

A Construction Rationale to Tailor Crew Resource Management Training to Target Audiences

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Abstract— This paper gives an overview on the first steps of a 3-year Crew Resource Management and Human Factors training project. A construction rationale consisting of a training needs assessment phase and of theory driven reflections on training design is presented. For the needs assessment, a careful choice and application of methods to gather information is vital, because this information will form the base of training design. Furthermore, a learning theory (instance-based learning theory), training methods, legal requirements and training strategies (cross training, guided team self-correction and team coordination and adaptation training) as well as their contributions to training design are described. The intention to generate a training theory and the development of a classification of training methods along the criteria knowledge, skills and attitudes and theory- or experience-based learning are presented.

Keywords: Crew Resource Management; Teamwork; Teamtraining; Human Factor; Needs Assessment; Training Theory

I. INTRODUCTION

Crew Resource Management (CRM) trainings have been utilized in civil and military aviation for more than 20 years now [1]. But although CRM training and the like, as Human Factors (HF) training in aircraft maintenance or Team Resource Management (TRM) training in air traffic control, are well established and, depending on the industry, mandatory, the topic continues to be of great relevance. Recent examples like the lucky ending crash-landing of a British Airways Boeing 777 in January 2008 at Heathrow Airport demonstrate this. CRM trainings have been defined as programs and instructional strategies to train crews to effectively use all their available resources - information, equipment and people - in order to improve safety and performance [2,1].

Although there exists a substantial amount of research in the field, [1] emphasize that "the full impact of CRM training on safety cannot yet be ascertained (p. 393)" and is still not understood. They report findings on the impact of CRM trainings on trainees' reactions, learning and attitudes, behaviors and/or its impact on the organization. Participants generally showed positive reactions towards trainings, but the results concerning learning, attitude change, transfer of behavior and organizational effects were mixed. What are the

reasons for this mixed picture? Reference [1] state amongst other reasons that firstly, trainings are *often not tailored to the target audience* and secondly, *programs are often designed by subject matter experts, who know what to teach, but not necessarily how*. Here, the knowledge of training experts is needed.

II. AIM AND RESEARCH QUESTIONS

The *aim of our work* is to tackle these deficiencies in a 3-year CRM and HF training project started in January 2008. The project is a cooperation with a training providing company in the aviation sector which is owned by an airline. It provides pilot and cabin crew training as well as training for maintenance personnel.

In this paper, we present a construction rationale for training and follow *two goals*:

1) We describe the research questions, method and preliminary results of the training needs assessment phase of our project. A sound needs assessment is the first step to well-tailored and effective training programs, as people, tasks, behaviors and the organization have to be taken into account. [3]. Our first four *questions* are:

(a) What is being done by researchers and by practitioners in the field of civil aviation and other areas where team training is conducted?

(b) What is the current practice of CRM training in our partner company?

(c) What contents, i.e. what knowledge, skills and attitudes (KSA) have so far been trained in the area of CRM? How could they be ameliorated by including behavioral descriptions that specify theoretical concepts?

(d) How tight are the legal constraints when it comes to the design of training?

2) We outline results and insights from training research literature that will guide training development on the basis of the results of the needs assessment phase. In this second phase of our project, the focus clearly lies on *how* teaching of CRM could be done. Our last three *questions* are:

(e) How can we translate a learning theory that focuses on experience-based learning into a training theory?

(f) And within this training theory, which methods/tools (lecture, case-study, role-play, exercise, simulation, video,

LOFT or behavioral role modeling) are adequate for gaining the specific required KSA and how big should be the portion of each of these methods in a CRM training?

(g) How can we combine the most successful elements of several training strategies (e.g. cross training, guided team self-correction and team coordination and adaptation training) in order to create the most efficient training intervention to train CRM?

III. PROCEDURE

At the moment, we are doing an exploratory interview study on the actual practice of CRM and similar trainings in different industrial sectors, e.g. air traffic control, military aviation (jets and helicopters), swiss army armoured corps and mechanised units, flight schools and airlines. The underlying reason is that, although numerous theoretical articles have been written about the evolution, evaluation and effectiveness of CRM trainings and empirical studies have been published, *there is very little information on what is actually done in CRM trainings by practitioners, and how trainings are planned and composed.*

In parallel, we started the needs assessment process in our partner company and already evaluate strategies for training design (see figure 1). The next section describes the methods we employ in our needs assessment stage.

IV. METHOD

The goal is to gain a clear picture on accurate, multiple photographs of the current situation [3]. The use of several different techniques helps to avoid methodological biases. In the following, we will shortly describe what techniques we mainly plan to apply to answer our research questions.

A. Best industry practice

Interviews. Our exploratory study is done in an interview study to shed some light on what is done by CRM and HF training practitioners in different companies and industry sectors. We question key informants, i.e. heads of training or responsible persons in charge of CRM in semi-structured interviews. We explicitly ask our interview partners to express their concerns of and personal attitude toward CRM. The goal of these interviews is to get an overview on models and methods and tools used in CRM trainings and on the assumptions and concerns of trainers and training developers.

This shall help us to incorporate best practice approaches, but also to avoid pitfalls that were experienced by our interview partners. First results show that practitioners are generally convinced of the importance of CRM and similar training strategies, but are confronted with several problems as well. Especially in military aviation, it is difficult to motivate trainees for CRM topics, which are often judged as "psycho-babble" or as "charm schools" [4]. This might be a result from the early days of human aspects training, where the focus was much more psychological and less applied.

B. Current practice in our partner company

Interviews. We will conduct interviews with trainers and trainees to gather information on the design and conduct of and the participation in existing CRM and HF trainings. These interviews will shed light on problems and well-working aspects of actual trainings.

Observation. To get insights into the current practice of training, we will host sessions of all trainings with CRM or HF content. The focus will be on *how* training is conducted. Ideally, those trainers will be interviewed whose sessions we host, and those trainees who participate in these sessions. This approach allows us to compare our observations with the statements from trainers and trainees.

C. Legal requirements

Document analysis. The important legal documents for training of human factors aspects are JAR-OPS and JAR-FCL (Joint Aviation Requirements, Operations/Flight Crew Licensing) [5,6] for pilots and cabin crew and Annex 2 of EASA-Part 145 [7] for maintenance staff. The different trainings that have to be conducted (e.g. introductory CRM course, annual recurrent training), their content and prescribed training elements (also called "core elements"), as well as their repetition cycle are specified. Examples of training elements are "assertiveness" for cabin crew members or "stress and stress management", "communication" and "decision-making" for both cabin crew members and pilots. *Although it seems clear what assertiveness means, it is vital for training design to define specific behaviors that are judged as "assertive".* This is part of the specifications of KSA and training requirements described below.

D. Specifications of KSA and training requirements

Literature analysis. Efforts to specify behavioral patterns within training elements have been made before by researchers as well as by airlines themselves and can be found in literature, but mainly to construct rating systems used in performance appraisal of CRM skills. The NOTECHS rating system, for example, which is the European taxonomy of pilot's non-technical skills was composed from three sources: existing rating systems, research findings reported in literature and discussion with subject matter experts [8]. However, behavioral markers used to judge performance should also be applied to construct training, because before assessing performance, the desired competencies have to be trained [9]. But information on behavioral specifications used to build training programs is less readily available.

Training needs assessment <ul style="list-style-type: none"> • Best industry practice • Current practice in our partner company • Legal requirements • Specification of KSA and training requirements
Development of a training concept <ul style="list-style-type: none"> • Special emphasis on experience-based learning • Fit of training methods and training goals • Combination of successful team training strategies

Figure 1. Intended course of action.

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Document analysis. We will analyze existing training manuals and other training material like movies, cases etc. to get an overview on how training requirements have been translated into training measures.

Interviews. We will conduct Critical Incident interviews with experienced job incumbents to adapt or derive behavioral descriptions and training objectives of training elements. Critical Incident interviews aim at gathering information on situations where CRM behavior played a crucial role. Critical incidents shall contain descriptions of the situation, the task at hand, the actions and their results.

Questionnaires. We will employ questionnaires to gather further information on the behavioral descriptions of training elements we derive from the literature analysis and the Critical Incident interviews. The questionnaire will contain behavioral descriptions like "encourages inputs and feedback from others" (example from NOTECHS; [8]). Pilots will rate these statements on three dimensions: a) importance, b) learnability of this behavior, and c) frequency with which this behavior is demanded in daily work. Our sample will consist of first officers and captains from the airline owning our partner company.

Group discussion. To synthesize the information from Critical Incident interviews and questionnaires, a choice of interview partners and questionnaire respondents will be invited for a group discussion. Group discussions allow it to share the problem and data analysis with participants. The goal will be to challenge our preliminary conclusions. We plan two sessions with ten participants each.

Preliminary results of the activities described will be presented at the doctoral symposium at ICRAT'08. But as the design of training programs is not done with the needs assessment, we also want to provide an outlook on the second phase of our project.

V. TRAINING DESIGN

The focus lies on *tailoring the contents, strategies and tools of a CRM training to the audience*. This procedure is based on the results from training research literature and our needs assessment in a previous phase of this project.

A. Legal requirements

First of all, one characteristic that has to be kept in mind when developing training is the high degree of *regulation* in the aviation industry. Demands on training prescribed by law have to be met, as trainings have to be approved by the regulatory body. As mentioned above, "Core elements" of CRM training, for example, are defined in the JAR-OPS and JAR-FCL [7,6]. These elements have to be taken into account when developing the contents. Moreover, training design must be tailored to the specifications and behavioral markers (that we will get from our needs assessment) of these elements in order to train the desired competencies. Therefore the methods and strategies described below are very essential.

B. Training theory

A superior goal will be the *transfer of a learning theory into a training theory*. This novel and innovative course of action within our study takes *experience-based learning* into account, because we have a close look at the *Instance-based*

learning theory (IBLT) that assumes five sequenced learning mechanisms within the context of dynamic decision making situations [10]. One important learning mechanism and the first one is the formation of "instances", which contain triplets of (1) the situations, (2) the decisions that have been made in these situations, and (3) the utility of these decisions. These instances are often retrieved and re-used in moments of decision-making instead of learned rules or heuristics. Therefore, it is important to give trainees the chance to gain experiences, i.e. instances, during training. Within this setting they can explore their decisions and learn from doing mistakes. Learning is terminated by a feedback update, the last learning mechanism, that helps to understand what had happened and what kind of new strategies are necessary for a successful outcome. A training theory should describe, explain and predict how learning can be enhanced with regard to defined learning objectives by using well considered methods. Our training theory for social decision making situations should devise how relevant aspects of such decision making situations could be trained most successfully by creating "instances". Simulations and role-plays for example, are of importance.

C. Training methods

Furthermore, it is also indispensable to establish a perfect fit between *training methods* and *learning outcomes* [9], in order to achieve the intended goal of a CRM training (e.g. error prevention, decision making, coordination, leadership). The methods and tools used in trainings must be tailored to the tasks and competencies of the trained team to enhance teamwork [11,12]. Competencies combine different KSA necessary to succeed in an organization [13]. A lot of methods like lecture, video based demonstration and practice are declared to be effective in enhancing teamwork [11]. Reference [9] developed a classification if a method supports knowledge (e.g. how to communicate), skill (e.g. giving feedback or being assertive) and/or attitude (e.g. valuing my crews comments). According to these distinctions and the fact that learning can be theory- and experience-based, we *developed a classification*: Methods are differently categorized whether they enhance knowledge, skill and/or attitude and whether they are theory- or experience-based (see table 1). Lecture, lesson, case study, exercise and Line Oriented Flight Training (LOFT) are supposed to enhance knowledge. Skills should be developed through role-play, exercise and LOFT and these three methods plus case study and videos are supposed to alter attitude. Moreover, simulators are often used to facilitate technical/task related and team related competencies in order to reduce human failure and accidents [14].

TABLE I: CLASSIFICATION OF TRAINING METHODS

	<i>Knowledge</i>	<i>Skill</i>	<i>Attitude</i>
<i>Experience-based learning</i>	exercise, LOFT, simulation	role-play, exercise, LOFT, simulation	role-play, exercise, LOFT, simulation
<i>Theoretical-based learning</i>	lecture, lesson, case-study	behavioral role modeling	case-study, video

Using simulators supports error learning and developing shared mental models among team members with different tasks and duties. We suppose that simulation enhances knowledge, skill and attitude during experience-based learning. Behavioral role-modeling is also a method that leads to significant performance and behavior improvement in trained teams [15], but a match between the behavior model, the role play and the real work situation must exist. This method is supposed to alter skills during experience-based learning. If an indented goal of the CRM training would be just to know, for example, how to lead, the selection of the method would be a different one as compared to the goal that the trainee should be able to show a trained behavior (e.g. being assertive at work).

D. Training interventions

Within a training intervention, methods will be applied and, if suitable, combined. Two team training strategies that showed promising results in enhancing team performance are, for example, *Guided Team Self-Correction* or *Cross-Training*. The first strategy focuses on the leader, who helps the team in diagnosing and solving problems whereas the second one enables team members to use more efficient communication and coordination strategies and to built up shared mental models [16]. A third successful team training strategy is called *Team Coordination and Adaptation Training* [17]. Here, team members learn to improve team work during periods of high stress by anticipating and discussing potential challenges during low-workload periods.

VI. CONCLUDING REMARKS

A lot of research on CRM trainings has been done before [11,18,1], but results show several limitations: Training studies don't report evaluations on all necessary levels (reaction, learning/attitude, behavior, organization) and don't specify what was done in training interventions. Furthermore, a significant amount of research was conducted within the military aviation context. These factors hinder generalization and application of results for teams in other contexts outside (military) aviation. The goal of our project is to detect mechanisms responsible for the success of CRM trainings within civil aviation. By developing training based on a sound needs assessment and on insights from theory and research and by evaluating implemented training measures, we want to contribute to the research field and enable a transfer of the findings to other fields of application outside aviation.

REFERENCES

- [1] E. Salas, K. A. Wilson, C. S. Burke and D. C. Wightman, "Does crew resource management work? An update, an extension, and some critical needs," *Hum Factors*, vol. 48, pp. 392-412, 2006.
- [2] R. L. Helmreich and H. C. Foushee, "Why crew resource management? Empirical and theoretical bases of human factors training in aviation," in *Cockpit Resource Management*, E. L. Wiener, B. G. Kanki and R. L. Helmreich, Eds. San Diego: Academic Press, 1993, pp. 3-45.
- [3] I. L. Goldstein, *Training in Organizations*, 3rd ed. Pacific Grove: Brooks/Cole, 1993.
- [4] R. L. Helmreich, A. C. Merritt and J. A. Wilhelm, "The evolution of crew resource management training in commercial aviation," *Int J Aviat Psychol*, vol. 9, pp. 19-32, 1999.
- [5] Joint Aviation Authorities (JAA), "JAR-FCL (Aeroplane)," Colorado: Global Engineering Documents, 2006.
- [6] Joint Aviation Authorities (JAA), "JAR-OPS 1," Colorado: Global Engineering Documents, 2007.
- [7] European Aviation Safety Agency (EASA), "Regulation (EC) 2042/2003 Annex II-Part 145," http://www.easa.eu.int/doc/Regulation/reg_2042_2003_Part145.pdf, (2003)
- [8] R. Flin, L. Martin, K. M. Goeters, H. J. Hörman, R. Amalberti, C. Valot and H. Nijhuis, "Development of the NOTECHS (non-technical skills) system for assessing pilots' CRM skills," in *Contemporary issues in human factors and aviation safety*, D. Harris and H. C. Muir, Eds. Aldershot: Ashgate, 2005, pp. 133-154.
- [9] N. MacLeod, *Building safe systems in aviation: A CRM developer's handbook*. Aldershot: Ashgate, 2005.
- [10] C. Gonzales, J. F. Lerch and Ch. Lebiere, "Instance-based learning in dynamic decision making," *Cognitive Sci*, vol. 27, pp. 591-635, 2003.
- [11] R. J. Stout, E. Salas and J. E. Fowlkes, "Enhancing teamwork in complex environments through team training," *Group Dynam*, vol. 1, pp. 169-182, 1997.
- [12] C. R. Paris, E. Salas and J. A. Cannon-Bowers, "Teamwork in multi-person systems: a review and analysis," *Ergonomics*, vol. 43, pp. 1052-1075, 2000.
- [13] I. Goldstein and J.K. Ford, *Training in organizations*, 4th ed. Belmont: Wadsworth, 2002
- [14] K. Sonntag and R. Stegmaier, *Arbeitsorientiertes Lernen*. Stuttgart: Kohlhammer GmbH, 2007.
- [15] K. Sonntag and N. Schaper, "Förderung beruflicher Handlungskompetenz," in *Personalentwicklung in Organisationen*, K. Sonntag, Eds. Göttingen: Hogrefe Verlag, 2006, pp. 270-297
- [16] J. A. Cannon-Bowers and E. Salas, "Team performance and training in complex environments: recent findings from applied research," *Curr Dir Psychol Sci*, vol. 7, pp. 83-87, June 1998.
- [17] E. Salas, D. R. Nichols and J. E. Driskell, "Testing three team training strategies in intact teams: a meta analysis," *Small Gr Res*, vol. 38, pp. 471-488, Aug 2007.
- [18] B. B. Morgan, E. Salas and A. S. Glickman, "An analysis of team evolution and maturation," *J Gen Psychol*, vol. 120, pp. 277-291, July 1993.