CHAPTER 1

Getting on the same page: team cognition and team learning in emergency management command-and-control teams

An introduction

Around 10.30 in the morning on February 25, 2009, Turkish Airlines passenger flight TK 1951 crashed during landing at Amsterdam Schiphol Airport, the Netherlands. The plane was cleared for an approach to a runway at Schiphol Airport, but came down short of the runway threshold, sliding through the wet clay of a plowed field. The aircraft broke into three pieces, both engines separated, but the wreckage did not catch fire. The cause was a combination of a technical error (a faulty radio altimeter influencing the autopilot) and a human one (a failure to notice the incorrect altitude measures caused by the broken instrument on time and to take the correct actions). The plane was under the command of one of the airline's most experienced senior pilots. There were 128 passengers and seven crew members on board. Nine of them died, including all three pilots and a stewardess and dozens got severely injured.[1]

The coordinated help of the fire department, the police and the medical assistance unit was required, as well as, among others, the government, the airport rescue service and the (local) hospitals. Approximately 750 people were involved in the assistance. The emergency management was organized in an up scaled structure, referred to as GRIP 3, in which a policy team (responsible for strategic issues such as the communication with the media and Turkish Airlines), an operational team (OT, responsible for managing the effects of the incident outside of the scene of the incident itself, such as the division of victims over different hospitals and the communication with the family of the passengers), and an on-scene-command-team *(OSCT) collectively managed the emergency response.*

The OSCT has the responsibility to coordinate the required multidisciplinary cooperation at the scene. Tasks[2] *for the different disciplines at the scene of the airplane crash were, for instance, exploring the situation on the scene (e.g. victims, fire, dangers, number of assisting civilians; all disciplines), identifying a safe location ("gewondennnest") for the victims to be initially transported to (police), exploring the number of victims that were stuck in the plane (eight in total of whom one already died; fire department) and freeing them (five out of eight victims survived; fire department and medical assistance unit), triage of victims, meaning the structured classification of victims according to the severity of the injury and immediate need for medical assistance (ambulances), assisting victims to get to the safe victim location (ambulances), medical treatment of victims at the scene (ambulances), and registration of the victims (government).*

[1] Source: "Poldercrash 25 February 2009. An investigation by the Inspection of Public Order and Safety, in cooperation with the Inspection of Public Health Care" (July 17, 2009); original Dutch version: "Poldercrash 25 februari 2009. Een onderzoek door de Inspectie Openbare Orde en Veiligheid, in samenwerking met de Inspectie voor de Gezondheidszorg".

[2] Source: "Emergency assistance after airplane crash Turkish Airlines, Haarlemmermeer. February 25, 2009"; original Dutch version: "Hulpverlening na vliegtuigongeval Turkish Airlines, Haarlemmermeer. 25 februari 2009 (2010). Onderzoeksraad voor de Veiligheid.

1. Emergency management command-and-control teams

At the scene of an incident, such as the airplane crash described above, assistance units of different disciplines are present: the fire department, the police, the medical assistance unit, the government, and possibly other disciplines or organizations that are relevant depending on the character of the incident. Each assistance unit has specific expertise and experience and is therefore capable of conducting different types of tasks. Together with the command-and-control teams (e.g. policy team, operational team, and on-scene-command-team) they are a multi team system: "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals" (Marks, Mathieu, & Zaccaro, 2001, p. 290).

As a typical example of an emergency management command-and-control team, this dissertation focuses on the on-scene-command-team (OSCT) working at the scene of the incident. A team can be defined as a distinguishable set of two or more people that interact dynamically, interdependently, and adaptively toward a common and valued goal/object/mission, with a specific role or function to perform and a limited life span of membership (Salas, Dickinson, Converse, & Tannenbaum, 1992). In general, a command-and-control team consists of individuals with high levels of skills and abilities, who are specialized in their respective duties and who come together for the duration of a specific task to work interdependently toward a common valued goal (Salas, Burke, & Samman, 2001).

The task of the OSCT is to organize and coordinate the multidisciplinary assistance at the scene (Salas, et al., 2001). This is a so-called intellectual task (Devine, 2002) because it requires decision-making about required actions by collecting and integrating information from a variety of sources. Concerning its composition, the OSCT can be typified as a multidisciplinary ad hoc team: each team member represents an assistance unit (e.g. fire department, police, medical assistance) and the team is composed of the people on call. The team members may or may not have cooperated before. The members are thus diverse in expertise, experience, parent organization, and familiarity.

Because it operates in a turbulent environment and under considerable time pressure, the OSCT has a dynamic nature (Ilgen, Hollenbeck, Johnson, & Jundt 2005; Kozlowski & Klein, 2000; Marks, et al., 2001). In line with the team development model of Marks and colleagues (2001), the OSCT experiences repeating cycles of action and transition phases. During action phases, each OSCT member works in his or her own mono disciplinary unit at the scene executing the collective decisions on the required actions and collecting the discipline-specific information about the incident needed for further multidisciplinary coordination. During transition phases, the OSCT members have meetings in which they share information, assess the current situation, and plan and decide upon which actions to take in the next step (Salas, et al., 2001).

As to the desired team outcome, the emergency management team should function as a high reliability team which consistently, effectively, and interdependently works towards a shared goal in a complex and dynamic environment while working under high levels of stress (Wilson, Burke, Priest, & Salas 2005). Reliability here refers to the final goal of achieving crisis control, with low error rates and high workplace safety (Baker, Day, & Salas, 2006; Wilson, et al., 2005).

2. Team cognition

To be able to deal with the unique emergency situation, the multidisciplinary OSCT faces the challenge of integrating the different expertise, experiences, and values present in the team. Research indicates that this is not just a matter of putting people with relevant knowledge together, since not all teams are able to benefit from this diversity (Jehn, Greer, & Rupert, 2008). In this respect, the capability of creating a mutual understanding among the team members is considered to be crucial (Salas & Fiore, 2004; Salas, Cooke, & Rosen, 2008). Teams need a shared understanding of the problem at hand and of the best way to solve it. This shared understanding is also referred to as team cognition, an emergent structure in which the knowledge important to team functioning is mentally organized, represented, and distributed within the team (Kozlowski & Ilgen, 2006).

In this context, we investigate the value of the team situation model (TSM) which is the dynamic and continuously changing understanding of the momentary situation (Canon-Bowers, Salas, & Blickensderfer, 1999; Cooke, Stout, & Salas, 1997; Cooke, Salas, Cannon-Bowers, & Stout, 2000). This dynamic team cognition structure is valuable for the OSCT, since it tries to capture the inevitable and continuous change in the emergency situation and the forthcoming task. While ample team cognition research has investigated the more long-term structures of the team mental model (collectively owned long-term knowledge which team members have developed during former team training, earlier experiences, or team discussions, and bring to the situation; Mohammed, Ferzandi, & Hamilton, 2010) and the transactive memory system (the extent to which the team members have a shared awareness of who knows what and form a group information-processing system; Kozlowski & Ilgen, 2006), so far only a few studies have addressed the dynamic nature of team cognition by studying the team situation model and its value for team effectiveness (e.g. Cooke, Kiekel, & Helm, 2001) .

Moreover, team cognition research so far has merely focused on work teams (Cooke, Salas, Kiekel, & Bell, 2004). Examples are military combat teams (Lim & Klein, 2006), air traffic controllers directing air planes in the tower (Smith-Jentsch, Mathieu, & Kraiger, 2005), and students performing a research task as a study assignment (Peterson, Mitchell, Thompson, & Burr, 2000). Studying dynamic team cognition in emergency management command-and-control teams, with the OSCT as one typical example,

enables us to cross-validate former team cognition research in the setting of a different team type.

3. Team learning

During the emergency management process, the OSCT members collectively develop new insights and knowledge concerning the present crisis. Moynihan (2009) refers to this process as intra-crisis learning. The results of this learning process are stored in the team situation model (TSM). Former research (e.g. Van den Bossche, Gijselaers, Segers, & Kirschner, 2006; Van den Bossche, Gijselaers, Segers, Woltjer, & Kirschner, 2011) revealed that a shared understanding, such as the TSM, can be seen as an outcome of team learning processes. Team learning is a dynamic behavioral process of interaction and exchange among team members (Kozlowski & Ilgen, 2006) and consists of a compilation of team-level processes that generate change or improvement for teams, team members, organizations, etc. (Decuyper, Dochy, & Van den Bossche, 2010). In the case of the OSCT, this change concerns the collective knowledge about the emergency situation and required actions that is stored in the TSM.

Van den Bossche and colleagues (2006, 2011) found that the team learning process of *co-construction* (the team members share the facts that they know and ideas that they have and together build meaning by refining, further developing, or modifying the original input, leading to mutual understanding; Van den Bossche, et al., 2006) facilitates the exchange of information and ideas. In addition, the process of *constructive conflict* (the negotiation of differences in interpretation between team members by arguments and argumentations; Van den Bossche, et al., 2006) is required to develop actual agreement among team members (Van den Bossche, et al., 2006, 2011). Especially this capability of being critical towards each other's contributions and the collective process is important for developing a shared understanding (Blicksenderfer, Cannon-Bowers, & Salas, 1997; Bolstad & Endsley, 1999; Van den Bossche, et al., 2011).

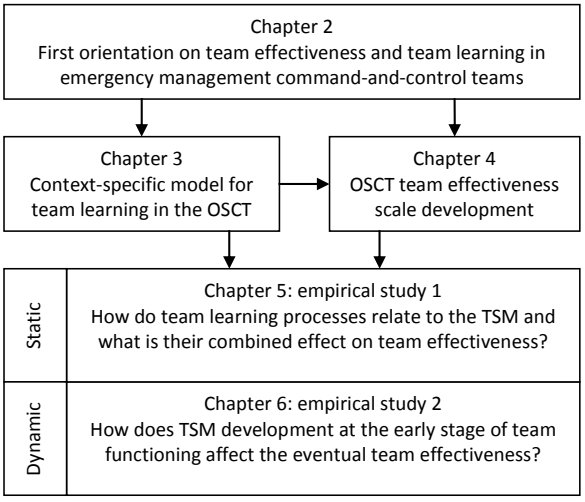
Up until now, studies on the relation between team learning and shared understanding were mainly conducted with student teams (e.g. Van den Bossche, et al., 2006; Van den Bossche, et al., 2011). The question is whether these findings can be generalized to other team types as well. With our research, we intend to confirm these findings in the applied setting of emergency management command-and-control teams.

4. Overview of the dissertation and research questions

The main research question of this dissertation is how the members of the OSCT, while working under time pressure, manage to get on the same page (i.e. create a team situation model [TSM]) concerning what is going on and what needs to be done, using team learning processes. The first aim of this dissertation is to improve the understanding of

the concept of intra-crisis learning (Moynihan, 2009) by developing a team learning model for the OSCT. Doing so, we intend to explore the relevance of a context specific approach of team learning in addition to general team learning models. The second aim is to unravel the relation between team learning processes (co-construction and constructive conflict, Van den Bossche, et al., 2006) and the TSM and how the TSM influences team effectiveness in the context of the OSCT. Third, we aim to further the understanding of how the TSM evolves over time and how this evolution influences team effectiveness. With these three aims as our starting point, we address different research questions in the chapters of this dissertation, which we will describe briefly below. A schematic overview of this dissertation, including the foci of the chapters, is displayed in Figure 1.

Figure 1. Overview of this dissertation



Chapter 2: Towards a model for team learning in multidisciplinary emergency management command-and-control teams. This chapter is a first orientation of team learning in the context of emergency management. What does it mean to perform in a reliable way as an emergency management command-and-control team and how can learning be described in such teams according to the team learning literature? By answering these questions we develop a broad model of how team learning occurs in emergency management command-and-control teams. We use the so called operational team (OT) as an illustration and we merely focus on the team characteristics that follow from the team composition's ad hoc and multidisciplinary nature.

In this chapter we state that reliable and effective performance in emergency management command-and-control teams such as the OT requires connectivity (i.e. available knowledge and opinions are shared using communication, leading to shared visions and intentions). We will further specify the concept of connectivity in terms of team

cognition in the following chapters. In this chapter we argue that a team can establish connectivity (team cognition) by using team learning processes and face-to-face-communication, and by developing a transactive memory system (TMS), shared situation awareness, team (or shared) mental models of the task and team, and a model for how to cooperate in the team. We suggest that these different concepts and how they are interrelated are valuable for understanding emergency management command-and-control teams.

However, this first orientation reveals that the literature about team cognition is a sort of Tower of Babylon; different concepts are used to describe comparable phenomena such as shared mental models, team mental models, shared situation awareness, transactive memory system, and team situation models. Based on further readings, we have decided to focus our studies in this dissertation to the dynamic character of the knowledge needed by emergency management command-and-control teams. In the following chapters we study the emergence of the team situation model (TSM), a team cognition structure which acknowledges this change of knowledge over time.

Chapter 3: Towards a contextualized model of team learning processes and outcomes. In chapter 3 we further refine the orientation we started in chapter 2 and build a contextualized team learning model. How do team learning processes and team cognition structures emerge in emergency management command-and-control teams? We focus on the composition as well as the task of emergency management command-and-control teams. Since the on-scene-command-team (OSCT) operates at any incident that requires multidisciplinary assistance, while the operational team (OT) is only activated if there is an effect area broader than the incident scene itself, we focus on the OSCT as one particular example of emergency management teams. Furthermore , since the OSCT operates at the scene the effect of its actions is more directly linked with the eventual results of the emergency response. We keep the focus on the OSCT in the other chapters as well.

Existing review studies on team learning present integrated models suggesting general applicability to any team type. In this conceptual chapter we argue that team learning is context-specific. We develop a context-specific team learning model distinguishing team learning processes and team learning outcomes used in different stages during a team's life. We focus on the emergency management command-and-control team and, more specifically, on the multidisciplinary on-scene-command-team (OSCT) which operates at the scene of an incident. This model can fuel future research on team learning in such teams, support the development of tools to evaluate these teams, and fuel training programs that increase the quality of their interventions. Moreover, if the work structure to develop a context specific model we used is applied to other team types working in different professional fields as well, we can unravel which team learning elements are present in any team type and which elements are variable depending on team characteristics.

Chapter 4: Measuring the team effectiveness of emergency management command-and-control teams: Scale development and validation. In this chapter we describe the team effectiveness measurement scale that we developed for emergency management command-and-control teams. We validated the scale addressing internal consistency, convergent validity, discriminant validity and participant-external rater invariance. We use this scale in the empirical studies (chapter 5 and 6) we conducted on team learning and team cognition in the OSCT. The scale will assist future research in further increasing our understanding of emergency management, relevant for both emergency management command-and-control teams and other people involved with emergency incidents. This scale can also have value for the evaluation of actual incidents and emergency management exercises.

Chapter 5: Investigating the relation between team learning and the team situation model. In an applied setting of the emergency management on-scene-command-team (OSCT) we study the relation between the team learning processes of co-construction and constructive conflict and the team situation model (TSM, i.e. a shared understanding in the OSCT of which emergency management processes to continue or initiate at the scene) as well as how this relation, in turn, influences team effectiveness in terms of the quality of actions, goal achievement, and error rate. The study includes 47 realistic OSCTs performing an emergency management exercise. We employ a multi-rater approach including team members, researchers, and field experts.

Chapter 6: Evolving team cognition: The impact of early development of team situation models on team effectiveness. In this study, including 32 realistic on-scene-command teams (OSCTs), we investigate how the early development of team situation models (TSM, i.e. a shared understanding in the OSCT of which emergency management processes to continue or initiate at the scene) influences the final team effectiveness. We use both an inter-team longitudinal approach that examines the relative change of TSMs at the sample level and an intra-team longitudinal approach that examines TSM development at the level of individual teams.

Chapter 7: General discussion. In this chapter we conclude with a brief summary of the research described in this dissertation. We discuss how the findings contribute to understanding the relation between team learning and team cognition in the context of emergency management, and, thus, of intra-crisis learning. In addition, we elaborate on the theoretical implications of our findings and directions for future research, and we also outline the limitations of our studies. We conclude with practical implications for multidisciplinary ad hoc emergency management command-and-control teams.

Note:
This dissertation is not a book in the traditional sense, but a collection of highly related articles which are either published/in press or under review. Since every chapter is written to be read on its own, repetitions and overlap across chapters is inevitable.