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Pioneering with UAVs at the battlefield: The influence of organizational design on self-organization and the emergence of safety

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This paper aims to investigate how the ad-hoc and temporary way in which Dutch expeditionary military organizations are designed influenced self-organization and the emergence of safety of UAV operations in Uruzgan. This is done by means of a qualitative case study for which in-depth interviews with operators of the UAV unit within the Task Force Uruzgan were conducted. The analysis shows that developing safe operations depended largely on "self-designing" operators. It is also shown that aspects of Task Force design hindered self-organization and emergence of safety substantially. As a result Task Force design had significant safety consequences for both UAV operations and the operations of Task Force Uruzgan. These findings are used to reflect on contemporary safety management concepts and practices such as "resilience", "percolation" and safety management systems.

1. Introduction

> *"It was like the Wild West out there. We could not reach other aircraft. We could not inform Apaches on our location, we were unable to contact anyone. We could have had a thousand near-misses"*
>
> [Captain, Royal Netherlands Army]

The Army Captain quoted above was a commanding officer of a unit that flew with Unmanned Aerial Vehicles, or UAVs, within Task Force Uruzgan (TFU) during military missions in Afghanistan between 2006 and 2010. His quote reveals that during these missions in Uruzgan, his unit may have had countless near misses with other, friendly, flying units such as Dutch Apache helicopters. The possibility of countless near misses between UAVs and other units within Task Force Uruzgan clearly indicates that – at least for UAV operations – safety failed to emerge within TFU.

Defining safety as an *emergent* phenomenon (e.g., Dekker et al., 2011; Leveson, 2002) implicates that instead of being a property of individual system components, system safety ("order") is developed out of "chaos" by means of interaction and "self-organizatio n" (e.g., Kauffman, 1993). For organizations, this could be translated into the idea that safety is developed by interacting operators doing everyday normal work (e.g., Dekker, 2004). If safety can be interpreted as a phenomenon that depends on self-organizing activities of operators, dynamically complex environments challenge safe operations in particular (cf. Senge, 1992). As Woods et al. (2010, p. 13) have argued: "the enemy of safety is complexity". However, not merely environmental complexity can challenge the self-organizing activities of operators. It can be interpreted that the Army Captain quoted above does not refer to complexity of the Uruzgan mission area as being problematic. Instead his unit seems to have suffered from internal problems within TFU. With regard to these internal problems, it is well established in organization science that an organization's structural design influences both the type and amount of problems operators experience (e.g., De Sitter, 2000). Also, Perrow (1984) has shown that structural "tight coupling" increases the potential for so-called Normal Accidents. Furthermore, Kramer (2007) argues that such "tight coupling" negatively impact operators' ability to operate insightfully. Therefore, if safety depends on self-organizing activities of operators, then an organization's structural design can be regarded as a crucial factor in determining whether self-organization eventually results in emergence of safety.

With regard to organizational design of Dutch military Task Forces, a salient characteristic is that they are temporarily assembled out of "building blocks" from Army and Air Force "parent" organizations (Kramer, 2007; De Waard and Kramer, 2008). This design strategy is referred to in this paper as "expeditionary organizing". Due to this rather ad-hoc design strategy, military units

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within TFU were working in organizational configurations in which they did not work or train before (Kramer et al., 2012). For the UAV unit introduced above, this poses the question how safety was developed by means of self-organization and how this process was influenced by the ad-hoc way in which TFU was designed.

Therefore, the goal of this paper is to investigate how expeditionary organizing influenced the ability of the UAV unit's operators to develop safety of their operations within TFU. This contributes to safety literature because, although a "normal work" perspective is advocated frequently (e.g., Dekker, 2004; Dekker et al., 2011), case study research on such "normal operations" is scarce and, as Bourrier (2010, 2011) states, needs encouragement. In particular the paper contributes to safety literature by conducting such "normal work" research in an ad-hoc expeditionary organizational context. Subsequently, the paper is divided into several sections. Firstly, the relationship between expeditionary organizing and the emergence of safety is explicated in more detail. Secondly, the methodology is presented with which the study is carried out. Thirdly, the results are presented. Fourthly, the analysis is detailed. Fifthly, the reflection is explicated that stresses the relevance of the results for contemporary safety management concepts and practice. Finally, the conclusion is presented.

The next section presents a more detailed perspective on the relationship between organizational design and safety is presented.

2. Expeditionary organizing, self-organization and the emergence of safety

In this section the relationships between expeditionary organizing, self-organization and safety are explicated in more detail. In order to do so, this section aims to build on work of Snook (2000), who conducted an in-depth organizational analysis of a friendly fire incident during operation "provide comfort" in 1994.

Snook (2000) has shown that US Task Force design had implications for safety as he related some aspects of its design to a friendly fire incident between two F15 US Air Force fighter jets and two US Army Black Hawk helicopters. His analysis is relevant for the analysis in this paper because as De Waard and Kramer (2008) point out, the Dutch military employs a similar strategy as the strategy the US military uses to assemble its Task Forces. In his analysis of a friendly fire incident, Snook (2000) states: "Task Forces are designed by taking basic unit building blocks and assembling them along hierarchical lines consistent with the demands of the mission and time-honored military traditions of command and control" (2000, p. 33). Based on work by Lawrence and Lorch, Snook uses an interpretation of "division of labor" to show that *differentiation* between units in the US military parent organization resulted in the need for complex *integration* at the battlefield. This hindered local self-organization of operators because, according to Snook, "ongoing interdependent sequences were no longer assembled into sensible sequence" (2000, p. 212). In this way expeditionary organizing can be related to safety. That is to say, differentiation hindered normal work of operators in such a way that it resulted in a Task Force in which the emergence safety was problematic.

In addition to the concepts of differentiation and integration, the Dutch Integral Organizational Renewal approach (IOR; e.g., De Sitter, 2000; Kuipers et al., 2010; Van Eijnatten and Van der Zwaan, 1998) provides a detailed perspective on organizational design, its influence on the type and amount of internal problems and the ability of the organization to deal with environmental complexity. In order to do so, De Sitter defines organizational structure as *the way activities are grouped and coupled to workstations*. Next, De Sitter (e.g., De Sitter et al., 1997) distinguishes between a *production structure* and a *control structure*. The production structure refers to the way performance, or executive, activities are grouped and coupled in an organization's primary process. Control structure, refers to the way control activities, such as measuring, evaluating and adjusting, are grouped and coupled to controlling workstation (i.e. design of control loops). De Sitter (2000) argues that it depends on characteristics of the organization's production structure whether individual efforts of operators eventually result in an organization that is able to develop deal with environmental complexity successfully. For example, classic bureaucratic (production) structures are characterized by "functional concentration". This means that each activity of an organization's primary process is grouped at a separate workstation, which results in reduced autonomy and process oversight at individual workstations, which hinders the ability of operators to solve the varying flow of unknown problems that result from operating in a dynamic complex environment. Also, functional concentration increased the need for coordination, which results in extensive coupling of workstations. According to IOR, this hinders self-organizing abilities of operators because interaction patterns quite often become too complex and incomprehensible for operators at low hierarchical levels of the organization.

It has to be emphasized, however, that the concepts of the Dutch IOR approach are not specifically tailored to temporary, ad-hoc, military Task Forces. Instead, it is mainly aimed at transforming standard bureaucratic organizations into more flexible ones. Nevertheless, it is argued that, combined with Snook's concepts, IOR can be used to investigate the influence of structural design on self-organization in a military Task Force context because of the abstract nature of its concepts. Before the method is presented in which it will be explicated in more detail how the concepts presented in this section will be employed in the analysis of the case, the next section will present background information on the UAV unit, the 107th Aerial Systems Battery, and Task Force Uruzgan.

3. Background information on the 107th Aerial Systems Battery and Task Force Uruzgan

Within the Royal Dutch Army, the 107th Aerial Systems Battery (107 ASBt) is a unit of about 100 soldiers that operates with Unmanned Aerial Vehicles. From 1996 until 2010, they operated with Sagem's Sperwer UAV. A Sperwer is a so-called Short Range Tactical UAV. This means that the UAV is able to gather tactical information with a maximum range of approximately 90 km. For gathering such information the Sperwer is equipped with a camera that can record both at daytime and at night. The camera is able to record in black and white only. The UAV does not have any weapons. Depending on the local circumstances, it is able to operate at a maximum height of 15,000 feet. The Sperwer UAV is 3.5 m in length and has a wingspan of 4.1 m. It is propelled by a two-stroke petrol engine and is capable of carrying fuel for a four-hour flight. Next to the airframes, a Sperwer "system" consists of a Ground Control Center (GCC), a Ground Data Terminal (GDT) and a launching platform (LANS). During the operations of 107 ASBt in Uruzgan, a Report and Analysis Center (RAC) was also part of the Sperwer "system".

To get a Sperwer UAV in the air, a specific sequence of activities is required (Moorkamp et al., 2014a; see Fig. 1). Firstly, the UAV has to be maintained according to strict aviation rules. Next, the assembly crew prepares the aircraft for flight by filling the aircraft with fuel and carrying out pre-flight checks. After that, the aircraft is put on a launching device, with the size of a large truck, and the launching crew has – among other things – to make sure the aircraft is launched with a certain velocity. After that, the operating crew in the Ground Control Center navigates the aircraft during its operations. When the assignment is complete, the UAV lands

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