant 2, ATCO). The remark is fascinating as it could indicate a strong day-to-day attention towards efficiency and on a day of challenging weather, the focus shifts to thoroughness. A thought-provoking question is then whether they perceive normal work as being so efficient that they consequently need to 'borrow' from safety on a daily basis?

An assessor informant did point out that controllers are; "drilled to handle as much traffic as possible but there are times where it is better to be more thorough" (Informant 7, Assessor). An efficiency/thoroughness trade-off is closely linked to time and traffic amount or traffic flow. Another assessor refers to this kind of trade-off as being visible during a change in working pace.

A management informant introduced the perspective of efficient service provision and a potential further development of efficiency into slickness. Working a procedure to make it fit could been seen as balancing safety with expedition. This is similarly described by management as the terms of running a business, since on-time-performance enhances the business opportunities.

When probing if the ATCOs would make trade-offs during a competence assessment, the reaction from the ATCO informants was that it would depend upon the assessor. The assessor and management informants view it to be feasible up to a certain degree however emphasises that explicit rule breaking will most likely not occur.

In reviewing the data it is apparent that efficiency/thoroughness trade-offs are a normal part of the ATCOs work. Trading thoroughness with efficiency is seen as a way of ensuring a high level of service. The ATCOs are willing to work around certain rules to obtain efficiency, save time

and prevent them from forgetting an aircraft. These actions seems to be driven by an aspiration of providing an excellent service. The statements provided by all informants recognise trade-offs as being part of normal and common practice and should therefore be included in the competence assessment. Understanding the interphase between the ATCO and the intricate features of a highly dynamic work environment is in line with Rasmussen argument that;

> The efficiency of humans in coping with complexity is largely due to the availability of a large repertoire of different mental representations of the environment from which rules to control behavior can be generated ad hoc. An analysis of the form of these mental models is important to the study of human interaction with complex man-made systems. (Rasmussen, 1983, p.258).

For these reasons a sixth competence element was added to the competence model to cover the efficiency/thoroughness trade-offs: *Service-driven competence.*

4.1.7 Perception of measurement

Describing and defining competence is not straightforward and many of the informants found it to be both difficult and problematic. Still the process of unfolding competency seemed simple compared to the herculean task of specifying how it should be measured. Many of the ATCOs were unsure and referred to the means of measurement as a 'feeling', 'work knowledge' and 'experience';

"By a feeling. By your knowledge of how you would work and maybe to compare it to others and how they work. I don't know how to explain it" (Informant 1, ATCO)

"Good question! Someone who is very experienced and who knows the game. We do need to be checked out, but how we should be checked out - I don't know" (Informant 5, ATCO)

"It's not an empirical measurement. I don't know how you measure competency, but I know what it looks like when I see it and I know what it looks like when I don't see it" (Informant 6, ATCO)

One ATCO suggested bringing in someone from the outside could be useful. As a contrast, there was similarly a recommendation of keeping the current structure, as it was seen to "pick up recurring events or tendencies" (Informant 3, ATCO).

It was not merely the ATCOs who seemed split in their interpretation. The assessor informants appeared to be equally divided, since some were lagging a clear definition;

"We do not have a definition of it, so how can we measure it! It is a feeling whether it is good or bad" (Informant 7, Assessor).

> It almost comes to subjectiveness doesn't it, there is no figure obviously, one cannot state this in a book really or manual, it almost comes down to a gut feeling. It is related to one's own experience. What you would do is measured against your experience and you measured against your own perception of what is an acceptable level of demonstrated ability. If you know how you would handle the situation, and at the same time relate it to the individual who may not be as experienced as you. But as long as it's still safe, and that is really what you're

> looking for. But there comes a point where it's an overall perception of the picture they portray (Informant 9, Assessor).

These statements were contrasted by an assessor informant with an explicit example of using predetermined objectives extracted from the unit training plan;

> We measure against the described training objectives for first validation of students. They are described in the Unit Training Plan. We have taken the main objectives and boiled it down to accommodate licensed controllers, but it is almost the same (Informant 8, Assessor).

The divergence between the two types of accounts authenticate the perceived difficulty of quantifying competence.

This discrepancy was furthermore illustrated by the descriptions made by both management and the safety managers;

> That's not easy! You can check that the colleague is doing sufficient spacing at the final and that each departure gets his requested flight level, these are hard facts! But the sense of competence is that you have to work like the whole community works that you fit together. That you're one brick in the house (Informant 10, Management).

> That is a really tricky part. In a reactive way we can measure it by the reporting of occurrences and so on. But in a proactive way it is really hard to measure. You can measure it by looking at the amount of traffic handled without occurrences. Efficiency is absolutely one part of the competencies (Informant 11, Management).

"Through how this is done today, theoretical and practical assessment" (Informant 12, Management).

> In my point of view, you cannot measure competence. Competence is always a judgement and there is someone who is judging if you are competent or not. The best judge to do it, is an open self-assessment. As an ATCO you should be honest enough to yourself and your colleagues if you are competent enough to work (Informant 15, Safety Manager).

> I would tend to go down the R/T sampling route or form. So how do we capture the errors, lapses whatever you want to call them? I would see a column by rule, those rules dictating exactly what you are looking for, where there has been some sort of error, lapse, slip - then you've got a scoring system alongside of that which gives you some sort of opportunity for trend analysis. Whether it is just a simple, (- 1, 0 & + 1 or poor practice, standard practice & very good practice) then that is the sort of stuff that could be captured. And with the right sort of software you can do a trend analysis for the whole company where you can see a particular area where there are a trend or weakness and then we can do something about it (Informant 16, Safety Manager).

Once again the span between the statements is striking. Measuring competence was described as not easy, tricky and even to the point that it could not be done. While another informant felt it should continue as presently with the use of theoretical and practical assessment. It was argued that there are some hard facts which can be measured, however it was also highlighted that there is a holistic and social perspective of working like the whole community which should be considered. The question is whether this kind of holistic and societal approach would be able to accommodate an open self-assessment as suggested by one of the informants. The idea of an open self-assessment is a vast contrast to the proposed sampling of and trend analysis of errors and lapses. Counting errors represent a reductionist approach of simplifying the ATCOs work into something which can be easily quantified and understood. This is a classic Safety-I path with a reactive response and a focus on restraining performance variability. Even though a proactive approach is argued as being hard to measure, the outcome of placing attention on traffic handled without occurrences will undeniably result in a better understanding of Work-As-Done. Comprehending Work-As-Done will most likely uncover and explain not only why efficiency is an important aspect of competence. It will similarly clarify the amounts of trade-offs and facilitate anticipation of potential events or occurrences.

4.1.8 Reflections on competence as a versatile concept

In this section the ESARR 5 competence requirements were explored through interview data. A number of shortcomings were identified and three new competence elements were introduced. The emergence of *Social, Adaptive* and *Service-driven* competence resulted in a six stage competence model that better suits the operational communities' view of what competence means to them. The model epitomises a synthesis of elements associated with the features of Work-As-Imagined as well as Work-As-Done.

In the current Competence Assessment Scheme, emphasis is placed on Work-As-Imagined and the means of measurement are limited to *Skill*-based competence during the practical part of the assessment, and *Knowledge*-based competence commonly assessed through theoretical examination in conjunction with the assessment. Both skills are measured against some nominal standard of Work-As-Imagined and hence justifies the location, the visualisation and the linkage of these three aspects in the model.

While exploring the concept of operational competence in terms of requisite skills representing Work-As-Done, it became apparent that working as an ATCO involves different skills than what has previously been imagined. *Adaptive* and *Service-driven* competence were identified as essential Work-As-Done aptitudes and was therefore located next to each other in the competence model. The introduction of new competencies accentuates, that the competence assessment scheme needs *versatility to be able to cope with complexity* and the changes in the operational skill set.

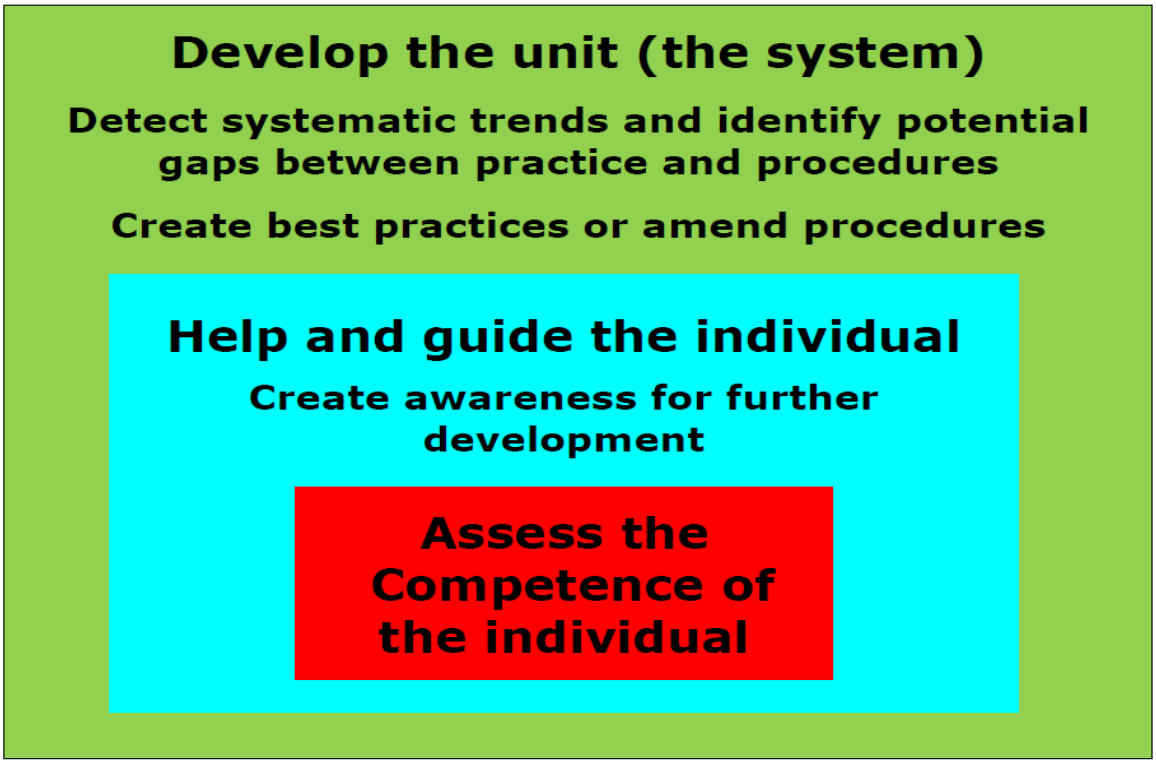
Today our view of competence must be adjusted to the many new functions of normal work. The question is then:

- How do the informants perceive the current competence assessment?

4.2 Competence assessment as of today

To be able to determine exactly how the informants view competence assessment, both in terms of the chosen assessment methodology as well as the perceived purpose of what is currently being assessed, a simplified picture was created to facilitate the discussion. Figure 5 illustrates three colour coded boxes, each containing a short description of a plausible approach to competence assessment. It should however be emphasised that the depiction of the three boxes does not represent a specific Safety-I or Safety-II perspective. It is merely a tool created to balance the informant's perspective with the aim of exploring the transition between the two views on safety.

Figure 5. Assessment methodology: The individual and the system



All informants were presented with this picture and given a short introduction to each of the boxes and their associated implication. The conceptual model was introduced to frame the interview and develop a common level of understanding. An outline of the introduction is shown below;

- The red box represents the mandatory prerequisite of assessing the competence of each individual ATCO
- The blue box embodies an approach of creating awareness for further development of the individual ATCO and should be viewed as an add-on to the red box. The blue box thus symbolise a mind-set of actively increasing the ATCO's consciousness pertaining to work performance. Further development of the individual is explored even though the ATCO is assessed as competent according to the defined performance objectives laid out in the red box.
- The green box exemplifies a systemic focus which targets unit or systems specific issues. In this box the attention has shifted from an individual centred approach to a more holistic view of the functionality of the sociotechnical system itself.

The informants were asked if their unit's competence assessment methodology included one or several of the previously described boxes. The answers showed some variation, however all 20 informants clearly indicated that the red box is presently included in today's competence assessment on all three units. This is not unexpected as there is a regulatory requirement governed by Commission Regulation (EU) No 805/2011, stating that "The competence of each air traffic controller shall be appropriately assessed at least every three years" (EASA, 2011, p.35).

The data clearly confirmed the manifestation of the red box in all three units, irrespective of the assessment method being used. The next step was then to explore the presence of the surrounding boxes. The blue and the green boxes were designed to capture activities representing an assessment approach described in the Guidelines for competence assessment issued by Eurocontrol in 2005. It specifies that; "The purpose of competence assessment is to affirm competence and to identify areas in need of improvement as appropriate either in the individual or the system within which the individual works. Competence assessment supports the individual and the system" (EUROCONTROL, 2005, p.7).

Though this document is merely issued as an EATMP Guideline and consequently not mandatory, it does provide a systemic perspective as it argues that competence assessment supports the individual and the system. The question is whether the informants recognise this to be the case or not. The intention was therefore to collect data regarding the perceived assessment methodology, to examine if competence assessment is indeed viewed as something which supports the individual as well as the system.

In the following section, data associated with the concept of competence assessment is presented as unit specific due to the difference in assessment methodology. This data was examined and categorised according to the chosen group structure and compared against each other. The data obtained from the two safety manager informants is not included in this comparison, as it was found to be inadequate due to their centralised company position. Both safety managers have an ATCO background, yet none of them have been working at the chosen research site and are thereby not familiar with the explicit details of the unit. Their data was thus judged as less relevant to this analysis.

The results are presented below, firstly as a summarised table overview, and secondly as significant informant statements supporting the visualisation of the table content. Thirdly, key elements derived from the data are highlighted and analysed. In the table overview an **X** indicates group confirmation of the perceived presences of one or several of the previously described assessment approached illustrated in the contour of coloured boxes.

4.2.1 Vienna APP

Table 4. Vienna Approach overview

VIENNA APP - Continuous assessment	Assess the competence of the individual ATCO	Help, guide and develop the individual ATCO	Develop the system and look for gaps
ATCO	X		
ASSESSOR	X		X
MANAGEMENT	X	X	

> Before the continuous assessment was implemented it was just the red box. Now I don't know. I'm not quite sure if the green box is meant to be within the assessment. We are often discussing about how to bring the practice we do into procedures, to adapt procedures, but I'm not quite sure if this is within the assessment. We could be in the blue box if the assessor will give you feedback, but that has never happened so far. I would like to get feedback to know the system is running. I think the assessors should talk to the controllers once a year. If you never hear anything, you don't really know if your work is good, you are not able to improve yourself and improve your work). Continuous assessment is a better way than the previous dedicated check we had every 3 years. If you do it once every 3 years, that 1 or 2 hours you are being assessed, you can act or work differently than you do. So if the assessment is done continuously you are forced or you should work in a good way throughout the hours of work you do. It also depends upon who will be the assessors and who is choosing the assessors (Informant 1, ATCO).

"When we had dedicated check, I didn't work with my normal behaviour. You are working completely different and it is not a good feeling" (Informant 2, ATCO).

> My feeling is that we are in the green box, but the blue box it not necessarily included. It starts with the green box and then inwards. So we are more in the green box and sometimes some relations to the blue. The main thing is the green box (Informant 7, Assessor).

> I think it's the blue one! We tried to take a step towards the green one, but stepped back. We actually have no time for that. All the energy of the unit is used for the Top Sky system, since we are changing it in 2015. So we have no time to produce the step towards the green one (Informant 10, Management).

The ATCO group paints a multifaceted picture of their competence assessment methodology. The continuous assessment is described as being better than the dedicated check since the ATCOs are required to work in a consistent way, making it impossible to divert from normal work and revert to Work-As-Imagined to satisfy the traditional requirements and measurements of Safety-I. The prior assessment structure of dedicated check was seen by all ATCO informants as a hindrance in terms of normal behaviour and normal work. One informant described it as "working completely different and it is not a good feeling" (Informant 2, ATCO), which could indicate the perception of a large gap between Work-As-Imagined and Work-As-Done. Despite the expressed contentment with the continuous assessment, the data showed that the ATCO informants were uncertain as to what is essentially being assessed apart from the red box. The presence of the blue and the green box could not be confirmed and it was emphasised that the lack of feedback is seen as an obstacle to individual improvement. The selection process of the assessors was mentioned as a critical parameter for the continuous assessment. The ATCO informants unanimously concluded that the assessors should be elected.

The assessor and the manager clearly have dissimilar perceptions of what the continuous assessment is currently measuring. The assessor describes a focus devoted to the green box and is reluctant to include the blue box due to the new assessment structure; "If I give them feedback after a session, will it then technically be a dedicated check? I'm forced into saying nothing as long as nothing is bad" (Informant 7, Assessor).

The manager's perception of being in the blue box could indicate an individualistic assessment perspective as oppose to a systemic outlook. The large scale change of operational system during 2015 was briefly mentioned and could possibly be considered as a demotivational factor in terms of embracing a systemic view. There was however an identified need for the competence assessment scheme to help the operators understand something about safety of the new operation. When questioned if they actively use the competence assessment scheme to monitor changes in the operational environment, the management replied that they; "would like to use it as a tool for change, or to support some changes. But sometimes things are just implemented and the continuous assessment is quite new" (Informant 10, Management).

The mentioned step towards the green box was not elaborated in detail and can therefore not be supported by additional data. Yet when asked whether the chosen assessment method or philosophy is presenting the organisation with a realistic picture of normal work or Work-As-Done, the answer supported the blue box focus on the individual but could similarly indicate the beginning of a systemic observation; "it is definitely a realistic picture of what *we* are doing. It's safer now, because more eyes look at *you* and you definitely *see potential problems* and you can react *earlier*" (Informant 10, Management, emphasis added).

One of the key questions posed in terms of exploring the concept of the competence assessment methodology was whether the informants perceived the competence assessment as supporting the individual, the system or both. The analysis of the data exposed a multiplicity of views both in terms of the assessment method being used, as well as the focus of what is currently being assessed. The approach unit in Vienna displayed the greatest spread in data concerning the focus and attention of the assessment. While the ATCOs are hesitant to place their assessment beyond the red box, the assessor defines his task as being more universal;

> I work according to a holistic impression of my colleagues. As a coordinating and planning controller you can watch and you see a lot of things. I do not do any kind of examinations. On our assessor meetings we can find and discuss hotspots, so we are alerted and will be looking a little bit closer. The idea is not to be checked every day (Informant 7, Assessor).

A holistic approach to the colleagues and a systemic emphasis on hotspots support the study of normal work, which again were preferred by the ATCO informants. The management placed the assessment in the blue box with a reference to the limitations of implementing a new operational system during 2015. It was furthermore highlighted by management that; "The assessors focus on the person, not on the procedures. Procedure design is not their task, so they just look at how to use it, but not if the procedure is good and if it's good for the time" (Informant 10, Management).

The data unmistakably shows contradictory views of the perceived purpose of the current assessment methodology. A conceivable explanation could be the recent change from dedicated check to continuous assessment. At the time of the thesis research, the new assessment method had only been practiced for seven months and could be considered as still in the implementation phase. An interesting aspect worth pointing out is that the change of assessment method was initiated by the assessor group. It is described by management in the following way; "the pressure came from the local assessors saying, - *'the dedicated check is worthless, we do not want to waste our time'* - so the development has come from the bottom up" (Informant 10, Management).

The assessor group's instigation of a new assessment approach could have emerged from an unpretentious desire to bridge the gap between Work-As-Imagined and Work-As-Done. This

would be in line with the Hollnagel's argument that "seen from the sharp end it is no surprise that descriptions based on Work-As-Imagined cannot be used in practice and that actual work is different from prescribed work" (Hollnagel, 2014, p.41). It is similarly consistent with the ATCO's statements regarding working completely different during a dedicated check. Since the assessor group evidently had a strong desire to transition from observing Work-As-Imagined on a random basis, to monitor Work-As-Done on a daily basis, their vision and expectations could have shaped a more holistic approach without anchoring it with management. This however could not be validated by the collected data, and is therefore purely speculation based upon a general impression from the interviews with management and assessor informants.

The new assessment method was praised by all four ATCO informants who moreover had a few recommendations in regard to further development of the concept;

> The continuous assessment is pretty good, but I would improve some things. Each colleague should get a yearly assessment where the local assessors talk about his way of working (wrong & right). Notes are also important and the assessors should get tasks e.g. focus areas. They would then be able to give feedback to the authorities, the company and the ATCOs (Informant 1, ATCO).

A feedback mechanism for the individual ATCO, as well as the system, is critical if the competence assessment shall succeed in supporting the individual and the system. The absence of a feedback process is experienced by the ATCOs as a hindrance to personal development and improvement. This gaping hole could easily be targeted through a feedback structure described by Barrett as Generative Competence; "The organization constructs integrative systems that allow members to see the consequences of their actions, to recognize that they are making a meaningful contribution, and to experience a sense of progress" (Barrett, 1995, p.40).

The intention is to use an appreciative approach to increase empowerment and awareness of the individual in a high-performing organisation. This awareness or mindfulness is about the quality of attention as argued by Weick & Sutcliffe (2007). Yet mindfulness is not just seen in terms of the individual, it is "about the ability of a system to concentrate on what is going on here and now" (Weick & Sutcliffe, 2007, p.35).

Within the competence assessment structure at Vienna APP, additional systemic issues were mentioned as being important. Not only was feedback identified as being essential, the assessor selection process and focus areas were also highlighted. These items are areas which could be explored further in a novel assessment method which conceivably is not fully developed thus far.

4.2.2 Malmö ATCC

Table 5. Malmö ATCC overview

MALMÖ ATCC - Dedicated check	Assess the competence of the individual ATCO	Help, guide and develop the individual ATCO	Develop the system and look for gaps
ATCO	X	X	X
ASSESSOR	X	X	X
MANAGEMENT	X	X	(X)[1]

[1]Note: The brackets indicate that only one of the two informants has confirmed the manifestation of the green box.

> I think the assessment is present in all boxes. It is both about checking that the individual is at the required level, if not then he/she will receive help and guidance. But is it also about identifying frequent or systemic issues which can be improved. The assessment itself (the check) is perhaps in the red box, but if something emerges, then the individual will receive help whether it might be additional training or similar. The green box is represented by the yearly focus areas[3] and the annual report[4] which aims to inform about identified trends. Our continuation training[5] is also part of the blue box (Informant 3, ATCO).

> We are in the red box during the observational part of the assessment, because our task is to sit behind, without interfering and simply observe and assess. The blue box comes into play during the debriefing. If we get many remarks[6] within a certain area, then perhaps we need to change some procedure. You could possibly say that the annual report which describes the focus areas and the general impression could belong to the green box (Informant 8, Assessor).

> I think we are in the outer rim of the blue, close to the border to the green box. The objective is to help and guide the individual. I think the assessors are mostly in the blue. They want to raise the awareness of the individual that this is important, you have to improve. They are not thinking so much in the green area. Some of their ideas are in a systematic way, but they mostly want to increase the awareness of the individual (help & guide), that is why we have the remark thing (Informant 11, Management)

---

[3] The yearly focus areas are determined by the Manager of Operations in cooperation with the assessor group. Typically there are three to five focus areas per year. The focus areas can vary between the different rating groups.

[4] The annual report is made by the assessor group. It is compilation of the yearly findings of the practical part of the competence assessment. The focus areas of that particular year are covered as well as additional discoveries.

[5] The competence assessment scheme demands that the ATCOs are trained within non-normal and emergency situations. The theoretical part of the competence assessment is conducted in conjunction with the simulator exercises. Additional training can be conducted as well, e.g. releases of new system software, etc. At Malmö ATCC this is called continuation training and is conducted yearly.

[6] In 2014 a remark item was introduced at Malmö ATCC by the assessor group in cooperation with management. Previously the grading was either Passed or Failed. With this new addition, there is now the possibility of passing the assessment with a standing remark. This remark will then be re-evaluated on the coming year's assessment. The intention was to heighten the awareness of the individual as well as identifying systemic areas in need of improvement within the unit.

> Spontaneously I reckon we are in the green box since we are very much interested in attaining information from the assessor group regarding the system (good & bad). Once a year the assessor group publishes a report where they look at the system and personnel holistically with a focus on how we can improve. They have on numerous occasions found gaps in procedures which then lead to a change according to their findings. If they see a potential trend, they will include this into next year's focus areas. The red and blue box are presently covered (Informant 12, Management).

The research conducted at Malmö ATCC provided strong evidence supporting the assumption of a common view of the competence assessment for all three group categories. The red box is exemplified by the dedicated check carried out in position (typically 2 times 1 hour).

The blue box is seen in the context of two different aspects; the debriefing and the continuation training. At Malmö ATCC the debriefing is regarded as an essential part of the competence assessment and time is allocated to accommodate a debriefing of 45 – 60 minutes. All ATCOs are measured against well-defined performance objectives and these are raised and discussed during the debriefing. The continuation training was mentioned by the ATCOs as something which belongs to the blue box. A plausible explanation could be that the ATCOs view this training as an opportunity to receive professional development, since this is purely training and thus not assessed. The recent implementation of the remark item was described as helpful in increasing the awareness of the individual ATCO.

The systemic view, represented by the green box, is defined by all three informant groups as the yearly focus areas and the annual report. The yearly focus areas are clearly vital in terms of identifying or anticipating potential trends. While discussing the focus areas, one of the management informants emphasised that; "What is more interesting is what they find in the focus areas. It's the most valuable part, because that is where we can learn something" (Informant 11, Management).

The annual report is interesting as it is presented and perceived by management as the assessors' 'holistic view' of the system and the ATCO personnel. The assessor group is similarly commended for discovering gaps in procedures and for their proactive approach in regard to the inclusion of new focus areas. Still the essential question must be whether the assessors' annual report is backed up by other independent data and how this is linked to the daily operation? In order to investigate this area, the management informants were asked if they were confident that the Competence Assessment Scheme provided them with a representative picture of safety in their operation. One of the managers stated that;

> I'm fairly confident that it does, because the things the assessors find/detect, whether it is a focus area I have given them, or it is something that they themselves bring up in the annual report. It often shows the same picture that the reporting system shows me. They are often hand in hand, they correlate. So it gives me confirmation that we are focusing on the right things (Informant 11, Management).

When exploring the data collected at Malmö ATCC, one is surprised by the remarkable uniqueness and coherence of the informants' statements. The manifestation of all three boxes is confirmed not just in general terms, but through specific examples connected to each of the three dimensions of assessment. The exemplification of debriefing and continuation training as elements which support the development of the individual is explicit and tangible.

The systemic outlook is illustrated by all three informant categories as the yearly focus areas and the annual report. Even the newly implemented remark appears to be regarded as a constituent element that runs through the blue and the green dimension to facilitate a focused development. Management sees it as a tool to increase the awareness of the individual, and the assessors refer to it as an opportunity to change procedures. The assessors similarly describe the ATCOs as being "positive towards the new remark item" (Informant 8, Assessor). Like the assessor group in Vienna, it was the assessors who wanted to upgrade their assessment and thereby introduced the remark item as a complementary component to monitor or anticipate change. All assessors are licensed and operative controllers and can consequently be regarded as part of the sharp-end operators as they are well familiar with the complexity and constraints of normal work.

What was furthermore found to be unique with Malmö was the amount of support and resources allocated to the assessor groups. The five groups have four yearly whole-day meetings where they all meet to discuss and share experiences. On top of this, the assessors of each rating groups are given four working days to compile their contribution to the annual report. The assessors describe the support in the following way: "Management appreciates the work we do and regards it as important. The manager is often present at our meetings due to his interest. He is very much giving us free hands to form the structure according to our preferences" (Informant 8, Assessor).

This kind of empowerment is interesting in terms of the organisational and cultural aspects like information processing. Westrum (2004) suggests that the effects of the information flow climate are pervasive due to the key variables of; *alignment, awareness* and *empowerment*. He argues that;

> Generative organisations require empowerment for maximum performance. Individuals' minds are harnessed to fulfil the organisation's goals through a culture of conscious inquiry. They are encouraged to speak up, think outside the box, and to act as fully conscious participants in a great cooperative enterprise (P.24).

This description is well suited for Malmö ATCC and it links back to the previously discussed topic of Generative competence and the importance of a well-functioning feedback structure. According to Westrum the alignment takes place through identification with the mission and awareness comes through conscious efforts to keep team members informed about all the variables that affect their efforts. He additionally describes Generative organisations as proactive in terms of information, more effective, more creative, more harmonious, and safer: "The reason is simple: the kind of conditions that create good information flow tend to be those that favour cooperation, creativity, and safety" (P.24). He concludes that not only will an open generative culture make the best use of its assets, it will have better acceptance of innovations and better response to danger signals: "A generative culture requires that alignment, awareness, and empowerment replace suspicion, isolation and passivity" (P.26).

Malmö ATCC shows clear signs of being a generative organisation, with high generative competence through the core values of *alignment, awareness* and *empowerment*. In competence assessment the alignment can be represented by the briefing prior to the dedicated check. Awareness and empowerment is epitomised by the debriefing, the yearly focus areas and the annual report, along with the correlation of the findings from the reporting system.

According to the informants, the current competence assessment methodology at Malmö ATCC actually do support the individual as well as the system. This operationalisation of all three dimensions could possibly be the basic framework from which it would be possible to explore a Safety-II way of conducting competence assessment. A motivational factor is that the ATCOs are very positive towards the existing practice;

> Competence assessment is a good thing especially to ensure that we are working alike, so that no one develops a way of working which is different compared to everyone else. It is easier when there is a forum to identify possible deviations. I find that what we do today works really well, and I see no reason to change it! (Informant 3, ATCO)

4.2.3 Inverness TWR

Table 6. Inverness TWR overview

INVERNESS TWR – Continuous assessment & Dedicated check	Assess the competence of the individual ATCO	Help, guide and develop the individual ATCO	Develop the system and look for gaps
ATCO	X	(X)[1]	X
ASSESSOR	X	X	X
MANAGEMENT	X	X	(X)[2]

[1]Note: The brackets indicate that only two of the three informants has confirmed the manifestation of the blue box.
[2]Note: The brackets indicate that only one of the two informants has confirmed the manifestation of the green box.

"We are in the red and the blue box. A little bit in the green, but it could be better, though they aim to be there" (Informant 4, ATCO).

"All three gets done to a certain extend. I think it is a bit of all three and I'm not going to say that it is anyone of them" (Informant 5, ATCO).

> We certainly assess competence of the individual. I think we have systems in place to develop the unit. But what we don't have is the join between the two. We are not developing individuals, we are not good at joint up thinking as an organisation. We completely ignore the blue one (Informant 6, ATCO).

> We don't always manage it with the resources we have, but we are definitely and constantly discussing best practices and amending procedures so we are hopefully in the green box because we are doing that. We don't always get the chance to do that very quickly but we certainly and in a fairly consistent basis are updating what we are doing and changing it, passing out the information to the controllers. We are doing the blue and the red box as well (Informant 9, Assessor).

> For the unit, the green box is where we want to be and we use the competency system not only to assess the red area and the total interphase between the controller and the aircraft. But we have to at the end of the day to look at; are we giving the right and the correct guidance and material? What we do here is we allow the ATCOs issue an OSAR, which is an Operational SAfety Request/change. If they see something that they are not happy with or they believe could be done better, then they seek to a change. From a managers point of view I have to make a decision on either to agree to it or disagree. Now if I disagree I have to make a case as to why I have disagreed and I think that is very important. It puts me as a manager in an interesting situation because now I'm having to argue a case that in fact the procedure being adapted by the management may not be the best procedure to be adapted by the controllers in the operational position. So again I would like to see Inverness in the green box in relation to and benefitting from

> conventional and traditional competency assessment of the individual, right down to the fact that we are able to change our procedures and policies in order to adapt. Every day we are striving to be in the green box, we do have a very open policy in relation to making that change and our procedures are evolving to deal with the competency of the unit (Informant 14, Management).

> The regulator is definitely in the red box. Inverness is in the blue box. We should be moving towards the green box. Competence to me is not just about the controller on a given day. It's about the opportunity that this presents the controller with. It's about the weaknesses, the latent weaknesses, it's about the strengths, and it's about identifying how we can make his job better, easier, to have the right procedures, right equipment, right management structure, the right culture within the unit. All that comes together and the controller is only one of the elements (Informant 13, Management).

The statements of the ATCO informants indicates an ambiguity connected to the presence and enactment of the three boxes. The boxes are described as being done to a certain degree, however there are no tangible examples to clarify this perception. One informant maintains that the presence of the blue box is non-existent "We are not developing individuals, we are not good at joint up thinking as an organisation. We completely ignore the blue one" (Informant 6, ATCO). The statement was not backed up by any mitigating suggestions or examples, making it problematic to speculate on a better course of action. Nevertheless the informant's perception of not receiving further development should be taken seriously and considered when evaluating the unit's competence assessment scheme.

The ATCOs view of the green box were correspondingly equivocal and not exemplified in any way. One informant did comment that the assessment was; "a little bit in the green, but it could be better, though they aim to be there" (Informant 4, ATCO). The aim was not specified or elaborated, still it was suggested that the green box could be further developed in the following way;

> Maybe we should check and make sure that everything is anonymous, so they are not really checking any individual person, just checking how the system works, that should be done. Look at how strips are marked, listen to the tapes. If they are finding anything that is a bit non-standard, then they should provide general feedback (Informant 5, ATCO).

The assessor informant displayed commitment to the green box by emphasising the frequent discussions concerning best practices along with the amendment and updating of procedures. This was described as "hopefully" placing Inverness in the green box. However there is evidence to suggest, from the interviews, that the individual is the focus of attention and not the system;

> I think the continuous assessment is a much more realistic way of dealing with our industry in a day-to-day basis because you are getting an overall feeling and a picture about *the individuals concerned*. It's much more likely to highlight any trends rather than the one-off assessment where the chances of something being picked up are reduced. Colleagues can understand that we spot things but they are much more unlikely to be acted upon if there is no system or a scheme to encompass that. (Informant 9, Assessor, emphasis added).

> I think it's very valuable. I think the combination of the dedicated check with the samplings spread over the year gives the best overall picture of how *an individual is performing*. Certainly the one dedicated check a year is not really adequate. In an ideal world I think you would go more the other way and aim to eventually have the routine samplings sufficiently strong and regular that the annual situation of signing of a license is always just that (Informant 9, Assessor, emphasis added).

These two quotes suggests that Inverness is very much geared towards the individual and not necessarily the system. The explanation could be found in the regulatory framework where there is a stringent demand of assessing ATCO competence and thus far not the systemic issues.

The two management perspectives are not completely aligned concerning the green box, still there are distinctive statements pointing towards a systemic view comprising contextual aspects included in the managers' area of responsibility. The OSAR (Operational Safety Request) is interesting as it offers the controllers an opportunity to actively seek a change of operational procedures. This in itself is perhaps not unique, however the managements' view on how to handle an OSAR rejection indicates an awareness of the complexity and variance between Work-As-Imagined and Work-As-Done. The manager informant clarified that;

> If there is a procedure or policy that we as managers have put in there, as we believed is going to be effective or efficient, and we discover that in fact it is difficult to work with from a controller's point of view. Then we have to be open enough to be able to roll back and say – 'well that is not working for us, we need to change it (Informant 14, Management).

This is in line with the statement by the other management informant, where he stresses management's role in identifying and ensuring how they can make the ATCOs job better and easier by having the right procedures, equipment, management structure and the right culture within the unit.

The summarised table overview of Inverness TWR could at first hand give one the impression that there is consensus among the informants in regard to the perceived purpose and focus of the competence assessment. Yet when exploring all statements, a discontinuity between the three groups emerge as they clearly all have different views. There are very few palpable examples or patterns which describe the operationalisation of the three dimensions. The informant groups appear to have diverse perceptions on the usability and effectiveness of the assessment process. One of the ATCOs states that;

> It works to a degree. I'm not convinced that it is currently picking up all the changes. We need to come up with a system of feeding back experience from other units into our own at the grass-root level and that is not currently happening (Informant 6, ATCO)

Sharing experience with other units or interrelated domains seem important for the ATCOs, as this is perceived as an element which would broaden the usefulness of competence assessment;

> I think competence assessment should be wider than just simply sitting and assessing if someone is doing their job. I think you should have the opportunity to discuss theoretical situations, it would be great if this could include more domains than just controllers (Informant 4, ATCO).

A direct inclusion of other domains in the competence assessment scheme is an interesting notion as it would display understanding and acceptance of both the coupling and complexity of external actors like the UK RAF airbase Lossiemouth. The close location of the airbase was identified as an operational challenge by all informants as the traffic is more complex, the radar cannot cope, consequently demanding frequent adjustments and adaptations of the ATCOs. This is in line with Perrow's argument that the airways system is potentially quite complex; "unexpected interactions can occur when aircraft enter the airspace that are not under the control of ATC or even not seen by them. This is a proximity problem". (1984, p.159). Including external actors both through discussion, or by creating fictions scenario interviews, could perchance enhance a loose coupling between ATC and the military traffic and thereby ensure the ability to recover from small failures (Perrow, 1984).

The scenario interview element is recommended by EUROCONTROL as something which can be used to confirm understanding and gather information on how a "controller would have reacted in circumstances that were not observable but are nevertheless considered important to the overall operation at that Unit" (EUROCONTROL, 2005, p. 12). This type of scenario interviews are currently used with great success during competence assessment of ATSEP[7] personnel. The scenario interview structure has been incorporated and further developed to accommodate the challenge of not always being able to conduct realistic assessments settings in offline systems.

Building scenarios with the purpose of exploring systemic issues in addition to the operator's role and constraints while working within this system, will aid a transition from an individual to a systemic perspective. For an assessor this could be a valuable tool as the structure in Inverness appears to be tailored around the individual and not the system. According to the assessor informant the scenario interview is presently included in the yearly dedicated check, where the ATCO is asked to; "explain different scenarios of 'what would you do if'...?" (Informant 9, Assessor). This type of questions could however result in an answer reflecting Work-As-Imagined and not Work-As-Done, unless the purpose of the scenario interviews has been clearly defined. The aim should not be to hunt errors but to appreciate the local rationality principle of each operator, as it will provide information of actions which are systematically connected to features of the work environment the ATCOs are working in (Dekker, 2011).

From the data and the informants' comments it is highly probable that Inverness can be categorised as a bureaucratic organisation as defined by Westrum (2004), as he argues that bureaucracy is often a compromise between competing interests.

At Inverness this could perhaps explain the lack of shared awareness among the different informant groups. Fruhen et al. (2013) describe characteristics of skills, knowledge and senior managers' safety commitment as something which can;

> …be stimulated to develop their ability to understand safety problems, to consider different types of information sources, to creatively generate solutions for safety problems and to be sensitive to others' intentions and issues as this is likely to support their demonstration of safety commitment (p.7).

Considering new sources of information could facilitate a transition from bureaucratic towards a generative communication and information flow, where alignment, awareness and empowerment

[7] ATSEP is an abbreviation for Air Traffic Safety Electronics Personnel who operate and maintain ATM equipment approved for operational use.

help the organisation archive its safety goals. It could conceivably enable a shift towards an organisational joint up thinking as called upon of one of the ATCO informants.

The assessment structure in Inverness, with the yearly dedicated check and the monthly samplings, is not only suitable for monitoring the individual, it could, with some adjustments, be used to monitor the system as a whole. The system is in place with allocated resources and a committed assessor team. One of the ATCOs even describe the assessment form as "less nerve wrecking having the continuous assessment because it is done by colleagues and you've got a better working relationship with them" (Informant 4, ATCO).

Based upon statements from the management it is moreover evident that they are dedicated towards providing the right working environment, culture and openness. To ensure that competence assessment can support the individual as well as the system it is imperative to also look beyond the scope of rule compliance and embrace the reality of work day in day out.

4.3. Competence and competence assessment in consonance with Safety-II

For the purposes of this research Safety-II is considered to be what is proposed in Hollnagel (2013a & 2014) as well as the two White papers published by EUROCONTROL (2013 & 2014).

Safety-II is characterised by a shift in perspective in terms of how the system performs and adapts under varying conditions. Safety-I is characterised by minimising the number of negative events and safety interventions, invariably by reducing and eliminating human error. The difference between these two approaches to safety has an impact on what form competence and competence assessment takes in a Safety-II paradigm. The subject is clouded by the fact that for some time to come, there will be a need for competence and competence assessment to support both approaches to safety.

4.3.1 What is competence in Safety-II?

Competence – a word or a concept we all seem to understand without having the need to elaborate or explain it further. We all know what we are talking about since we unquestionably recognise it when we see it, - or do we?

Within Air Traffic Control, competence has traditionally been regarded as *Knowledge* and *Skill*. In simplified terms, - *you need to know the rules and how to apply them*! Taking ESARR 5 into account, will add the notion of *Experience* to the constituent parts of ATCO competence. This trio works nicely in a Safety-I environment, where compliance can be viewed in terms of the individual and measured against the standards of Work-As-Imagined.

Safety-II is primarily concerned with the system's ability to succeed under varying conditions (EUROCONTROL, 2013). The contrast of having the systems view and not the individual view, could easily question the role and relevance of competence. It is therefore important to ask what competence means in a Safety-II environment.

Safety-II recognises that the work situations of today are increasingly intractable and that in order to ensure and sustain successful outcomes, people must be flexible and adjust their performance to the current conditions. Performance adjustments are viewed as something which takes place every day and it will consequently vary. Hollnagel (2014) argues that there are three main motivations for making performance adjustments;

- *To maintain/create good working conditions*. "the more stringent the demands to work output are, the more effort is put into ensuring that these conditions are in place" (p.158)
- *To compensate for something that is missing.* Compensating for unacceptable conditions, missing equipment, information underload or perhaps lack of time. Irrespectively of what might be missing, the individual will search for a way to substitute or compensate.
- *To avoid future problems.* Adjusting to avoid negative consequences for the individual, the group or the organisation.

These three types of performance adjustments are seen as an integrated part of Work-As-Done, and could for that reason also be argued as requisite Safety-II competencies. Understanding Work-As-Done is one of the key elements of Safety-II, but in order to truly comprehend Work-As-Done, one must examine the operational environment and the contextual strains embedded in the ATCOs day-to-day work. A conceivable way of doing this could be through the enactment of competence assessments in agreement with Safety-II as a supporting or collaborative mechanism to exploring Work-As-Done.

4.3.2 Competence Assessment in accordance with Safety-II

It has previously been argued that the synthesis of competence elements pertaining to Work-As-Imagined and Work-As-Done requires versatility in order to cope with complexity and the monitoring of different skills. The structure of how the six competence elements can be assessed or monitored will be explored in this section.

Measuring competence was seen by the majority of the informants as problematic. Many lacked a clear definition, thereby making it abstract and difficult to quantify. A small number of informants found it less complex as they were measuring against predefined performance objectives. Irrespective of approach or method being used, it is vital to differ between competence elements that are suitable for assessment or measurement, and those that are not.

In the six stage competence model, the *Skill-* and *Knowledge-based* competence elements epitomise the rule and compliance based mind-set of Work-As-Imagined. Both competencies are well suited for practical as well as theoretical assessment. The process of doing so will be aided by the use of performance objectives and should hence be considered to ensure a fair and objective measurement.

For the purpose of exploring Safety-II in terms of competence assessment, the remaining four competence elements are more interesting and relevant, as they can provide significant insight into Work-As-Done. If approached correctly, they can be a source of information regarding potential changes within the operational environment. However two fundamental questions remain. Firstly, can the new competencies be validated as elements associated with Safety-II? Secondly, should these four competencies be assessed in the same way as the Skill- and Knowledge-based competence?

The review of the literature on Safety-II resulted in six key features of Safety-II. Where the aim was to enhance understanding of;

- Why things go right
- Work-As-Done
- Approximate adjustments
- Performance variability

- People as a resource to ensure flexibility
- Trade-offs

These key features are used to validate the last four competence elements and their appositeness in terms of Safety-II.

The new competence elements of *Adaptive-* and *Service-driven* competence are constructed to incorporate central aspects of Safety-II. These competence mechanisms can provide a means of calibrating the view of the operational environment providing insight into the dynamics of the system by exploring trade-offs, approximate adjustments and adaptations as well as performance variability. An example could be, that with the purpose of avoiding future problems – performance adjustments are made to avoid negative consequences. In order to identify this kind of performance adjustment one would need to have a feedback mechanism. With the new six stage competence model, the element of *Adaptive* competence would be able to identify and appreciate this kind of performance adjustment. Understanding every day activities is important as Work-As-Done is always underspecified. According to Hollnagel (2015) "the underspecification is intentional in relation to the granularity of work descriptions. Here it is always necessary to take some basic skill and competence for granted and therefore exclude them from instructions or procedures" (p.254)

In terms of competence as seen from a Safety-I view, everything is specified and prescribed. In Safety-II it is quite different. Safety-II is about the messy details of an imperfect world of imperfect information and the practicalities of uncertainties. From this we can draw that competence is how a function or an organisation interacts with others. Along with how it uses its capabilities to sustain an effective and safe operation ensuring that things go right. Some aspects that are seen as negative artefacts of Safety-I, may be seen a positive artefacts of Safety-II. An illustration taken from the *Service-driven* competence, is the ATCO statement saying that: "Competence is not only to work safe, though safe is very important in our job. For competence it is also necessary to work in a normal speed" (Informant 2, ATCO). Here it is implied that you have to make trade-offs between efficiency and thoroughness in order to be competent.

Providing a good service is seen as an important skill and therefore you adapt. A Safety-I view is more focused on consistency – you do not make trade-offs and you do not borrow from safety. In Safety-II it could be the case, that without breaking the rules, you might think creatively of how you can expand your capability for a short period and then recover. In Safety-II, recovery back to some normative state is a really important part which is missing from Safety-I altogether. The explanation for this can be found in the contrasting view of the human operator. Whereas Safety-I view the human as a potential liability or hazard, Safety-II recognise the operator as an asset, a necessary resource for system flexibility and resilience (EUROCONTROL, 2013).

The role of the operator relates to the *Social* competence element in the model. Safety-II is about the effectiveness of the system and not the individual per se. Even so, working in a system with many interdependencies and many actors, requires a certain amount of social competence of all individuals involved. The value of interactions are increasingly viewed and valued as being fundamental for guaranteeing good cooperation and thereby ensuring an effective teamwork. It was emphasised by some of the informants that the operational performance adjustments greatly depended on colleagues and the team; "If you have the right shift, the right colleagues by your side, you do not even have to talk to each other" (Informant 1, ATCO). Social competence has got a much wider implication than competence assessment of technical skills since it is also about how ATCOs and managers interact with each other in terms of openness and honesty, as previously confirmed by a manager informant. This insight could facilitate internal discussions of

how effective a system is. The notion of Social competence might not be very tangible, still all informant groups included this element as an important part of defining competence.

The *Experience-based* competence has formerly been mentioned as an integrated part of the ESARR 5 competence definition and has as a result of this, been linked to Work-As-Imagined. In many respects it could be argued that that Experience-based competence is better placed among the elements of Work-As-Done, since it adds the acumen of operational experience. Building on Hutton & Klein's (1999) notion that expertise is experience dependant, will augment the use of ATCOs as experts navigating the system with all its complexities on a daily basis. This is similarly in line with Shorrock et al. in (EUROCONTROL, 2014) and their recommendation of field expert involvement as they are a critical source of safety knowledge. Weick & Sutcliffe (2007) and Dekker (2015) refer to this as deference to expertise. Dekker argues that "if people are not a problem to control, but a resource to harness, then taking their experience and expertise seriously is a strong first step" (Dekker, 2015, p.251). Recognising ATCOs as expert informants, with a vast amount of knowledge concerning the gaps between Work-As-Imagined and Work-As-Done, is essential in order to sustain operations and ensure a future increase in system capacity.

Mapping the six key Safety-II features against the new competence elements confirmed that there are indeed a strong correlations between them. The informants complemented the classic competence model with additional competencies which have proven to be in line with the key features of Safety-II. This validates the relevance of the six stage competence model and answers the first of the previously posed questions.

The second and last question pertains to the assessment method of the remaining four elements. Perhaps one might ask whether it is indeed possible to measure Adaptive, Service-driven, Social and Experience-based competence? It could perchance be feasible if applying a reductionist approach, however it is far from the core values of Safety-II. A cornerstone of Safety-II is an emphasis of talking to people about their work. Their work is characterised by an environment which is constantly changing, meaning they constantly have to adjust. This cannot be viewed through a ruleset, it has to be explored through talking to people. This is in agreement with (EUROCONTROL, 2014) stating that;

> Discussion with field experts is essential to understand why things work in the way that they work. Discussion may follow an observed period of work, or may relate to work and the system more generally, including activities, situations, occurrences or scenarios (p.28).

Setting the scene for obtaining this kind of information is crucial in order for the ATCO to feel comfortable in passing information on how the system is behaving. An appropriate scene would be a debriefing based upon the six stage competence model as this includes the perspective of Work-As-Done. Understanding the quintessence of the six Safety-II features can be done through the four competence elements, provided that these are approached in an appreciative and lenient way.

The content of a debriefing has traditionally been based purely on what was observed during the practical part of the competence assessment. If the session has been uneventful, the debriefing will with great likelihood be short and only consist of a short feedback session and signing of papers. One could easily argue that there could be an element of adjusting performance according to Work-As-Imagined and thereby ensuring standardised performance, which meet the intended requirements of measurement. This approach is not compatible with an assessment conducted from a Safety-II perspective, as the debriefing will play an increasingly and more important role.

The four elements of *Adaptive, Service-driven, Social* and *Experience-based* competence are key aspects to be facilitated during the debriefing. Although some of the elements might not be observed during the practical part of the assessment, they should still be investigated and targeted through the use of focus areas and scenario type questions. The purpose it not to measure or evaluate performance, it is more to gain an understanding of how and why the ATCOs adjust their performance on a day to day basis.

Embracing the new six stage competence model will facilitate a transition from the traditional Safety-I approach towards a Safety-II framework where the daily activities of work can be explored.

5. DISCUSSION

The aspiration of this thesis was to investigate if the mandatory competence assessment of Air Traffic Controllers can be utilised, as a means of transitioning from the traditional Safety-I methodology of exclusively assessing the individual, towards a Safety-II approach where the interaction between the ATCO and the system is incorporated.

The research disclosed a need for calibrating the traditional view of competence, as well as a prerequisite of recognising and embracing new competencies. A proposal was derived from the research data and is presented in this thesis as the six stage competence model in Figure 4. The elements of Adaptive, Service-driven and Social competence emerged from the data as the informants described how coping with the complexity of a constantly changing traffic picture requires flexibility, adaptability, efficiency and teamwork. Considering that these are features of Work-As-Done, they should be appreciated and understood as significant constituents of competence. It is essential to find the appropriate method of assessing these new elements, as measuring competence is an area which is both multifaceted and underspecified in respect of well-grounded assessment tools suitable to encompass elements of Work-As-Done.

The introduction of new competencies accentuates that the competence assessment scheme needs versatility to be able to cope with complexity and change. The nature of competence will change in the years ahead, as significant and far reaching systemic changes are coming. The competence assessment scheme needs to be consistent with the changes in technology and the changing ATCO skill set. Complying with the traditional Safety-I approach of constraining performance variability and enforcing strict procedure compliance is counterproductive in the operational systems of today. Amalberti argues that:

> The ultimate robustness or resilience of the system is always based on the remaining adaptive capacity of the actors. It is important to ensure that they are not strait-jacketed by unnecessary procedures, since each procedure slightly reduces the adaptive capacity of the system (Amalberti, 2013, p.128).

As the skill sets change, new competences will be required and the assessment or measurement of these must then follow. Moreover, the nature or philosophy of the competence assessment scheme itself has potential to change and support the management of change that ATM will be required to undertake.

Preceding the commencement of collecting research data, a hypothesis was developed, speculating if continuous assessment would be better suited for recognising Safety-II system dynamics such as performance adjustments, performance variability and adaptations. It was therefore of particular interest to examine if the units that are currently using continuous assessment have procedures and tools in place to monitor these system dynamics. The assumption was based upon Hollnagel's argument that "effective monitoring requires both that there is time available, and that there is a monitoring strategy, and that the people or operators involved have the requisite skills and knowledge" (Hollnagel, Pariès, Woods, & Wreathall, 2011, p.293). The investigation showed that although the continuous assessment provides an ideal timeframe, the monitoring strategy mainly revolves around the individual and not the system. It was similarly found that knowledge concerning system dynamics like trade-offs and performance variability was minimal. The data disclosed that continuous assessment does not necessarily mean that the organisation is better at monitoring systemic interactions between the ATCO and the system as a whole.

Competence assessment is conducted not only to assess the competence of the individual, it is correspondingly the aim to assess the competence of the system (EUROCONTROL, 2005). Safety-II has an emphasis on the coupling between the individual and the system, hence the structure of the competence assessment should reflect this emphasis. Comprehending the coupling between the two, places a focus on understanding what is 'normal', to understand what is unusual (Hollnagel, 2015a). This is also in agreement with Perrow's argument that "we should be sensitive to trivial events in nontrivial systems" (1984, p.43). Information concerning trivial events can only be provided by the people working within the system. Recognising the ATCOs as system informants is important to ensure that competence assessment support the individual as well as the system. This relates back to the previous discussion of the versatility of the competence assessment scheme. The current EASA regulation is focused on the individual level and should be raised to the systems level. In order for the competence assessment scheme to work, it needs to have the regulatory perspective that recognises the systemic view.

Whatever form or format we need for Safety-II, it has got to be proportionate since time and money are limited assets. The competence assessment scheme can provide a structure without spending additional resources on observational safety surveys. Observational surveys or techniques can to some extent provide a Safety-II framework, if they base their observations on Work-As-Done. The research of this thesis has however shown that good feedback mechanisms and talking to people is more important than just observing. An observer does not have privileged access to the operators mind and actions, partly due to the high level of automation. It is therefore vital to have a good debriefing structure to maximise learning. Since competence assessment is a mandatory requirement, the resources are already allocated, and this favours the competence assessment scheme as an instrument for Safety-II deployment. Combining the elements of observation and discussion is similarly conforming to the recommendations of Shorrock et al. in (EUROCONTROL, 2014) in terms of understanding Work-As-Done and systems thinking. Including a systems view will provide the organisation with vital information concerning performance variability, adaptations and thus Work-As-Done.

Looking back at the research conducted at the three sites, with differing assessment methods, it becomes clear that this diversity has contributed greatly in defining enablers of Safety-II. The research showed, that in order to understand Work-As-Done and why things go right, in addition to approximate adjustments and performance variability, the organisation must have suitable feedback mechanisms to both access and share information. The notion of generative competence (Barrett, 1995) in combination with mindfulness as described by Weick & Sutcliffe (2007) can augment awareness and empowerment of the individual in a high-performing organisation. Westrum (2004) argues that high cooperation and risk sharing ensures alignment, awareness and empowerment within a performance oriented organisation. Organisations that are able to process information and adhere to this kind of information flow are labelled as generative. Generative competence in a generative organisation acknowledge people as a key resource in the same way as is the emphasis in Safety-II.

When investigating the competence assessment scheme and methodology of the three research sites, one of them stood out as a result of the consistency of the informants' statements. Independently of each other, all informant groups described the same features connected to the operationalisation of the unit's assessment methodology. Specific examples of elements which support the assessment and development of the individual, as well as the system, were given. The research data indicates that this site is effectively operating mechanisms that allow them to learn, not just on the individual level, also the level of the system. The informants feel they have the opportunity to provide feedback, which is then used with the prospective purpose of understanding and improving the unit. The described framework is that of Malmö ATCC. Their

competence assessment scheme could be considered the closest to a competence assessment scheme which incorporates feedback mechanisms both on the individual and systemic level. A similar structure could conceivably enable or facilitate a transition from Safety-I to a synthesis of Safety-I and Safety-II. The competence assessment scheme at Malmö ATCC is not flawless, there are still areas which should be developed further in order to fully embrace Safety-II. New competencies must be recognised and incorporated. The question is also whether the assessment method of using dedicated check could be advanced and improved by changing to continuous assessment? A change to continuous assessment would place them more in line with how they presently conduct all their unit training.

The topic of training brings in a future challenge which was identified during the research. Today we are training people according to the elements of Work-As-Imagined and thereby the features Safety-I.

A potential research areas for future studies could be the role of training in a Safety-II environment. Essential questions one could pose are;

- At what stage during training should Safety-II be introduced and promoted?
- Should the given training be mapped against Work-As-Done?
- Will the competence assessment need a different structure to compensate for the trainees lack of experience during the first year?
- Could the On the Job Training Instructor (OJTI) be the instrument of getting Safety-II into the organisation?

The trainees will, to a vast extent, get their safety knowledge from the OJTIs during their training. The role of training, the role of the OJTI and the role of competence assessment seen through a Safety-II lens, is well worth exploring. It could be that the concept of competence assessment is entirely redundant in a future where complexity and interconnectivity requires a different kind of information sharing.

Competence assessment conducted in accordance with Safety-II will provide vital information about the effectiveness of the unit's operation. However in order to optimise and benefit from this, managers of ANSPs need to understand that they have a new source of information, a new source of safety intelligence that can be used. Their interaction and relationship with the workforce, or system informants, can reduce the burden and make the system more effective. In order to really make the most out of a Safety-II approach it will require preparation and training of managers, safety managers and assessors. The ATCOs should be involved and included in certain parts of the process, to build trust and increase awareness of the Safety-II principles. The evidence gained from this research would indicate that the role and structure of debriefing along with other potential effective feedback mechanisms, will play a significant part in deriving the understanding of how the system behaves. In order to achieve this, all actors in the chain of competence assessment will need appropriate training to ensure consistent application of the six stage competence model. This is to make clear the responsibilities and expectations associated with the new flow of information.

At this moment in time competence assessment is not used to the full extent possible. There is still great potential in examining the dynamics of the system and placing an emphasis on understanding why things go right. The competence assessment scheme can play an important role in understanding Safety-II, and it can correspondingly act as a facilitator for an effective transition of change management.

6. CONCLUSION

In the exploration of the thesis question it became evident that for the competence assessment to transition from Safety-I to Safety-II, new competencies must be recognised and the coupling between the individual ATCO and the system must be understood more in depth. The six stage competence model can help facilitate the process and at the same time increase knowledge and understanding of Work-As-Done. The competence elements of the model are:

- **Skill-based competence**
- **Knowledge-based competence**
- **Experience-based competence**
- **Adaptive competence**
- **Service-driven competence**
- **Social competence**

A prerequisite for the utilisation of the six stage competence model, is the recognition of the ATCOs as System informants. In Safety-II, the human operator is seen "as a resource necessary for system flexibility and resilience" (Hollnagel, 2014, p. 147).

The mind-set by which competence assessment is presently conducted is rooted in compliance and procedural adherence, thereby giving very little space for understanding normal work. Emphasis and attention is predominantly placed on the individual, not the system. A transition towards a Safety-II approach is hence reliant on a shift in focus to embrace and include the systems view, a fundamental philosophy of Safety-II.

In its current form and state, competence assessment of air traffic controllers do not fully support or provide the framework for exploring and understanding performance variability and adaptation. The necessity and relevance of both performance variability and adaptive capacity were confirmed by the informants, and should therefore be acknowledged as a means of ensuring robustness and resilience of the system as argued by Amalberti (2014). The element of Adaptive competence was constructed to incorporate these central Safety-II aspects.

The data collected from the ATCO informants furthermore provided significant evidence of efficiency/thoroughness trade-offs, as ATCOs clearly distinguish themselves as being efficient and service-oriented rather than strictly rule compliant. This supports Hollnagel's argument that people will choose the more efficient mode of operation, providing it is perceived as safe (2009). The element of Service-driven competence was designed to provide the organisation with essential information on daily trade-offs used to ensure an efficient and safe operation.

The competence assessment scheme has potential, with the support of the six stage competence model, to facilitate a transition towards Safety-II through the investigation and understanding of Adaptive and Service-driven competence. Both competence elements integrate central aspects of Safety-II and can offer insight into these critical aspects, provided they are approached with an appreciative mind-set and a focus on understanding why thing go right. The transition to Safety-II will for the foreseeable future coexist with Safety-I. It must similarly be acknowledged that the classic safety paradigm has yielded significant safety benefits to ATM. Therefore the transition will not be to Safety-II alone, it will be a transition to a blend of Safety-I and Safety-II. The six stage competence model represents a synthesis of competence elements associated with the features of Work-As-Imagined and Work-As-Done, as both approaches to safety will need to be supported in competence assessment of air traffic controllers. A competence assessment scheme with a combined emphasis on the individual and the system, will play an important part in the transition from Safety-I to the new world of Safety-II and a competence assessment synthesis.

7. ACKNOWLEDGEMENTS

It is truly a daunting task to write acknowledgements, as I may unintentionally forget someone. There are nevertheless many whom I wish to show my sincerest gratitude for all their help during my studies, especially on the long and winding road that a thesis work can be. Though it has been challenging at times, I feel very privileged to be given this opportunity. I would therefore like to thank both the management and my colleagues at Entry Point North for supporting me all the way through the education. You have all been brave, responsible, innovative and open-minded during our many fruitful discussions, or as part of the never ending data collection process.

This thesis is largely a product of onsite research. I'm therefore both humble and grateful that the three participating units, and all the informants, welcomed me with open arms and willingly shared their view on competence assessment. I thank you all for your trust and for taking the time to enlighten me. All your inputs and insights were a great source of inspiration and I can only hope that my findings will be of some inspiration to you as well.

In many senses, it feels like the journey leading up to this thesis already commenced back in 2008 when I ran into Professor Sidney Dekker in Sterling's crew room. Thoughts and ideas were planted and at some point the enrolment at Lund's university was a fact. Thank you Sidney for inspiring me to do this, it has truly been a mind blowing experience.

Björn Erik, even though you were only able to supervise me during the initial phase of the thesis work, I would like to thank you for your inputs and guidance. I hope you recognise our brainstorming sessions in the final product.

Professor Johan Bergström, as the architect behind this amazing experience you deserve a special thank you for the huge amount of work you put into this Master program. Not only do you facilitate inspirational lectures and stimulating discussions, you have also managed to create an environment where the close correspondence between the mentors and the students emerged into something I can only describe as my second family. For that I feel both blessed and enriched. I'm forever grateful to all the mentors and fellow students of this program, no words can rightfully describe our fascinating journey through the complexity of system safety.

Dr Anthony Smoker, you more than any deserve a warm and heartfelt thank you. Your constant encouragement, combined with a continuous bombardment of articles, helped me navigate these waters. I feel fortunate to have you as my academic library and lighthouse right at hand. You persistently ignited my curiosity and never allowed me to stay within my comfort zone, for that I'm eternally grateful.

Last but not least, the people closest to me deserve a gratitude beyond compare. None of this would have been possible without the help and support from my family and close friends. I'm deeply grateful for your understanding and acceptance.

This thesis is dedicated to Gaute, Isabel and Sander, I apologise for my absence. My mind may have been preoccupied, however my heart was with you all the time. I love you!

8. REFERENCES

Amalberti, R. (2013). *Navigating safety: Necessary compromises and trade-offs – Theory and Practice.* London: Springer

Barrett, F. J. (1995). Creating Appreciative Learning Cultures. *Organizational Dynamics* Volume 24, 15 Issue 2, 36-49

Blaxter, L., Hughes, C., & Tight, M. (2010). *How to research*. Berkshire, England: McGraw-Hill

Bosk, C.L. (2003). *Forgive and remember: Managing medical failure*. Chicago: The University of Chicago Press.

Branlat, M. & Woods, D. (2010). How do Systems Manage Their Adaptive Capacity to Successfully Handle Disruptions? A Resilience Engineering Perspective. In M. Hadzikadic & T. Carmichael**,** *Adaptive Systems —Resilience, Robustness, and Evolvability: Papers from the AAAI Fall Symposium FS-10-03* (pp. 26-34). Paolo Alto, CA: Association for the Advancement of Artificial Intelligence.

Brinkmann, S. & Kvale, S. (2015). *Interviews: Learning the craft of qualitative research*. Los Angeles: Sage Publications

Corbin, J. & Strauss, A. (2008). *Basics of Qualitative Research: Techniques and procedures for developing grounded theory*. Doi: 10.4135/9781452230153

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches*. London: SAGE Publications

Czarniawska, B. (2014). *Social Science Research: From field to desk*. London: Sage

Dekker, S. (2003). Failure to adapt or adaptations that fail: contrasting models on procedures and safety. *Applied Ergonomics* 34, 233–238

Dekker, S. (2011). *Drift into failure: From hunting broken components to understanding complex systems.* Farnham, England: Ashgate

Dekker, S. (2015). *Safety differently: Human factors for a new era.* Boca Raton: CRC Press

EASA. (2011). COMMISSION REGULATION (EU) No 805/2011. Retrieved from EASA's website: https://easa.europa.eu/document-library/regulations/commission-regulation-eu-no-8052011

EUROCONTROL. (2002) ESARR 5. Retrieved from Eurocontrol's website: http://www.eurocontrol.int/sites/default/files/article/content/documents/single-sky/src/esarr5/esarr5-e2.0.pdf

EUROCONTROL. (2005) Guidelines for Competence Assessment. Retrieved from Eurocontrol's website: http://www.eurocontrol.int/sites/default/files/field_tabs/content/documents/nm/safety/guidelines-for-competence-assessment.pdf

EUROCONTROL. (2011) Ensuring Safe Performance in ATC Operations: Observational Safety Survey Approaches. A White Paper. Retrieved from Eurocontrol's website: http://www.eurocontrol.int/sites/default/files/article/content/documents/nm/safety/safety-white-paper-20111.pdf

EUROCONTROL. (2013). From Safety-I to Safety-II: A White paper. Retrieved from Eurocontrol's website: http://www.eurocontrol.int/sites/default/files/content/documents/nm/safety/safety_white257paper_sept_2013-web.pdf

EUROCONTROL. (2014). Systems Thinking for Safety: Ten principles. A White paper. Moving towards Safety-II. Retrieved from Skybrary's website: https://dl.dropboxusercontent.com/u/4953549/Shorrock%2010%20Principles%20White%20Paper%2020141101%20web.pdf

Fruhen, L.S., et al. (2013). Skills, knowledge and senior managers' demonstrations of safety commitment. *Safety Science*. http://dx.doi.org/10.1016/j.ssci.2013.08.024

Glaser, B. & Strauss, A. (1967). *The discovery of grounded theory: strategies for qualitative research.* New York: Aldine de Gruyter

Hollnagel, E. (2009). *The ETTO principle*: *Efficiency-thoroughness trade-off. Why things that go right sometimes go wrong.* Farnham, England: Ashgate

Hollnagel, E. (2012). *FRAM: The functional resonance analysis method. Modeling complex socio-technical systems.* Farnham, England: Ashgate

Hollnagel, E. (2013a, February). A Tale of Two Safeties. Paper presented at the Resilience Engineering – from Safety-I to Safety-II conference. Linköping, Sweden

Hollnagel, E. (2013b, February). The Resilience Analysis Grid (RAG). Paper presented at the Resilience Engineering – from Safety-I to Safety-II conference. Linköping, Sweden

Hollnagel, E. (2014). *Safety-I and Safety-II: The past and future of safety management*. Farnham, England: Ashgate

Hollnagel, E. (2015). Why is work-as-imagined different from work as done? In, Eds Wears. R.L., Hollnagel, E. & Braithwaite, J. *Resilient health care volume 2*: *The resilience of everyday clinical work*. Farnham, England: Ashgate

Hollnagel, E. (2015a, May). Safety-I and Safety-II: Safety Analysis and Safety Synthesis. Power point presented at the safety seminar – The changing landscape of ATM Safety. Malmö, Sweden

Hollnagel, E., Woods, D. & Leveson, N. (2006). *Resilience Engineering: Concepts and Precepts.* Farnham, England: Ashgate

Hollnagel, E., Pariès, J., Woods, D. & Wreathall, J. (2011). *Resilience Engineering in Practice: A guidebook*. Farnham, England: Ashgate

Hutton, R., & Klein, G. (1999). Expert Decision Making. *Systems Engineering*. John Wiley & Sons, Inc. 32-45

Kontogiannis, T., & Malakis, S. (2012). Remaining safe by working at the edge of compliance and adaptation: reflective practices in aviation and air traffic control. Theoretical Issues in *Ergonomics Science*, 1–27. Doi: 10.1080/1463922X.2012.672597

Licu, T., Shorrock, S., Cioponea, R., & Blajev, T. (2013, November). Moving forward towards Safety-II: Finding out why work-as-done (usually) goes right [PowerPoint presentation].

Perrow, C. (1984). *Normal Accidents: Living with high-risk technologies*. Princeton University Press.

Rankin, A., Lundberg, J., Woltjer, R., Rollenhagen, C., & Hollnagel, E. (2013). Resilience in Everyday Operations: A Framework for Analyzing Adaptations in High-Risk Work. *Journal of Cognitive Engineering and Decision Making*, 1-20. Doi: 10.1177/1555343413498753

Rasmussen, J. (1983). Skills, Rules, and Knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE transactions on systems, man, and cybernetics* 3, 257-266

Shorrock, S. (2013, December 13). Déformation professionnelle: How profession distorts perspective [Safety differently Website]. Retrieved from http://www.safetydifferently.com/deformation-professionnelle-how-profession-distorts-perspective/

Stake, R.E. (2010). *Qualitative Research: Studying How Things Work*. New York: Guilford Publications

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: techniques and procedures for developing grounded theory*. California: Thousand Oaks

Weick, K.E., & Sutcliffe, K.M. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty*. San Francisco: Jossey-Bass

Weichbrodt, J. (2015). Safety rules as instruments for organizational control, coordination and knowledge: Implications for rules management. *Safety science* 80, 221-232

Westrum, R. (2004). A typology of organisational cultures. *Quality safe health care* 2004; 13 (Suppl II): ii22–ii27. Doi: 10.1136/qshc.2003.009522

9. APPENDICES

9.1 Appendix 1: Informed Consent Form

Appendix

Informed Consent Form

MSc in Human Factors and System Safety

Title of project
Can Competence Assessment of Air Traffic Controllers enable or facilitate a transition from Safety-I to Safety-II by recognising Performance Variability and Adaptation?

Student Investigator
Anne-Mette Petri
Email: amp@entrypointnorth.com
Phone: 0046-733852708

Project Purpose
The aim is to examine if competence assessment of air traffic controllers can be used as a viable method for monitoring, identifying and recognising performance variability and adaptation in addition to confirming competence and procedure compliance.
The purpose is to observe and identify to which extent the Safety-II philosophy is integrated in today's Competence Assessment Scheme.

Confidentiality
Identities of all participants will remain anonymous and will be kept confidential from all other parties other than the interviewer. During the interview notes will be taken and the conversation will be taped for the purpose of recall by the researcher for future analysis. Anonymity will be further protected in any future portions of the thesis paper and any presentations that may result from this work. Participant names will be kept in a locked secure filing cabinet separate from the information collected by the researcher. Participant names and researcher notes will be disposed of, using confidential waste no later than January 2018.

Contact Information about this Thesis Work
Supervisor: Björn Erik Besserudhagen
Email: Bjorn.Erik.Besserudhagen@avinor.no
Assessor: Johan Bergström
Email: johan.bergstrom@risk.lth.se
Address: Leonardo da Vinci Laboratory for Complexity and Systems Thinking
Department of Societal Safety and Risk Management
Lund University
P.O. Box 118
SE-221 00, Lund
Sweden

Risks/Benefits
There are no known risks or benefits to participating in this research.

LUND UNIVERSITY

Informed Consent Form

MSc in Human Factors and System Safety

Consent

Your participation in this research project is entirely voluntary. You may refuse to participate or withdraw from the research at any time.

Your signature indicates that you have received a copy of this consent form for your own records and that you consent to participate in this research.

I, _____agree to participate as outline above. My participation is voluntary and I understand I can withdraw at any time.

_____

Participant's Signature

Date

_____

Student Investigator Signature

Date

Leonardo da Vinci Laboratory for Complexity and Systems Thinking, Department of Societal Safety and Risk Management, Lund University, P.O. Box 118, SE-221 00, Sweden

9.2 Appendix 2: Interview guide Vienna APP - ATCO

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?

2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?
   - Why did you change from dedicated check to continuous assessment?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence?
   - How is this measured?

Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.

6. If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose?
   - Please elaborate!

Present and discuss the picture "The Assessment Environment" with the informant(s).

7. What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ATCO

8. Could you briefly describe the way you work during a normal working day and one where you work with a Competence Assessor?
   - Do they differ? - If yes, in what way?

9. How would you describe the operational environment?
   - Is the working condition stable (mainly routine) or does it require a lot of improvisation?
   - If yes, please give an example!

10. How often do you need to adjust, customize, compensate or adapt to a specific situation?
    - How predictable are these situations?
    - Can you prepare for them?
    - Please give an example of how you adjust your performance
    - Could you specify the reason why you would need to adjust your performance?
    - Would you do the same adjustment(s)/adaptation(s) during a competence assessment?

11. Could you describe a typical situation (working with traffic) where you would trade-off thoroughness for efficiency?
    - Would you do the same trade-off during a competence assessment?

12. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

13. How would you describe the linkage between Competence Assessment and the following four actions;
    - Monitor
    - Respond
    - Learn
    - Anticipate

14. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? (refrase)
    - If yes, in what way?

15. In your experience, how do you think the management and the safety department view the function of the Competence Assessment?
    - In what way do they use the yearly findings?

16. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

17. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

18. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.3 Appendix 3: Interview guide Vienna APP - ASSESSOR

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?
    - Why did you change from dedicated check to continuous assessment?
4. Could you describe your thoughts concerning the concept of Competence Assessment?
5. What is competence to you? How would you define/describe competence? How is this measured?

Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.

6. If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

Present and discuss the picture "The Assessment Environment" with the informant(s).

7. What is the purpose of the Competence Assessment? ((Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ASSESSOR

8. Could you briefly describe how you work as a competence assessor? (continuous assessment)
    - How were you selected?
    - Do you have dedicated days for observations? (Targeted days or a holistic impression?)
    - Do you observe all colleagues?
    - Is briefing part of the concept?
9. Do you use Performance Objectives?
    - If yes, please give an example! - If no, why not?
10. Do you have yearly focus areas?
    - If yes, are these communicated to your colleagues? - If no, why not?
11. Do you use the Scenario Interview?
    - If yes, in what way? If no, - why not?
12. What would you describe as characteristic findings in a Competence Assessment?
    - How are these communicated to the colleagues?
    - And to management?
    - What do you do if there is competence in doubt?

13. Do your colleagues get any yearly individual feedback?

14. How would you describe the operational environment?
    - Is the working condition stable (mainly routine) or does it require a lot of improvisation?
    - Please give an example!

15. How often do you see your colleagues adjust, customize, compensate or adapt to a specific situation?
    - How predictable are these situations?
    - Can they prepare for them?
    - Could you give an observed example of how your colleagues adjust their performance?
    - Could you specify the reason why they need to adjust their performance?
    - Would they do the same adjustment(s)/adaptation(s) during a dedicated check?

16. Could you describe a typical situation (that you have observed) where your colleagues would trade-off thoroughness for efficiency?
    - Would they do the same trade-off during a dedicated check?

17. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

18. How would you describe the linkage between Competence Assessment and the following four actions;
    - Monitor
    - Respond
    - Learn
    - Anticipate

19. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure?
    - If yes, in what way? – If no, why not?

20. In your experience, how do you think the management and the safety department view the function of the Competence Assessment?
    - In what way do they use the yearly findings?

21. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

22. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done?
    - Please elaborate!

23. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

24. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.4 Appendix 4: Interview guide Vienna APP - MANAGEMENT

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?
    - Why did you change from dedicated check to continuous assessment?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence?
    - How is this measured?

Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.
If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

Present and discuss the picture "The Assessment Environment" with the informant(s).
What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) MANAGEMENT

6. How confident are you that the Competence Assessment Scheme provides you with a representative picture of safety in the operation?

7. Do you use the Competence Assessment Scheme to assure yourself of changes in the operational environment? - How?

8. How do you anticipate or expect the Competence Assessment Scheme to support those undergoing the change?

9. How would you describe the operational environment? (In order to determine if the view of the operational staff and management differ)

10. Is the working condition stable (mainly routine) or does it require a lot of improvisation?

11. How often do you think the controllers need to adjust, customize, compensate or adapt to a specific situation? - How predictable are these situations and can they prepare for them?

12. Are you aware of how and why the controllers adjust their performance? Do you think they would do the same adjustment(s)/adaptation(s) during a competence assessment (dedicated check)?

13. Does Work-As-Imagined/designed and Work-As-Done, and the difference therein, matter to you? If so why?

14. Do you consider trade-offs as a means of assuring safe operation? If yes, in what way?

15. Would the ATCOs do the same trade-off during a competence assessment?

16. What contribution to lesson learning, does your competence assessment scheme make?

17. How do you assess the Competence Assessment in terms of making progress on safety?

18. Do you have a process/technique for understanding the success of everyday activity as a method for understanding failure?

19. Have you identified a difference in data from the dedicated check to the continuous assessment?

20. How do you use the assessor's findings? (Please exemplify)

21. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

22. How would you describe the linkage between Competence Assessment and the following four actions;
    - Monitor
    - Respond
    - Learn
    - Anticipate

23. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way? – If no, why not?

24. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

25. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

26. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

27. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.5 Appendix 5: Interview guide Vienna APP - SAFETY MANAGER

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?
    - Why did you change from dedicated check to continuous assessment?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence? How is this measured?

6. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.**
   If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

7. **Present and discuss the picture "The Assessment Environment" with the informant(s).**
   What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) SAFETY MANAGER

8. Could you describe how you view the link between Competence Assessment and your role and responsibility as a Safety Manager?

9. How effective is the Competence Assessment Scheme?

10. Is it used for the management of change? (If new systems are implemented or current systems are upgraded) - How?

11. Does it provide you with the assurance that you need?

12. How would you describe the operational environment? (In order to determine if the view of the operational staff and management differ)

13. Is the working condition stable (mainly routine) or does it require a lot of improvisation?

14. How often do you think the controllers need to adjust, customize, compensate or adapt to a specific situation? How predictable are these situations and can they prepare for them?

15. Are you aware of how and why the controllers adjust their performance?

16. Do you think they would do the same adjustment(s)/adaptation(s) during a competence assessment (dedicated check)?

17. Does Work-As-Imagined/designed and Work-As-Done, and the difference therein, matter to you? If so why?

18. Do you have a process/technique for understanding the success of everyday activity as a method for understanding failure?

19. Do you use trade-offs as a measure of how safe the operation is?

20. Have you identified a difference in data from the dedicated check to the continuous assessment?

21. How do you use the assessor's findings? (Please exemplify)

22. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

23. How would you describe the linkage between Competence Assessment and the following four actions;
    - Monitor
    - Respond
    - Learn
    - Anticipate

24. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way?

25. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

26. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

27. How do you assess the Competence Assessment in terms of making progress on safety? (and why)

28. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

29. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.6 Appendix 6: Interview guide Malmö ATCC - ATCO

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?

2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence?

6. Could you summarise it in 4 - 5 core competences? How is this measured?

7. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.**

If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

8. **Present and discuss the picture "The Assessment Environment" with the informant(s).**

What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ATCO

9. Could you briefly describe the way you work during a normal working day and one where you have your yearly competence assessment? Do they differ? - If yes, in what way?

10. How would you describe the operational environment? Is the working condition stable (mainly routine) or does it require a lot of improvisation? If yes, please give an example!

11. How often do you need to adjust, customize, compensate or adapt to a specific situation?

12. How predictable are these situations? Can you prepare for them?

13. Please give an example of how you adjust your performance

14. Could you specify the reason why you would need to adjust your performance?

15. Would you do the same adjustment(s)/adaptation(s) during a competence assessment?

16. Could you describe a typical situation (working with traffic) where you would trade-off thoroughness for efficiency?

17. Would you do the same trade-off during a competence assessment?

18. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

19. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way?

20. In your experience, how do you think the management and the safety department view the function of the Competence Assessment?

21. In what way do they use the yearly findings?

22. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

23. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

24. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.7 Appendix 7: Interview guide Malmö ATCC - ASSESSOR

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence?

6. Could you summarise it in 4 - 5 core competences? How is this measured?

7. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.**
If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

8. **Present and discuss the picture "The Assessment Environment" with the informant(s).**
What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ASSESSOR

9. Could you briefly describe how you work as a competence assessor? (Dedicated check) How were you selected?

10. Do you use Performance Objectives? If yes, please give an example! - If no, why not?

11. Do you have yearly focus areas? If yes, are these communicated to your colleagues? - If no, why not?

12. Do you use the Scenario Interview? If yes, in what way? If no, - why not?

13. What would you describe as characteristic findings in a Competence Assessment?

14. How are these communicated to the colleagues? And to management?

15. What do you do if there is competence in doubt?

16. Do your colleagues get any yearly individual feedback?

17. How would you describe the operational environment? Is the working condition stable (mainly routine) or does it require a lot of improvisation? Please give an example!

18. How often do you see your colleagues adjust, customize, compensate or adapt to a specific situation? How predictable are these situations? Can they prepare for them?

19. Could you give an observed example of how your colleagues adjust their performance?

20. Could you specify the reason why they need to adjust their performance?

21. Would they do the same adjustment(s)/adaptation(s) during a dedicated check?

22. Could you describe a typical situation (that you have observed) where your colleagues would trade-off thoroughness for efficiency?

23. Would they do the same trade-off during a dedicated check?

24. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

25. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way? – If no, why not?

26. In your experience, how do you think the management and the safety department view the function of the Competence Assessment?

27. In what way do they use the yearly findings?

28. Is your expertise/experience used when performing safety assessments or when investigating incidents/occurrences?

29. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

30. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? Please elaborate!

31. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

32. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.8 Appendix 8: Interview guide Malmö ATCC - MANAGEMENT

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit? Why dedicated check?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence?

6. Could you summarise it in 4 - 5 core competences? How is this measured?

7. Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.
If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

8. Present and discuss the picture "The Assessment Environment" with the informant(s)
What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) MANAGEMENT

9. Could you describe how you view the link between Competence Assessment and your role and responsibility as a Manager?

10. How confident are you that the Competence Assessment Scheme provides you with a representative picture of safety in the operation?

11. Do you use the Competence Assessment Scheme to assure yourself of changes in the operational environment? How?

12. How do you anticipate or expect the Competence Assessment Scheme to support those undergoing the change?

13. How would you describe the operational environment? (In order to determine if the view of the operational staff and management differ) Is the working condition stable (mainly routine) or does it require a lot of improvisation?

14. How often do you think the controllers need to adjust, customize, compensate or adapt to a specific situation?

15. How predictable are these situations and can they prepare for them?

16. Are you aware of how and why the controllers adjust their performance?

17. Do you think they would do the same adjustment(s)/adaptation(s) during a competence assessment (dedicated check)?

18. Does Work-As-Imagined/designed and Work-As-Done, and the difference therein, matter to you? If so why?

19. Do you consider trade-offs as a means of assuring safe operation? If yes, in what way?

20. Would the ATCOs do the same trade-off during a competence assessment?

21. What contribution to lesson learning, does your competence assessment scheme make?

22. How do you assess the Competence Assessment in terms of making progress on safety?

23. Do you have a process/technique for understanding the success of everyday activity as a method for understanding failure?

24. How do you use the assessor's findings? (Please exemplify)

25. To what extent, on a scale from 1-5, do you think Competence Assessment strengthen the organisation's ability to anticipate and monitor change?

26. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way? – If no, why not?

27. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

28. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

29. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

30. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.9 Appendix 9: Interview guide Inverness TWR - ATCO

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?

2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?

4. Why the combination of dedicated check & continuous assessment?

5. Could you describe your thoughts concerning the concept of Competence Assessment?

6. What is competence to you? How would you define/describe competence?

7. Could you summarise it in 4 - 5 core competences? How is this measured?

8. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.**
   If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

9. **Present and discuss the picture "The Assessment Environment" with the informant(s).**
   What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ATCO

10. Could you briefly describe the way you work during a normal working day and one where you are observed as part of the continuous assessment? Do they differ? - If yes, in what way?

11. How would you describe the operational environment?

12. Is the working condition stable (mainly routine) or does it require a lot of improvisation? If yes, please give an example!

13. How often do you need to adjust, customize, compensate or adapt to a specific situation?

14. How predictable are these situations? Can you prepare for them?

15. Please give an example of how you adjust your performance

16. Could you specify the reason why you would need to adjust your performance?

17. Would you do the same adjustment(s)/adaptation(s) during a competence assessment?

18. Could you describe a typical situation (working with traffic) where you would trade-off thoroughness for efficiency?

19. Would you do the same trade-off during a competence assessment?

20. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way?

21. In your experience, how do you think the management and the safety department view the function of the Competence Assessment?

22. In what way do they use the yearly findings?

23. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

24. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

25. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.10 Appendix 10: Interview guide Inverness TWR - ASSESSOR

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit? Why the combination of dedicated check & continuous assessment?

4. Could you describe your thoughts concerning the concept of Competence Assessment?

5. What is competence to you? How would you define/describe competence? Could you summarise it in 4 - 5 core competences? How is this measured?

6. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.** If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

7. **Present and discuss the picture "The Assessment Environment" with the informant(s).** What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) ASSESSOR

8. Could you briefly describe how you work as a competence assessor? (Combining dedicated check and continuous assessment)

9. How were you selected?

10. Do you have dedicated days for observations? (Targeted days or is it a holistic impression?) Do you observe all colleagues?

11. Is briefing part of the concept?

12. Do you use Performance Objectives? If yes, please give an example! - If no, why not?

13. Do you have yearly focus areas? If yes, are these communicated to your colleagues? - If no, why not?

14. Do you use the Scenario Interview? If yes, in what way? If no, - why not?

15. What would you describe as characteristic findings in a Competence Assessment? How are these communicated to the colleagues? And to management?

16. What do you do if there is competence in doubt?

17. Do your colleagues get any yearly individual feedback?

18. How would you describe the operational environment? Is the working condition stable (mainly routine) or does it require a lot of improvisation? Please give an example!

19. How often do you see your colleagues adjust, customize, compensate or adapt to a specific situation?

20. How predictable are these situations? Can they prepare for them?

21. Could you give an observed example of how your colleagues adjust their performance?

22. Could you specify the reason why they need to adjust their performance?

23. Would they do the same adjustment(s)/adaptation(s) during a dedicated check?

24. Could you describe a typical situation (that you have observed) where your colleagues would trade-off thoroughness for efficiency?

25. Would they do the same trade-off during a dedicated check?

26. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way? – If no, why not?

27. In your experience, how do you think the management and the safety department view the function of the Competence Assessment? In what way do they use the yearly findings?

28. Is your expertise/experience used when performing safety assessments or when investigating incidents/occurrences?

29. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

30. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? Please elaborate!

31. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

32. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.11 Appendix 11: Interview guide Inverness TWR - MANAGEMENT

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?
2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?

4. Why the combination of dedicated check & continuous assessment?

5. Could you describe your thoughts concerning the concept of Competence Assessment?

6. What is competence to you? How would you define/describe competence?

7. Could you summarise it in 4 - 5 core competences? How is this measured?

8. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.** If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

9. **Present and discuss the picture "The Assessment Environment" with the informant(s).** What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) MANAGEMENT

10. Could you describe how you view the link between Competence Assessment and your role and responsibility as a Manager?

11. How confident are you that the Competence Assessment Scheme provides you with a representative picture of safety in the operation?

12. Do you use the Competence Assessment Scheme to assure yourself of changes in the operational environment? How?

13. How do you anticipate or expect the Competence Assessment Scheme to support those undergoing the change?

14. How would you describe the operational environment? (In order to determine if the view of the operational staff and management differ?

15. Is the working condition stable (mainly routine) or does it require a lot of improvisation?

16. How often do you think the controllers need to adjust, customize, compensate or adapt to a specific situation?

17. How predictable are these situations and can they prepare for them?

18. Are you aware of how and why the controllers adjust their performance?

19. Do you think they would do the same adjustment(s)/adaptation(s) during a competence assessment (dedicated check)?

20. Does Work-As-Imagined/designed and Work-As-Done, and the difference therein, matter to you? If so why?

21. Would the ATCOs do the same trade-off during a competence assessment?

22. Do you consider trade-offs (thoroughness & efficiency) to be a necessary part of assuring safe operation? - If yes, in what way?

23. What contribution to lesson learning, does your competence assessment scheme make?

24. How do you assess the Competence Assessment in terms of making progress on safety?

25. Do you have a process/technique for understanding the success of everyday activity as a method for understanding failure?

26. How do you use the assessor's findings? (Please exemplify)

27. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way? – If no, why not?

28. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

29. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

30. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

31. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

9.12 Appendix 12: Interview guide Inverness TWR - SAFETY MANAGER

A) INTRODUCTION

Presentation of the aim and scope of the research project.
The purpose and structure of the interview will be explained in detail along with the informed consent form. Statements and quotes will only be used in a way which ensures anonymity and solely after receiving acceptance from the involved informants.

B) BACKGROUND INFORMATION

1. Please state your name and work position?

2. Could you briefly summarise your work experience within the field of Air Traffic Control?

C) GENERIC QUESTIONS TO ALL INFORMANTS

3. Please describe the assessment method practiced here at your unit?

4. Why the combination of dedicated check & continuous assessment?

5. Could you describe your thoughts concerning the concept of Competence Assessment?

6. What is competence to you? How would you define/describe competence?

7. Could you summarise it in 4 - 5 core competences? How is this measured?

8. **Introduce the picture "The Boxes" to the informant(s) and explain their associated implication.** If you should place your units' assessment approach/methodology in one of the boxes, which one would you choose? Please elaborate!

9. **Present and discuss the picture "The Assessment Environment" with the informant(s).** What is the purpose of the Competence Assessment? (Is it to evaluate or investigate/understand the performance of the ATCO? Is the focus placed on hunting errors or on affirming/confirming competence?)

D) SAFETY MANAGER

10. How confident are you that the Competence Assessment Scheme provides you with a representative picture of the daily operation (and thereby also safety)?

11. Do you use the Competence Assessment Scheme to assure yourself of changes in the operational environment?

12. How do you anticipate or expect the Competence Assessment Scheme to support those undergoing the change?

13. How would you describe the operational environment? (In order to determine if the view of the operational staff and management differ)

14. Is the working condition stable (mainly routine) or does it require a lot of improvisation?

15. How often do you think the controllers need to adjust, customize, compensate or adapt to a specific situation?

16. How predictable are these situations and can they prepare for them?

17. Are you aware of how and why the controllers adjust their performance?

18. Do you think they would do the same adjustment(s)/adaptation(s) during a competence assessment (dedicated check)?

19. How would you describe the correlation between Work-As-Imagined/designed and Work-As-Done?

20. Do you have a process/technique for understanding the success of everyday activity as a method for understanding failure?

21. Do you consider trade-offs (thoroughness & efficiency) to be a necessary part of assuring safe operation?

22. What contribution to lesson learning, does your competence assessment scheme make?

23. Do you consider Competence Assessment to be a viable tool in identifying the gap between practice and procedure? If yes, in what way?

24. In your experience, how do you think the ATCOs view the function of the Competence Assessment?

25. Would you say that your units chosen assessment method/philosophy is presenting the organisation with a realistic picture of normal work/ Work-As-Done? (Elaborate)

26. How do you weigh the Competence Assessment Scheme in terms of making progress on safety?

27. If you were given free hands in designing and implementing an assessment method with the purpose of collecting vital data on Work-As-Done (Performance variability, performance adjustments, adaptation and the daily trade-offs), what would this look like?

28. Do you have any additional comments or related topics you consider to be useful or relevant for my research connected to Competence Assessment?

E) CLOSING REMARKS

Would you approve that I can contact you again should I need to confirm, clarify or follow-up on the content of this interview?
Please remember that you are very welcome to contact me should you wish to include further reflections, or if you wish to deepen or remove parts of your interview!
Thank you so much for your time and willingness to participate in this interview!

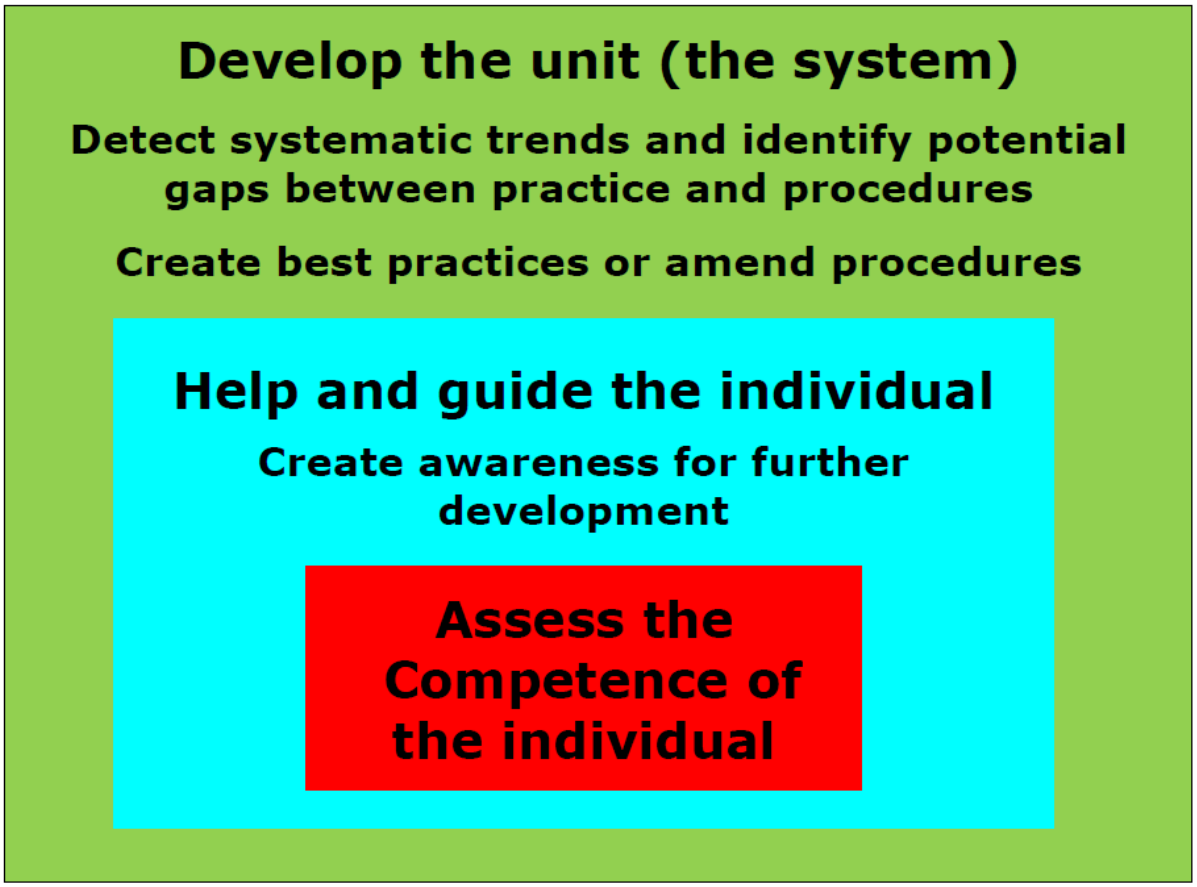
9.13 Appendix 13: The boxes

Informant Introduction:

- The red box represents the mandatory prerequisite of assessing the competence of each individual ATCO

- The blue box embodies an approach of creating awareness for further development of the individual ATCO and should be viewed as an add-on to the red box. The blue box thus symbolise a mind-set of actively increasing the ATCO's consciousness pertaining to work performance. Further development of the individual is explored even though the ATCO is assessed as competent according to the defined performance objectives laid out in the red box.

- The green box exemplifies a systemic focus which targets unit or systems specific issues. In this box the attention has shifted from an individual centred approach to a more holistic view of the functionality of the sociotechnical system itself.

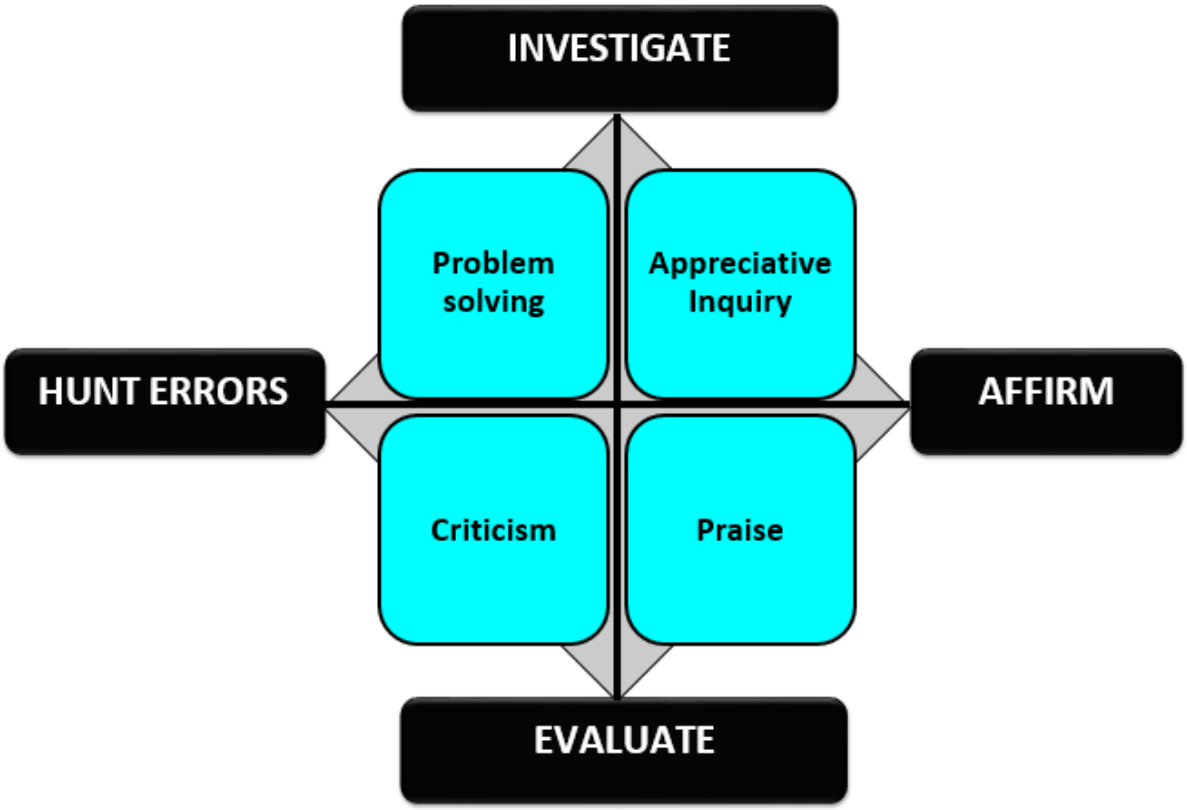


9.14 Appendix 14: The assessment environment

Informant introduction:

What is the purpose of the Competence Assessment?

- Is it to evaluate or investigate/understand the performance of the ATCO?
- Is the focus placed on hunting errors or on affirming/confirming competence?



9.15 Appendix 15: Competence – coding of data

- **Skill-based competence**
- **Knowledge-based competence**
- **Experience-based competence**
- **Adaptive competence**
- **Service-driven competence**
- **Social competence**

ATCO:

- You should know the rules regarding our air traffic and our airspace. You should know the actual rules, so you have to brief yourself every day, once or two times a week to be up to date. And you should obey the rules where it is necessary and you should know when to break a rule. Don't misunderstand me but you should know when you have to do something to adapt the rules if there is a benefit for safety
- It is competence to know and to be aware of what you are doing
- A good mix of theoretical and practical work
- Competence is not only to work safe, though safe is very important in our job. For competence it is also necessary to work in a normal speed.
- I think you have to know what you do in the job and you must have enough experience. Of course you get more and experience the longer you work. The first year is very hard. You are often afraid since you do not know how to manage difficult traffic situations. You don't have the experience and you don't really know how it works.
- I would say it is having a professional outlook, wanting to do your job to the best of your ability and ensure that you are equipped to do so, making sure you are up to date with any changes that are going on.
- Competence is the ability to do the job you have been tasked to do. Doing the job you've been trained to do. You have the books and guidelines and try to keep it as standard as possible. It's pretty obvious.
- It's the ability to use previous experience to safely manage any given situation to the best possible outcome for that situation.
- Being able to perform your job according to the prescribed rules and regulations. It is also about cooperation and teamwork (E & P), that you help each other.

  - **Core competencies;**
    - Flexibility, Professionalism, willingness to continue to learn, to adapt to changing circumstances.

- I think it is an all-round thing. You need to get on with people you work with, follow the book, be as standard as possible, and be able to be flexible if something unusual happens.
- Flexibility within a regulated framework. Knowing where the boundaries lie - pushing to the boundaries, but never exceeding them. It's knowing your job.
- Knowledgeable, good at analysing situations, decision making.

- **How to measure?**
  - By a feeling. By your knowledge of how you would work and maybe to compare it to others and how they work. I don't know how to explain it.
  - Could be useful to have someone from the outside coming in and checking once a year
  - Good question! Someone who is very experienced and who knows the game. We do need to be checked out, but how we should be checked out - I don't know!
  - It's not an empirical measurement. I don't know how you measure competency, but I know what it looks like when I see it and I know what it looks like when I don't see it.
  - As we do it today, especially with the new item - passed with remark. This can pick up recurring events or tendencies.

ASSESSORS:

- The ability to do the work in a safe and in a good way. It's hard to describe what competence is because if you ask 5 people, you get 6 answers. On one side I have the impression that competence in our unit is to work fast and expeditiously. But that doesn't necessarily mean that you are competent. Because if it's fast and expeditious it's possible that it's not safe. On the other side if someone is working according to the book, according to the rules but not fast enough, then he's incompetent because he's slowing down the whole process. It's a mixture of both. Also the personality, he has to fit into the group of the day (the shift). It's not so easy to define competence, that's the problem we have with our training system as well (where is the level?).

- An ability to demonstrate on a consistent basis the ability to undertake one's chosen role to an acceptable standard.

- It is many different parts and all are important. You have to fit in socially and be able to adapt since you work with many different colleagues. Then there are of course the theoretical part. It is important for us to see that people feel comfortable and confident while working, especially if you are working part-time. There are many new rules and the operational environment can be quite complex. And it is not just the new rules you need to keep up with, there can also be workarounds and best practices to make it smoother and this might not be written down anywhere. All this can be hard if you only work part-time.

- **Core competencies;**
  - Assertiveness, confidence, rapport, working in a team
  - Flexible, theoretical knowledgeable

- **How to measure?**
  - We do not have a definition of it, so how can we measure it! It is a feeling whether it is good or bad.
  - It almost comes to subjectiveness doesn't it, there is no figure obviously, one cannot state this in a book really or manual, it almost comes down to a gut feeling. (It is related to one's own experience). What you would do is measured against your experience and you measured against your own perception of what is an acceptable level of demonstrated ability. If you know how you would handle the situation, and at the same time relate it to the individual who may not be as experienced as you. But as long as it's still safe and that is really what you're looking for, but there comes a point where it's an overall perception of the picture they portrait.
  - We measure against the described training objectives for first validation of students. They are described in the Unit Training Plan. We have taken the main objectives and boiled it down to accommodate licensed controllers, but it is almost the same.

MANAGEMENT:

- Competence, on one side you know the procedures, you know how they work. And a social part, how to be with people, how to work in a team, react and actually being a strong part of the team (that you know the common way to work)
- I'm not looking for somebody who can reach a standard on a given day, because there is an assessor behind him. And during that time he is under pressure and he is performing to his absolutely maximum for one reason - he has to do it for this 1/2 hour period of time. I want somebody who does this every day and that I as a manager has created an environment where I have ensured that his workspace and the development I have given him, the people he works with, the equipment he uses all comes together where he can apply his skills into an ongoing day to day service that has a continuous high standard rather than peaks.
- Competency is to demonstrate the ability to perform a function in accordance with the rules and regulations. There are guidance and procedures that the controller has to work with. They have also got their training and background to interpret that information. So the competency, I suppose is to ensure that the level of service provision is consistent and meets the requirements of the legislation.
- Competence is the thing you need to have to be able to perform your duties in a professional way.
- That you are well-prepared and well-read within the required subject matters and that you can convert theory into practice.

- **Core competencies;**
  - Comfortable, reasonable self-assured, confident that the service he's providing is of the required standard to provide a safe environment.
  - R/T competence - the ability to perform the radio transmissions, To be able to interact and manage a team, be able to deal with the issues of unusual circumstances (able to interpret emergency order), being able to interact with the management of the unit and feel open and honest in relation to incident and

accident investigation (being able to provide a competent record of what happened on the day or hour in question).
    - Knowledge, Skills, Situational Awareness, Flexibility
    - Good team member. Stress tolerant. Ability to focus and concentrate during challenging scenarios. Ability to adapt.

- **How to measure?**
    - That's not easy! You can check that the colleague is doing sufficient spacing at the final and that each departure gets his requested flight level, these are hard facts! But the sense of competence is that you have to work like the whole community works that you fit together. That you're one brick in the house!
    - That is a really tricky part. In a reactive way we can measure it by the reporting of occurrences and so on. But in a proactive way it is really hard to measure. You can measure it by looking at the amount of traffic handled without occurrences. Efficiency is absolutely one part of the competencies.
    - Through how this is done today, theoretical and practical assessment.

SAFETY MANAGERS:

- To me a competent person is one who can fulfil the required tasks above the average. You will get more competent with more routine, with more experience. Competence is an ongoing process it never stops
- From an operational point of view it is acting and delivering in exactly the same way as you've been trained to do by a competent trainer.

- **Core competencies;**
    - Correct R/T phraseology, correct application of procedures, Correct R/T discipline & correct management of de-confliction minima.

- **How to measure?**
    - In my point of view, you cannot measure competence. Competence is always a judgement and there is someone who is judging if you are competent or not. The best judge to do it, is an open self-assessment. As an ATCO you should be honest enough to yourself and your colleagues if you are competent enough to work.
    - I would tend to go down the R/T sampling route or form. So how do we capture the errors, lapses whatever you want to call them? I would see a Colum by rule, those rules dictating exactly what you are looking for, where there has been some sort of error, lapse, slip - then you've got a scoring system alongside of that which gives you some sort of opportunity for trend analysis. Whether it is just a simple (- 1, 0 & + 1 or poor practice, standard practice & very good practice) then that is the sort of stuff that could be captured. And with the right sort of software you can do a trend analysis for the whole company where you can see a particular area where there are a trend or weakness and then we can do something about it.


SIGILLVM · VNIVERSITATIS · GOTHORVM · CAROLINÆ
AD VTRVMQVE
1666